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Utilizing telecommunications/ information and communication technologies for disaster risk reduction and management




Output Report on ITU-D Question 5/2

Utilizing telecommunications/ information and communication technologies for disaster risk reduction and management

Study period 2018-2021

Utilizing telecommunications/information and communication technologies for disaster risk reduction and management: Output Report on ITU-D Question 5/2 for the study period 2018-2021

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The study groups of the ITU Telecommunication Development Sector (ITU-D) provide a neutral platform where experts from governments, industry, telecommunication organizations and academia from around the world gather to produce practical tools and resources to address development issues. To that end, the two ITU-D study groups are responsible for developing reports, guidelines and recommendations based on input received from the membership. Questions for study are decided every four years at the World Telecommunication Development Conference (WTDC). The ITU membership, assembled at WTDC-17 in Buenos Aires in October 2017, agreed that for the period 2018-2021, Study Group 2 would deal with seven Questions within the overall scope of "Information and communication technology services and applications for the promotion of sustainable development."

This report was prepared in response to Question 5/2: **Utilizing telecommunications /information and communication technologies for disaster risk reduction and management** under the overall guidance and coordination of the management team of ITU-D Study Group 2 led by Mr Ahmad Reza Sharafat (Islamic Republic of Iran), as Chairman, supported by the following Vice-Chairmen: Mr Nasser Al Marzouqi (United Arab Emirates)(resigned in 2018); Mr Abdelaziz Alzarooni (United Arab Emirates); Mr Filipe Miguel Antunes Batista (Portugal)(resigned in 2019); Ms Nora Abdalla Hassan Basher (Sudan); Ms Maria Bolshakova (Russian Federation); Ms Celina Delgado Castellón (Nicaragua); Mr Yakov Gass (Russian Federation)(resigned in 2020); Mr Ananda Raj Khanal (Republic of Nepal); Mr Roland Yaw Kudozia (Ghana); Mr Tolibjon Oltinovich Mirzakulov (Uzbekistan); Ms Alina Modan (Romania); Mr Henry Chukwudumeme Nkemadu (Nigeria); Ms Ke Wang (China); and Mr Dominique Würges (France).

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Table of contents

List of figures and tables

Figures

Tables

Executive summary

Study Group 2 of the ITU Telecommunication Development Sector (ITU-D) is pleased to share the final report on Question 5/2 ("Utilizing telecommunications/information and communication technologies for disaster risk reduction and management"). The report is based on the contributions of, and interactive discussions between, Member States and Sector Members during the study period 2018–2021. It provides an overview of the telecommunications/information and communication technologies (ICTs) used for disaster risk reduction and management and describes a range of technologies and policy case studies presented by administrations and organizations regarding the use of ICTs during all disaster phases.

Disasters, whether natural or man-made, can have an incredibly adverse impact on societies, disrupting the normal functioning of social and economic life. The authorities and people must react immediately to help those affected and to re-establish acceptable thresholds of well-being and life opportunities. The combination of hazards, vulnerability and inability to reduce the potential negative consequences of risk can be catastrophic. Because many disasters cannot be predicted, preparedness and disaster risk management are crucial for saving lives and protecting property. It is also important to give some thought to risk management (i.e. damage mitigation, damage preparedness and early warning/prediction) before disaster strikes. Effective planning and preparedness can and do save lives.

Telecommunications and ICTs play a pivotal role in disaster prevention, mitigation and management. Effective disaster management requires timely and effective sharing of information between various stakeholders, and ICTs are essential for that purpose. They are a source of support in all phases of disasters, including prediction and early warning. Indeed, effective risk reduction techniques have been observed worldwide significantly to reduce the loss of lives and property when disaster strikes.

During the 2018–2021 study period, the deliberations on Question 5/2 focused on the use of telecommunications/ICTs for disaster risk reduction and management. Effective policies play an essential role in the overall design and implementation of national emergency telecommunication plans (NETPs). Accordingly, the policy and regulatory environment should be devised to enable and facilitate effective preparedness and response. Policies should exist for the deployment of emergency communication systems, for early warning, for communication continuity and for more effective responses. They should be designed bearing in mind communication accessibility, and should therefore be inclusive, covering all strata of society. Thanks to their rapid development, new technologies, particularly the Internet of Things (IoT), machine-to-machine (M2M) communication and artificial intelligence (AI), have been facilitating work during all phases of disaster – and will continue to do so. This makes it important to keep abreast of the latest developments in disaster communication technologies, which are covered in one of the chapters of this report.

Early-warning systems play a crucial role in informing people about impending disasters and should therefore be deployed in disaster-prone areas. Effective information transmission and dissemination are important before, during and after a disaster. A workshop on early-warning systems held during the study period received many good inputs on the topic, which is therefore the subject of a chapter in this report.

Disaster preparedness involves drills and exercises, which range from table-top exercises to full-scale drills. The gaps revealed by such drills and exercises require analysis and corrective action, so that, in the event of an actual disaster, everyone acts as expected, coherently and in coordinated fashion. It is important to learn from the best practices adopted by other countries, particularly those that are prone to disasters and have learned from experience. This report therefore contains case studies from various countries describing the lessons they have learned. Following a dedicated workshop on drills and exercises held during the study period, the experts' deliberations were put together in a set of guidelines for small island and landlocked countries, and included in this report.

An enabling policy environment is a must for managing any disaster. The policies should be such that they enable flexibility when deploying emergency communication equipment and ensure successful use of telecommunications and ICTs for disaster preparedness and response. It is important to ascertain the components of an enabling policy environment, one that improves emergency telecommunication preparedness, network resilience, disaster risk reduction and disaster management.

The world is currently facing a huge challenge due to the COVID-19 pandemic, which has resulted in millions of deaths and affected the world economy to the tune of trillions of dollars. No country has been left unaffected. A webinar on an enabling policy environment for disaster management, including pandemic responses, considered feasible and effective responses to the pandemic and provided an opportunity for many countries to share their experience of enhancing and augmenting ICT infrastructure when people started to work from home and countries introduced lockdown conditions, leading to a significant increase in Internet traffic. Contributions received in response to Question 5/2 also described national responses to the COVID-19 pandemic. The relevant details are captured in Chapter 2 of this report.

In short, this report comprises seven chapters, as follows:

- **Chapter 1** outlines the scope of the report and provides a brief overview of the role of telecommunications/ICTs in the overall disaster-management cycle.
- **Chapter 2** provides a comprehensive overview of the enabling policies and regulatory environment, including policies for the deployment of emergency communication and early-warning systems, for supporting communication continuity and for enabling more effective responses.
- **Chapter 3** discusses disaster communication technologies.
- **Chapter 4** discusses early-warning and alert systems, and the use of ICTs in their planning; it also discusses deployment of early-warning systems for disaster risk reduction, broadcast emergency warning systems, disaster information and relief systems, and resilient network technologies.
- **Chapter 5** summarizes the guidelines for preparing and conducting disaster communication exercises and drills.
- **Chapter 6** presents various country and industry case studies based on the contributions of ITU-D members.
- **Chapter 7** discusses the best practices and lessons learned identified, together with the guidelines suggested during the study period.

Abbreviations and acronyms

2G/3G/4G/5G	second/third/fourth/fifth generation of mobile networks
AI	artificial intelligence
BDT	Telecommunication Development Bureau
BGAN	broadband global area networks
CAP	Common Alerting Protocol
COVID-19	coronavirus disease 2019
ETC	UN Emergency Telecommunications Cluster
FEMA	US Federal Emergency Management Agency
GIS	geographic information system
GSMA	GSM Association
ICT	information and communication technology
IoT	Internet of Things
ITU	International Telecommunication Union
ITU-D	ITU Telecommunication Development Sector
ITU-R	ITU Radiocommunication Sector
ITU-T	ITU Telecommunication Standardization Sector
IPAWS	Integrated Public Alert & Warning System
IPAWS-OPEN	IPAWS Open Platform for Emergency Networks
LDC	least developed country
M2M	machine-to-machine
MDRU	moveable and deployable ICT resource unit
MHEWS	multi-hazard early-warning system
ML	machine learning
NETP	national emergency telecommunication plan
NGO	non-governmental organization
NOAA	US National Oceanic and Atmospheric Administration
OSCAR	WMO Observing Systems Capability Analysis and Review Tool
PPDR	public protection and disaster relief
SDGs	Sustainable Development Goals

(continued)

SIDS	small island developing States
SNS	social networking services
UAV	unmanned aerial vehicle
UNISDR	United Nations International Strategy for Disaster Reduction
UNITAR	United Nations Institute for Training and Research
UNOSAT	UNITAR Operational Satellite Applications Programme
UN-SPIDER	UN Platform for Space-based Information for Disaster Management and Emergency Response
VoLTE	voice over LTE (long-term evolution)
VSAT	very small aperture terminal
WFP	World Food Programme
WHO	World Health Organization
WMO	World Meteorological Organization

Chapter 1 – Introduction

1.1 Background

Various resolutions of the ITU Plenipotentiary Conference, the World Telecommunication Development Conference (WTDC) and the World Radiocommunication Conference (WRC), along with reports from the ITU Telecommunication Development (ITU-D), Telecommunication Standardization (ITU-T) and Radiocommunication (ITU-R) Sectors, have emphasized the role of telecommunications/information and communication technologies (ICTs) in disaster preparedness, early warning, rescue, mitigation, relief and response. Moreover, the World Summit on the Information Society (WSIS) action lines, the United Nations Sustainable Development Goals (SDGs), a number of United Nations International Strategy for Disaster Reduction (UNISDR) resolutions and the Sendai Framework for Disaster Risk Reduction 2015–2030 all recognize the need to reduce the risk of disasters and build sustainable and resilient infrastructure. ICTs also play a role in humanitarian assistance and in public protection and disaster relief.

In its efforts to promote national and regional preparedness for natural and man-made disasters, ITU has consistently advocated the use of telecommunications/ICTs for the purpose of disaster preparedness, mitigation, response and recovery, and to that end has encouraged regional and global collaboration and experience sharing. During the previous study period (2014–2017), ITU-D Question 5/2 examined multiple aspects of disaster communication planning, management and response. During the study period 2018–2021, the emphasis was on the use of telecommunications/ICTs in disaster risk reduction and management.

1.2 Aim of the report

The aim of this report is to continue examining the application of telecommunications/ICTs for disaster prediction, detection, monitoring, early warning, response and relief, including consideration of best practices/guidelines for implementation, and for ensuring a regulatory environment that enables rapid deployment and implementation. The report contains national experiences and case studies in disaster preparedness, mitigation and response, and in the development of national disaster communication plans; it examines their common themes and best practices. It covers four broad fields:

- enabling policy and regulatory environment;
- disaster communication technologies;
- early-warning and alert systems;
- drills and exercises.

Relevant case studies and best practices are referenced in the respective chapters.

1.3 Telecommunications/ICTs and disaster management and relief

It is well known that telecommunications/ICTs play a vital role in disaster management and disaster risk reduction. In order to save lives and property during and after a disaster, it is crucial to design a national emergency telecommunication plan (NETP), set up early-warning and monitoring systems using ICTs, and ensure the availability of emergency telecommunication equipment. Telecommunications/ICTs have a role in all phases of disaster detection, risk reduction, early warning, monitoring and rescue and post-disaster relief work. Access to information and timely communication are key to limiting the impact of disasters. Different ICTs and networks (including satellite, radio and mobile networks, the Internet, geographic information system (GIS) software, satellite Earth observation systems, the Internet of Things (IoT), real-time analysis using big data and advanced computing, mobile communication technologies and social media) can all help enhance capacities for disaster management and reduce people's vulnerability. The local community, the government, the private sector, disaster-management agencies, meteorological organizations, civil society, humanitarian agencies and international organizations all contribute to coordination of disaster-management activities, making partnerships and advance planning and preparation involving all stakeholders essential.

1.4 Use of telecommunications/ICTs in all phases of disasters

Telecommunications/ICTs are essential tools in all phases of disasters, and effective disaster management takes advantage of a diverse range of means of telecommunication/ICTs. Examples include remote sensing via satellites, radar, telemetric and meteorological systems and satellite M2M sensing technologies, to issue early warnings; broadcast and mobile technology (radio and television broadcasting, amateur radio, satellite, mobile telephony and the Internet), to distribute alerts; and temporary base stations, portable emergency systems, etc., to help assess the damages, relay instructions to search, rescue, relief and rehabilitation teams, and restore communication and other infrastructure, including through the use of devices like satellite phones. Holistic management of disasters using ICTs thus requires robust and reliable telecommunication infrastructure able to ensure effective communications before, during and after disasters, to minimize loss of lives and property.

Moreover, it is essential to learn lessons after every disaster, the better to prepare for the next one. Telecommunications/ICTs are therefore used to collect data in the wake of major disasters, including in order to analyse their own use and performance. Lessons learned also contribute to technological developments and help improve disaster plans and processes.

1.5 Enabling policy and regulatory environment

An enabling policy and regulatory environment is an important component of disaster communication management. Such an environment comprises two things: a general telecommunication regulatory and policy framework for the overall deployment and use of ICTs; and frameworks and policies specific to disaster events. Public-policy considerations include reducing regulatory barriers to the deployment of ICTs, promotion of robust and resilient ICT infrastructure development, streamlining of licensing procedures and spectrum management. Disaster communication frameworks and policies help guide activities and responsibilities throughout a disaster and ensure the continuity of ICT operations during recovery. Specific ICT policy and regulatory measures for disaster-response frameworks include expedited licensing procedures during a disaster, addressing possible customs barriers to the entry of emergency communication equipment and implementation of the Tampere Convention on the Provision of Telecommunication Resources for Disaster Mitigation and Relief Operations. A number of the contributions received during the 2018–2021 study period addressed government and organizational policy and planning.

1.6 Disaster communication technologies

As mentioned earlier, telecommunications/ICTs can be used in all phases of disasters: sensing technology provides early warnings of impending disasters such as cyclones or hurricanes; and thanks to ICTs, critical information can be exchanged between those affected by a disaster, including the public, and those participating in the short- and long-term response. It is also essential to understand the communication technologies and types of information that need to be shared. For example, the communication technologies used to provide early-warning information to citizens include mobile phones, very small aperture terminals (VSAT), satellite phones, interactive voice response systems, the Internet (including web-based media), television, radio, the press, digital signage loudspeakers and national knowledge networks. Social media platforms can be used to collect data and share information, enabling relief and response authorities to answer requests for help and establishing contacts across and within groups for information sharing, situational awareness and reporting. There are numerous ICT tools for disaster management, but this report discusses only a few. Experts should give serious consideration to a standards-based approach, to avoid being locked into one or more specific design solutions or technologies.

1.7 Existing response mechanisms

When a State experiences a disaster and is left without its usual telecommunication capabilities, it can elect to declare an emergency, which in turn enables the UN Emergency Telecommunications Cluster (ETC) to trigger a mechanism for the swift identification and deployment of vital communications technology to the disaster zone free of charge. States should be aware that this mechanism exists and is available to them. The mechanism is designed to avoid an ad hoc approach whereby different non-governmental organizations (NGOs) may be involved that each arrive on site with duplicative and potentially wasteful equipment and solutions. Furthermore, it provides a more predictable response for the humanitarian community and governments alike.[1]

1.8 Early-warning and alert systems

Early-warning systems are essential to limit loss of lives and damage to property. They can detect or forecast a disaster and then provide timely information to the population, using telecommunications/ICT networks to monitor the situation and issue alerts. Early-warning systems promote risk assessment based on historical experience and vulnerabilities, help monitor and forecast disasters, and provide clear messages to those in disaster-prone areas. They are also useful in emergency response activities, once a warning has been issued.

The Common Alerting Protocol (CAP) is a digital protocol for exchanging emergency alerts over multiple communication pathways: mobile telephony, television, radio, loudspeakers/sirens, computer pop-ups, e-mail and text messages, etc. Alert messages in the CAP format are machine- and human-friendly. The *ITU Guidelines for national emergency telecommunication plans*[2] recommend that early-warning systems should be designed and deployed, whenever possible linking all hazard-based systems, to take advantage of economies of scale and enhance sustainability and efficiency through a multipurpose framework that considers multiple potential

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1 EMEA Satellite Operators Association (ESOA). Services. Emergency communications.

2 ITU. Thematic reports. ITU Guidelines for national emergency telecommunication plans. ITU, Geneva, 2020.

hazards and end-user needs. An inventory of such systems should be included in the NETP and periodically reviewed and updated.

1.9 Drills and exercises

Drills and exercises play an important role in emergency management preparation, as they help boost capacity and training so that when a real disaster strikes, people respond as expected. The main purpose of drills and exercises is to identify and then address gaps between defined procedures and their practical implementation. Another advantage of this type of capacity building is that it enhances the speed, quality and effectiveness of emergency preparedness and response, improves accountability and measurement of outcomes, and reduces the risk of disasters wherever possible.

1.10 Good practices and guidelines

The idea of a collaborative study is to exchange collective learning from each other's experiences and then to identify and follow the best practices. In addition to the discussions that took place during the Study Group meetings, the four workshops held during the study period and the information presented in the annexes to this final report helped to identify guidelines for all countries, especially small island developing States (SIDS) and landlocked countries, and to identify best practices in early warnings, drills and exercises, and policy-making.

1.11 Human factors and stakeholder collaboration

Disasters take no account of national borders. To mitigate the damages, a variety of stakeholders – governments at national, regional and local level, foreign aid and relief organizations, NGOs and civil-society organizations, private-sector entities, and volunteers and citizen action groups – must contribute. They must work in close coordination, and therefore communicate efficiently, if they are to respond effectively to the challenges posed by the disaster. Another factor to consider is how the disaster may affect the family of a response team member and how that person then may or may not be in a position to contribute to response efforts. Back-up plans are essential in such situations. Additionally, all disasters are local, i.e. when a disaster strikes, neighbours are the first responders, and people will seek to help themselves first. ICTs help address this reality, enabling people to help themselves or each other. For this purpose, hazard maps should be prepared in advance, with the help of citizens and local government, of areas likely to be affected by a disaster or of evacuation and shelter locations.

Human factors and stakeholder collaboration are very important when dealing with disaster situations. During drills and exercises, this aspect of communication and coordination is carefully monitored; wherever gaps are found, they need to be corrected and documented, and standard operating procedures or guidelines drawn up on the subject.

An additional consideration is that, in the wake of a disaster, women are more vulnerable and more likely to die than men. The COVID-19 pandemic has devastating social and economic consequences for women and girls because they make up an estimated 70 per cent of healthcare workers, are over-represented in the informal economy, and take on most domestic work – three areas that compound pre-existing inequality. At the same time, women are critical partners in building disaster resilience. Women's perspectives and experiences, as well as their ability to organize, lobby and inform, can dramatically advance the disaster risk management agenda.

However, a range of existing barriers limit their ability to protect themselves and to participate in disaster decision-making throughout the phases of the disaster-management cycle.

An ITU Telecommunication Development Bureau (BDT) and ETC publication on Women, ICT and emergency telecommunications: Opportunities and constraints[3] outlines a range of factors that underscore the digital gender divide and the increased vulnerability of women and girls before, during and after disasters. It also showcases good practices and examples of how ICTs can be exploited to advance gender equality in disaster risk management.

1.12 ICTs for disaster management and smart sustainable development

Smart sustainable development is intertwined with human factors and stakeholder collaboration. It involves overcoming a number of key challenges: developing mechanisms to improve coordination between the wide array of stakeholders involved in emergency ICT response; devising the financing strategies needed to build effective partnerships and secure predictable and flexible funding; ensuring the effectiveness of volunteer training programmes and expansion of volunteer exchange networks; and building the capacity of regional networks and tapping their expertise. In addition, steps have to be taken inter alia to develop public-private partnerships that can foster regional and global opportunities for collaboration; to create a broader platform for disaster management and thus ensure disaster telecommunication relief services at all times; to put pre-planned solutions in place so as to avoid losing time with improvised solutions on the ground; and to build the right regulatory framework to facilitate relief efforts. The action taken on these points will help achieve the SDGs. An ITU report on disaster management and smart sustainable development[4] is based on the deliberations of three working groups – on the Global Emergency Fund for Rapid Response (GEF), on the volunteers for emergency telecommunications, and on the regulatory toolkit and guidelines – that have dealt comprehensively with the subject.

1.13 Accessibility considerations

Disasters are particularly devastating for the vulnerable: persons with disabilities, children, the elderly, migrant workers, the unemployed, those displaced from their homes by earlier disasters. Disaster management must be inclusive, to respond to their needs. Comprehensive information on the role of ICTs in assisting marginalized populations who face barriers to accessing disaster-response services may be found in the relevant ITU-D report,[5] which makes specific recommendations for stakeholders at each phase of disaster management. Cross-cutting recommendations include the following:

- consult with members of vulnerable populations directly on their needs and facilitate their involvement at all stages of the disaster-management process;
- ensure that accessibility and usability of ICTs is considered in any project on ICT-based disaster-management processes or ICT-based development projects;

[3] ITU-D and ETC. Women, ICT and emergency telecommunications: Opportunities and constraints. ITU, Geneva, 2020.
[4] ITU. Smart Sustainable Development Model Advisory Board. Smart Sustainable Development Model (SSDM) Report, 2018. Tools for rapid ICT emergency responses and sustainable development. ITU, Geneva, 2018.
[5] ITU, Centre for Internet and Society, India (CIS) and Global Initiative for Inclusive Information and Communication Technologies (G3ict). Accessible ICTs for persons with disabilities: Addressing preparedness. ITU, 2016.

- use different types of strategies and mechanisms to promote accessible ICTs, including legislation, policy, regulations, license requirements, codes of conduct, and monetary or other incentives;
- build the capacity of vulnerable populations to use ICTs in disaster situations through awareness-raising, training and skills-development programmes;
- use multiple modes of communication to provide information before, during and after disasters, including:
  - accessible websites and mobile apps designed as per the current Web Content Accessibility Guidelines;
  - radio and television public service announcements (using measures for accessibility such as audio, text, captions and sign language interpretation);
  - announcements and tips sent by SMS, MMS or mass e-mails to citizens from government authorities, aid and relief agencies, and others;
  - accessible electronic fact sheets, handbooks and manuals;
  - multimedia presentations (webinars, webcasts and videos, including on popular sites such as YouTube);
  - dedicated social media such as Facebook pages and Twitter accounts created by governments and disaster-response organizations.

Thanks to advances in the field of AI, technology can be used to develop chatbot systems for collecting and distributing disaster-related information. Such applications will be helpful for vulnerable groups, including persons with disabilities.

Chapter 2 – Enabling policy and regulatory environment

The international community recognizes the vital role that ICTs play in all phases of disasters and the importance of preparing NETPs. It acknowledges that efforts to reduce disaster risks must be systematically integrated into policies, plans and programmes for sustainable development. The successful deployment and use of ICTs, together with the development and implementation of NETPs, requires an effective enabling policy environment. The Hyogo Framework for Action 2005-2015 highlighted this need: "*An integrated, multi-hazard approach to disaster risk reduction should be factored into policies, planning, and programming related to sustainable development, relief, rehabilitation, and recovery activities in post-disaster and post-conflict situations in disaster-prone countries*".[6] It emphasized that legislative frameworks are key for integrating disaster risk reduction into development policies and planning: "*Countries that develop policy, legislative and institutional frameworks for disaster risk reduction and that are able to develop and track progress through specific and measurable indicators have a greater capacity to manage risks and to achieve widespread consensus for, engagement in and compliance with disaster risk reduction measures across all sectors of society*".[7] Legislation and formal, written rules are important because they define the responsibilities of people occupying specific positions. Laws and regulations can determine the framework for coordination mechanisms, communication channels and operating procedures, and identify decision-makers at relevant agencies. In addition, legislation and written rules can contribute to the sustainability of the disaster risk management process, so that disaster-management policies outlast individual government administrations and secure, among other things, a budget independent from partisan politicking. In many cases, national legislation for disaster risk reduction helps shape the relevant national strategies with corresponding structures at sub-national level. This allows roles and responsibilities to be decentralized to lower tiers of government and provides an overall coordination structure that can move between sectors and government levels.[8]

Disaster communication frameworks and policies help guide activities and responsibilities throughout a disaster and ensure the continuity of ICT operations during recovery. Specific ICT policy and regulatory measures for disaster-response frameworks include expedited licensing procedures during a disaster, addressing possible customs barriers to the entry of emergency communication equipment and implementation of the Tampere Convention.

As mentioned in **Chapter 1**, one of the aims of Question 5/2 was to deliberate on the enabling policy and regulatory environment. Accordingly, a public webinar held on 14 July 2020 and entitled "The Enabling Policy Environment for Effective Disaster Management, including for COVID-19 Response" (see **Annex 4, § A4.4**), brought together experts who discussed the components of a policy environment able to enhance emergency telecommunication preparedness, network resilience, disaster risk reduction and disaster management. They also

6 International Strategy for Disaster Reduction (ISDR). Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters. Extract from the final report of the World Conference on Disaster Reduction (A/CONF.206/6), Part III.A, para. 13(c).

7 Ibid., Part III.B.1, para. 16.

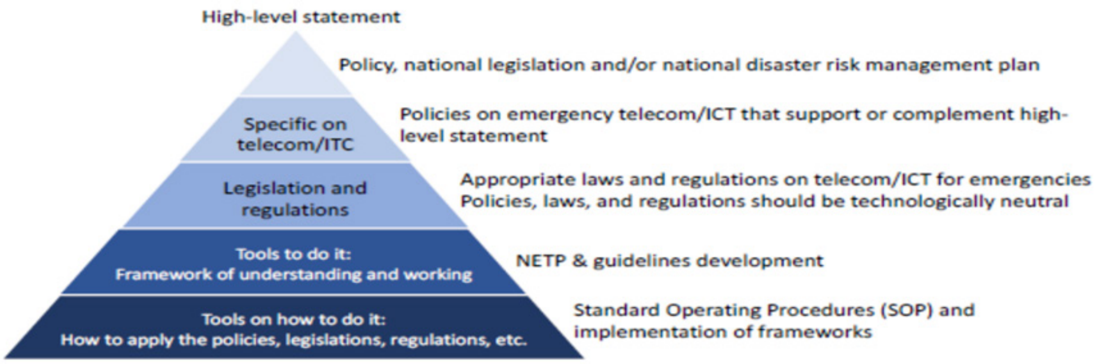
8 ITU, op. cit. (note 2).

discussed policies to enable flexibility when deploying emergency communication equipment, successful disaster preparedness and response with respect to telecommunications and ICTs, and the lessons learned in developing and implementing enabling policies and NETPs.

2.1 Policies for the deployment of emergency communication systems

National emergency communication plans set out clear strategies for ensuring that communications are available during all phases of a disaster, promoting coordination and engagement between all levels of government, humanitarian agencies, service providers and communities at risk.

Figure 1: Policy for the deployment of emergency communication systems: Building blocks



Source: ITU[9]

Policies for the deployment of emergency communication systems are derived from a high-level policy statement, national legislation and/or a national disaster risk management plan (see **Figure 1**), which together provide an institutional and interinstitutional framework for government and civil society action in the face of a threat or disaster.

The plan should have the commitment of the highest levels of government, which in turn must provide organizational and leadership support, allocate resources and commit to deliver and maintain the desired outcomes. A specific set of policies should exist on emergency communications, to support or complement national legislation. Care must be taken to ensure that policies are designed to establish, develop or improve national interoperable telecommunication capabilities.

Several countries already have such a policy framework. In India, disaster communication is deemed important at the highest level. The National Telecom Policy 2012 emphasizes the importance of creating robust and resilient telecommunication networks to address the need for proactive support to mitigate natural and man-made disasters. It prescribes sectoral standard operating procedures to promote effective and early mitigation during disasters and emergencies, and encourages the use of ICTs to predict, monitor and warn of disasters and disseminate information. The Government of India has established a disaster policy, plan and guidelines through a series of measures: the Disaster Management Act, 2005; the Disaster

[9] Ibid.

Management Policy, 2009; the Disaster Communication Guidelines 2012; and the Disaster Management Plan 2019. During the response to the COVID-19 pandemic, instructions for lockdown/reopening and safety and security measures have been issued under the Disaster Management Act. India's telecommunication regulator, the Telecom Regulatory Authority of India, has also worked on emergency telecommunications. It has issued recommendations to the Government on the single emergency number (112), on priority call routing for the people involved in relief and rescue operations, and on the need for telecom service providers to allow their subscribers to roam on other networks during disaster periods at no extra cost. It has also recommended the establishment of a public protection and disaster relief (PPDR) network in India.

Haiti does not yet have an integrated emergency telecommunication system, but it has established a sectoral committee on emergency telecommunications (*Comité sectoriel sur les télécommunications d'urgence, or COSTU*), charged with coordinating sectoral responses in accordance with the national disaster and risk management plan. The committee was set up with a view to using telecommunications and ICTs to enhance the coordination of disaster prevention, preparedness and response. Through it, the government demonstrates its determination to strengthen disaster prevention, preparedness and response measures.

The World Food Programme (WFP) and ITU-D have prepared an Emergency Telecommunications Preparedness Checklist that examines key thematic areas for possible inclusion in an NETP and provides a simple scoring approach to assess the state of progress on each decision point or action over time. The checklist primarily supports the establishment and refinement of NETPs, with a focus on understanding national readiness to enable response communications in a disaster and identifying targeted areas that may require attention.

2.2 Policies for enabling early warnings, continuity of communications and more effective responses

The goal of early-warning systems for natural hazards is to reduce the damage such hazards inflict on the people who may be affected. Natural hazards can turn into disasters if the people affected cannot cope. Therefore, the primary objective of a warning system is to empower individuals and communities to respond in a timely and appropriate fashion in order to reduce the risk of death, injury, property loss and damage, and to mitigate a disaster's impact. A community without early warnings will be unprepared and experience greater suffering as a result of the hazard.

The second priority for action on the five-point list set out in the Hyogo Framework for Action 2005–2015 is to "*identify, assess and monitor risks and enhance early warning*".[10] Disaster mitigation decision-making authorities require increasingly precise early warnings to ensure the formulation of effective measures. This includes extending the lead time of warnings, improving their accuracy, responding to heightened demand for probabilistic forecasts, better communication and dissemination of warnings, using new technologies to alert the public, directing warning services to relevant and specific users, and sending clear, unambiguous and easy-to-understand warning messages that elicit appropriate action in response. It is better to have longer warning lead times and probabilistic forecasts, to reduce the number of false alarms. The Member State contributions received during the study period revealed that many countries

[10] Hyogo Framework for Action 2005–2015, op. cit. (note 6), Part III.B.2.

had taken steps to set up a robust and effective early-warning system. India, for example, has designated primary nodal agencies to monitor and give early warning of disasters in the country: the Indian Meteorological Department, for cyclones, floods, droughts and earthquakes; the Central Water Commission, for floods; the Geological Survey of India, for landslides; the Indian National Centre for Ocean Information Services, for tsunamis; and the Snow and Avalanche Study Establishment, for avalanches.

Indian early-warning agencies also send important information to neighbouring countries and to several similar agencies in the Indian Ocean and Asia-Pacific region. Thanks to the coordinated efforts of these various agencies, and to the dissemination of information in the community using electronic media, landline/mobile phones and technologies like the CAP, India has been able to increase the warning lead time for cyclones, for example, so that the relevant rescue and recovery agencies have enough time to rescue people and bring them to safer places. It has thus been able to substantially reduce loss of human and animal lives and damages to property during cyclones, which strike the country's coastal regions almost every year.

In Burundi, multiple agencies handle disaster response. The Geographic Institute of Burundi, a public agency, is responsible for promoting national meteorological activities for the well-being of the population. The Burundi Red Cross ensures a rapid response, assisting victims during climate-change-related disasters. Local governments play a leading role, protecting the population with the help of other stakeholders in the fight against disasters. Burundi has set up a national risk management platform responsible for disaster-related risk prevention and management, raising awareness and taking concrete action when disaster strikes. All these entities work in coordination to reduce the risk of and respond to disasters.

Brazil, Japan, New Zealand and the United States also have early-warning systems and use various media, most recently through the CAP, to issue alerts.

Disaster prevention, resilience and emergency service capabilities can all be improved by using the latest satellite communication networks, the public mobile communication network and private networks for emergency communication, and by integrating space and terrestrial emergency communication network resources. Other disaster communication technologies are described in **Chapter 3** (China, for example, uses a Ka-band High Throughput Satellite alongside 4G services in emergency response and disaster relief (see **Annex 1, § A1.2.8**). Several different applications exist, and solutions can be deployed by leveraging satellite communications and imagery to detect and transmit disaster-related information. Satellites can enable real-time communications from any place on the globe.

As part of its work, the study group organized a panel session on early-warning systems, including safety confirmation, on 8 May 2018. The session brought to light a number of best practices in respect of early-warning policies, continuity of communication and effective response (see **Annex 4, § A4.1** for further details), in particular in terms of regulatory and overall flexibility, evolving technologies and emergency alert systems, the need for enabling policies, connectivity, capacity building, ongoing improvement in emergency procedures and checklists.

2.3 Policy interventions related to the COVID-19 pandemic

The World Health Organization (WHO) declared the COVID-19 pandemic on 11 March 2020. The disease quickly spread all over the world, causing millions of deaths and economic losses in the trillions of dollars. With the help of ICTs, countries have provided a diverse array of responses to the issues they have all faced: such as by taking steps to meet increased demand for broadband; waive or reduce telecom fees/charges; facilitate free recharge of prepaid mobile phones for subscribers unable to recharge during lockdowns; enable tracing of infected persons and their contacts using mobile applications; and develop mobile applications showing the availability of hospital beds and associated health infrastructure.

Among the many lessons learned from the pandemic and discussed during the webinar "Enabling policy environment for disaster management, including for COVID-19 response" was the realization by all that the world's telecommunication networks and digital infrastructure must be robust, resilient, modular, scalable and better prepared to handle disasters of all kinds.

Chapter 3 – Disaster communication technologies

This chapter describes different emerging disaster communication technologies that can be implemented to support disaster management.

3.1 Communication technologies

The use of telecommunications/ICTs can be helpful in disaster prevention, preparedness, early warning, response and relief. Most ICTs are connected to telecommunication networks, and it is therefore important to ensure that the right telecommunication infrastructure is in place. Different telecommunication networks can be useful in disaster management.

- **Satellite communication networks**: Communications via satellites have the advantage that they are not damaged during natural disasters. Many satellite services, including fixed satellite equipment, equipment on moving vehicles such as incident response vehicles or ambulances and portable equipment such as satellite phones or broadband global area networks (BGANs) are currently used in emergency communications. In addition, satellite communications play a valuable role in prediction, mitigation, early warning and response to disasters, and are often the first technology to be deployed when land-based technologies are affected. They can also assist in data aggregation, and resilient and recovery communications, and have been integrated into terrestrial networks for this purpose, for example in the UK Emergency Services Network.
- **Aerial vehicles**: Similar to satellite communication networks, radiowave transmissions from transponders mounted on aerial vehicles, including unmanned aerial vehicles (UAV), to relay stations face no barriers on the ground and so are useful in natural disasters.
- **Ad hoc network technology**: Although ad hoc networks do not have large-scale networking capabilities, they have unique mesh capabilities, which can be used as a supplementary technology for emergency rescues in wilderness areas, temporary basements and high-rise egress routes.
- **5G mobile networks**: The three main 5G application scenarios – enhanced mobile broadband, ultra-reliable and low-latency communications, and massive machine type communications – meet most emergency communication business needs for large bandwidth, low latency and high reliability. They have the potential to enhance emergency communication rescue and comprehensive emergency support capabilities, with a view to achieving a new level of emergency management. It is anticipated that, in the future, private networks and 5G public networks will work together to provide resilient communication services for emergency management. Combinations of public and private networks will result in three-dimensional guaranteed emergency communication networks involving space-Earth integration and interoperability, and will adapt and match emergency guaranteed communication systems.

3.2 Emerging technologies in disaster communications

3.2.1 Mobile applications

With the popularization of smartphones, people are making heavy use of Internet-based services such as social networking, information searches and e-commerce, and Internet-based mobile applications are becoming important solutions in disaster situations. The Fisher Friend Mobile Application, for example, is a mobile early-warning app and a unique, single-window solution for the holistic shore-to-shore needs of the fishing community, providing vulnerable fishermen immediate access to critical, near real-time knowledge and information services on weather, potential fishing zones, ocean state forecasts and market-related information. Fishermen now receive regular ocean weather forecasts, early warnings about adverse weather conditions and advisories on potential fishing zones.

Another example is Facebook Disaster Maps. People using the Facebook app with the location service enabled receive regular information on the longitude and latitude of their position. When gathered and de-identified, such geological location data can be a source of post-disaster information. Facebook dataset types include movements of people, crowd density and Facebook Safety Check information collected after the disaster.

3.2.2 Utilizing social networking services

Social media are platforms that enable users to participate in, comment on and create content while communicating with other users and the public. Online social networking services (SNS) and social media such as Facebook, Twitter, YouTube and Google+ can be used during disasters to alert those outside the areas concerned, recruit volunteers and/or donors, connect displaced families and friends, and provide information about unclaimed property and bodies, or aid centres and other resources. They can be used to provide updates on, for instance, road closures, power outages, fires, accidents and other incidents. They can help people better prepare for disasters and understand which organizations can help. During the disaster, they allow users to communicate directly with their families, reporters, volunteer organizations and other residents, and to share information immediately. After the disaster, they help bring the community together to discuss the event, share information, coordinate recovery efforts, obtain information about aid, etc.

In the aftermath of a major disaster in Japan, for example, social media were widely used during rescue operations and to raise funds. Compared with traditional communication channels, social media can disseminate information about disaster recovery facilities and materials more rapidly, accurately and reliably.

During the 2015 floods in Chennai, India, people made extensive use of social media to connect to the outside world. The city's residents took to social media to offer their homes to strangers seeking shelter from the rain and floods. Victims and helpers alike used the hashtags #ChennaiFloods and #ChennaiRainHelps.

For cases where disasters lead to outages of telecommunication services, especially Internet-based services, Japan has developed a portable local networking system called the Locally Accessible Cloud System. The system consists of a Wi-Fi access point, a small computer server, a battery and other peripheral devices. These components are assembled in a portable carrying case that can be easily transported to disaster-affected areas. The server acts as a web server and offers the basic communication functions needed in disaster situations.

Japan has also developed a chatbot-based system called SOCDA (SOCial dynamics observation and victims support Dialogue Agent platform for disaster management). The system uses AI technology to collect disaster-related information from people via SNS, aggregates the contents by applying disaster information analysis and summary technologies (see **Section 3.6** below), plots them on a map and distributes the information needed to evacuate people in a timely manner. Citizens and first responders can use the system simply by "friending" it on SNS. It is anticipated that the system will be used by national and local governments, first responders (including healthcare workers) and people in disaster-affected areas in both developed and developing countries.

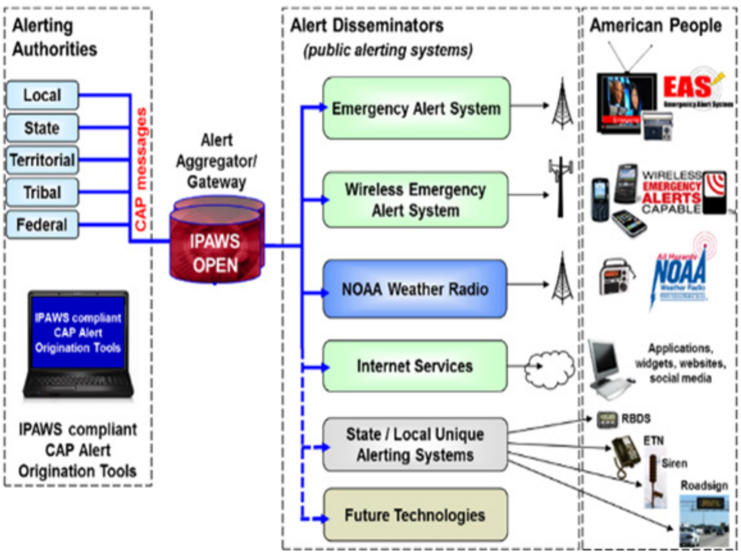
3.2.3 Integrated public alert

It is critical, when developing an alert and warning system, to have the proper authority, policy and governance, in order to prioritize personnel and funding.

In the United States, the United States Federal Emergency Management Agency (FEMA) Integrated Public Alert & Warning System (IPAWS) is a unique, multi-hazard, multi-user nationwide alert and warning system used by federal, state, local, tribal and territorial entities across the country. It uses technology and information standards to join multiple private-sector communication technology infrastructures and enable them to deliver a single emergency message simultaneously over multiple public dissemination pathways: radio, TV, mobile devices and Internet-connected systems, websites and applications.

The IPAWS architecture (see **Figure 2**) was designed to support interoperability with any of the country's alert and warning systems that employ the same standards. IPAWS-OPEN is the infrastructure used to route authenticated alert and warning messages to the public using the radio and television systems in the Emergency Alert System, Wireless Emergency Alerts to cell phones, NOAA Weather Radios and other communication systems.

Figure 2: IPAWS architecture



Source: United States[11]

[11] ITU-SG2 Document SG2RGQ/152+Annex from the United States.

3.2.4 The use of manned or unmanned aerial vehicles

UAVs are increasingly used by governments, consumers and businesses. They support a broad range of sector solutions and are widely used by utilities, in agriculture, for express delivery and emergency response, in the energy field, and so on.

Use of UAVs in firefighting

UAVs, or aerial drones, have proved to be quite useful in firefighting. They can track the spread and source of fires and help guide the firefighting. Images of the fire and its spread, including thermal images, can be used to decide how to extinguish it. In April 2019, two civilian UAVs were used to put out the fire at Notre-Dame Cathedral in Paris. At present, the 4G network is able to support communication needs in some UAV scenarios, but there are many challenges in terms of bandwidth, latency and interference coordination. With the rapid development of the UAV industry, new requirements have emerged for UAV communication links and for close integration with cellular-mobile communication technology. These can be addressed once 5G technologies are in widespread use.

Emergency telecommunications via a high-altitude base station

In the event of a natural disaster, UAVs can quickly put high-altitude base stations in place to restore communication functions (voice and data).

Traditionally, emergency communication vehicles are used temporarily to ensure communications when earthquakes, floods, mudslides and other natural disasters cause large-scale disruptions. However, such vehicles provide relatively limited service coverage and have weak signal stability; they may not even be able to reach the central disaster area if roads collapse or are congested. This traditional way of setting up emergency communication stations and restoring base stations is therefore inefficient, costly, difficult and time-consuming. The maturity of UAV technology and its integration into emergency communication systems make it a new, faster and more convenient way for operators to restore communications in disaster areas.

Tethered UAV + high-altitude base station

Tethered UAV systems are powered from the ground and raised to a UAV take-off platform by a tethering cable capable of uninterrupted flight. Once the UAV aerial base station is working, ground power-generating devices supply power to the tethered system and the onboard remote radio units. The onboard units communicate with the emergency communication vehicles via ground baseband unit devices using the fibre-optic line of the tethered system, and the emergency communication vehicles can connect to the nearby base station tower via microwave devices, optical fibre or satellite communication vehicles and then relay the signal to the core network to achieve mobile signal coverage. The impact of terrain on the electromagnetic wave is thus effectively dealt with and continuous coverage guaranteed in a certain area.

UAV emergency high-altitude base stations can cover up to about 50 square kilometres and provide instant messaging service to thousands of mobile phone users simultaneously. Capable of climbing quickly to between 50 and 200 metres, they can provide 24-hour uninterrupted voice over LTE (long-term evolution) (VoLTE) and other data services to disaster areas. Tethered UAVs used in combination with aerial base stations can quickly restore onsite communication, address the problem of signal coverage in emergency situations and effectively improve the emergency communication support capability of the government and operators in response to natural disasters.

Fixed-wing UAV + high-altitude base station

Large fixed-wing UAVs carrying mobile communication base stations and satellite communication systems, when flown to a target area, can provide stable continuous mobile signal coverage over a long period (not less than 24 hours) in an area of more than 30 square kilometres, thus restoring communications in no time and reducing loss of life and property in the disaster area.

A networked fixed-wing UAV equipped with an orthographic camera and a photoelectric pod can be used to obtain the GIS data needed for rapid data transmission and efficient generation of a three-dimensional map of an earthquake area, providing a basis for rescue decisions.

During single-soldier system drills, ground advance teams can report key rescue information, send back real-time video and images, and quickly dispatch rescue personnel and equipment based on the GIS data, effectively improving the timeliness and accuracy of emergency rescue operations.

UAV emergency communication: Next steps

Standard-setting is one of the challenges facing UAV emergency communications. China is developing technical requirements for the emergency communications of high-altitude base stations with tethered UAVs. In addition, since ordinary base stations provide mainly ground coverage, UAVs need special base stations for aerial coverage. 5G UAVs currently rely on the general 5G customer premises equipment used to convert 5G signals to Wi-Fi signals for communication; in the future, dedicated terminals and 5G communication modules will be needed to improve integration.

3.3 Emerging technologies in disaster response and relief

Emerging technologies and tools such as remote-sensing data analysis and the World Meteorological Organization (WMO) Observing Systems Capability Analysis and Review Tool (OSCAR)[12] analyse disaster-related information and help develop appropriate disaster response and relief measures. Several United Nations agencies are developing and using these tools, a few of which are described below.

To gain the maximum benefit from remote-sensing data, a local emergency management agency is needed to direct the appropriate information to people in the field. The United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER) is focused on helping nations develop the capacity to manage disasters. While it helps organize relief organizations and train their personnel, other organizations are more data-oriented.

The WMO OSCAR includes a table showing all known past, current and future satellites for meteorological and Earth observation purposes. The tool can be used to identify additional sources of data.

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12 See: WMO OSCAR.

Another source of analysed remote-sensing data is the United Nations Institute for Training and Research (UNITAR) Operational Satellite Applications Programme (UNOSAT), a United Nations programme created to provide the international community and developing nations with enhanced access to satellite imagery and GIS services.

3.4 Terrestrial and satellite-based remote-sensing technologies to manage natural disasters

Managing natural disasters requires large amounts of multi-temporal spatial data. Satellite remote sensing is an ideal tool for disaster management, since it offers information over large areas and at short intervals. Although it can be utilized in all phases of disaster management, in practice it has so far been used mostly for warnings and monitoring. In recent decades, satellite/space technology has been used in the disaster preparedness and warning phases for cyclones, droughts and floods.

Meteorological aids, meteorological-satellite and Earth exploration-satellite services play a major role in activities such as the following:

- identifying areas at risk;
- forecasting weather and predicting climate change;
- detecting and tracking earthquakes, tsunamis, hurricanes, forest fires, oil leaks, etc.;
- providing alerts/warnings of such disasters;
- assessing the damage caused by such disasters;
- providing information for planning relief operations; and
- monitoring recovery from a disaster.

These services provide useful if not essential data for maintaining and improving the accuracy of weather forecasts, monitoring and predicting climate changes, and collecting information on natural resources. The targets and associated applications of satellite-based technologies are summarized in **Table 1**.

Table 1: Targets and associated satellite-based technologies

Objective / Technologies	Synthetic-aperture radar imagery	Interferometric synthetic aperture radar imagery	Active microwave imagery	Radar altimetry	Radar scatterometry	Precipitation radar	GPS radio occultation	Passive microwave imagery	Passive microwave sounder	Geographic visual and infrared imagery	Optical imagery	Multispectral optical imagery	Infrared imagery
Coastal hazards	X										X		
Drought	X		X	X	X			X		X	X	X	
Earthquakes	X	X					X				X		
Extreme weather					X	X	X	X	X	X	X		
Floods	X		X		X	X	X	X	X		X		
Landslides	X	X									X	X	
Ocean pollution	X											X	
Pollution											X	X	
Sea/lake ice	X							X			X		
Volcanoes	X	X						X			X	X	X
Wildland fires								X			X	X	X

3.5 Satellite communications

Satellite-based communications have provided support to international relief organizations and stricken areas and populations for decades, and are an essential component of disaster preparedness and relief operations worldwide. They can provide broadband communications, often unaffected by the circumstances on the ground. The ecosystem for satellite-based disaster communications that has emerged over 50 years is now more affordable and effective.

Satellite-based communications also operate independently of local telecommunication infrastructures, and small batteries and independent power supplies can help offer continuity when local power sources are damaged during a disaster. Satellite communication terminals are self-sufficient and have shown through diverse deployments that they can be in operation within minutes of arriving at the site.

Disaster communications equipment can be compact, lightweight and hand-carried, enabling relief teams to exchange communications with their home base for urgent tasks ranging from uploading detailed damage reports to making supply orders.

Some of the key characteristics of satellite-based communications that make them particularly suited to disaster risk reduction and management are summarized in **Table 2**.

Table 2: Key characteristics of satellite-based communications

Flexible	– Ideal for rapid deployment – Instant set-up on site as soon as a disaster happens – Can control and restrict access to services
Portable	– Compact terminals ideal for anyone travelling alone and moving from site to site
Easy to use	– Simple training can provide technical expertise required to set up and use most satellite devices
Global coverage	– Remote site connectivity – Extended team coverage
Reliable	– Reliability for critical data – Independent of terrestrial infrastructure
Provides essential connectivity	– Provides backhaul for terrestrial infrastructure – Offers broadband connectivity at a cost that is not dependent on density of deployment

3.6 Big-data analysis for disaster management

The world is now heavily dependent on information technology, with the advent of big data making it possible to take decisions based on data analysis. Big-data analysis is allowing societies to adapt their disaster-management strategies to reduce human suffering and economic loss. The prime objective of computer experts and policy-makers is to use big data to source information from varied formats and store it for effective use during disaster management.

Social media analysis is the process by which huge volumes of data, for the most part semi-structured or non-structured, are collected from social media sites and analysed. The process uses various machine-learning algorithms, such as decision trees, support vector machines, random forests, Naive Bayes classifiers, logistic regression and the Artificial Intelligence for Disaster Response platform. The algorithms analyse the data, generate outcomes therefrom and help visualize the outcomes precisely and from the desired angle. The resulting information can be used for search-and-rescue operations and for post-disaster triage, relief and rehabilitation. Many AI and machine-learning tools focus on how social media updates provide incident indications and contribute to situational awareness.

Whenever a disaster strikes, huge numbers of short messages and tweets are posted on SNS; the information they contain may be invaluable – or it may be trivial. These messages and tweets can be analysed using big-data analytics techniques. In Japan, the National Institute of Information and Communications Technology (NICT) has developed two data analytics systems: the Disaster information SUMMarizer (D-SUMM) and the DISaster information ANAlyser (DISAANA) systems. The former automatically extracts disaster reports from SNS and organizes, summarizes and presents the content in a user-friendly way. The latter outputs the extracted disaster reports as they are (e.g. "there is an earthquake!" or "we still have aftershocks!"). By summarizing the disaster reports for each sub-area, D-SUMM enables users to quickly understand what is happening where. Multiple categories can also be specified and displayed on a map, as can the number of times an item was reported, making it easy to obtain an overview of disaster conditions.

3.7 Artificial intelligence for disaster management

AI is the simulation of human intelligence processes by machines, especially computer systems. The processes include learning (the acquisition of information and rules imbibed in the form of algorithms for using the information), reasoning (using rules to reach approximate or definite conclusions) and self-correction. Several new and recent smartphones also have hardware optimized for AI.

Machine learning (ML) is defined as the ability of machines to learn automatically by using AI. It involves the creation of algorithms that can modify themselves without human intervention or without being explicitly programmed to produce learning output. This is achieved by analysing structured data fed to a machine's algorithms. The learning process thus involves observing, processing and analysing data, and acting accordingly. The potential opportunities and benefits of ML and AI have been leveraged by the Artificial Intelligence for Disaster Response platform, which uses ML to analyse data on natural and man-made disasters collected from tweets in real time and automatically. It is accessible to all those involved in disaster response.

AI and ML have advanced to the point that they are highly proficient in making predictions and in identifying and classifying. Real-time information generated through crowdsourced data-sharing with the help of data analytics is useful for response and relief work and for mitigating suffering.

3.8 The Internet of Things for disaster management

The Internet of Things (IoT) is a network of "things" (i.e. physical objects such as electronic sensors, software and other devices) that are interconnected over the Internet and exchange information with other devices and systems. Developments in cloud computing, broadband wireless networks, the sensors themselves and data analysis have led to the emergence of powerful, integrated and real-time IoT systems. Today, IoT applications are used in every sector: health, education, transport, agriculture, industry, etc. In disaster management, IoT can be used to monitor sudden-onset natural hazards such as earthquakes and mudslides, to issue emergency alerts, and to transmit data in near real time to emergency management and command centres, thereby boosting disaster prevention and mitigation capabilities. The 3rd Generation Partnership Project (3GPP) has already launched a set of LTE-based narrowband IoT technologies (i.e. narrowband IoT and enhanced machine-type communication), which have expanded the LTE technology portfolio to support broader application of more energy-efficient IoT services; in addition, they are looking at communications via satellite and other non-terrestrial networks (NTN NB-IOT).

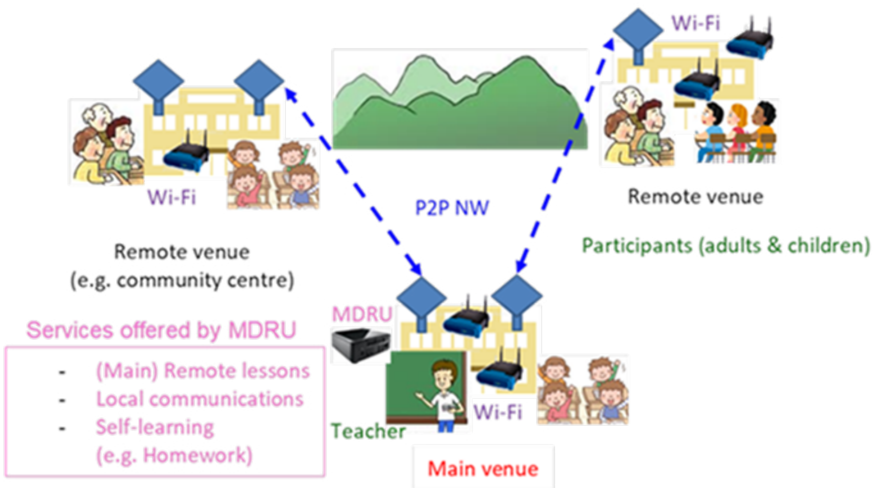
3.9 Smart-city disaster management

Apart from introducing new generations of ICTs to emergency telecommunications via the conventional telecommunication industry, countries around the world have shown great enthusiasm about the application of ICTs in the emergency management of the smart cities they are striving to build. One key aspect of building smart cities is using digital technologies to improve emergency telecommunications. With more comprehensive, real-time and dynamic data, it is possible to implement emergency response plans speedily and cost-effectively. Emergency technological systems and emergency efforts that can be linked to the development of smart cities include the following: disaster early-warning systems; emergency response optimization (i.e. back-office call processing and field operations such as the strategic deployment of emergency vehicles); personal alert applications (for transmitting location and voice data to emergency response services or loved ones); and smart monitoring of the operation zone.

3.10 Using emergency telecommunication systems during normal times

Emergency telecommunication systems such as MDRUs (movable and deployable ICT resource units used in emergency situations) should be assembled in sufficient number before a disaster occurs. In general, however, any such systems installed in advance may be on stand-by for years, since it is very hard to gauge when a disaster will strike. Because of this, they may fail when the time comes because of problems linked to operating skills or battery life. It is therefore a good idea to use them in ordinary situations, for instance as temporary telecommunication infrastructure in rural areas where such infrastructure is insufficient. See **Figure 3** for an example of an MDRU enabling a connection between an elementary school and two nearby villages. The fact that the children and farmers will thus be trained in the use of the system means that they will have the skills required to operate it in response to a disaster.

Figure 3: Telecommunication infrastructure being used in a rural area in normal times



Source: Japan[13]

[13] ITU-D SG2 Document SG2RGQ/188(Rev.1) from Japan.

3.11 Autonomous distributed ICT system

In the event of disasters, local governments play several important roles, such as being the first to respond to disaster-affected areas, providing first aid for citizens and handling fire rescue. These roles require governmental ICT systems, which connect to on-premises servers or cloud servers via the Internet or telecommunication networks. Telecommunication blackouts may thus cause disruption of governmental services. The use of autonomous distributed ICT systems is one solution to help ensure continuity of governmental services when telecommunication networks are down, as a business continuity plan. NICT (Japan) developed the "Die-Hard Network" as an autonomous distributed ICT system with a store-carry-forward network supported by vehicles for disaster countermeasures. The Die-Hard Network consists of several edge servers, which are located in headquarters such as local government city halls, in distributed offices such as city hospitals and in vehicles, and communication networks such as Wi-Fi and store-carry-forward networks.[14]

[14] ITU-D SG2 Document 2/401 from the National Institute of Information and Communications Technology (NICT) (Japan).

Chapter 4 – Early-warning and alert systems

Telecommunications/ICTs play a critical role before, during and after any disaster. They are a source of support in all phases of disasters, including preparedness, prediction, early warning, response and recovery. Technological advancements are making it possible to boost resilience and ensure redundancy, rapidly restoring connectivity after a disaster takes place. However, effective disaster management depends on preparedness, including the implementation of early-warning systems and regular drills and exercises. Early-warning systems are well-recognized and critical life-saving tools in floods, droughts, storms, bushfires and other hazards (earthquakes, tsunamis). Recorded economic losses linked to extreme hydrometeorological events have increased by a factor of nearly 50 over the past five decades, yet global loss of life has decreased significantly, by a factor of about 10, meaning that millions of lives have been saved over the same period.[15]

4.1 Use of ICTs to plan early-warning and alert systems

The roadmap for disaster management rests on the premise that disasters are inevitable and that proper initiatives to obtain early warning thereof will save lives and property, reduce large-scale impacts, enable immediate relief and help mitigate the effects of similar calamities in the future.

It is important to spread information before, during and after disasters. Effective early warning before disasters requires the ability and means to publish disaster warning information. When necessary, the warning of imminent danger should reach every person in the designated area as soon as possible.

Technologies such as GIS software, satellite Earth observation systems, IoT, real-time analysis using big data and advanced computing, mobile communication technology, social media networks, robotics and blockchain can be used to manage disasters and inform more sustainable and resilient development perspectives.

4.2 Deploying early-warning systems for disaster risk reduction

4.2.1 The Common Alerting Protocol and its use in early-warning systems

The CAP is an XML-based data format for exchanging public warnings and emergency information between alerting technologies. It allows a warning message to be sent consistently and simultaneously over many warning systems to many applications. It increases warning effectiveness and simplifies the task of activating a warning. Standardized alerts can be received from many sources and configured so that applications can process and respond to them as desired. Because it standardizes alert data across threats, jurisdictions and warning systems, the CAP can also be used to detect trends and patterns in warning activity. India has conducted case studies and trials, using the CAP in early-warning systems to spread information in the

[15] See WMO. Disaster Risk Reduction (DRR) programme. Multi-hazard Early-Warning Systems (MHEWS).

case of earthquakes, flash floods, etc. New Zealand also uses CAP feeds to obtain alerts about earthquakes, severe weather and civil-defence emergencies.

4.2.2 Early-warning systems for earthquakes and tsunamis

In the case of earthquakes and tsunamis, early-warning systems help limit loss of human lives and damage to property. Present-day technology can detect moderate to large earthquakes so quickly that a warning can be sent to locations outside the epicentre before the destructive waves arrive. Data from a single station or from a network of stations form the basis of earthquake early warnings. A combination of alerts from single stations and a regional seismic network can be used to enhance accuracy and warning time. During a moderate to large earthquake, onsite and regional warning alerts are combined in the Shake Alert demonstration system. In the future, earthquake early-warning systems may be embedded in smartphones and vehicles, "smart" appliances and the growing number of everyday objects containing sensors and communication chips that connect them to a global network.

In India, more than 100 sensors deployed in the Himalayas region provide early warnings of earthquakes for the cities of northern India, detecting events, identifying their location, estimating their magnitude and issuing alerts. In the wake of the 2004 tsunami, the Government of India took steps to build robust early-warning systems: the Ministry of Earth Sciences established the National Tsunami Early Warning System at the Indian National Centre for Ocean Information Services in Hyderabad, Andhra Pradesh; and the ministry's Meteorological Department developed ICT-based systems that issue accurate warnings and generate real-time weather reports for all major disaster-management agencies.

4.2.3 Early-warning systems for cyclones

Cyclones, hurricanes and typhoons are storms caused by atmospheric disturbances wherein the air rotates cyclically around a low-pressure centre called the "eye". In the northern hemisphere, winds rotate counter-clockwise, and in the southern hemisphere, clockwise. Cyclones of varying intensity are born almost every year in the seas around India during the months of June and July. Thanks to the robust early-warning systems it has established, India was able to respond effectively to Cyclones Phailin (2013) and Fani (2019), for example, which made landfall with winds of over 200 km/hour and brought heavy rainfall. The alert messages sent via the early-warning system proved to be concise and accurate. They also indicated where and what type of damage was expected to shelter and infrastructure. As a result, fatalities among people and livestock were substantially reduced.

4.2.4 Early-warning systems for torrential rainfall

Events such as cloud bursts and torrential/heavy rainfall lead to disaster. Japan has developed the Phased Array Weather Radar to detect torrential rainfall and thus prevent the damage it causes. The radar can observe three-dimensional rainfall information (radar reflectivity and Doppler velocity) every 30 seconds to detect locally and rapidly developing cumulonimbus at an early stage.

4.2.5 Early-warning systems for floods, landslides and mudslides

Early-warning systems can be used in disasters such as floods, landslides and mudslides. Recently developed technologies equipped with sensors/IoT can be used to detect soil movement, moisture content, etc., and to generate timely alerts. In Japan's Shiojiri municipality, where soil moisture levels are detected using IoT sensors, alerts are sent out automatically to the municipality's risk manager when the level of soil moisture exceeds a certain digital value.

In Zambia, ITU and the Zambia Information and Communications Technology Authority have co-financed a project for the establishment of early-warning systems in two communities, Mbeta Island and Kasaya Village. The systems disseminate alerts on flooding and impending disasters to the communities, which are situated close to the Zambezi River. They will also be used for public safety, facilitating the exchange of information between local communities and government agencies.

4.3 Broadcast emergency warning systems

Alert messages can also be broadcast via radio and television, cable television and direct broadcast satellite. China, New Zealand, the United States and many other countries use broadcast emergency warning systems. In the United States, the Emergency Alert System, for example, delivers alert messages by broadcast radio and television, cable television and direct broadcast satellite. Another system, Wireless Emergency Alerts, can send alert messages to mobile phones in targeted areas (it can also transmit Child Abduction Alerts). In China, 4G networks are being continuously improved to ensure that mobile subscribers can receive vital emergency alert messages in time. China has developed a broadcast system, Tuibida, which is a live-to-push mobile Internet infrastructure.

4.4 Early-warning and alert system technology

4.4.1 Multi-hazard early-warning systems

The Sendai Framework for Disaster Risk Reduction 2015–2030 recognizes the benefits of multi-hazard early-warning systems (MHEWS) and enshrines them in one of its seven global targets (Target (g): "Substantially increase the availability of and access to multi-hazard early-warning systems and disaster risk information and assessments to people by 2030").

The Framework urges a paradigm shift in the way risk information is developed, assessed and utilized in multi-hazard early-warning systems, disaster risk reduction strategies and government policies. During the May 2018 Q5/2 panel session on early-warning systems, a WMO expert explained the WMO tools that can be of benefit to national early-warning and alert activities, such as the MHEWS Checklist (available on the WMO website) and the Climate Risk and Early Warning Systems Initiative. WMO has also adopted the CAP (ITU-T X.1303) and the platform called Alert Hub. The aim of the Global Multi-hazard Alert System is to provide authoritative information and advice to the operational and long-term decision-making processes of United Nations agencies and the humanitarian community.

4.4.2 Integrated Public Alert & Warning System

FEMA's IPAWS uses technology and information standards to link multiple private sector communication technology infrastructures, giving them the ability to deliver a single emergency message simultaneously to multiple public dissemination pathways (e.g. radio, television, mobile devices, and Internet-connected systems, websites and applications).

The first critical step in initiating this design solution was to use the CAP and other technical standards. When alert and warning services are made CAP-compliant and integrated with IPAWS, the platform acts as a mediator, authenticating messages from authorized users disseminating authentic emergency information to people in a specific geographic area quickly through multiple dissemination pathways. Information from a single source about a single incident can thus reach the public via radio, television, wireless phones, Internet services and future CAP-compliant IPAWS-connected technologies. The standards-based approach enables a national alert and warning architecture to adapt to and leverage future technologies. Making use of multiple dissemination pathways for public alerts significantly increases the likelihood that the message will reach its target. In addition, disseminating a single CAP alert message simultaneously via multiple pathways reduces the time needed to send alerts and the workload on emergency managers, who would otherwise have to prepare and send multiple separate channel-specific formatted alerts. The IPAWS standards-based approach speeds the delivery of critical, life-saving information.

4.5 Early-warning and remote-sensing systems

As discussed earlier, ICTs are a source of support in all phases of disasters, including prediction, vulnerability analysis and risk assessment, early warning and post-disaster recovery. Early-warning information is collected using remote-sensing systems (satellites, radar, telemetric and meteorological systems, satellite M2M sensing technologies, etc.) and disseminated through various media. This requires a local emergency management agency to direct the appropriate information to the right people in the field. Detailed information on the role of UN-SPIDER, WMO and UNOSAT is provided in **Section 3.3**. Recommendation ITU-R RS.1859 covers the use of national remote-sensing systems for data collection in the event of a disaster.

At national level, Japan has developed the Phased Array Weather Radar to detect torrential rainfall and prevent the damages it causes (see **Section 4.2.4**).

In India, the National Remote Sensing Centre of the Indian Space Research Organisation (ISRO), together with other organizations such as the Geological Survey of India, the Bureau of Indian Standards and the Organisation for the Prohibition of Chemical Weapons (OPCW), has produced maps dividing India into zones on the basis of hazard vulnerability using sensing data. These maps are very useful for pre-disaster planning, prevention and mitigation activities. Bhuvan, ISRO's geoplatform, provides an extensive range of services based on Geological Survey maps.

Indian early-warning agencies send important information derived from satellite-based sensing data to neighbouring countries and to several similar agencies in the Indian Ocean and Asia-Pacific region. The Indian early-warning system is also part of the WMO World Weather Watch (WWW) Global Telecommunication System (GTS).

Similarly, meteorological aids, meteorological-satellite and Earth exploration-satellite services play a major role in early-warning and remote-sensing activities in the United States (see **Section 3.4** for a description).

4.6 Disaster information and relief systems

Addressing natural catastrophes is a challenge for governments and private companies alike. Their need to process information quickly and accurately makes communication crucial. Information systems can be used to establish appropriate procedures, define responsibilities and make decisions, improving the efficiency and effectiveness of disaster management. Information systems support government and corporate efforts to regain trust, rebuild reputations and sustain the ability to operate.

In India, for example, thanks to the establishment of procedures and protocols, the definition of responsibilities and the institution of decision-making structures, accurate data on the paths of Cyclones Phailin (2013) and Fani (2019) were shared at national, state and local level, substantially reducing the number of deaths they caused. In addition, the early warning issued by the Indian Meteorological Department was backed up by state government disaster preparedness and mitigation activities: shelter and food had been made available, a volunteer system put in place, drills regularly conducted and standard operating procedures prepared for disaster management at the state and village level.

Use of social media

Social media can be very helpful in disaster relief operations, not only for individual communications but also to collect damage information for first responders. In Japan, for example, social media were in constant use during the recent floods caused by severe storms and heavy rains. NICT's Disaster-information and SUMMarizer system automatically extracts disaster reports from SNS and organizes, summarizes and presents the content in a user-friendly way. The system alerts users by retrieving not only disaster-related information but also any contradictory data.

In India, the Government of the Indian State of Kerala took to social media to share information about donations to the Chief Minister's Distress Relief Fund.[16] As the scope of the disaster became clear, it reached out to software engineers from around the world, asking them to join the state government-run Information Technology Cell to create a website. The website allowed volunteers who were helping with disaster relief in Kerala's many flood-affected districts to share the needs of stranded people so that the authorities could provide a timely response. Similarly, a fraternity of mechanical engineering students at a government-run engineering college in Kerala created a group called Inspire. The group built over 100 temporary power banks and distributed them among those unable to contact their families in flood-affected areas and relief camps. A power bank could boost a mobile phone's charge by 20 per cent in minutes, which could be critical for people without access to electricity. In another case, during the Chennai flood of 2015, people used social media extensively to connect to the outside world. The calamity brought out thousands of helping hands. Chennai residents took to social media to offer their homes to strangers seeking shelter from the rain and floods. #ChennaiFloods and #ChennaiRainHelps were used by victims and volunteers alike to find/offer shelter, food,

16 Scroll.in. As Kerala battles flood, social media helps connect anxious relatives, coordinate relief efforts. 17 August 2018.

transport and even mobile phone recharges, share government helpline numbers, provide information on NGOs offering help, etc.

Disaster information and data, effective organization of relief and rescue operations, the use of social media and community participation in relief operations can result in substantially fewer human and animal lives lost and promote a quick economic recovery.

Chapter 5 – Drills and exercises

Drills and exercises play an important role in emergency management preparation, as they help boost capacity and training so that when a real disaster strikes, people respond as expected. They have several aims, including those set out below.

- *Evaluate the preparedness programme and identify planning and procedural deficiencies*: Preparedness programmes may be untested, not updated or unable to adapt to new situations. Emergency telecommunication drills can reveal shortcomings in the programme, check its adaptability to unexpected situations and gauge the need for modifications and improvements.
- *Improve capabilities to respond to real events*: Emergency telecommunication drills can help verify new technology application and information communication resources, assess new equipment capabilities and enhance emergency telecommunication support capability. They can provide indications of the capabilities of existing resources and identify resource gaps.
- *Improve coordination between internal and external teams, organizations and entities and boost the level of cross-regional support*: Drills serve to strengthen the coordination ability of multi-department and rapid response operations, and to improve communication and coordination between emergency organizations and personnel.
- *Train the emergency telecommunication team*: Emergency drills help improve the team leader's ability to analyse, make decisions, organize and coordinate. They help telecommunication personnel understand onsite roles and responsibilities. They can also help heighten awareness and understanding of hazards and their potential impact, reduce panic and promote cooperation with the government and its departments, in order to improve the overall social emergency response capacity.

During the study period, Study Group 2 prepared draft guidelines[17] containing adaptable or scalable guidance that governments and organizations in developing countries, SIDS and least developed countries (LDCs) can use to conduct national emergency communication exercises and drills. The key elements are summarized in **Section 5.1** below. Conducting regular drills and exercises provides clear benefits and can help organizations involved in disaster preparedness to:

- test preparedness to maintain and restore communications in an emergency;
- assess the adequacy of emergency communication procedures, policies and systems;
- make improvements to NETPs based on exercise outcomes;
- increase stakeholder awareness of potential strengths and gaps in telecommunication coverage and continuity planning;
- enable practical learning in a safe environment;
- assess the allocation of resources and manpower among stakeholders, noting potential gaps and overlaps;
- develop teams and build strong working relationships;
- develop and test cross-sectoral cooperation;
- engage and motivate stakeholders to coordinate more closely on preparedness actions;
- ensure the communication competencies of emergency response professionals;
- evaluate communications between various stakeholders and increase interoperability;

[17] ITU-D SG2 Document 2/TD/32 from the Co-Rapporteurs for Question 5/2.

- build a continuous culture of improvement;
- increase communication resilience.

5.1 Guidelines for preparing and conducting disaster communication exercises and drills

The Study Group 2 draft guidelines provide comprehensive guidance for those planning and conducting a drill or exercise. They can be adapted to the scale or type of drill or exercise and the particular needs of the country or organizations involved. The key elements or steps in planning and conducting a drill or exercise are summarized below.

- Start with a concept note emphasizing objectives.
- Ensure top management are supportive of holding the drill.
- Assemble a planning/facilitation team to thoroughly plan the exercise.
- Write the scenario.
- Create an evaluation plan.
- Conduct the exercise.
- Record the exercise in detail to facilitate follow-up and lessons learned.
- Debrief the participants to help identify gaps in preparedness, reinforce what went well, and identify lessons learned, strengths and weaknesses.
- Hold an after-action review to ensure that the next steps are taken in a structured way.
- Identify and assign objectives for corrective action.
- Update response plans, policies, procedures and equipment as needed, to take account of results.
- Monitor ongoing progress and remain committed to supporting a programme of continuous improvement through regularly held drills/exercises.

5.2 Assessing and updating plans

Results from drills or exercises, as captured in the after-action review and debriefs, should be used to set the action plan for areas in an NETP or in related policies and procedures that need improvement or adjustment, and to identify areas of strength. In order to secure management support for a regular and continuing programme of drills and exercises, it is crucial to demonstrate the programme's impact.

Additionally, in order to develop a culture of continuous improvement, the momentum created by the after-action review should be reinforced by driving the points identified for improvement into best practices. By embedding the principle of recording, tracking and closing actions that have a positive effect on preparedness planning, assigning owners and holding regular improvement meetings, an organization can drive improvements into the next emergency preparedness plan iteration, including the next exercise. This process should be continued between and across each drill or exercise, as it will help build momentum for a methodology for continuously improving NETPs.

Chapter 6 – Country and industry case studies

This section summarizes the country and industry case studies submitted in respect of Q5/2 during the study period. There are five categories of case study: enabling policy and regulatory environment; disaster communication technologies; early-warning and alert systems; drills and exercises; and others. The case studies are described in detail in **Annex 1** to this report; **Table 3** lists the case study titles, submitting countries and related sections in **Annex 1** for each topic.

Table 3: Case studies

Topic	Country	Entity	Title of case study	Section
Enabling policy and regulatory environment	India		Policy frameworks on ICT and disaster management	A1.1.1
	India		The importance of ICTs in disaster management	A1.1.2
	Haiti		Emergency telecommunications under Haiti's Sectoral Working Group	A1.1.3
	Global	WFP	Emergency Telecommunications Preparedness Checklist	A1.1.4
	New Zealand		CAP-based early warning	A1.1.5
	Burundi		ICTs in managing the effects of floods	A1.1.6
	Several countries		Public webinar on Enabling Policy Environment for Disaster Management, including for COVID-19 Response	A4.4
Disaster communication technologies	China	China Telecom	Integration of space and terrestrial emergency communication network resources	A1.2.1
	India		Policy frameworks on ICT and disaster management (The Fisher Friend Mobile Application)	A1.1.1
	China		Intelligent emergency telecommunication management	A1.2.2
	China		Emergency communication services and networks	A1.2.3
	India		The role of social media platforms	A1.2.4

Table 3: Case studies (continued)

Topic	Country	Entity	Title of case study	Section
	China		Delivering communication services to disaster zones	A1.2.5
	Japan		Locally Accessible Cloud System	A1.2.6
	United States	Loon LLC	Balloon-enabled preparedness and emergency telecommunication solutions	A1.2.7
	China		Ka+4G model in emergency response and disaster relief	A1.2.8
	Europe	ESOA	Satellite connectivity for early warning (Fighting wildfires, Tailings dam monitoring)	A1.2.9
	Japan	NICT	"SOCDA" chatbot system for disaster management	A1.2.10
	Japan	NICT	Autonomous distributed ICT system	A1.2.11
	Global	ITU-T Study Group 11	Signalling architecture of the fast deployment emergency telecommunication network to be used in a natural disaster	A3.8
	Global	ITU-R Working Party 4A	Global broadband Internet access by fixed-satellite service systems	A3.7
	Global	ITU-T Study Group 11	The fast deployment emergency telecommunication network	A3.8
	Global	ITU-R Study Group 5	Fixed wireless systems for disaster mitigation and relief operations	A3.9
	Global	ITU-R Working Party 4B	Satellite systems	A3.10
	Global	ITU-R Working Party 5A	Public protection and disaster relief	A3.11
	Global	ITU-R Working Party 5D	IMT Public protection and disaster relief	A3.12
	Several countries		Session on disaster drills and emerging technologies on disaster management	A4.2
Early-warning and alert systems	India		CAP-based earthquake early-warning system in northern India	A1.3.1
	India		Policy frameworks on ICT and disaster management	A1.1.1

Table 3: Case studies (continued)

Topic	Country	Entity	Title of case study	Section
	Europe	ESOA	Satellite connectivity for early warning (Early flood warning, Earthquakes and tsunamis detection)	A1.2.9
	India		Implementing a CAP trial	A1.3.2
	China	China Telecom	ICT disaster preparedness	A1.3.3
	Brazil		Implementation of emergency alerts	A1.3.4
	Japan	NICT	Early warning and the collection of disaster information	A1.3.5
	Japan		Advanced early-warning technologies	A1.3.6
	China		Emergency alerts using the Tuibida service	A1.3.7
	United States		The status of remote-sensing activities	A1.3.8
	India		Monitor and accurately predict the path of cyclones	A1.3.9
	United States		Alert and warning systems	A1.3.10
	Global	ITU-T Study Group 2	Framework of disaster management for disaster relief systems	A3.6
	Several countries		Panel session on Early-Warning Systems	A4.1
Drills and exercises	China		Emergency telecommunication drills	A1.4.1
	Algeria		Exercise to simulate the implementation of the civil security plan for telecommunications	A1.4.2
	China	China Telecom	Integration of space and terrestrial emergency communication network resources	A1.2.1
	Japan	NICT	"SOCDA" chatbot system for disaster management	A1.2.10
	Japan	NICT	Autonomous distributed ICT system	A1.2.11
	Several countries		Session on disaster drills and emerging technologies on disaster management	A4.2

Table 3: Case studies (continued)

Topic	Country	Entity	Title of case study	Section
	Several countries		Session on Conducting National Level Emergency Communications Drills and Exercises: Guidelines for SIDS) and LDCs	0
Others	Japan		Global disaster statistics	A1.5.1
	Japan		Pre-positioned emergency telecom-munication systems	A1.5.2
	Democratic Republic of the Congo		Fighting the Ebola virus disease	A1.5.3
	United States	Facebook	Disaster Maps programme	A1.5.4
	China		ICT in the fight against the COVID-19 pandemic	A1.5.5
	United States		Response to COVID-19	A1.5.6
	Global	ITU-T Study Group 15	Framework of disaster management for network resilience and recovery	A3.1
	Global	ITU-R Working Party 7C	Remote-sensing systems	A3.3
	Global	ITU-T Study Group 2	Terms and definitions for disaster relief systems, network resilience and recovery	A3.5
	Several countries		Public webinar on Enabling Policy Environment for Disaster Management, including for COVID-19 Response	A4.4

Chapter 7 – Good practices, guidelines and conclusions

During the study period, the Question 5/2 team conducted workshops/sessions on four subjects: early-warning systems; disaster drills and emerging disaster-management technologies; national emergency ICT drills and exercises for SIDS and LDCs; and an enabling policy environment for disaster management, including for COVID-19 response.

7.1 Analysis and identification of best practice guidelines and lessons learned

The following best practices and guidelines emerged from the workshop/session discussions, deliberations, contributions and expert opinion.

(A) Early-warning systems

- **Keep developing-country needs in mind**: Alert systems must meet developing-country needs and take into account the level of technologies in use.
- **Ensure flexibility**: It is crucial to adopt a flexible approach to the design, tailoring and testing of alerts for the multiple hazards that developing countries experience.
- **Ensure regulatory flexibility**: It is critical to develop policies that enable regulatory flexibility before disaster strikes. For example, regulators can be given special temporary authority to shorten the approval period for emergency communication deployments.
- **Adapt emergency alert systems**: Countries must consider how people communicate. For example, broadcast media (radio, television, etc.) remain critically important for distributing information to citizens in the event of disaster; at the same time, however, it must be recognized that people are increasingly relying on mobile devices to get information.
- **Ensure connectivity**: Lack of connectivity is a safety as well as a development issue. It can prevent people from receiving life-saving alerts and warnings, and delay or hinder disaster response and recovery. Communication development policies must bear in mind potential emergency communication needs and network resilience.
- **Build capacity**: There are potential opportunities for BDT to enhance the capacity of LDCs and SIDS to generate and communicate effective, impact-based, multi-hazard, gender-informed early warnings and risk information. It is critical to build capacity to improve alerts, detection and response.
- **Develop enabling policies**: The Tampere Convention is a valuable tool that countries can use to enhance their disaster preparedness and response capabilities, but those that have signed the Convention have often not put the necessary enabling policies and procedures in place.
- **Continuously improve emergency procedures**: Pilot projects, disaster-management drills and exercises are important to test procedures and make adjustments as needed to better prepare for specific types of emergencies. Ongoing stakeholder coordination is also needed.
- **Be alert to technological advances**: Evolving technologies play an important role in the more effective and efficient dissemination of multi-hazard early warnings. For example, in addition to detecting natural disasters such as tsunamis and floods, IoT-based technologies can help collect data that can be processed using big-data analysis technologies to detect or mitigate disasters or model potential disaster impacts. Procedures and technology must

be continually evaluated and updated to ensure alerts and warnings are timely, relevant and followed by the communities that receive them.

- **Other areas for consideration**:
  - advance training on satellite systems and other systems that can be used for early warning and response;
  - last-mile warning messages from local government to citizens, and the capacity of satellite systems;
  - the ongoing pursuit of disaster risk knowledge, which can be expanded by systematically collecting data and assessing disaster risks (detection, monitoring, analysis and forecasting of hazards and possible consequences) and thus enable the communication of timely, accurate, relevant and actionable warnings with information on likelihood, impact and recommended action.

(B) Disaster drills and emerging disaster-management technologies

- Satellite imagery is important when it comes to assessing the extent of disaster-affected areas and of the damages incurred.
- It is important to use exercises such as Triplex[18] and to ensure effective coordination between the local site and the control centre.
- Drills and exercises should be based on actual data from past disasters, to help build more realistic disaster scenarios and make training more "life-like".
- MDRUs can be important tools for the quick restoration of ICT networks.
- Plans must be made for network resiliency, including capacity and power considerations, because even undamaged networks tend to become congested during disasters, network batteries might be depleted and transmission lines disconnected, and there might be direct damage to physical infrastructure.
- Since technology does not stand alone, it is key to pay attention to planning, coordination, exercises and drills, with a view to revising policies and procedures on an ongoing basis; equipment must be regularly tested.
- Drills should test the availability and use of disaster equipment such as satellite phones to ensure at least a basic minimum number of responders have access to and know-how to use them.
- Low-tech solutions may be essential. Responders should be prepared for technologies not to work and have redundant means of communication in the event that they are disconnected or lose power.
- Planning is critical, and the goals of exercises must be established beforehand and conveyed to participants and stakeholders.
- The exercise scenario is important and should be adapted to local hazards and conditions. Everyone should nevertheless always be ready to adapt and adjust, and flexibility is key. To better prepare participants for complex and shifting scenarios, a number of "injects" should be planned to escalate the scenario and test their ability to react to increasingly complex situations.
- Practice! Practice! Practice! Frequent training, re-training and disaster-response simulations are key to identifying gaps and refining policies and procedures.
- Immediately after a disaster happens, the demand for communications will soar as people try to contact their loved ones and responders endeavour to coordinate responses on

[18] TRIPLEX is a regular, full-scale simulation exercise run by the International Humanitarian Partnership and enabling a range of humanitarian entities to practice their response mechanisms in a sudden-onset natural disaster scenario.

congested and damaged networks. Demand will fall over time and throughout the recovery period.

- Drills should be specialized according to priority needs and applications, such as for medical information.
- Drills and planning should include consideration of persons with disabilities and specific needs. Steps should be taken to ensure that such persons can access information and that their communication needs are met using all available means, including sign language and captions.
- Early evacuation is key for the survival of persons with disabilities.
- Countries should encourage use of amateur radio as a redundant means of communication when all other network infrastructures fail.
- The debrief (or after-action), when facilitators and participants share experiences, discuss challenges and provide feedback, is the most important part of the exercise. It should confirm the preparedness programme's strengths and lead to an action plan for areas that need improvement or adjustment. The action plan should prioritize follow-up activities, starting with "quick wins" identified during the exercise.
- A table-top drill can be a very effective first effort that serves to identify gaps and refine plans and procedures. It should be followed by mock drills, functional drills and full-scale exercises, in that order. Team building during drills will pay off in terms of coordination during real situations.
- It is important to include a range of different participants in communication drills, such as communication officials, emergency frequency operators, and public safety and regional officials.
- Drills and exercises should also consider ways to increase regulatory flexibility, such as special temporary authorities, to enable the quick import and deployment of ICT infrastructure.
- Countries should contact BDT for capacity-building assistance and information on disaster/emergency communication preparedness.
- Outside assistance should be sought whenever desirable.
- Standard operating procedures have to be prepared at the national, state and district/community levels, and consideration given to how to increase interoperability among the entities concerned.

(C) National emergency ICT drills and exercises for SIDS and LDCs

Recommended planning steps/milestones

- **Start with a concept note** that outlines the goal and expected outcomes of the exercise, the resources required and the timeline. The concept note will introduce stakeholders to the exercise.
- **Assemble a planning team** that plans every detail of the exercise scenario, the timelines, participants, necessary resources, etc.
- **Write the scenario**: All exercises, from table-top exercises to full-scale drills, need a scenario. The scenario is the script that sets the stage for the exercise. Ensure that the scenario links to the exercise goals!
- **Create an evaluation plan**, which will be the main element that makes the exercise a valuable learning experience.
- **Conduct the exercise**: Check that all equipment and other resources are in place, then have the facilitation team brief the participants and run the scenario-based exercise.
- **Monitor**: Evaluate how participants respond to key events. Have the objectives been met? What are the outcomes?
- **Record** all major decision points and outcomes.
- **Debrief** the participants.

- **Hold** the after-action/hotwash.
- **Identify and assign corrective actions** based on exercise observations.
- **Update** plans, policies, procedures and equipment as needed.

Exercise planning best practices

- **Ensure a long planning lead time**: Allow sufficient lead time in the exercise planning cycle to give notice to participants if that is the plan. For example, if an exercise or drill includes communication industry participants, they will need plenty of notice to line up the resources needed to respond.
- **Fully plan the scope of and draft the scenario**, then build a timeline and establish the resources that internal and external teams will need to achieve the expected outcomes.
- **Hold exercises or drills at regular intervals** (annually, if possible) to reinforce results.
- **Draft an exercise timeline that has two timescales**: real chronological time and exercise time duration. If, for instance, an exercise starts at 0900 on a Monday in real time but at 0300 on a Sunday morning according to the scenario, it should proceed in chunks of time understandable in both timescales (e.g. Start: 0300 = equals 0900; Exercise 1: start time + 1 hour = 1000; Exercise 2: start time + 2 hours = 1100).
- **Extend the exercise timeline** to discuss actions that would have taken place before or after the event being simulated. For example, a hurricane/cyclone scenario should cover preparedness, mitigation and recovery/response action from T minus 5 days through to plus 3 days, to include pre-positioning of assets, fuel, provisions, stand-by emergency teams, network lockdown, staff availability and flood control measures such as sandbagging. Insert the injects into the exercise timeline.
- **Consider scenario timing**: Peak tourist season or a less busy time of year? Holiday season or year- or month-end? This will test resource availability, especially if the aim of the simulation is to ensure readiness for an important upcoming event.
- **Include a detailed timeline** of the time and resources internal and external teams will need to achieve the expected outcomes.
- **Involve industry**: Design the scenario so that it is clear that industry operators can provide input on whether it is realistic and so that they can see the potential benefits of participating. These include cross-sector coordination, stronger links to the regulator and government agencies, and the possibility to test their own communications.
- **Base the exercise on existing plans (if they are available)**: Understand the scope and scale of the national plans and policies that will apply to the drill (it is inadvisable to design a test that bypasses all current regulatory processes). What recovery-time objectives do they have? What are the recovery targets (if any)? Then design an evaluation/test to assess the ability to meet those targets and pull in resources along the way. Have key response/business processes with associated recovery-time objectives been identified in the plans? If not, then you already have a finding that the exercise can spotlight.
- **Align language and vocabulary**: Ensure all players are familiar with the terms to be used. If necessary, issue a glossary beforehand.
- **Keep the scenario realistic**: Design a scenario that has benefits for all players. This will help the stakeholders play their roles better. Also consider the geographic scope of the exercise. Will people have to be moved over longer distances? Will the scenario involve the general population (evacuations, setting up emergency medical facilities, cell broadcasts, etc.)?
- **Scenarios and injects should be dynamic**, pushing organizations and individuals to deal with cascading events. Natural disasters do not follow a pre-determined plan, so it is crucial to be prepared for a multitude of scenarios.
- **Get key stakeholder buy-in**: Draft a list of key players who must participate and another of those whose participation is optional. Prioritize participants. If you involve stakeholders outside your immediate control and organization, ensure that you have their permission to include their staff, as they may be tied up for a significant period of time. Ensure their

reporting line and leadership are aware if you intend to have them participate for a number of days.

- **Resource impacts**: Be cognizant of resource impacts if the deliverables require a lot of work (such as data gathering).
- **Know when to terminate**: Be prepared to pull the exercise if circumstances render it impractical or the outcomes are not useful or realistic. This experience will serve to improve the next exercise.
- **Add "stress"**: Consider removing technology platforms from the exercise and fall back onto manual processes with limited communication possibilities. This will "stress" the processes and test the ability of teams to pre-plan, their knowledge of their plans and their ability to act without direction.
- **Use real-world processes and systems**: Avoid creating "exercise only" groups, e-mail addresses and communication paths that will not actually validate whether the systems used on a real event would be effective.

Conducting drills and exercises

- **Facilitating a scenario-based exercise**: The facilitator should distribute the organization's emergency plan – if it has one – to the participants in advance. The facilitator may also contact local and regional emergency managers and community responders for advance input, such as on current local emergency management issues that may impact the organization's planning.[19] The **role of the facilitator** is to create a framework that encourages dialogue and to steer discussions with a view to meeting the exercise objectives, informing the organization's emergency plans, promoting teamwork and educating participants. This can include:
  - giving participants an overview of the exercise, including the scope, scenario, timeline, participant roles and next steps;
  - having the participants introduce themselves;
  - having participants work together as a team (or breaking them up into multiple teams);
  - introducing participants to the incident as if it were real;
  - guiding the team through interactive modules based on the stages of disasters – preparedness, response, recovery and mitigation – and discussing the specific actions to be taken at each stage;
  - encouraging in-depth discussion of appropriate preparedness, mitigation and response actions, to improve the ability to communicate when future disasters occur;
  - introducing "injects" at critical times.
  - facilitating a "debrief" or "hotwash" discussion, in which the participants sum up their observations and findings, ideally to inform and amend national emergency plans;
  - participating in a comprehensive after-action process.

Best practices for conducting exercises

- **Record events**: Assign a report writer to capture the timeline and key decisions.
- **Provide a timeline** and start by explaining how the exercise will play out. Include the participant call frequency. Set out a timeline of what calls will happen when. Indicate the end time.
- **Keep a tight agenda**, whether face to face or on a conference call. Try to keep administrative tasks to a minimum.

[19] See also Exercising Business Continuity Plans for Natural Disasters: A Quick Guide for MNOs. GSMA, 2017.

- **Injects** should be designed to stimulate the actions, activities and conversations of the teams, agencies and individuals directly or indirectly involved in the exercise. They should also explore existing plans. For example, if the scenario involves examining the contingency response to a hurricane at a facility, the first inject could be a media weather report of a tropical depression that is developing into a hurricane. The next inject would be a follow-on report of the hurricane tracking toward the area.
- **Injects should link the simulated event to the actions that you want people to take**. They provide unity to the exercise and are provided by controllers to drive the scenario. Injects usually happen regardless of the participants' actions. For example, a simulated road emergency could impair the ability to evacuate via a key road. This is an inject because the exercise controller would inform the players at a pre-set time that this simulated event has taken place, regardless of their actions. Other examples include generator failures, fuel shortages (no fuel for the next three hours), chemical leaks that have to be cleaned up by hazardous materials teams, or a civil disturbance near a hospital. When planning the inject, link its simulated effect to the actions people should take.
- **Develop injects that challenge the structure of the response, test the flexibility of response plans and force priority discussions**: Examples include impacts on communications (e.g. cell towers in key areas are destroyed or damaged, the Internet or phone lines are down, submarine cables are damaged, no access to cloud recovery) and infrastructure issues affecting the response (e.g. airport closures, road damage).
- **Establish what deliverables are due when and to what level of detail** (full or partial).
- **Set ground rules for communications during the exercise**: Use "This is an exercise only" at the beginning and establish when all exercise-related communications have ended.
- **Set the terms for reporting during the event**: What is being monitored and by whom? What information can they give? What is the status of the reports being delivered? What are operators required to report and how will they do this?
- **Establish reporting lines**: What, to whom and how frequently? How well understood are these lines of communication?

(D) Lessons learned

- Access to robust, resilient and secure ICT infrastructure worldwide is critical in a pandemic and in any kind of disaster.
- ICTs facilitate essential services in a global emergency. However, in order to perform their functions, ICTs need an enabling policy environment to support development of resilient networks and the rapid restoration and deployment of ICTs when disaster strikes. For example, provision could be made to allow for the granting of temporary authority for additional spectrum use or to assign complimentary recharge margins for emergency calls.
- The world's telecommunication networks and digital infrastructure must be better prepared for disasters of all kinds. Cooperative action is required to help ensure that drills are carried out and rapid response measures are ready, since disasters – including pandemics – can occur anytime, anywhere, and with little or no warning.
- Any negative consequences of disasters can be diminished if robust and resilient networks and disaster-management tools and practices are in place well ahead of time.

7.2 Conclusions

Throughout the study period, ITU-D Study Group 2 examined a wide range of activities related to the use of telecommunications/ICTs during disaster and emergency situations in both developed and developing countries (Q5/2). It is heartening to note that more and more countries and organizations are taking steps to develop early-warning systems, deploy the latest technologies and make telecommunication/ICT networks more resilient to disaster risks. The lessons learned and guidelines prepared during the study period will help improve preparations in terms of early warning, drills and exercises, and timely and effective policy-making. That being said, it emerged from the discussions that developing countries require additional support to implement disaster communications, and the focus should therefore now shift to the use of telecommunications/ICTs in disaster response and recovery operations and implementation of disaster telecommunication plans. Countries should nevertheless continue sharing experiences and contributions for the use of telecommunications/ICTs in all areas of disaster management, particularly as concerns the response to the COVID-19 pandemic. Developing countries could also devote more time to exchanging experiences, including through interactive workshops, with a view to identifying common challenges, highlighting successful practices and supporting the ongoing development and implementation of disaster communication frameworks, technologies and plans.

Annexes

Annex 1: Detailed use cases

A1.1 Enabling policy and regulatory environment

A1.1.1 Policy frameworks on ICT and disaster management (India)[20]

(1) India's policy framework – Role of ICTs in disaster situations

The National Telecom Policy 2012 emphasizes the importance of disaster management and contains various provisions relating thereto, including with regard to:

- the creation of robust and resilient telecommunication networks to address the need for proactive support to mitigate natural and man-made disasters;
- sectoral standard operating procedures to promote effective and early mitigation during disasters and emergencies;
- the creation of an appropriate regulatory framework for the provision of reliable means of public communication by telecommunication service providers during disasters;
- encouraging use of ICTs to predict, monitor and issue early warnings of disasters, and to spread information;
- facilitating an institutional framework to establish a nationwide unified emergency response mechanism by providing a nationwide single access number for emergency services.

(2) India's standard operating procedures for the use of telecommunication services in disasters

The Department of Telecommunications, which is part of India's Ministry of Communications, prepared standard operating procedures for disaster-response and emergency communications in 2015. A crisis management plan for disaster communications was also released in 2015, and the standard operating procedures were last updated in March 2017. The update covers detailed procedures for communication services during all kinds of disasters, including the following:

- the organization of telecom services at all levels (central, state and district) for implementing and monitoring disaster-management plans;
- the constitution of committees at national, state and district level that meet once every six months to review disaster-management plans and activities;
- robust and preventive measures for telecommunication systems;
- the obligation for telecommunication service providers to make provision for physical infrastructure safety and redundancy in traffic management;
- the obligation for telecommunication service providers to identify the vulnerabilities of their respective telecommunication infrastructure and prepare emergency plans accordingly, including back-up components (e.g. engine alternator, batteries);
- an overload protection mechanism for traffic overload and congestion management;
- the provision of control room management/activities during and after the disaster;

[20] ITU-D SG2 Document 2/70 from India.

- periodic training to promote ongoing awareness and drills to check preparedness.

Details are available at the Department of Telecommunications website.

(3) Telecom Regulatory Authority of India initiatives

The recommendations of the Telecom Regulatory Authority of India (TRAI) regarding a single emergency number in India provide a framework for implementation of an integrated emergency communication and response system. The recommendations were accepted by the Government of India and the number "112" was allocated to this service. The Department of Telecommunications subsequently issued the necessary instructions to telecommunication service providers for implementation. In 2013, TRAI also issued recommendations on priority call routing for persons involved in rescue and relief operations, which were also largely accepted. Telecommunication service providers were asked to provide Intra Circle Roaming for their subscribers so that, should mobile services be interrupted because of infrastructure failure during a disaster, subscribers can obtain roaming service for 15 days on the network of another telecommunication service provider whose network is in working condition. TRAI is currently consulting on next-generation PPDR communication networks. Detailed information is available on its website.

(4) Early-warning systems

India has a very robust early-warning system, comprising the following primary nodal agencies:

- the India Meteorological Department (cyclones, floods, drought, earthquakes);
- the Central Water Commission of the Ministry of Water Resources (floods);
- the Indian Space Research Organisation (ISRO) National Remote Sensing Centre, which provides all manner of space navigation services;
- the Geological Survey of India (landslides);
- the Ministry of Earth Sciences, via the Indian Tsunami Early-Warning Centre at the Indian National Centre for Ocean Information Services, Hyderabad (tsunamis);
- the Snow and Avalanche Study Establishment (avalanches).

Indian early-warning agencies send important information derived from satellite-based sensing data to neighbouring countries and to several similar agencies in the Indian Ocean and Asia Pacific region. The Indian early-warning system is also part of the WMO World Weather Watch Global Telecommunication System.

The ISRO National Remote Sensing Centre, together with other organizations such as the Geological Survey of India, the Bureau of Indian Standards and OPCW, has produced maps dividing India into zones on the basis of hazard vulnerability using sensing data. These maps are very useful for pre-disaster planning, prevention and mitigation activities. Bhuvan is the ISRO geoplatform providing an extensive range of services based on Geological Survey maps.

(5) Disaster management: an integrated approach using ICT applications to enable efficacious disaster prediction

In the wake of the 2004 tsunami, the Government of India took steps to build robust early-warning systems: the Ministry of Earth Sciences established the National Tsunami Early-Warning System at the Indian National Centre for Ocean Information Services in Hyderabad, Andhra Pradesh; and the Ministry's Meteorological Department developed ICT-based systems that issue accurate warnings and generate real-time weather reports for all major disaster-management agencies.

The benefits of early warnings and preparedness became apparent when Cyclone Phailin, the strongest storm to hit India in more than a decade, swept across the Bay of Bengal to the eastern coast states of Andhra Pradesh and Odisha on Saturday, 12 October 2013, making landfall with winds over 200 km/h and bringing heavy rainfall. The red message, the highest alert message from the Indian Meteorology Department in New Delhi, was concise, accurate and to the point. It also indicated where and what type of damages were expected to shelter and infrastructure.

The Orissa State Disaster Management Authority team and the National Disaster Management Authority managed the largest-ever evacuation exercise in the state. Nearly 500 000 people were evacuated in time and moved to higher ground and safer cyclone shelters. State, federal and local administration officials, international and national NGOs, and community leaders joined hands in a well-planned large-scale relief operation. Control rooms were set up in ten districts, mobile phone numbers were updated and verified, leaves were cancelled to ensure that all staff members were on stand-by, and food and relief stocks were kept in readiness. The National Disaster Management Authority facilitated local efforts in Odisha, mobilizing rescue teams and sending equipment to possible hot spots. It deployed nearly 2 000 personnel of the National Disaster Response Force in Andhra Pradesh, Odisha and West Bengal. The teams were equipped with satellite phones and wireless sets to maintain smooth communications.

Thanks to the efficient early-warning system and the rapid evacuation measures deployed, a very low death toll was reported: only 21 people died (12 million lived in the storm's path). By contrast, a 1999 cyclone in the same area had a much more devastating impact, killing 10 000 people. Similarly, the 2004 tsunami took the lives of about 10 000 people in coastal states of India.

The early warning issued by the India Meteorological Department was also effective thanks to the state government disaster preparedness and mitigation activities for communities at risk carried out previously: shelters and food had been made available, a volunteer system established, drills regularly conducted and standard operating procedures drawn up for disaster management at state and village level.

(6) The Fisher Friend Mobile Application

The Indian National Centre for Ocean Information Services has collaborated with a very renowned research institution, the M.S. Swaminathan Research Foundation, to develop the Fisher Friend Network, which ensures safety at sea and improves the livelihoods of fishermen. The Fisher Friend Mobile Application is a unique, single-window solution for the holistic shore-to-shore needs of the fishing community, providing vulnerable fishermen immediate access to critical, near real-time knowledge and information services on weather, potential fishing zones, ocean state forecasts and market-related information. Fishermen now receive regular ocean weather forecasts, early warnings about adverse weather conditions and advisories on potential fishing zones. The application is an efficient and effective decision-making tool enabling the fisher community to make informed decisions about their personal safety and the safety of their boats, and to make smart choices about fishing and marketing their catches.

The application was developed on an android platform in partnership with Wireless Reach Qualcomm and Tata Consultancy Services. It is currently available in Tamil, Telugu and English.

Fishermen have been trained to recognize warning signs to ensure their own safety and that of their communities.

A1.1.2 The importance of ICTs in disaster management (India)[21]

(1) Disaster-management governance and law

Major disasters, such as the earthquakes in Uttarkashi (1991), Latur (1993) and Chamoli (1999), the Assam floods (1998) and the Orissa super cyclone (1999), led to serious brainstorming on the state of disaster management in India and on the actions required to improve the situation. A key step in that direction was the establishment by India, which was a party to the 1994 Yokohama Strategy for a Safer World, of the High-Power Committee under the chairmanship of Mr J.C. Pant, former secretary of the Indian Government. The Committee produced a detailed report and a set of fundamental and practical recommendations. The Gujarat Bhuj earthquake in 2001 triggered the proposed Disaster Management Bill, which was enacted after the 2004 Indian Ocean tsunami as the Disaster Management Act 2005. The Act enshrines the paradigm shift to "prevention-mitigation based holistic disaster management". Interestingly, in 2005 India also participated in the Kobe World Conference on Disaster Reduction, which adopted the Hyogo Framework for Action 2005–2015. Although India's pioneering legislation on systemic disaster planning and preparedness, the Emergency Planning, Preparedness and Response Rules 1996, was adopted as part of the Environmental Protection Act 1996, the mechanism for holistic planning for disaster management and a tiered approach involving national, state, district and local authorities was introduced by the Disaster Management Act 2005.

The Disaster Management Act 2005 clearly spells out the institutional structures and corresponding functional responsibilities needed to bring about the paradigm shift, leading to the establishment of the National Disaster Management Authority, the National Institute of Disaster Management (the National Authority's capacity-building arm) and the National Disaster Response Force. Similar responsibilities at state and local level resulted in the establishment of the respective institutions at state and district level. This institutional framework ensures that, in post-disaster situations, the communities concerned have assured sustainable livelihoods and reduced vulnerability to future disasters. India is also a party to all international disaster risk reduction strategies and a signatory of the Sendai Framework for Disaster Risk Reduction 2015–2030, the 2030 Agenda for Sustainable Development and the 2015 Paris Climate Agreement.

The National Disaster Management Authority has drawn up the National Policy on Disaster Management, which defines India's disaster-management vision. The policy aims to promote a culture of prevention, preparedness and resilience at all levels through knowledge, innovation and education. It encourages mitigation measures based on technology, traditional wisdom and environmental sustainability, and promotes mainstreaming of disaster management into the development planning process. The policy envisions the use of science and technology in all aspects of disaster management in India and is available on the website of the National Disaster Management Authority.

[21] ITU-D SG2 Document 2/70 from India.

(2) National telecom policy and emergency telecommunication initiatives

India's National Telecom Policy 2012 emphasizes the importance of disaster management and contains various provisions relating thereto, including with regard to:

- the creation of robust and resilient telecommunication networks to address the need for proactive support to mitigate natural and man-made disasters;
- sectoral standard operating procedures to promote effective and early mitigation during disasters and emergencies;
- the creation of an appropriate regulatory framework for the provision of reliable means of public communication by telecommunication service providers during disasters;
- encouraging use of ICTs to predict, monitor and issue early warnings of disasters, and to spread information;
- facilitating an institutional framework to establish a nationwide unified emergency response mechanism by providing a single access number for emergency services valid throughout the country.

Pursuant to the National Telecom Policy 2012, the Department of Telecommunications, which is part of India's Ministry of Communications, prepared standard operating procedures for disaster response and emergency communications in 2015. A crisis management plan for disaster communications was also released in 2015, and the standard operating procedures were last updated in March 2017. The update covers detailed procedures for communication services during all kinds of disasters.

Going further, the Department of Telecommunications has now created an organizational structure at each Telecom Licensed Service Area (which normally corresponds to India's states), a functional role specific to disaster management empowered to implement the standard operating procedures in all Telecom Licensed Service Areas and drive emergency telecommunications at federal and state government level.

The Telecommunication Engineering Centre, the Department of Telecommunications' telecom research and standardization arm, produced a paper on disaster communications in 2008. The paper's recommendations were adopted as the department's standard operating procedures. The Centre has recently released a testing procedure for enhanced Multi-Level Precedence and Pre-Emption priority services for emergency communications.

The Telecom Regulatory Authority of India has already issued recommendations on priority call routing, the single emergency number and next-generation PPDR communication networks.

(3) ICT-based forecasting and warning networks

In line with the ongoing paradigm shift in disaster management, and with the priorities and action points of the Sendai Framework for Disaster Risk Reduction 2015–2030, the 2030 Agenda for Sustainable Development and the 2015 Paris Climate Agreement, disaster risk reduction, climate change adaptation and sustainable development are now interrelated. In India, the emphasis is now on disaster risk reduction through prevention, mitigation and preparedness. India has built up a very strong early-warning system. The country's meteorological service, the India Meteorological Department (IMD), was established in 1875. It is the principal government agency in all matters relating to meteorology, seismology and allied subjects. The IMD offers observation, data collection, monitoring and forecasting services across various sectors: monsoons, hydrology, agriculture, health, aviation, transport, shipping, cyclones, climatology, mountaineering, disaster management, etc. It offers many web-based forecast services. For example, weather forecasts, meteorological information, nowcasts and warnings are provided from IMD headquarters in New Delhi and various IMD offices. The IMD's meteorological telecommunications consist of an integrated network of point-to-point and point-to-multipoint links with meteorological centres in the country and worldwide for receiving data and relaying it selectively. The IMD also has a VSAT-based network. It has a two-tier organization:

- the Meteorological Telecommunication Network, which is part of the WMO World Weather Watch Global Telecommunication System;
- the National Meteorological Telecommunication Network.

The Global Telecommunication System, the main part of the WMO National Meteorological Telecommunication Centre, in Mausam Bhavan, New Delhi, acts as a WMO regional telecommunication hub.

The IMD is mandated:

- to take meteorological observations and to provide current and forecast meteorological information for optimum operation of weather-sensitive activities such as agriculture, irrigation, shipping, aviation and offshore oil exploration;
- to warn against severe weather phenomena such as tropical cyclones, northwesters, dust storms, heavy rains and snow, and cold and heat waves, which cause destruction of life and property;
- to provide the meteorological statistics required for agriculture, water resource management, industries, oil exploration and other nation-building activities;
- to conduct and promote research in meteorology and allied disciplines;
- to detect and locate earthquakes and to evaluate seismicity in different parts of the country for development projects.

Apart from the IMD, other Indian agencies monitor and provide early warnings of disasters:

- the Central Water Commission of the Ministry of Water Resources (floods);
- the ISRO National Remote Sensing Centre, which provides all manner of space navigation services;
- the Geological Survey of India (landslides);
- the Ministry of Earth Sciences, via the Indian Tsunami Early-Warning Centre at the Indian National Centre for Ocean Information Services, Hyderabad (tsunamis);
- the Snow and Avalanche Study Establishment (avalanches).

Indian early-warning agencies send important information derived from satellite-based sensing data to neighbouring countries and to several similar agencies in the Indian Ocean and Asia Pacific region. The Indian early-warning system is also part of the WMO World Weather Watch Global Telecommunication System.

(4) Mapping and hazard zones

The ISRO National Remote Sensing Centre, together with other organizations such as the Geological Survey of India, the Bureau of Indian Standards and OPCW, has produced maps dividing India into zones on the basis of hazard vulnerability. The maps are specific to an area's hazard profile. The maps are very useful for pre-disaster planning, prevention and mitigation, and mainstreaming of disaster risk reduction and development planning activities. They are also used to implement building by-laws.

(5) Bhuvan data discovery and metadata portal

Bhuvan is the ISRO geoplatform providing an extensive range of services based on Geological Survey maps. The portal, which was developed by the ISRO National Remote Sensing Centre, is meant to:

- improve access to and integrated use of spatial data and information;
- support decision-making;
- promote multidisciplinary approaches to sustainable development;
- enhance understanding of the benefits of geographic information.

It is being extensively used for disaster risk reduction. It also helps pinpoint the location of events. For example, forest fires can be quickly located and remedial action taken thanks to this geo-portal. Details of the various disaster services on offer are available here.

A1.1.3 Emergency telecommunications under Haiti's Sectoral Working Group (Haiti)[22]

(1) Disaster management in Haiti

In Haiti, disaster management is entrusted to the Civil Defence Directorate (*Direction de la Protection Civile*, or DPC), which is under the authority of the Ministry of the Interior and Local Government Authorities. The DPC receives support for natural disaster management from many other State bodies and private and international institutions.

In addition to planning and coordinating relief activities, the DPC also manages a UHF telecommunication network to facilitate communication between the different bodies involved in the disaster-management process. For field telecommunications, the DPC relies on the support of the National Telecommunication Council (CONATEL) to mobilize all telecommunication/Internet operators and broadcasters. CONATEL's responsibilities in terms of emergency telecommunications are as follows:

- coordinate with telecommunication operators with a view to ensuring availability of telecommunication networks for relief operations;
- issue alerts via radio and television stations;
- activate and distribute satellite telephones to government officials for the coordination of relief operations;
- coordinate the deployment of telecommunication systems with ITU.

(2) Regulator's emergency telecommunication plan of action

The regulator's emergency telecommunication plan of action involves the following:

- coordination with the DPC, mobile operators, Internet access providers, and radio and television stations for emergency alerts to the public;
- ensuring the resilience of mobile operator, Internet access provider and radio and television station networks;
- coordination of assistance from ITU and other international organizations for emergency telecommunications;
- advocacy for the adoption and implementation of a national plan for emergency telecommunications;

22 ITU-D Document SG2RGQ/121 from Haiti.

- introduction of a mechanism for the efficient and optimal use of telecommunication resources during emergencies.

(3) Role of telecommunication/Internet operators and broadcasters

Telecommunication operators and Internet access providers have the following responsibilities:

- provide telecommunication services in disaster-affected areas;
- issue emergency alerts at the DPC's request;
- offer calls free of charge to persons living in disaster-affected areas.

Radio and television stations are supposed to broadcast alerts to disaster-affected populations.

(4) Support from international organizations

ITU provides appropriate support to Haiti during emergencies. Its interventions take two forms:

- deployment of emergency telecommunication equipment to facilitate communication among relief teams;
- distribution of satellite telephones to government officials for the coordination of relief activities.

Several other international NGOs, either established in Haiti or arriving specifically for emergencies, deploy their telecommunication equipment to support DPC activities.

(5) Projects under way

There are currently two emergency telecommunication projects under way.

Haiti does not yet have an integrated emergency telecommunication system. It has therefore been decided to establish a sectoral committee on emergency telecommunications (*Comité sectoriel sur les télécommunications d'urgence*, or COSTU), charged with coordinating sectoral responses, in accordance with the national disaster and risk management plan. COSTU was set up with a view to using telecommunications and ICTs to enhance the coordination of disaster prevention, preparedness and response.

COSTU reflects an ongoing commitment bringing together the Ministry of Public Works, Transport and Communications, through the participation of CONATEL, and the Ministry of the Interior and Local Government Authorities, through the participation of the DPC. It demonstrates the Government's determination to strengthen disaster prevention, preparedness and response measures through joint planning and to take advantage of the essential role of telecommunications in this regard.

COSTU's terms of reference include the following elements:

- mission and functions
- composition
- operating mechanisms
- task descriptions
- financing arrangements
- expected outcomes
- follow-up and assessment mechanisms.

WFP and the GSMA contributed to work leading to the establishment of the sectoral working group on emergency telecommunications.

The second project concerns the introduction of an early-warning system to issue public alerts in the event of a disaster. The system is designed to operate on mobile telephone operator networks. Arrangements are being made for it to be installed on the networks of the country's two mobile operators. The system, which will be provided by Microimage, receives assistance from the GSMA and is financed by the World Bank.

A1.1.4 Emergency Telecommunications Preparedness Checklist (WFP)[23]

As disasters continue to increase in frequency and scope across the world, and ITU-D Question 5/2 considers the critical role of how communication policy-makers can help enable emergency telecommunications in disaster preparedness, mitigation, response and relief, the WFP-led Emergency Telecommunications Cluster and ITU-D have jointly developed the Emergency Telecommunications Preparedness Checklist. The checklist examines key thematic areas that could be considered for inclusion in an NETP and provides a simple scoring approach to assess the state of progress on each decision point or action over time. It primarily supports the establishment and refinement of NETPs, with a focus on understanding national readiness to enable response communications in a disaster. It also identifies targeted areas that may require attention. For a more detailed listing of potential questions that communications authorities may ask when drafting an NETP, please refer to the Emergency Communications Checklist.[24]

A1.1.5 CAP-based early warning (New Zealand)[25]

(1) Governance

The New Zealand CAP Working Group is chaired by the Ministry of Civil Defence & Emergency Management (MCDEM) and is open to anyone with an interest in promoting the general uptake of CAP, using CAP for registered alerting authority alerts and developing software or supplying hardware to support the dissemination of alerts in New Zealand.

Owing to the CAP's flexible definition of hazard levels and nomenclature, the Working Group maintains a technical standard, Common Alerting Protocol (CAP-NZ) Technical Standard [TS 04/18], to assist with CAP implementation in the New Zealand alerting context. The standard aims to provide clarity for alerting authorities on the formatting and categorization of alerts and how those alerts should then reach the public via various alerting end-points. It encompasses the Working Group's decisions, recommendations and lexicons to ensure consistency within New Zealand's alerting environment. It is reviewed annually.

The MCDEM coordinates associated task groups and working groups, which implement information systems and alerting end-points utilizing CAP concepts such as its schema, its alert gradings of certainty, severity or urgency, its distribution through alerting end-points, and the New Zealand-specific lexicons to provide common understanding of the message contents. It also coordinates the development of best-practice messaging in New Zealand for the various end-point technologies.

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23 ITU-D Document SG2RGQ/182+Annexes from the World Food Programme.
24 ITU, op. cit. (note 2), Annex A.
25 ITU-D SG2 Document SG2RGQ/145 from New Zealand.

The Working Group does not have any decision-making capacity; instead it makes recommendations to the Public Alerting Governance Committee, which considers and approves the specification documents produced by the Working Group.

The Public Alerting Governance Committee was established by the Hazard Risk Board, one of the governance boards of the Officials' Committee for Domestic and External Security Coordination[26]. It comprises senior officials responsible for public alerting and representatives of New Zealand mobile operators and the scientific organizations that monitor natural hazards.

(2) New Zealand CAP feeds

New Zealand currently has three public live feeds of alerting information in CAP format; a fourth is under development.

Earthquakes

GNS Science uses the GeoNet system to maintain a CAP feed of Modified Mercalli intensity "moderate" (MM5) or higher earthquakes occurring in the last seven days in the New Zealand region and of a suitable quality for alerting.

Severe weather

The Meteorological Service of New Zealand Limited (MetService) maintains a CAP feed of severe weather warnings and watches for rain, wind, snow and thunderstorms.

Civil defence emergencies

New Zealand has sixteen regional Civil Defence Emergency Management Groups. They have adopted the Red Cross Hazard App as their preferred mobile device application for notifying multiple hazards in their region. The Storm CMS is used to prepare these alert messages and their impact zones, and these are published as a CAP feed.

Emergency Mobile Alert

New Zealand's public alerting technology is cell broadcasting. A CAP feed is currently being developed by system provider One2many BV to publish these alerts and allow their uptake by multiple other channels, such as apps, websites and digital signage. It is expected to go live by the end of 2019.

(3) High-priority alerts

New Zealand's registered alerting authorities have agreed to use the CAP to share and disseminate their alerts and warnings. But the CAP is not just a data protocol, it is also a way of classifying alerts. Its classification criteria were used to define the scenarios acceptable for use by New Zealand's Emergency Mobile Alert (EMA) system. The cornerstone attributes of urgency, certainty and severity enable agencies to grade their alerts and make them comparable.

New Zealand has also adopted the unofficial, but widely accepted, definition of high-priority alerts. These are defined to be at level (a) or (b) within each of the following three CAP criteria:

[26] ODESC is a committee of Chief Executives that manages national security in New Zealand. It is chaired by the Chief Executive of the Department of the Prime Minister and Cabinet.

Certainty

a. Observed: determined to have occurred or to be ongoing
b. Likely: probability of occurrence greater than 50%

Severity

a. Extreme: extraordinary threat to life, health or property
b. Severe: significant threat to life, health or property

Urgency

a. Immediate: responsive action should be taken immediately
b. Expected: responsive action should be taken soon

(4) Interpretations of "certainty", "severity" and "urgency"

When designing the protocol for use of the EMA system, decision-makers responsible for issuing EMA messages requested further guidance on the CAP definitions of certainty, severity and urgency in order for them to be more useful in an operational environment.

Certainty

Likely should consider that a qualitative estimate of probability may vary by up to 30 per cent, and erring on the side of caution may be preferable in some circumstances. The desire to wait for certainty is a trade-off against allowing sufficient time for action.

Severity

Extreme applies to an emergency affecting a town, city or region:

- **life**: widespread deaths are possible; or
- **health**: widespread permanently incapacitating injuries or illness are possible; or
- **property**: widespread destruction (or rendering uninhabitable) of buildings is possible.

Severe applies to an emergency affecting rural dwellers or a small part of a suburb in an urban area:

- **life**: limited deaths (i.e. individuals or small groups) are possible; or
- **health**: limited permanently incapacitating injuries or illness are possible; or
- **property**: limited (i.e. few or very localized) destruction (or rendering uninhabitable) of buildings is possible.

Urgency

Expected: *soon* must include time for action – the minimum amount of time people could reasonably be expected to carry out the instructions in the alert. For example:

- 5 minutes: "Do not take personal belongings other than critical medication and personal documents";
- 30 minutes: "Bring in outdoor objects such as lawn furniture, toys and garden tools, and anchor objects that cannot be brought inside".

(5) Optimal warning and guidance messages

The Working Group considers the social science around public messaging to be a logical extension of its terms of reference.

A consequence of the EMA system was the need for short warning messages of 90 characters or less, in effect the CAP **headline** element. A report[27] was commissioned that provides best practice for writing short warning messages for the public to achieve a desired behavioural response. It was based on an international literature review and some preliminary results from primary New Zealand research. It focused on warnings for regional tsunamis, with additional examples for a volcanic eruption and a flood event.

In order to permit a future relaxation of the 90-character limit, and for other channels featuring short messages, the guidance is useful for up to 930 characters, the technical limit for EMA messages in New Zealand under the most favourable conditions. This upper limit typically also covers social media, short emails and electronic billboards.

Another messaging initiative has been to support the Red Cross "What Now" service. This involves adapting standard multi-hazard key action messages to a New Zealand setting, to ensure consistency, clarity and safety. For each hazard, and for up to six stages of an emergency, several short, clear action messages are promoted as being the key ones for dealing with the hazard.

(6) Trigger levels matrix

New Zealand has been using the concept of a Hazard Intensity Metric (HIM). This is one or more measures that can be calibrated against their potential impacts, including causing death, injury or illness, or property damage.

The Working Group aims to set thresholds for the three critical CAP elements (certainty, severity and urgency) that work across a variety of hazards and their HIM metrics in the setting of the broadcasting and messaging end-points through which they should be distributed. For each hazard, the responsible alerting authority is consulted on the intensities that might trigger different alerting end-point behaviours.[28] For example, an EMA is only issued for high-priority alerts.

(7) New Zealand events and event codes lexicon

Like other nations, and in line with the current OASIS (Organization for the Advancement of Structured Information Standards) CAP initiative to provide a consistent set of event codes, New Zealand is creating a table of event codes that provide more specificity to the nature of the emergency. At this time, the table is restricted to those alerts available on public feeds, primarily weather and earthquakes.

With the EMA system soon to be providing its alerts as a CAP feed, further event descriptions and event codes have to be agreed, to cover situations such as boil water notices, flooding, biotoxins, hazardous substances and criminal activities. New Zealand has looked to previous

[27] Sally Potter. Recommendations for New Zealand agencies in writing effective short warning messages. GNS Science report 2018/2.Lower Hutt, New Zealand, 2018.

[28] For weather, wind speed can be measured in km/h, or rainfall in mm/hour. For tsunamis, it could be wave height in metres, and for earthquakes, Modified Mercalli intensity. Intensity levels are less clear for perils such as pandemics.

work by Australia[29] and Canada[30] for guidance, but with this topic being considered at a global level, it is pausing now to ensure that it is aligned with the future direction for these elements. At this time, the **event code** element is not used in New Zealand.

(8) Package names

Although work has not commenced, the Working Group has identified a need to work on the standardization of "package names" describing alerts (e.g. watch, warning, bulletin, outlook). Many of these terms have long been used by the alerting authorities that issue them, and there may even be legislative implications should change be deemed desirable.

Nevertheless, it is the sentiment of the Working Group that the use of these terms should be defined more clearly and align more consistently across the impacts of hazards they describe.

(9) Conclusion

Since 2015, New Zealand's CAP Working Group has been an active committee of approximately 60 member national and local agencies, industry members from the geospatial community, and alerting app and warning system hardware manufacturers. It has provided technical guidance and an opportunity for networking and collaboration, and enjoys official government recognition of the importance of the CAP to the alerting environment.

The Working Group remains committed to supporting the worldwide CAP community and following the initiatives being spearheaded by other nations in order to ensure that the CAP is a truly global, trusted and consistent alerting protocol.

A1.1.6 ICTs in managing the effects of floods (Burundi)[31]

(1) Management of the floods in March 2019 and 2020

In March 2019 and March 2020, successive torrential rains fell in the region of Imbo and the surrounding area. The rivers which flow into Lake Tanganyika via the town of Bujumbura burst their banks, causing material damage, including the destruction of homes, loss of life and the massive displacement of the inhabitants of Cibitoke, Bubanza and the Bujumbura districts of Buterere in 2019 and Gabtumba in March 2020.

During rescue operations, the use of mobile communications saved the lives of people in danger as a result of the floods. The use of short numbers assigned to the Burundi Red Cross and the police enabled the sick to be swiftly evacuated to hospitals in Bujumbura to receive treatment.

To assess the contribution of the telecommunication/ICT sector to disaster management, the Telecommunication Regulation and Control Agency (ARCT) carried out a survey on the use of ICTs in disaster management in Burundi. The data collected revealed that the floods and landslides in Cibitoke, Bujumbura and Bubanza resulted in casualties, displaced persons and the destruction of property and personal possessions. Flooding, strong winds and landslides

[29] For Australia event codes, see: Australian Government. CAP-AU-STD version 3.0: Australian Government Standard for the Common Alerting Protocol (CAP-AU-STD) and in particular Annex 2 to CAP-AP.
[30] For Canada event codes, see: Government of Canada. Public Safety Canada. CAP-CP Event References 1.0.
[31] ITU-D SG2 Document SG2RGQ/222 from Burundi.

had also occurred in the last five years elsewhere in the country, and ICTs played a significant role in their management.

Social media were used to involve the general public, facilitate communication between population groups, raise awareness of the situation and concerns in the event of an emergency, and facilitate the response at the local level.

(2) The role of stakeholders

Geographic Institute of Burundi

The Geographic Institute of Burundi is a public agency responsible for promoting national meteorological activities for the well-being of the population. Its mission is to provide high-quality, reliable and affordable meteorological services in line with its partners' expectations. It thus plays a part in protecting property, people and the environment in general, in line with the national objective of prosperous socio-economic development.

Burundi Red Cross

The Burundi Red Cross is a key player in the population's social development. It provides a rapid response in the event of climate change-related disasters. It has been assigned a toll-free short number so that victims of natural disasters and people in need of emergency aid can call its services free of charge.

Territorial administration

Local government plays a leading role in the protection of the population and is obliged to collaborate with stakeholders involved in fighting disasters. It has a duty to carry out awareness-raising campaigns on disaster prevention and management methods, and facilitates activities on the ground in the event of a disaster within the area administered.

National risk management platform

Burundi set up a national platform to focus on disaster management in the country by Decree No. 100/016 of 8 February 2019, on the appointment of the members of the National Platform for Disaster Risk Reduction and Management. This multi-party team is responsible for disaster-related risk prevention and management, raising awareness and taking concrete action in the event of disasters.

The media

The national radio and television service of Burundi (RTNB) is a public media outlet that contributes considerably to public information. It broadcasts weather reports for the purposes of prevention and airs information and awareness-raising campaigns during and after disasters.

Telecommunication operators

Telecommunication operators play a major role, ensuring communication and interconnection in order to relay and transmit information to users. Toll-free numbers are operational and mobile telephony, operating mainly through social media, is increasingly used to transmit information before, during and after disasters.

A1.1.7 Case studies of satellites in disaster risk reduction and management[32]

(1) Case studies of satellites

There are many examples or case studies demonstrating the vital role of satellite communications in disaster risk reduction and management. The following provide a few examples:

- In October 2016, when Hurricane Matthew struck Haiti, nine days before mobile networks were restored, satellite phones helped 2 461 people across 19 communities restore family links. VSAT equipment deployed to departmental emergency operations centres (COUDs) to replace local Internet connection stayed in place for months after the event.[33]
- In 2017, Inmarsat's high-speed solution was used by Télécoms Sans Frontières (TSF) for the first time in the wake of Hurricanes Irma and Maria in the Caribbean.[34]
- In September 2018, Inmarsat satellite connectivity supported the emergency response in three regions of the Philippines battered by Typhoon Mangkhut.[35]
- In September 2018, TSF deployed a team of technicians just hours after Sulawesi Island in Indonesia was hit by a 7.5-magnitude earthquake, triggering a deadly tsunami on 28 September 2018. With medical and food supplies in danger of running out and terrestrial communications down, it was essential to establish satellite connectivity to coordinate emergency response.[36]
- In September 2019, the Bahamas was in the path of Hurricane Dorian, the most powerful storm to hit the region since records began. The Category 5 tropical cyclone destroyed entire communities and left 70 000 people in need of food and shelter. TSF used Inmarsat's satellite connectivity to set up fast, reliable communication links for aid agencies and national governments coordinating relief efforts, as well as offering victims free satellite phone calls.[37]

(2) Policy considerations: the need for reduction of regulatory barriers

Although the previous section simply serves to highlight the role played by satellites in disaster risk reduction and management with practical examples, it is worth mentioning some of the lessons learned from disasters and some of the key policy considerations to be taken into account in order to be able to fully utilize satellite communications for disaster risk reduction and management.

Some of the lessons learned from disasters include the following:

- Disaster preparedness planning is essential.

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[32] ITU-D SG2 Document 2/410 from Inmarsat (United Kingdom).
[33] Inmarsat. Latest News. TSF on the ground in the wake of hurricane Matthew. 5 October 2016.
[34] Inmarsat. Disaster Response. Reliable connectivity when seconds count; Inmarsat. Latest News. TSF deploys to West Indies as hurricane Irma batters islands. 6 September 2017; and Inmarsat. Latest News. Over 1,000 hurricane victims helped by TSF. 26 October 2017.
[35] Inmarsat. Latest News. Typhoon relief efforts aided by satcoms. 28 September 2018.
[36] Inmarsat. Latest News. TSF deploys to Indonesia in aftermath of devastating tsunami. 1 October 2018.
[37] Inmarsat. Latest News. Hurricane Dorian victims offered satellite call lifeline. 12 September 2019.

- The business of disaster response is conducted before a disaster strikes.
- Efficient coordination and network sharing by NGOs and other end users is needed.
- Frameworks for customs clearance are required.
- Well-trained first responders and media are key.
- Prepared users drive satellite usage.
- Social networking and mobility-based applications are revolutionizing disaster response.
- Data requirements on the ground are growing dramatically.
- Responders need a mix of connectivity solutions (satellite, terrestrial, hybrid, fixed, mobile) in their daily toolkit.

Some of the key policy considerations to allow satellite communications to be most effectively used for disaster risk reduction and management include the following:

- Exemption from/temporary waiver of regulations that might restrict the use of telecommunication equipment/radio frequencies during the use of such resources for disaster mitigation and relief.
- Recognition of foreign type approval of telecommunication equipment and/or operating licences.
- Exemption from regulations that might restrict the import/export of telecommunication equipment.
- Facilitating the transit of personnel, equipment, materials and information involved in the use of telecommunication resources for disaster mitigation and relief into, out of and through the disaster area.

A1.2 Disaster communication technologies

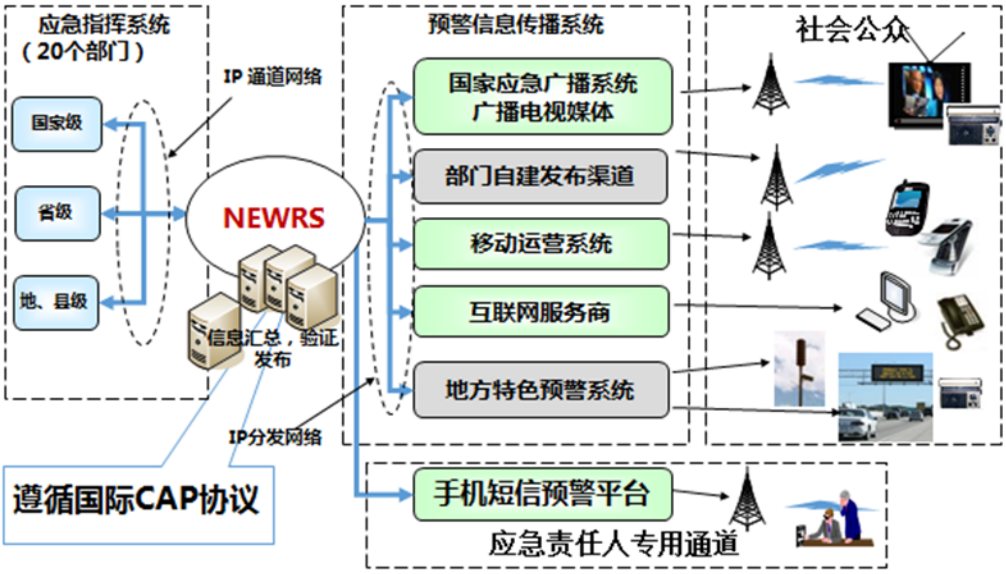
A1.2.1 Integration of space and terrestrial emergency communication network resources (China Telecom, China)[38]

(1) Introduction

Many governments around the world have recognized that cell broadcast technology can be used to deliver emergency alert notifications. China has developed public emergency alert notifications standards based on that technology that support global roaming and are compatible with standards in Europe and the United States. The emergency alert system in China is depicted in **Figure 1A**.

[38] ITU-D SG2 Document 2/158 from China.

Figure 1A: Emergency alert system in China



Legend:
应急指挥系统 20个部门: Emergency command system (20 departments)
国家级: National level
省级: Provincial level
地、县级: Prefecture and county level
IP通道网络: IP-based channel network
信息汇总、验证、发布: Information summary, verification and distribution
IP分发网络: IP-based delivery network
遵循国际CAP协议: Compliance with the CAP
预警信息传播系统: Emergency alerting system
国家应急广播系统广播电视媒体: National public alerting system
Broadcast and TV media
部门自建发布渠道: Self-built departmental dissemination channels
移动运营系统: Mobile operation system
互联网服务商: Internet service providers
地方特色预警系统: Local specialty emergency alert system
手机短信预警平台: Mobile phone SMS alerts platform
应急责任人专用通道: Dedicated channel for emergency management chief
社会公众: The general public

4G networks are being continuously improved, and it is particularly important that they be used efficiently, to ensure that mobile subscribers can receive vital emergency alert messages in time. It is strongly recommended that, for the benefit of the general public, efforts be made to develop emergency cell broadcast alerting systems based on 4G networks for use in major natural disasters and other public safety incidents such as earthquakes, typhoons and mudslides, and to ensure that 4G emergency alerting management platforms can interconnect with the existing interfaces of emergency alert management organizations.

To meet disaster mitigation and prevention needs, China Telecom has researched and developed the LTE cell broadcast technology-based multi-channel emergency alerting system. It has used the system to send emergency alert messages by concurrent mode in the shortest possible time, rendering it a vital component of the national emergency communication assurance plan. The system will be widely used in various scenarios and applications, including disaster prevention and emergency alerting.

China Telecom will further optimize its emergency alerting strategies to facilitate the inclusion of next-generation cell broadcasting in network entry standards for telecommunication equipment and will support the use of social media, including mobile Internet, to issue alerts, with a view to increasing emergency alerting capabilities.

(2) Detection and monitoring of natural disasters and other emergencies

In disaster management, IoT can be used to monitor sudden-onset natural hazards such as earthquakes and mudslides, to issue emergency alerts, and to transmit data in near real time to emergency management and command centres, thereby boosting disaster prevention and mitigation capabilities. The 3rd Generation Partnership Project has already launched a set of LTE-based narrowband IoT technologies (i.e. narrowband IOT and enhanced machine-type communication), which have expanded the LTE technology portfolio to support broader application of more energy-efficient IoT services.

To operate, conventional IoT devices rely on terrestrial communication networks, which can be easily damaged or destroyed in a severe natural disaster. Satellite IoT can compensate for that weakness. Extensive coverage, resistance to destruction and flexible network construction have together made satellite IoT irreplaceable for real-time monitoring of large areas impacted by a natural hazard.

China Telecom already has the ability to monitor and report on various natural hazards in real time using 4G IoT. It can provide end-to-end solutions, from data collection in earthquake zones to 4G-network coverage and transmission, and then to back-office processing and analysis. In 2017, in partnership with the China Earthquake Administration, China Telecom uploaded seismic data from an earthquake-affected region to a cloud platform via its IoT Link card. The monitoring data were mainly obtained from measurements of earthquake intensity, which are then used to analyse the earthquake's vibration process and real-time scenarios. Such data supplement those collected by professional seismic stations and provide a basis for decision-making and prediction.

In addition, China Telecom has used its exclusively operated satellite mobile communication system platform to provide satellite IoT applications and services, and expanded coverage of IoT monitoring applications thanks to satellite IoT terminal devices. Monitoring and detection operations focus on river water levels and discharge; sediment concentrations; environmental and atmospheric conditions; cereal pests and diseases; forest fires; seismic data; natural gas production and operations; water leakages; mudslides; avalanches; wind speed and direction; and rain and snowfall.

(3) Emergency communication exercises

It is recommended that more efforts be made to conduct cross-sector and -regional emergency communication exercises by various means, including table-top exercises, full-scale exercises and functional exercises, so as to increase synergy and interconnection, operability and continuity, and to build a specialized emergency communication support team characterized by professionalism, dedication and supportiveness.

China Telecom has conducted a number of special emergency communication exercises covering various disaster recovery scenarios. The exercises feature a national specialized emergency communication support team, include programmes such as "Building a Front-line Command System", "Emergency Relief Communications Support" and "Public Network Communications Support", and demonstrate China Telecom's integrated air/ground ICT applications and cross-sector emergency communication capabilities in times of natural disaster or other emergency. Apart from deploying conventional services related to emergency communications (e.g. Tianyi (Skywings) Walkie-Talkies, satellite phones, 4G individual communications and a variety of emergency vehicles), the exercises also involve new services, such as the new generation of narrowband IoT, big-data and visual dispatch systems, and new equipment, including helicopters, mooring UAV and airborne balloons.

(4) Emergency communication command and control capabilities

An emergency communication command and control system is an integrated emergency command and control platform that integrates such functions as presentation, dispatch, deployment, dial testing and intelligent analysis.

(5) Building airborne emergency communication platforms

Built to meet the needs of three-dimensional wireless coverage, airborne emergency communication platforms consist of mooring UAVs, wireless broadband access systems, 3G/4G trunked emergency communication systems, air safety protection systems, high-definition video live broadcast systems, airborne lighting and call systems, etc.

Airborne emergency communication platforms are used in emergency zones to facilitate disaster recovery and assistance in major public safety incidents and other important events. They serve to set up wireless broadband access and 4G mobile communication and trunked communication service networks, provide users in the field with mobile and data communication services, and transmit dynamic information to back-end command and control centres. China Telecom has already developed its airborne emergency communication platform specifications and can provide the relevant solutions and services, the application scenarios of which include the following:

- Emergency communications in isolated areas without access to communications: In areas devastated by natural hazards such as earthquakes, typhoons, floods or fires and in which emergency operations are ongoing, satellite communication access systems, ad hoc mesh networks and portable 2G/4G mobile communication access systems are set up and speedily activated, in order to provide government, corporate customers and the general public with emergency mobile communication and natural disaster surveillance services.
- Emergency communications at hotspots: At communication hotspots such as cultural, sports or business events at which emergency operations are ongoing, satellite communication access systems or optical transmission access systems, ad hoc mesh networks and portable 2G/4G mobile communication access systems are set up and speedily activated to provide the media, government, business customers and the general public with emergency mobile communications and data communication services.
- Emergency communications for emergency command and control: At cultural, sports or business events and at major public safety incidents at which emergency operations are ongoing, satellite communication access systems, ad hoc mesh networks and portable 800 MHz digital trunked communication access systems are set up and speedily activated to provide police forces and public safety agencies with critical digital trunked communication services.

A1.2.2 Intelligent emergency telecommunication management (China)[39]

(1) Upgrading emergency telecommunication command and control systems utilizing Internet+ cloud computing and big data

In many parts of China, attempts have been made to apply the Internet+ to the development of emergency telecommunication command and control systems. For instance, the Shanghai communication industry has used the Internet+ to reinforce its development of the command and control system covering emergency communication vehicles, emergency support supplies and response teams. In combination with digital maps, emergency-related data such as emergency support mission statistics, emergency telecommunication vehicle utilization rates, emergency service statistics, emergency response teams and emergency support equipment have been included in the command and control system. The system enables closed-loop management of satellite resource applications and allocation and approval of material reserves. It can be easily and speedily operated via mobile apps, significantly increasing emergency response efficiency.

(2) Using big data to analyse people flows and network traffic in hotspots

Through the integrated use of Internet and big-data processing technologies, valuable information can be drawn from massive, scattered, unstructured and constantly changing data relevant to the emergency, so that the associated macro environment can be analysed and understood, and the incident's development profile can be obtained in a timely and efficient manner to support scientific decision-making.

In public safety incidents, emergency alerts can be issued using data analytics and the Internet. Big data can be used to analyse the network access and transportation modes of mobile subscribers during major conferences and exhibitions, on holidays and during festivals, in order to predict and identify areas with high-moving crowd densities or large people flows during peak hours. Data on large crowds and flow trends are used as reference information by organizers, who can then notify people in areas at high risk of a safety-related incident via mobile Internet and avoid human stampedes and crushes.

In Shanghai, where mobile Internet is flourishing, people-flow monitoring, mobile Internet perception in key areas and an analytical platform were built based on big-data analytics of 2G/3G/4G cell service statistics. The relevant analytical results are displayed in such a way as to make it easy for emergency command centres to allocate resources, dispatch personnel and troubleshoot. In abnormal field situations, the platform can identify problems before mobile subscribers perceive them, enhancing safety in mass gatherings. Similar systems developed to analyse mobile service data targeting in key areas and hotspots provide information on the total number of people (mobile subscribers), popular apps, people flow, etc.

(3) Using Internet communication tools to support emergency responses

In recent years, Internet instant messaging tools such as Wechat and QQ have also been widely used in China. They are highly efficient, fast and convenient to use for assigning emergency tasks, reporting and delivering information, etc.

In the aftermath of a major disaster in Japan, social media such as Twitter and Facebook were widely used for rescue operations and to attract donors. According to a survey conducted

[39] ITU-D SG2 Document 2/159 from China.

after the disaster, social media had an outstanding impact on the transmission of information, spreading news of disaster recovery facilities and materials much more quickly, accurately and reliably than traditional channels of communication. Widely distributed cell broadcasts and dedicated message recordings played a significant role in providing locally generated information, including on the location of emergency food and water supplies, delivery time and location of disaster recovery supplies, and psychological counseling services.

Another example is Facebook Disaster Maps. People using the Facebook app with the location service enabled receive regular information on the longitude and latitude of their position. When gathered and de-identified, such geological location data can be a source of post-disaster information. Facebook data-set types include movements of people, crowd density and Facebook Safety Check information collected after the disaster.

(4) Increased smart-city capabilities facilitate the development of intelligent emergency telecommunications

Apart from introducing new generations of ICTs to emergency telecommunications via the conventional telecommunication industry, countries around the world have shown great enthusiasm about the application of ICTs in the emergency management sector. In a 2018 report,[40] consulting firm McKinsey and Company noted that one key aspect of building smart cities is using digital technologies to improve emergency telecommunications. With more comprehensive, real-time and dynamic data, emergency response services are able to monitor emergency incidents closely and understand the changing models of needs. They are therefore able to implement emergency response plans more speedily and more cost-effectively. Emergency technological systems and emergency efforts that can be linked to the development of smart cities include at least the following: disaster early-warning systems; emergency response optimization (i.e. back-office call processing and field operations such as the strategic deployment of emergency vehicles); personal alert applications (transmitting emergency alerts such as location and voice data to emergency response services or loved ones) and smart monitoring of the operation zone. According to McKinsey and Company's analysis of research data on a large number of cities around the world,[41] cities can cut emergency response times by 20 to 35 per cent on average by deploying new types of smart applications (e.g. smart systems to optimize call centres and field operations; traffic signal pre-emption to clear lanes for emergency vehicles). More mature cities with an already low response time of eight minutes can shave almost two more minutes off by doing smart-city upgrades and retrofits. Less-developed cities starting with an average response time of 50 minutes might be able to trim that by at least 17 minutes by introducing new types of smart applications.

(5) Accelerated integration and development of next-generation ICTs and emergency telecommunications

The future will see an accelerated integration of next-generation ICTs such as big data and AI into emergency telecommunication systems. With the expedited restructuring and rapid iterations of core technological systems, including new generations of hardware, software and services, future emergency telecommunication technological applications will experience

[40] McKinsey Global Institute. Smart Cities: Digital Solutions for a More Livable Future. McKinsey and Company, June 2018.

[41] The sample comprised 50 cities around the world that had already developed or announced ambitious smart-city development plans and were selected for their overall representativeness in terms of geographical coverage, differences in income levels, population density and infrastructure quality.

an increasingly manifest trend of integration and innovation. Thanks to the accelerated convergence of emergency telecommunication networks and edge computing technologies that promote and support self-perception, self-decision-making, self-optimization and self-execution, the blockchain technology that supports multiple party and reliable data storage and exchange capabilities, and virtual/enhanced reality technologies that support three-dimensional intuitive display, new types of emergency telecommunications featuring such newly emerged key elements as emergency status perception, data processing and immersive telepresence will expedite the realization of smart command and control, network control and maintenance, smart dispatch of work order tasks and smart reserves, and will help deliver opportunities for a new industrial ecosystem.

In the new development stage, with new features including physical integration of information, ubiquitous intelligence and computing, resilient platform components, data-centered operations, emergency telecommunications will enter a completely new track of smart development, embracing a historic turning point marked by capability upgrades in all dimensions. An integral part of emergency management, emergency telecommunications provide important tools for disaster mitigation and prevention. In the past, people tended to be concerned about the response times and capabilities of emergency telecommunications in the aftermath of a disaster. To a great extent, however, emergency telecommunication services should focus more on emergency preparedness. Turning disadvantages into strengths, building highly efficient emergency alert systems, delivering emergency alert messages to the public in a timely and effective manner, enhancing disaster prevention and mitigation capabilities, and improving emergency response capabilities at all levels of emergency management agencies – these are the future trends in emergency telecommunications.

A1.2.3 Emergency communication services and networks (China)[42]

(1) Overview

China suffers frequent natural disasters and therefore has a highly developed form of natural disaster prevention and response. On the other hand, state-level super-large-scale activities, sports events and so on make the task of emergency communication increasingly onerous. Whether for natural disasters or public incidents, emergency communication support has become increasingly important and urgent, raising the bar for the development of emergency communication services and networks.

(2) Current networks for emergency management in China

At present, the existing emergency communication network includes public communication networks, private networks, satellite networks, and so on.

1) Public communication networks: The existing public fixed telephone and mobile networks play an important role in emergency communication support, but find it difficult to meet all needs in emergency situations. For example, it is difficult to ensure call priority for voice communications amid the sharp increase in the number of calls during an emergency, resulting in network congestion. In the special circumstances of emergencies, it is difficult for public networks to guarantee that the need for efficient cluster scheduling capabilities will be met.

[42] ITU-D SG2 Document SG2RGQ/183 from China.

2) Private networks: Emergency communication has strict and special requirements. During a critical emergency response, when the public network cannot meet emergency communication requirements, emergency communication capability must be boosted through the private wireless communication network.

   The international community has reached a consensus that government emergency response command and dispatch communications should essentially rely on dedicated wireless systems. Currently, private wireless network technologies include:

   - analogue narrowband technology: analogue voice technology, providing only voice services;
   - digital narrowband technology: digital speech coding and channel coding can provide voice services and narrowband data services, but not real-time video or integrated data query services;
   - B-TrunC technology: LTE-based wireless broadband trunking technology can provide broadband data services such as voice services, real-time video and positioning;
   - in the long run, digital narrowband networks and wireless broadband B-TrunC networks will coexist and interconnect.

3) Satellite communication networks: Communication via radio waves from satellites to relay stations has the advantage that it is not damaged during natural disasters. Satellite systems such as Tiantong and BeiDou are currently used in emergency communications.
4) Ad hoc network technology: Although ad hoc networks do not have large-scale networking capabilities, they have unique mesh capabilities that can be used as a supplementary technology for emergency rescues in wilderness areas, temporary basements and high-rise egress routes.

In addition, although China's telecommunication network has matured, its coverage is still relatively limited. Many areas prone to natural disasters and emergencies, such as oceans, mountains and deserts, have not yet achieved ground network coverage. Therefore, other communication modes, such as satellite and private communication networks, also play a very important role in emergency communication and support.

(3) Analysis of key service requirements for future emergency communications

Future emergency communication services have the following key service requirements:

1) *key voice*: The business that the emergency communications must guarantee;
2) *real-time video*: Real-time video from cameras or through UAV transmission can show the scene in real time;
3) *multimedia messaging*: Transmission of drawings, maps, etc., of the scene, fire, etc.;
4) *remote database access*: To query emergency materials information, vehicle information, personnel information, plans and so on, remotely;
5) *indoor and outdoor positioning and flow tracking*: Realizing real-time situational awareness of personnel, vehicles and materials;
6) *interconnection*: Interconnection with broadband trunking, narrowband trunking and other networks.

In order to meet the above requirements, emergency communication networks must have broadband, security/isolation, an ad hoc network, priority guarantees, fast trunking communication capabilities, high reliability, portability, and unified dispatch and command characteristics.

(4) Research on the development of new emergency communication technologies

In the future, emergency communication systems will be comprehensive information systems integrating network technologies such as private networks, public mobile networks and satellite networks, able to unify dispatch and command, and to coordinate various departments to play an effective emergency role. Development support is moving in that direction, as described below.

- In order to meet the growing demand for mobile broadband for emergency personnel, advantage should be taken of mature LTE technology in public networks and user scale efficiency to reduce costs, encourage standard research and development of key LTE technology supporting tasks and promote support for LTE-based technology.

  1) Emergency communications can be delayed by damage to public infrastructure on the ground. In order to solve that problem, and to meet the need for large-capacity critical mission communication support in the incident area, regional emergency communication systems based on low-altitude platforms positioned near the ground are being studied and developed.
  2) In order to provide priority services for key tasks in the public network after the IP architecture network has been fully developed, standards and solutions are being studied and developed for emergency priority services in next-generation networks.
  3) Emergency communication scenarios are being studied to take advantage of 5G broadband, low latency and high reliability.

The 5G standard is constantly improving. There are still many key technologies that need to be urgently improved with a view to ensuring reliable access to emergency communications at any time, anywhere: multimedia multicast broadcasting service, enhanced security capability, end-to-end network visualization, integrated emergency command and dispatch capability, and base station non-core network working mode in emergencies.

5G plays a very important role in promoting the development of emergency communication towards broadband and intelligence. The three main 5G application scenarios – enhanced mobile broadband, ultra-reliable and low-latency communications, and massive machine-type communications – meet most emergency communication business needs for large bandwidth, low latency and high reliability. They have the potential to enhance emergency communication rescue and comprehensive emergency support capabilities, with a view to achieving a new level of emergency management.

Research is currently being carried out on the potential demand for 5G, the relevant business model and the technical support required for its use in emergency response. Various characteristic 5G+ emergency applications have been deeply excavated and incubated, including 5G+ monitoring and early warning, 5G+ safety production, 5G+ fire prevention and 5G+ emergency dispatch. In addition, some operators have 5G-equipped emergency communication vehicles.

It is anticipated that private networks and 5G public networks will work together in the future to provide guaranteed communication services for emergency management. Combinations of public and private networks will result in three-dimensional guaranteed emergency communication networks featuring space-Earth integration and interoperability, and will adapt and match emergency guaranteed communication systems.

A1.2.4 The role of social media platforms (India)[43]

(1) Artificial intelligence for disaster response

The huge volumes of real-time information generated through crowdsourced data sharing can be used, with the help of AI-based data analytics, to predict important outcomes required for response and relief. AI is the simulation of human intelligence processes by machines, especially computer systems. The processes include learning (the acquisition of information and rules imbibed in the form of algorithms for using the information), reasoning (using rules to reach approximate or definite conclusions) and self-correction. Several new and recent smartphones also have hardware optimized for AI. Machine learning is defined as the ability of machines to learn automatically by using AI. It involves the creation of algorithms that can modify themselves without human intervention or without being explicitly programmed to produce learning output. This is achieved by analysing structured data fed to a machine's algorithms. The learning process thus involves observing, processing and analysing data, and acting accordingly.

The potential opportunities and benefits of machine learning and AI have been leveraged by the Artificial Intelligence for Disaster Response platform, which uses machine learning to analyse data on natural and man-made disasters collected from tweets in real time and automatically. It is accessible to all those involved in disaster response.

(2) Social media platforms and disaster management

Social media analysis is the process by which huge volumes of data, for the most part semi-structured or non-structured, are collected from social media sites and analysed. The process uses various machine-learning algorithms, such as decision trees, support vector machines, random forests, Naive Bayes classifiers, logistic regression and the Artificial Intelligence for Disaster Response platform. These algorithms analyse the data, generate outcomes therefrom and help visualize the outcomes precisely and as desired. The resulting information can be used for search-and-rescue operations and for post-disaster triage, relief and rehabilitation. Many AI and machine-learning tools focus on how social media updates provide incident indications and contribute to situational awareness.

(3) Utilization of social media platforms for managing disasters in India

Case 1: Kerala floods

The southern Indian state of Kerala was hit by the worst floods in a century on 16 August 2018, the result of unusually high rainfall during the monsoon season. All 14 of the state's districts were placed on red alert. Around one million people were evacuated, mainly from Chengannur, Pandanad Edanad, Aranmula, Kozhencherry, Ayiroor, Ranni, Pandalam, Kuttanad, Malappuram, Aluva, Chalakudy, Thrissur, Thiruvalla, Eraviperoor, Vallamkulam, North Paravur, Chellanam and Palakkad. The National Disaster Relief Force was deployed alongside the Indian Army and Navy to conduct intensive search-and-rescue operations. During the floods, thousands of people took to social media platforms via mobile phones to coordinate search, rescue and food distribution efforts, and to reach out to people who needed help.[44]The National Disaster Management Authority and the state government, for their part, used a CAP-based warning system to send

[43] ITU-D SG2 Document 2/269 from India.
[44] Nikita Mandhani. How Indians are using social media to help flood-hit Kerala. BBC.com. BBC News Delhi, 20 August 2018.

alerts to mobile users. Social media were extensively used to provide information about those stranded in different parts of Kerala who needed access to relief.

As part of its coordinating efforts, the state government took to social media to share information about donations to the Chief Minister's Distress Relief Fund.[45] As the scope of the disaster became clear, it reached out to software engineers from around the world, asking them to join the state government-run Information Technology Cell to create a website. The website allowed volunteers who were helping with disaster relief in Kerala's many flood-affected districts to share the needs of stranded people so that the authorities could provide a timely response. The volunteers comforted the victims in emergency operation centres. People joined social media groups with hundreds of members who were coordinating rescue and relief efforts. They were able to reach people marooned at home and faced with medical emergencies. A team of volunteers called the Kerala Designers Collaborative compiled vital information in the form of infographics on anything from post-flood car maintenance (check for lizards and venomous snakes, and remove moisture content from the lights) to burying animal bodies to prevent the spread of disease. The infographics were very useful and were translated into five Indian languages.[46]

Similarly, a fraternity of mechanical engineering students at a government-run engineering college at Barton Hill in Kerala created a group called Inspire. The group built over 100 temporary power banks and distributed them among those unable to contact their families in flood-affected areas and relief camps. A power bank could boost a mobile phone's charge by 20 per cent in minutes – a critical feature for people without access to electricity. The authorities agreed to distribute the power banks, wrapping them in bubble wrap and airdropping them into areas where people were marooned. As the waters receded, ordinary citizens tweeted about where to go for free medical care and other services.[47] Charity organizations used their websites to collect donations for relief kits.

Case 2: Use of social media during the Chennai flood

Between October and December 2015, the southern Indian state of Tamil Nadu received 90 per cent more rainfall than during a normal monsoon season, because of El Niño. The state capital, Chennai, received more rainfall than at any other time in this century. The flood caused severe damages, made even worse by poor urban planning and drainage systems. An estimated 500 or more people were killed and 1.8 million displaced, with huge economic losses ranging in the thousands of millions of rupees. The Indian Army and Navy were deployed in the city for search-and-rescue operations, Chennai airport was closed and several other transport facilities in the city came to a standstill. During this testing time, people used social media extensively to connect to the outside world.[48]The calamity brought out thousands of helping hands. Chennai residents took to social media to offer their homes to strangers seeking shelter from the rain and floods. #ChennaiFloods and #ChennaiRainHelps were used by victims and volunteers alike to find/offer shelter, food, transport and even mobile phone recharges, share government helpline numbers, provide information on NGOs offering help, etc.

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45 Scroll.in. As Kerala battles flood, social media helps connect anxious relatives, coordinate relief efforts. 17 August 2018.

46 Kamala Thiagarajan. How Social Media Came to the Rescue after Kerala's Floods. npr.org, 22 August 2018.

47 Ibid.

48 Scroll.in. #ChennaiRainsHelp: How a flooded city is using Twitter to lend a hand to strangers. 2 December 2015.

Case 3: Fighting drought with the help of the Internet of Things

A Hyderabad-based start-up has offered technology-based solutions in crucial sectors such as agriculture, water management, education and smart-city planning.[49] It has built a water resources information and management system for India's southern states. Its website enables the public to view information on rainfall, ground water, reservoirs – major, medium and minor – soil moisture, rivers and streams, irrigation canals and environmental factors like temperature, humidity, sunshine and wind speed. The technological solutions offered are powered by IoT devices such as automatic weather stations, ground water sensors, and reservoir and canal level sensors, backed up by satellite-based imagery and manual data. As a result, all data relevant to water are available on one platform and presented in real time for all the water-related assets of a large state, county, district or block. Information on water stress mitigation is also available. The AI-based system is being trained to learn and produce effective results. The application uses the same data to produce village water budgets on the basis of village water supply and demand. The water budgets make villagers aware of their water sources, impending water crises and water stress mitigation possibilities, helping to fight droughts.

Case 4: Using AI to enhance crop yield

The International Crop Research Institute for the Semi-Arid Tropics, a non-profit, non-political agricultural research organization for development in Asia and sub-Saharan Africa, has developed a sowing app that uses AI, cloud machine learning, satellite imagery and advanced analytics to help smallholder farmers increase their incomes through higher crop yields and greater price control.[50] The app helps farmers gauge the right time to sow their crops, using an AI-based study of climate data collected over 30 years in the Devanakonda area of Andhra Pradesh. The Moisture Adequacy Index (MAI) is the standardized measure used to assess whether rainfall and soil moisture will be adequate to meet the water requirement of crops. The real-time MAI is calculated from the daily rainfall recorded and reported by the Andhra Pradesh State Development Planning Society. The future MAI is calculated from weather forecasting models. Sowing advisories are issued accordingly; they indicate an optimal sowing date, the need for soil test-based fertilizer and farmyard manure, seed treatment, optimum sowing depth, etc. This AI-based sowing advisory leads to 30 per cent higher yields and helps farmers exercise better price control.

A1.2.5 Delivering communication services to disaster zones (China)[51]

(1) Integrating UAV and wireless communication technology

In recent decades, wireless communication migrated rapidly from voice-dominated 2G to data-dominated 3G and 4G. It is now entering the 5G era, which is characterized by the Internet of Everything. In the past, wireless signals mainly covered people and objects on the ground, without aerial coverage specifically designed for UAVs. Low-altitude digitization is therefore a treasure to be explored. UAVs have been partially networked in 4G networks.

Mobile networks continue to offer people greater choices in terms of means of communication and daily life; they also enable the digital transformation of all industries, improving operational

[49] See The Economic Times website.
[50] Microsoft. Microsoft Stories India. Digital Agriculture: Farmers in India are using AI to increase crop yields. Microsoft News Center, India, 7 November 2017.
[51] ITU-D SG2 Document 2/277 from China.

efficiency and service quality. The brand-new 5G network architecture represents another leap in network performance, providing over 10 Gbit/s of bandwidth, millisecond latency and ultra-high density connection. ITU proposes three 5G scenarios: enhanced Mobile Broadband, ultra-reliable and low-latency communications, and massive machine-type communications. Compared with 4G networks, 5G networks are better able to meet the communication needs of most UAV application scenarios. Networked UAV will drive the application upgrade of multiple scenarios.

The integration of 5G cellular mobile technology and UAVs makes what was once inconceivable possible. To satisfy future needs for more automated and intelligent UAV applications, such as autonomous flight and flight in formation, greater demands will be made of mobile communication network capabilities.

(2) Demand analysis of UAV emergency scenarios

1) In the event of a natural disaster, UAVs can quickly put high-altitude base stations in place to restore communication functions (voice and data).

Traditionally, emergency communication vehicles are used temporarily to ensure communications when earthquakes, floods, mudslides and other natural disasters cause large-scale disruptions. However, such vehicles provide relatively limited service coverage and have weak signal stability, owing to limitations in technology, hardware and other factors; it may even be impossible to transport them to the central disaster area if roads collapse or are congested. This traditional way of setting up emergency communication stations and restoring base stations is therefore inefficient, costly, difficult and time-consuming. The maturity of UAV technology and its integration into emergency communication systems make it a new, faster and more convenient way for operators to restore communications in disaster areas.

2) During major sports events when traffic increases sharply, UAVs help ensure uninterrupted communication, build networks and provide aerial video footage.

(3) UAV emergency communication mode

1) Tethered UAV + high-altitude base station

Tethered UAV systems are powered from the ground and raised to a UAV take-off platform by a tethering cable capable of uninterrupted flight. Once the UAV aerial base station is working, ground power-generating devices supply power to the tethered system and the onboard remote radio units. The onboard units communicate with the emergency communication vehicles via ground baseband unit devices using the fibre-optic line of the tethered system, and the emergency communication vehicles can connect to the nearby base station tower via microwave devices, optical fibre or satellite communication vehicles, and then relay the signal to the core network to achieve mobile signal coverage. The impact of terrain on the electromagnetic wave is thus effectively dealt with and continuous coverage guaranteed in a certain area.

UAV emergency high-altitude base stations can cover up to about 50 square kilometres and provide instant messaging service to thousands of mobile phone users simultaneously. Capable of climbing quickly to between 50 and 200 metres, they can provide 24-hour uninterrupted VoLTE and other data services to disaster areas.

In a natural disaster, tethered UAVs used in combination with aerial base stations can quickly restore onsite communications, address the problem of signal coverage in emergency situations and effectively improve the emergency communication support capability of the government and operators in response to natural disasters.

Tethered UAVs, which can stay in the air for long periods and carry large payloads, can be used in conjunction with high-altitude searchlights and loudspeakers to provide high-altitude illumination over large areas to support rescue operations at night. Loudspeakers facilitate command and coordination of people onsite, message broadcasting and other similar tasks, and improve the level of hardware support onsite. Using a mount-and-drop mechanism, UAVs can carry rescue items into areas too difficult and dangerous to access at short notice and with a heavy load.

The mobile phones of people trapped in an area covered by a UAV base station will be automatically connected to the onboard base station, which will send the user's international mobile subscriber identity number and current geographic information in graphical form to the search-and-rescue teams in real time.

This all-new emergency communication method aims to solve the problems of slow device deployment, high cost and poor environmental adaptability. It features quick response capabilities, is easy to operate, provides flexible coverage, can be airborne for long periods and is readily scalable.

2) Fixed-wing UAV + high-altitude base station

Large fixed-wing UAVs carrying mobile communication base stations and satellite communication systems, when flown to a target area, can provide stable continuous mobile signal coverage over a long period (not less than 24 hours) in an area of more than 30 square kilometres, thus restoring communications in no time and reducing loss of life and property in the disaster area.

A networked fixed-wing UAV equipped with an orthographic camera and a photoelectric pod can be used to obtain the GIS data needed for rapid data transmission and efficient generation of a three-dimensional map of an earthquake area, providing a basis for rescue decisions.

During single-soldier system drills, ground advance teams can report key rescue information, send back real-time video and images, and quickly dispatch rescue personnel and equipment based on the GIS data, effectively improving the timeliness and accuracy of emergency rescue operations.

(4) UAV emergency communication: next steps

Standard-setting is one of the challenges facing UAV emergency communications. China is developing technical requirements for the emergency communications of high-altitude base stations with tethered UAVs. In addition, since ordinary base stations provide mainly ground coverage, UAVs need special base stations for aerial coverage. 5G UAVs currently rely on the general 5G Customer Premises Equipment used to convert 5G signals to Wi-Fi signals for communication; in the future, dedicated terminals and 5G communication modules will be needed to improve integration.

Meanwhile, China has issued successive series of regulations on UAV production, sales and flight. Regulations concerning the transaction process include the Regulations on the Management of Real-name Registration of Civil Unmanned Aircraft and the Interim Regulations on the Management of Unmanned Aircraft Flight (Draft for Comments). The difficulties related to flight plan applications, the complicated procedures involved and other issues are expected to be resolved following the establishment of a comprehensive UAV regulatory platform. In terms of corporate operations, the Management Measures for the Operational Flight Activities of Civilian Unmanned Aircraft (Interim) have greatly simplified the entry requirements for unmanned aircraft operating licenses, retaining only basic licensing requirements such as corporate legal persons, real-name registered unmanned aircraft, certified training capabilities (for enterprises in the training category) and ground third-party liability insurance.

A1.2.6 Locally Accessible Cloud System (Japan)[52]

(1) Background

Every year, the global community faces numerous disasters, including earthquakes, typhoons and floods. Such disasters often damage social infrastructure like telecommunication networks, electric power distribution networks and transportation systems, severely disrupting the lives of people.

When disasters occur, telecommunication networks may be damaged. Base stations for mobile communication services, access network cables, communication equipment and even communication buildings can be damaged in large-scale disasters. The damages cause outages of telecommunication services including not only fixed/mobile telephone services, but also Internet services and any other services delivered over the Internet. To address this issue, movable and deployable ICT resource units have been proposed and standardized. Their chief objective is to restore fixed/mobile telephone services. With the growing use of smartphones, people have come to rely heavily on Internet-based services for social networking, information searches and e-commerce. Restoring Internet-based services is becoming a key aspect in disaster situations.

The Japanese Government endorsed research and development projects on disaster-management technologies after the Great East Japan Earthquake in 2011. In one of the projects, the Cabinet Office's Strategic Innovation Programme conducted several disaster-management exercises involving movable and deployable ICT resource units (MDRUs); it aims to implement the results throughout society. MDRUs can provide telephone and file-exchange services using Wi-Fi and IP-PBX when telecommunication infrastructure is damaged. Similar to the MDRU, one of the Programme's solutions is the Locally Accessible Cloud System (LACS), which instantly provides Internet-based service in local disaster areas.

A LACS feasibility study carried out in the Philippines in December 2019 examined the use of LACS for e-education and e-health in island areas.

(2) Introducing the Locally Accessible Cloud System

The LACS comprises a Wi-Fi access point, a small PC server, a battery and other peripheral devices assembled in a portable carrying case (see **Figure 2A**) for easy transport to disaster-affected areas. The server acts as a web server and offers the basic communication functions required in disaster situations. The LACS offers basic communication functions, including information broadcasting, information sharing and bi-directional communication between users, although service delivery is restricted to small areas, namely, the area around the LACS. The LACS handles demands for local communications, which is generally where most demand is. Users access the service using a Wi-Fi-enabled network device like a smartphone to deliver

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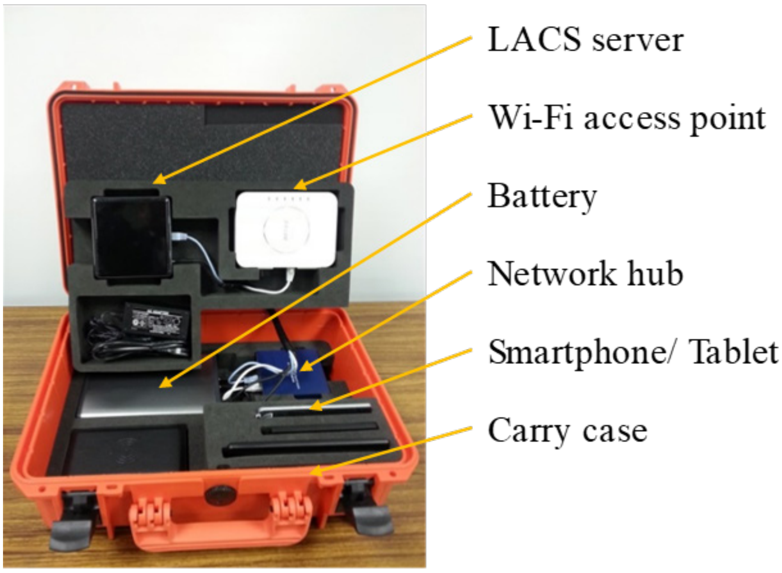
52 ITU-D SG2 Document 2/309 from Japan.

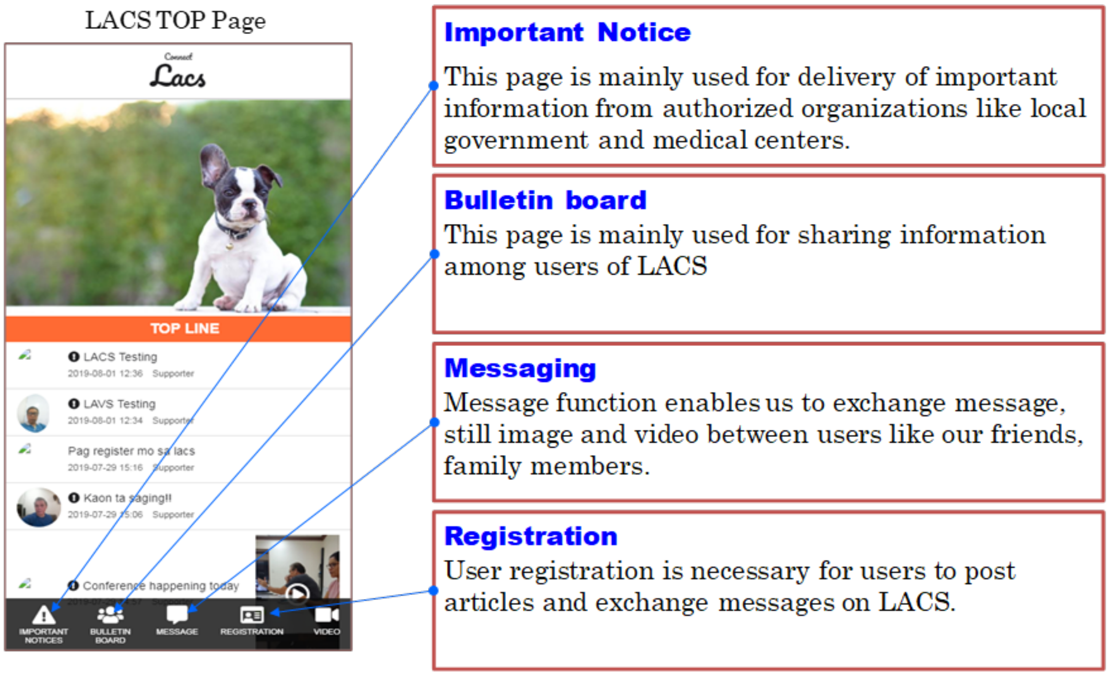
and collect information and to communicate locally with people like family members, friends and neighbours. They can send and receive large-size content in the form of text, voice, videos and still images. The LACS is able to collaborate with other systems (e.g. Internet disaster-management systems) once its access to the Internet has been restored.

Figure 2A: LACS pilot product



Users can access the top page of the LACS server over the web browser, as shown in **Figure 3A**. By clicking on the icons at the bottom of the top page, they can access the functions the system offers. The pilot product offers three basic functions: the "Important notices" function delivers important information from authorized organizations like local governments and hospitals; the "Bulletin board" function enables users to share information; and the "Messaging" function enables them to exchange messages, still images and videos. "Registration" is a management function for user registration. Users who upload information via the important notice and/or bulletin board function or who use the messaging function are required to register so that they can be identified in the system.

Figure 3A: LACS basic functions



(3) Case study in the Philippines

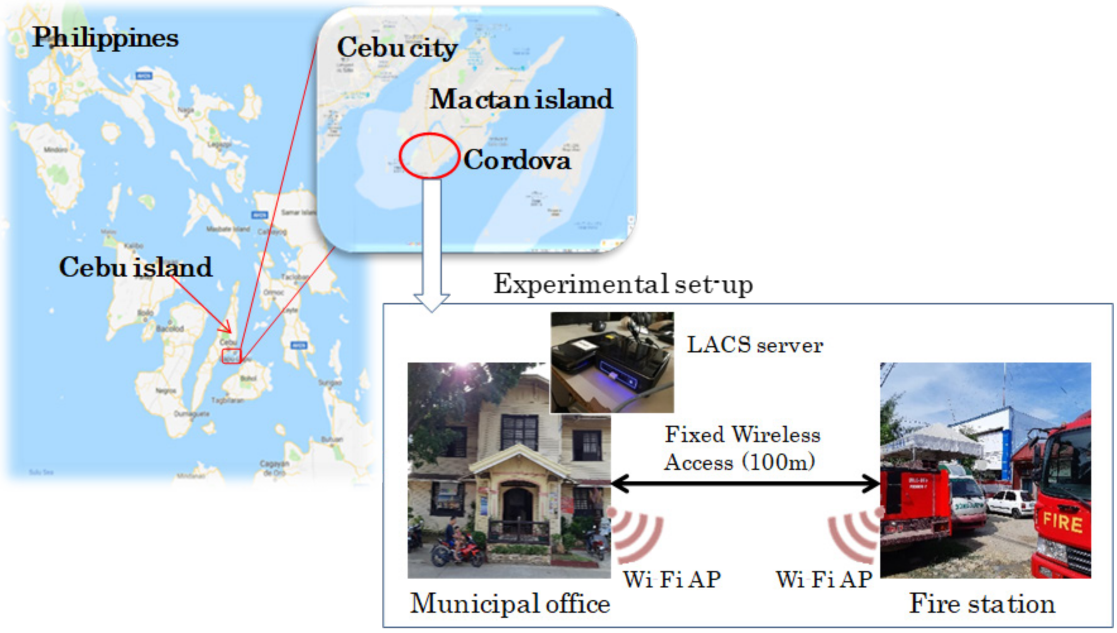
The LACS is not only an answer to communication difficulties in disaster situations; it can also be used in ordinary, non-disaster situations. Its anticipated users are disaster relief workers (including government, police and hospital staff), people in disaster areas and residents in developing countries. The LACS is expected to play an important role in developing countries with insufficient networking infrastructure.

In order to confirm the feasibility of the LACS concept, an experiment was conducted in the Philippines with the cooperation of Cordova municipality in Cebu, in the central Philippines. **Figure 4A** shows the location and setup. A LACS server and Wi-Fi access point equipment were installed in the Cordova municipal office to form a locally accessible cloud environment. The local area was extended to the fire station, located 100 metres from the municipal office, using point-to-point fixed wireless access equipment and a Wi-Fi access point installed in the fire station.

The experiment was conducted for both the residents of Barangay Poblacion, a part of Cordova municipality, and students of Cordova Public College. In the first experiment, to test LACS e-education possibilities, students used the LACS file-sharing function to download an educational video to their smartphones, then watched the video on their smartphones and uploaded their comments to the LACS bulletin board for their teacher. In the second experiment, a disaster simulation, residents of Barangay Poblacion were asked to use the LACS bulletin board to take pictures of supposed disaster areas and upload them to the LACS server, so that officials in municipal offices could confirm the status of disaster areas. To demonstrate the system's e-health possibilities, selected residents consulted medical professionals using the LACS video communication function.

The experiment's 32 participants were asked to evaluate the LACS. All the participants said that the LACS was useful during disasters and in ordinary times; 99 per cent found the LACS easy to use.

Figure 4A: Experimental set-up in Cordova, Cebu

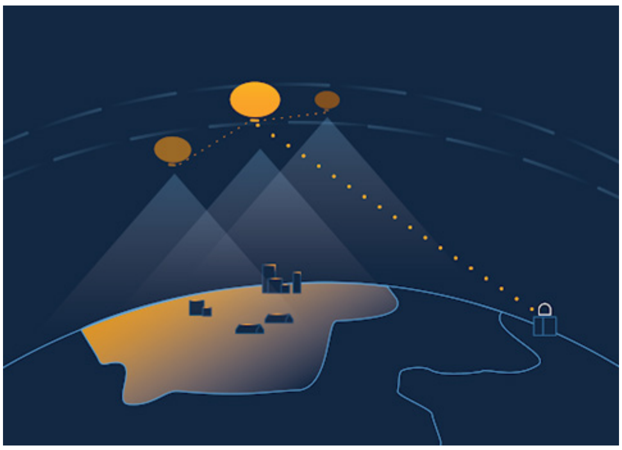


A1.2.7 Balloon-enabled preparedness and emergency telecommunication solutions (Loon LLC, United States)[53]

(1) Overview

Loon is a network of high-altitude balloons designed to deliver stratospheric Internet connectivity to unserved and underserved communities around the world (see **Figure 5A**). The network aims to connect people everywhere by inventing and integrating new and emerging technologies and concepts.

Figure 5A: Illustration of stratospheric Internet delivery



[53] ITU-D SG2 Document 2/327 from Loon LLC (United States).

Each balloon carries a payload with an LTE base station connecting users to the network of the local mobile operator. With the advantage of height, one balloon can transmit service over an area 20 to 30 times greater than a traditional ground-based system. Unlike cell-on-wheels or satellite technologies, each balloon can connect directly to LTE/4G smartphones, including in remote and hard-to-serve areas (islands, mountains, jungles). The network (including mesh links between balloons) operates above the ground and is therefore weather resilient, with independent solar power for each balloon and minimal ground logistics. It can be deployed quickly if infrastructure and network integration are prepared ahead of a crisis and the vehicles are properly positioned.

The most effective communication system is one that can expediently provide basic Internet connectivity to the public and emergency response providers after natural disasters, and offer disaster preparedness service to mobile network operators to quickly reconnect people on the ground. Therefore, preparedness and related training activities are the most effective ways to be ready for disasters, whether natural or man-made.

It is imperative to work in close partnership with local aviation and telecommunication authorities, and to partner with local mobile network operators, to ensure integration with existing network equipment before disaster strikes. On regulatory matters, Loon LLC works with local partners to obtain all necessary approvals for spectrum use, aviation overflights and other operating requirements. With the local carrier partner, it pre-installs ground equipment in the country or region, prepositions fleet resources, and performs network integration and testing with the telecom partner.

(2) Disaster preparedness service description

Loon LLC has extensive experience of preparedness planning and recovery communication operations, and has developed a robust set of tools for non-disaster communications. In collaboration with local mobile network operators, regulators and other stakeholders, it offers a three-phase service: initial set-up and integration; ongoing "stand-by" operations; and emergency service activation.

Phase 1: Set-up

In the initial integration phase, Loon LLC works to:

- coordinate regional ground station certification with regulators;
- complete an assessment of installation, operation and maintenance considering geographic diversity;
- secure reliable, high-speed IP connectivity from ground station locations to the Loon-evolved packet core (EPC), in collaboration with local cable operators;
- integrate the balloon-based network and Loon EPC components with a local mobile operator, IP exchange provider, or Telecom Roaming Sponsor;
- to secure authorization for Loon-compatible LTE spectrum bands (e.g. Band 28) and for millimetre wave (mmWave) spectrum for backhaul and balloon-to-balloon links (E band, 71-76 GHz and 81-86 GHz);
- conduct end-to-end ground-to-balloon-to-LTE user testing;
- secure overflight approvals from local aviation authorities to operate the balloons over each country.

Phase 2: Stand-by

After integration, Loon LLC prepares the fleet and network for expedient emergency response by performing the following activities:

- monitor weather patterns, providing guidance for locations where telecom networks may be impacted by weather;
- pre-position a balloon fleet to expediently navigate to impacted areas, with expected time-to-destination 24/7 air traffic and radio coordination.

Phase 3: Service activation

In the event of an emergency, Loon LLC:

- makes reasonable best efforts to provide a balloon-based LTE radio access network for local operator subscribers at designated locations and times (this may be affected by the severity of the disaster, other location factors, weather and coordination with the local carrier partner);
- customizes each coverage area's network availability capacity by monitoring demand levels and areas of determined need;
- coordinates with carrier partners to provide network outage reporting as required or needed to regulatory agencies.

(3) Regulatory requirements to enable the stratospheric Internet

Meeting regulatory mandates is critical for successful deployment of stratospheric Internet for preparedness and emergency communications.

Equipment homologation: The ground station equipment is certified to national regulatory requirements before use. This includes equipment type approval, electromagnetic compatibility, safety and demonstrating that the equipment has met national radio spectrum requirements.

Streamlined import process: Ground stations, which are compact systems measuring 1.3 m across by 1.6 m high, connect the mmWave backhaul service to the LTE service. Typically, two ground stations are deployed to cover a service area, with options for both roof and tower mounting. The number of ground stations depends on the geography, the local carrier partner's network and the area needing to be covered.

Spectrum authorizations, for both mmWave and LTE: Two spectrum bands are used to enable Loon technology. The first is mmWave spectrum in the E band (71-76 GHz/81-86 GHz), which is used between the balloons and with the ground station, to provide backhaul service. The second is the local operator partner's LTE spectrum, to provide connectivity between the balloons and the user equipment.

Authorization to use the E band for backhaul is critical for providing the stratospheric Internet. The E band is a 71-76 GHz uplink paired with an 81-86 GHz downlink. A channel bandwidth of 750 MHz is used to ensure sufficient system capacity. Two frequency pairs are used per site, with centre frequencies of 71 500 MHz / 81 500 MHz and 74 000 MHz / 84 000 MHz. The backhaul service is integrated into the local carrier partner's network.

To transmit the LTE spectrum, the local carrier partner identifies spectrum bands between 700 and 900 MHz. Loon LLC ensures that its technology meets any national licensing requirements.

It works with local agencies and does testing with the local carrier to ensure that there are no interference issues that could disrupt other services within the country.

Cross-border coordination: The technology can geofence areas to mitigate interference. The Loon carrier partner has also done previous work and achieved regulatory approvals to operate in an area under its licensing terms.

Other non-telecommunication regulatory considerations

- Overflight authorizations: The balloons require overflight authorization from the civil aviation authority of every country that they may fly over.
- Business registration: Loon LLC is not a direct customer-facing entity; the local mobile operator still represents the service and handles all billing and related customer-facing operations.

(4) Recommendations/lessons learned

The following recommendations should be considered to allow innovative solutions like stratospheric Internet to occur.

Consider an overall spectrum strategy, including mmWave and 5G applications

- Members States are encouraged to consider spectrum licensing in the larger context of technological developments and what applications they would like to enable. Loon LLC uses E-band spectrum for backhaul services because it has wide channels that enable long range, narrowly targeted communications between directional antennas. Member States have different ways of licensing E band, from licence exempt to self-coordinated and flexible licensing. In the United States, there is a "flexible licensing" scheme for the E band that allows for innovative uses of mmWave spectrum but nonetheless requires that users seek licensing from the Federal Communications Commission. That entails coordination across the Government and registering individual links in a third-party database. This transparency also allows for efficient and innovative use of the spectrum to spur competition in the industry.
- In countries like the United States, having a database of spectrum licence holders has enhanced understanding of the market potential and ways to use spectrum more efficiently. Member States should also consider ways to assess their spectrum assets and make spectrum holdings and usage transparent, to enable future thinking about how to use spectrum more efficiently, particularly as new technologies are developed and deployed.
- A complementary strategy to enable innovation is to consider how experimental licences would allow for proof-of-concept ideas to move to commercialization. In many cases, companies apply for an experimental licence to test technologies over the airwaves, but after the licence expires, there is no clear regulatory path for transitioning to a commercial licence.

Streamline homologation procedures and timeframes

- Support innovative technologies by developing streamlined national or regional processes to certify equipment that can be used to supply preparedness or emergency communication services. These requirements should be made publicly available, for example, on the regulator's website.
- In most cases, it might be possible to utilize the supplier's declaration of conformity to show that equipment meets a country's technical specifications. If a country does not allow such declarations, countries and regions should consider developing a common set of

homologation requirements for emergency communication equipment, to facilitate speed and availability.

Streamline equipment import processes

Countries can support innovative technologies by making it easier for local providers to partner with companies like Loon to deliver services. While a country may have emergency procedures to allow the import of equipment to provide communications in times of disaster, the focus on preparedness means that equipment procedures should be predictable and timely.

Encourage cross-border coordination for innovative services

Serious consideration must be given to the ability to protect communication services from interference. Countries can encourage all carriers to coordinate in a timely and effective manner to effectively operate systems that serve communities in time of need. This may include network management opportunities like using facilities across borders, as long as this is compliant with related telecommunication regulations.

Partner with civil aviation authorities to approve overflight authorizations

In most countries, overflight authorization is approved by the national civil aviation authority. To ensure that aerial connectivity solutions are available during and after emergencies, telecommunication regulators should work collaboratively with civil aviation authorities in support of the necessary overflight authorizations.

A1.2.8 Ka + 4G model in emergency response and disaster relief (China)[54]

(1) Overview

In order to meet the requirements for the activation of 4G base stations at emergency disaster sites, satellite communication is usually used as the means of relay and backhaul for emergency base stations. However, because of transmission capacity and cost factors, traditional satellite communication can only provide satellite relay capability up to about 2 Mbit/s, and can therefore meet the application requirements of basic voice and low-speed data services only below 2Mbit/s; it is difficult to meet the requirements for relay and backhaul of 4G base stations.

The new-generation Ka high-throughput satellites (HTS) have technical features such as multi-spot beams, frequency reuse and high beam gains. Compared with a traditional communication satellite, Ka HTS have advantages in terms of capacity and unit bandwidth cost, which can help address the bottleneck created when traditional satellites are used for 4G base station backhaul.

Chinasat-16 is the first geostationary HTS in China. It has 26 spot beams and provides Ka frequency band HTS communication services, with a total system capacity of 20 Gbit/s. It provides the end users with an access speed of up to 150 Mbit/s in downlink and 12 Mbit/s in uplink, delivering satellite broadband Internet in the true sense.

China Telecom is actively conducting studies on the application of Ka HTS in the field of emergency communication to explore how to implement the Ka + 4G application model and improve the application capability of emergency satellite broadband services. It has also applied

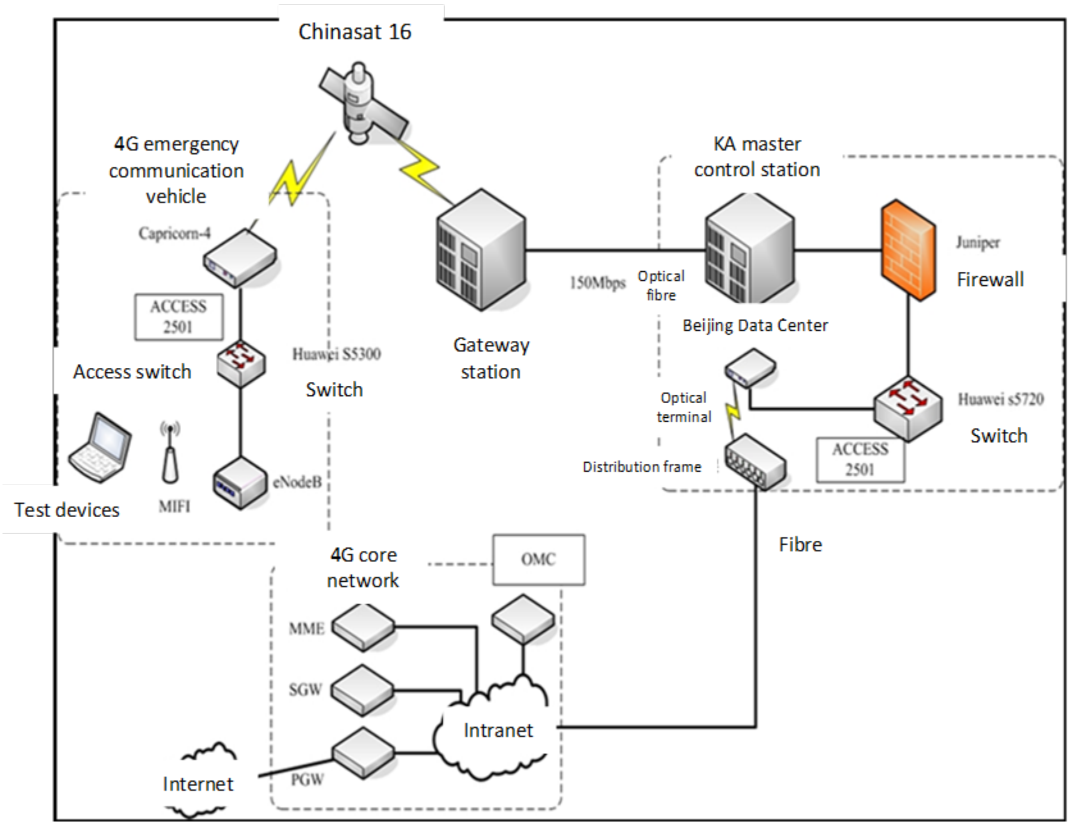
[54] ITU-D SG2 Document SG2RGQ/228 from China.

relevant study results to actual emergency communication guarantee tasks and achieved excellent results. Depending on the characteristics and business requirements of different emergency scenarios, there are two different satellite backhaul models for 4G emergency base stations.

Two-layer private line model

The two-layer private line model connects the Ka HTS network to the bearer network on the ground; from there, the satellite network is connected to the mobile core network (see **Figure 6A**). As it extends the wide-area wireless coverage of the existing 4G network, this model can meet the access requirements of most base stations in the public network. It has the advantages of stable transmission quality and strong 4G service capability, and is therefore widely used in various emergency communication guarantee scenarios.

Figure 6A: Topology of a two-layer private line model



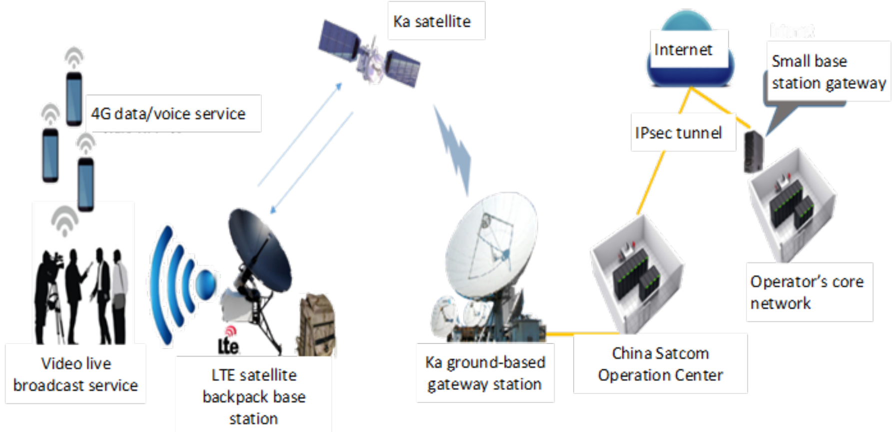
In order to be simultaneously activated in different regions within the same network architecture, different types of service need to be segregated and isolated. Two-layer services mainly rely on virtual local area network tagging and related IP addresses for service segregation and isolation.

Three-layer Internet model

The three-layer Internet model, which is based on the public Internet through a secure encrypted IPsec tunnel and a dedicated service gateway, connects the satellite communication to the bearer network on the ground; from there, satellite communication is connected to the mobile core network (See **Figure 7A**).

This model is mainly suitable for access by small base stations. It can quickly activate emergency base stations through public interconnection when there is a lack of private line transmission on the ground. It can provide various emergency broadband value-added services through innovative technologies such as multi-access edge computing and software-defined networking.

Figure 7A: Topology of a three-layer Internet model

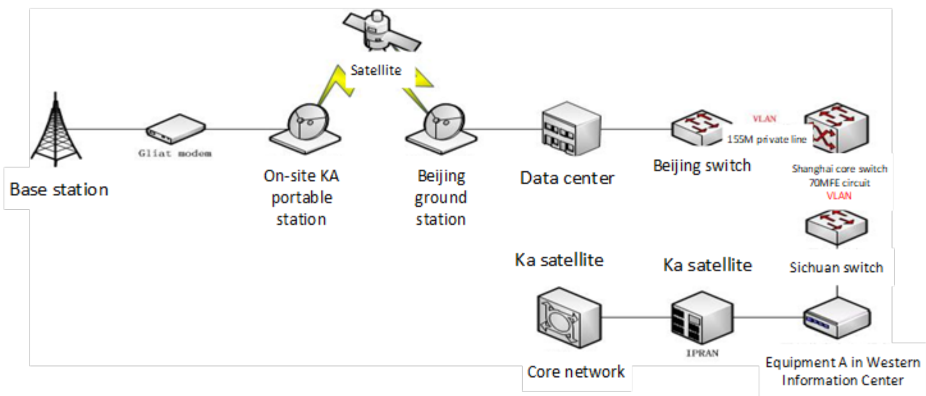


(2) Application promotion

Having completed its study of the innovative application of Ka HTS for emergency communication, China Telecom has gained a comprehensive and systematic understanding of the functional characteristics and business capabilities of HTS, and obtained a huge amount of first-hand test data, laying the technical foundation for the applications of Ka HTS in actual situations of emergency response and disaster relief. The technology has also been tested in an actual situation.

On 20 August 2019, torrential rainfall and heavy mudslides occurred in Wenchuan, Aba, and communications in many towns and villages in Wenchuan County were interrupted. At the disaster relief site, the mobile communication bureau of China Telecom in Sichuan activated the 4G backpack base station through the Ka portable station based on the two-layer private line model to guarantee 4G services for the staff in the emergency response command and control office. The overall system topology is shown in **Figure 8A**.

Figure 8A: Topology for the application of Ka + 4G when mudslides struck Wenchuan, Aba, on 20 August 2019



The onsite service testing data are shown in **Figure 9A**.

Figure 9A: Screenshot of service testing data of the 4G backpack base station

- Download rate: 57.2 Mbit/s (the Ka satellite station downlink speed limit is 60 Mbit/s)
- Upload rate: 4.28 Mbit/s (the Ka satellite station uplink speed limit is 10 Mbit/s)
- Latency: 700 ms
- Jitter: 11 ms
- Coverage distance: 200-300 metres
- Test environment: moderate to heavy rain, thick clouds, and a Ka satellite receive level of about 11 dB.

A1.2.9 Satellite connectivity for early warning (ESOA)[55]

Early warning is as much about satellite communications as it is about satellite imagery. Imagery is necessary but so is communication. Satellite communications play an important role because they enable real-time data for real-time action. Specifically, they provide solutions for areas where it is often difficult to send people and in response to large threats and risks, and they enable data delivery for an unlimited number of users, often using small, low-power, portable terminals.

Below are some examples that show how satellite plays an important role for early-warning systems and monitoring of earthquakes; tsunamis; floods; wildfires; and mining.

Fighting wildfires

The destructiveness of a fire can be devastating. Emergency workers may not have the manpower to manage a growing fire or must evacuate for safety reasons before a fire is out. The solution includes a mobile trailer containing hoses and sprinklers carried on a mobile platform that can be remote-controlled from a laptop or mobile phone relying on satellite/cellular terminals depending on the location and network coverage.[56]

Tailings dam monitoring

The mining industry increasingly stores often toxic or radioactive by-products in so-called 'tailings dams'. A failure of the dam can have disastrous consequences for the environment and so constant monitoring is essential. The solution collects data from sensors distributed along

55 ITU-D SG2 Document SG2RGQ/237 from the EMEA Satellite Operators Association (ESOA).
56 W.A.S.P. Manufacturing Ltd. https://waspwildfire.com/.

the dam which are then transferred across a satellite network to a single cloud dashboard. This enables mining companies and other stakeholders to gain a comprehensive view of the status of their dams with detailed metrics such as pond elevation, piezometric pressures, inclinometer readings and weather conditions displayed in one place, no matter where the mine is located, minimizing environmental risks and achieving high levels of safety.[57]

Early flood warning

Water levels are on the rise in many places for various reasons, and require constant monitoring. The solution consists of several water-level monitoring sites with stream gauges connected to a satellite messaging terminal frequently powered by solar panels. Changes in water levels are transmitted via satellite to a central monitoring site. Since many of the monitoring stations are in mountains, canyons and other remote areas, satellite messaging terminals provide a cost-effective means to install a communication link where other services providing real-time data and guaranteeing data delivery are not available.[58]

Earthquake and tsunami detection

The increasing disasters in the world include earthquakes and tsunamis, and several solutions that rely on satellite communications are implemented in some parts of the world. These range from sensors along coastlines measuring minute changes in tides or currents, to broadband stations deployed across a territory measuring seismic movements, or deep-ocean tsunami detectors. The solutions rely on satellite to transmit real-time data for international coordination and early warning – often through WMO's Global Telecom System.[59, 60, 61]

Safety systems are often seen as a cost and only considered once a disaster has happened. Solutions to increase our preparedness for climate change and other disasters are available today.

A1.2.10 "SOCDA" chatbot system for disaster management (NICT, Japan)

(1) Background

Every year, the global community faces numerous disasters, including earthquakes, typhoons and floods. Such disasters often damage social infrastructure like telecommunication networks, electric power distribution networks and transportation systems, severely disrupting the lives of people.

SNS are known to be useful not only for individual communications but also for collecting information on damages for first responders. They have been used in recent floods caused by severe storms and heavy rains in Japan. However, it is also well known that SNS can cause confusion, because the information they are used to spread is not always true; it may be misleading or even fake. The NICT has been developing an SNS disaster information analysis system called DISAANA, which compiles useful disaster-related information from huge volumes

57 Inmarsat. Solutions and Services. Tailings insight: Award-winning tailings dam monitoring solutions, enabling smarter and faster decision-making, safer operations and enhanced regulatory compliance.
58 Skywave.com. Application Profile: satellite for Early Flood Warning.
59 Australian Government. Bureau of Meteorology. Deep Ocean Tsunami Detection Buoys.
60 Inmarsat. Solutions and Services. BGAN 2M.
61 Inmarsat. Solutions and Services. Connectivity you can rely on.

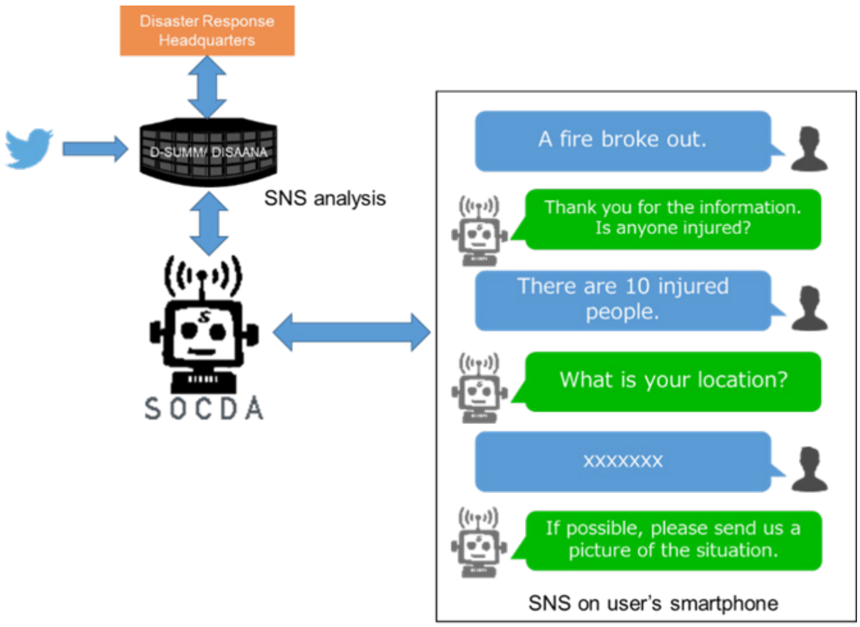
of SNS data, and a disaster information summarizing system called D-SUMM. An overview of the systems was provided in an NICT contribution in 2018. DISAANA and D-SUMM retrieves both disaster-related and contradictory information. When disaster strikes, information can help save lives. The type of information sought by the victims varies widely, depending on their situations, so it needs to be collected from as many sources as possible. However, postings on SNS are currently voluntary, and this means that much important disaster-related information is not reported. SNS chatbots are a useful means of collecting disaster-related information effectively. When operated on smartphones/tablets, chatbots can reach many victims and facilitate two-way communication. They can survey and deliver disaster-related information proactively.

(2) Overview

As part of the Cabinet Office's Strategic Innovation Programme, a chatbot called SOCDA (SOCial dynamics observation and victims support Dialogue Agent platform for disaster management) has been jointly developed by the NICT and other organizations. Since the Programme aims to implement research results throughout society, feasibility studies employing SOCDA have been conducted involving several local governments in Japan. Expected users of SOCDA are the national government, local governments, first responders (including medical staff) and ordinary citizens in disaster-affected areas in both developed and developing countries. They have been involved in several emergency drills and exercises simulating a natural and/or pandemic situation.

SOCDA uses AI to collect disaster-related information via SNS. It aggregates the contents by applying DISAANA and D-SUMM technologies, plots them on a map and distributes the information needed for people's timely evacuation. Citizens and first responders can use SOCDA simply by "friending" it on SNS. **Figure 10A** shows an example of interactive information collection using SOCDA, which answers users automatically and collects information on their situation and damages.

Figure 10A: Interactive information collection by SOCDA



SOCDA has three main functions.

1) Disaster-related information-sharing function: When a disaster occurs, users can submit a wide variety of information via SNS after friending SOCDA's account.
2) Inquiry function: A huge inquiry operation can be automated thanks to FAQ written beforehand.
3) Evacuation support function: Appropriate evacuation support information is provided for individual users in the light of their attributes and location.

(3) Case study: safety confirmation training for people requiring evacuation support

In January 2020, the Council on Artificial Intelligence for Disaster Resilience conducted a demonstration of a new safety confirmation model, using the SNS app "LINE" to confirm that around 300 people in Itami, Hyogo prefecture, were safe. The demonstration aimed to confirm that SOCDA could be used by elderly and other people who needed evacuation support. This was the first safety confirmation project employing SNS for people requiring evacuation support, including elderly persons. The demonstration was based on the assumption that Itami had been hit by a heavy earthquake at 10 a.m. After the demonstration started, SOCDA sent safety confirmation messages to all participants, who answered questions such as "Please tell me where you are now" and "Is the health of the person requiring nursing care okay?" By 4 p.m., replies had been received from nine people in need of evacuation assistance and 32 people had heard from relatives.

The demonstration also aimed to collect disaster-related information, including reports on the disaster situation sent by city officials. The information was aggregated by SOCDA and used at the city disaster-response headquarters.

(4) Case study: training in disaster information sharing (heavy rainfall)

In June 2020, the Council on Artificial Intelligence for Disaster Resilience conducted a demonstration in Kurashiki, Okayama prefecture, where many people had been affected by heavy rainfall in June 2018. People had observed how difficult it was to know what was happening at the time of evacuation, so the purpose of the demonstration was to share information throughout the region.

The training involved local residents using an SNS account on a smartphone/tablet on which SOCDA had been installed. Information on rising water levels in the Takahashi and Oda rivers that could trigger floods was posted on SNS, mapped by SOCDA and sent throughout the region. The 398 participants, including local residents, posted about 270 reports. It was concluded that SOCDA is able to collect information over a wide area across multiple local governments.

(5) Case study: evacuation assistance during the COVID-19 pandemic

In a pandemic situation such as COVID-19, appropriate arrangements must be made to avoid the "Three Cs": closed spaces with poor ventilation; crowded places; and close contacts (e.g. close-range conversations at evacuation shelters). To make such arrangements, local governments need to have a full understanding of evacuation shelters, especially those where people gather voluntarily, or they will face serious difficulties.

The SOCDA AI chatbot system, which is in the research and development phase, will first provide information on such voluntary evacuation shelters and then distribute provisional information on COVID 19. SOCDA serves to visualize and analyse such situations in order to help protect people from the pandemic even in disaster evacuation shelters. Should the pandemic situation worsen, well-separated evacuation is required to avoid the "Three Cs". SOCDA can help both infected and non-infected victims by providing several types of useful information in a timely manner.

A1.2.11 Autonomous distributed ICT system (Japan)[62]

(1) Autonomous distributed ICT systems

In order to address the issues and needs facing local governments in the event of disasters, the use of an autonomous distributed ICT system should be considered as much as possible as a business system in the local governments. Such a system offers major benefits in an environment with limited telecommunications. It allows on-site workers to continue their business and share information between various remote departments and organizations, even when the telecommunication network is down. In addition, voice communication can be achieved by voice data exchanged via distributed servers.

(2) Development of the "Die-Hard Network"

NICT Japan has developed the Die-Hard Network as an autonomous distributed ICT system with a store-carry-forward network supported by vehicles for disaster countermeasures. Parts of the study were supported by the Cross-ministerial Strategic Innovation Promotion (SIP) programme of the Council for Science, Technology and Innovation (CSTI) of Japan's Cabinet Office , entitled "Enhancement of national resilience against natural disasters" (Funding agency: National Research Institute for Earth Science and Disaster Resilience - NIED).

The Die-Hard Network consists of various communication systems and several edge servers, as shown in **Figure 11A**. In the event of telecommunication network outage in some areas, the system can transfer rescue and/or governmental information between distributed offices and headquarters through available networks, for example a low-power wide-area (LPWA) or satellite network, or a vehicle with an edge server as a part of store-carry-forward network. The vehicle-borne edge servers go around headquarters and distributed offices in telecommunication outage areas, and send and receive data to edge servers using device-to-device (D2D) communication technology and fast initial link setup (FILS) when the vehicle approaches a distributed area. Features of the Die-Hard Network are summarized below:

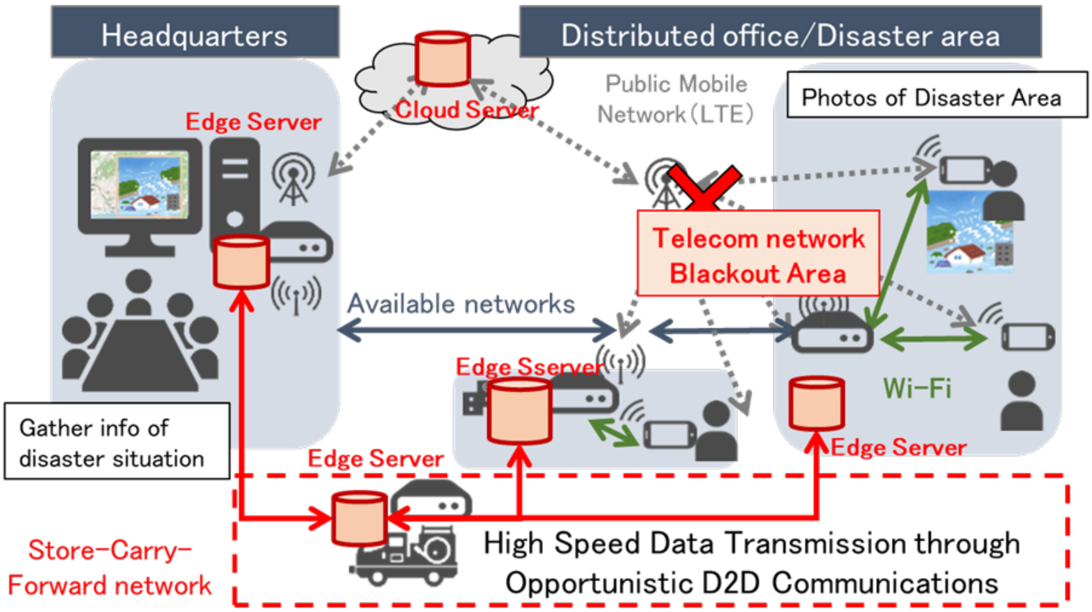
- *Links between distributed on-premises systems*: An autonomous distributed architecture does not have a node that centrally manages and controls the system; each node provides application services as on-premises. When a connection is detected, it is possible to automatically share information between remote locations by synchronously sharing data between the nodes.
- *Utilization of heterogeneous communication systems*: In the event that the fixed-line telecommunication network is down, various kinds of available transmission technologies should be exploited to connect the network. For example, cellphone network, Wi-Fi, LPWA, convenience radio and satellite should be used in an appropriate manner.
- *Proactive use of mobile resources*: By not assuming constant connection, D2D communication technology can be used just when a vehicle with the device installed approaches, and information can be stored and transported by actively utilizing the vehicle.

[62] Document 2/401 from the National Institute of Information and Communications Technology (NICT) (Japan).

This type of communication network is called "store-carry-forward network" or "delay/disruption-tolerant network".

- *Authentication and access control in distributed environments*: Even in the event of a disaster, officers of local governments have to process secure information such as personal data. Therefore, it is necessary to restrict the connection of each node to the distributed systems and access to data and information stored and managed, so that it is allowed only via the authenticated user and terminal.

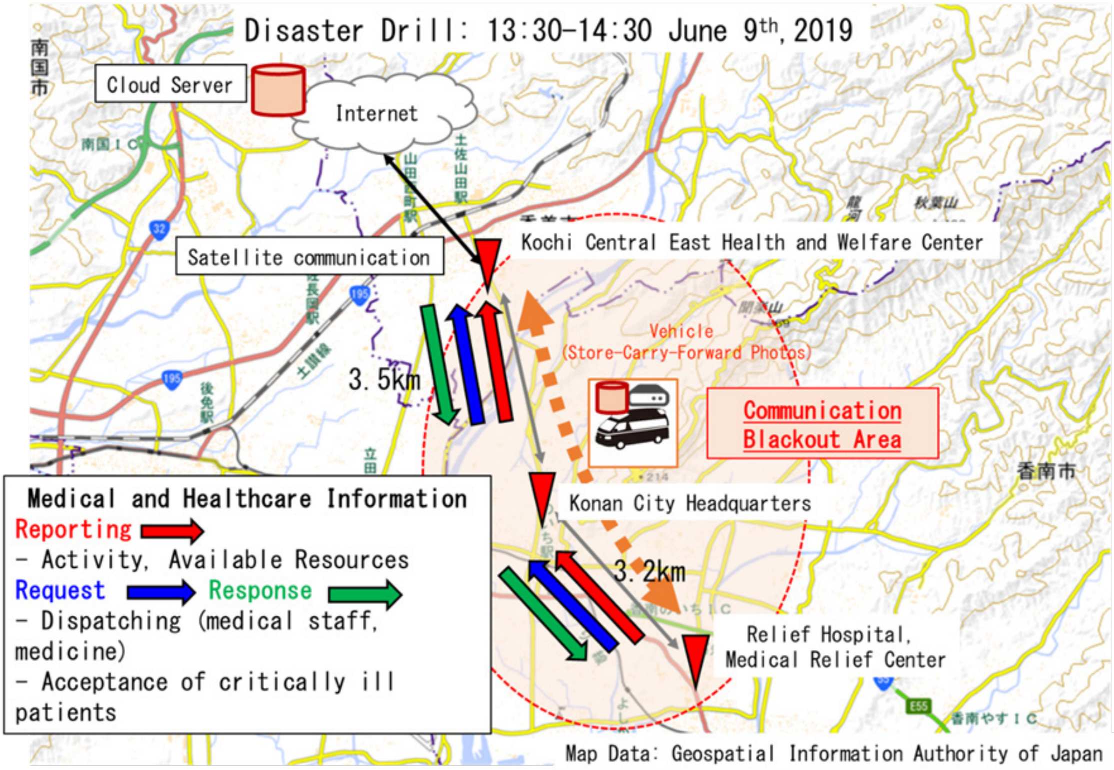
Figure 11A: Concept of Die-Hard Network



(3) Case study in Kochi prefecture in Japan

The Kochi Prefecture Comprehensive Disaster Prevention Drill was held on 9 June 2019. The nodes of the Die-Hard Network system were set up in the Kochi Central East Welfare Health Centre, the Konan City Headquarters, and the Relief Hospital and Medical Relief Centre (Akaoka Health Centre in Konan City). In this disaster medical training exercise, people were trained in information transmission using the system, such as the transmission of activity status reports from medical care centres, requests for dispatch of medical personnel and requests and consent for the acceptance of critically ill patients. An overview of the drill is shown in **Figure 12A**.

Figure 12A: Overview of disaster drills using Die-Hard Network



Assuming a Nankai Trough earthquake scenario in which public telecommunication networks were totally unavailable, the disaster drill was carried out using conventional means of information exchange, such as fax-based communication, involving filling out a paper form used in the prefecture and faxing it from the Medical Relief Centre to the City Headquarters, and from there to the Kochi Central East Welfare Health Centre. In parallel with this fax-based communication drill, a similar drill was carried out using the Die-Hard Network system.

With the latter system, when the report and the request were input at the Medical Relief Centre, the input text information was shared automatically and synchronously with the City Headquarters and the Prefecture Health and Welfare Centre by means of digital convenience radios.[63] At each site, the status information was automatically shared after approval processing. The drill was carried out according to the disaster drill scenario, with the system being used by city and prefecture employees.

Transmission of information that could not be accommodated in the format of the prefecture form, such as the condition of severe patients housed in medical relief centres and photos of triage tags, was also demonstrated by automatically synchronizing information through Wi-Fi via communication nodes mounted on moving vehicles. It was confirmed that the high-resolution photo data registered in the medical relief centre system were automatically synchronized to the vehicle through Wi-Fi. These data were automatically transferred from the system in medical relief centre to the server on the vehicle when the vehicle arrived at the centre's parking lot. As a result, it was confirmed that information sharing could be performed automatically by the Die-Hard Network, even in the case of large-capacity data that are difficult to transmit with the digital convenience radio during a public telecommunication blackout.

63 https://www.soumu.go.jp/main_content/000361388.pdf [in Japanese].

A1.3 Early-warning and alert systems

A1.3.1 CAP-based earthquake early-warning system in northern India (India)[64]

(1) Disaster-management framework in India

Due to its unique geo-climatic and socio-economic conditions, India is vulnerable in varying degrees to disasters such as floods, droughts, cyclones, tsunamis, earthquakes, landslides and forest fires. Of the country's 35 states and union territories, 27 are disaster prone. In addition, 58.6 per cent of the landmass is prone to earthquakes of moderate to very high intensity; 12 per cent is prone to floods and river erosion; of 7 516 km of coastline, 5 700 km are prone to cyclones and tsunamis; 68 per cent of arable land is vulnerable to drought; and hilly areas are at risk from landslides and avalanches. Fires, industrial accidents and other man-made disasters involving chemical, biological and radioactive materials are additional hazards that have underscored the need to strengthen mitigation, preparedness and response measures.

National Policy on Disaster Management

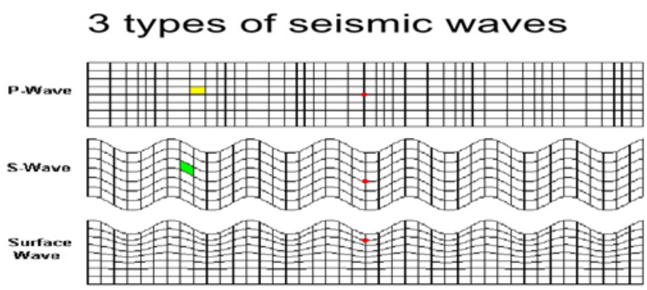
Pursuant to the Disaster Management Act, 2005, the National Policy on Disaster Management envisages a safe and disaster-resilient India that develops a holistic, proactive, multi-disaster-oriented and technology-driven strategy through a culture of prevention, mitigation, preparedness and response.

Earthquake Early-Warning system

Earthquakes produce vibrations – seismic waves – that travel in all directions and release huge amounts of energy. There are three types of wave (see **Figure 13A**):

- P waves compress and expand the ground like an accordion, travel through solids and liquids, and are fast moving and longitudinal;
- S waves vibrate from side-to-side as well as up and down, travel through solids only, and are slow moving and transversal;
- Surface waves move up and down like ocean waves; they are the slowest-travelling waves, with movement greatest at the Earth's surface and weakest beneath the surface.

Figure 13A: Types of seismic wave



During an earthquake, seismic waves radiate out from the epicentre. It is these waves that make the Earth shake and cause damage to structures. The technology exists to detect moderate to large earthquakes so quickly that a warning can be sent to locations outside the area where

64 ITU-D SG2 Document 2/36 from India.

the earthquake begins before these destructive waves arrive. Data from a single station or from a network of stations form the basis of earthquake early warning. In a "single station" warning system, data are not sent to a central processing site. The single station alert is more prone to false alarms. The accuracy of early warnings can be enhanced by using a combination of alerts from single stations and a regional seismic network. The CISN Shake Alert demonstration system, for example, combines onsite and regional alerts for moderate to serious earthquakes. The future of earthquake early-warning systems may be in smartphones and vehicles, "smart" appliances and the increasing number of everyday objects embedded with sensors and communication chips that connect them to a global network.

Single-station approach: A single sensor located at the site to be protected detects the arrival of the P wave and sends out a warning before the arrival of the S wave. This method is simple, but is less accurate; it gives rise to false alerts and provides less warning time.

Network approach: Many seismic sensors distributed over a wide area where earthquakes are likely to occur are networked. A central site receives the data from these sensors, analyses ground motion signals, detects earthquakes and issues suitable warnings. The system maintains a higher level of readiness all the time and is more accurate in predicting quakes. Earthquake early warnings are most effective when the earthquake begins on a fault far from the current location and the rupture propagates towards that location. Earthquake early-warning messages are sent quickly to all members of the public with the help of every available ICT and IoT technology. The public is periodically sent messages and tutorials on how to understand and respond to alerts.

Earthquake early-warning alerts warn people to take protective action and trigger automatic responses in places like factories, dams and transit systems. They operate in means of transport, utilities, offices, industrial sites, medical facilities, restaurants, schools, cars and trucks, and during emergencies.

CAP-based earthquake early-warning system

ITU-T X.1303 Common alerting protocol establishes a common standard-oriented platform instead of a separate public warning system for each particular type of emergency and for each particular communication medium. The CAP is an XML-based data format for exchanging public warnings and emergencies between alerting technologies. It allows a warning message to be consistently disseminated simultaneously over many warning systems to many applications. It increases warning effectiveness and simplifies warning tasks. Standardized alerts can be received from many sources and configured for applications to process and respond as desired. By normalizing alert data across threats, jurisdictions and warning systems, the CAP can also be used to detect trends and patterns in warning activities or hostile acts. From a procedural perspective, the CAP reinforces a research-based template for effective warning message content and structure.

The CAP data structure is backward-compatible with existing alert formats, including Specific Area Message Encoding (the protocol used to encode the Emergency Alert System and NOAA Weather Radio, Wireless Emergency Alerts, etc.), while adding capabilities such as the following:

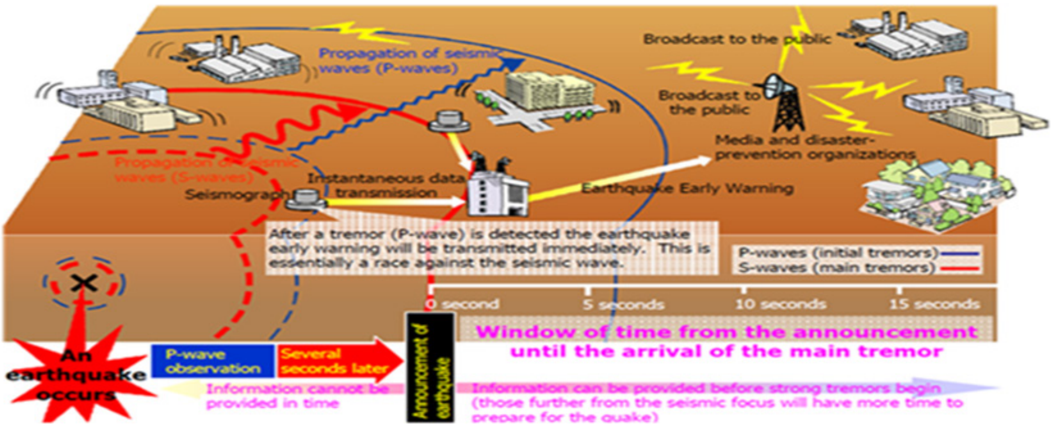
- flexible geographic targeting by using latitude/longitude "boxes" and other geospatial representations in three dimensions;
- multilingual and multi-audience messaging;

- phased and delayed effective times and expirations;
- enhanced message update and cancellation features;
- template support for framing complete and effective warning messages;
- digital encryption and signature capability; and,
- facility for digital images, audio and video.

Central and state government agencies can all receive information in the same format for the same type of application and then sound different alarms based on the information received. The CAP also detects trends and patterns in warning activity, such as might indicate an undetected hazard or hostile act. International organizations such as UNDP, ITU and WMO are urging nations to implement the CAP as an essential communications formatting step for emergency early warnings.

The main components of earthquake early-warning systems are velocity of electromagnetic waves >>> velocity of seismic waves (seismograph), propagation of seismic waves (S waves), propagation of seismic waves (P waves), instantaneous data transmission, e-warning-broadcast to the public (see **Figure 14A**).

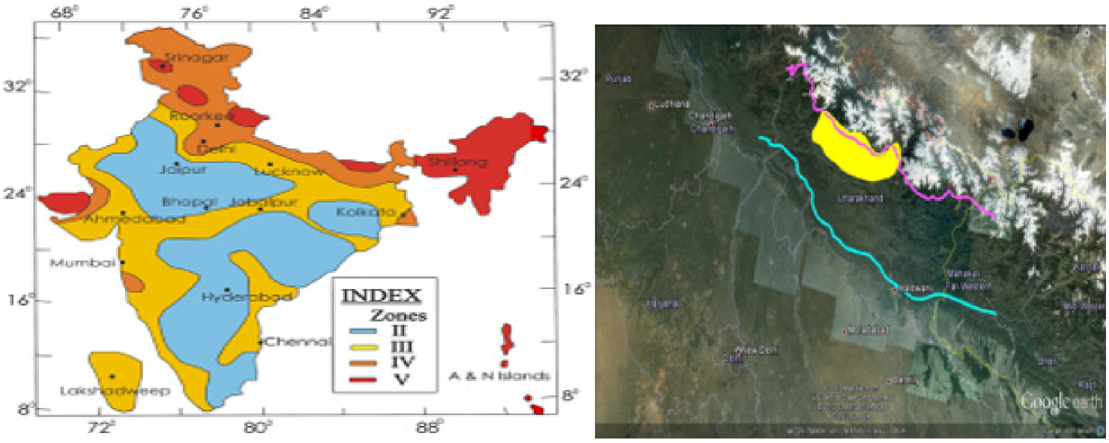
Figure 14A: Earthquake early-warning systems



Earthquake early warning in northern India

Major earthquakes originating in the central Himalayas, a prominent "seismic gap", frequently rock Indian cities (including New Delhi) and industrial hubs with high population densities located 100 to 300 km from the epicentre, with a lead time of 25 to 80 seconds. This makes an earthquake early-warning system very useful. More than 100 sensors (see **Figure 15A**) have been deployed in the Himalayas to detect and locate seismic events potentially affecting the cities of northern India, estimate their magnitude and issue alert notifications.

Figure 15A: Earthquake early warning in northern India



Components of the CAP-based earthquake early-warning system

- Information sharing by alerting agencies such as the Indian Metrological Department, the Geological Survey of India, the Central Water Commission, the Ministry of Home Affairs and the Indian National Centre for Ocean Information: Information in the same format can be received by all central and state government agencies, which can sound different alarms based on the information received.
- Alert-forwarding media agencies (see **Figure 16A**) include telecom operators, All India and other radio stations, Doordarshan and other television broadcasting agencies, the National Highway Authority of India for road displays, the Internet and other related organizations. People need to receive alerts of earthquakes, cyclones and heavy rainfall in advance.

Figure 16A: Common alerting media agencies

- The earthquake early-warning system has a management platform (see **Figure 17A** and **Figure 18A**) for collecting CAP-compliant input messages in XML/JSON format sent via web portals/mobile apps/SMS in standard message format by alerting agencies; processing SMS/e-mail notifications sent to the first-level alert-generating authority (i.e. the National Disaster Management Authority); storing (BTS data are stored); transmission; and control (for state/regional warning-issuing authorities). It also has a feedback evaluation system.

Figure 17A: Earthquake early-warning management platform

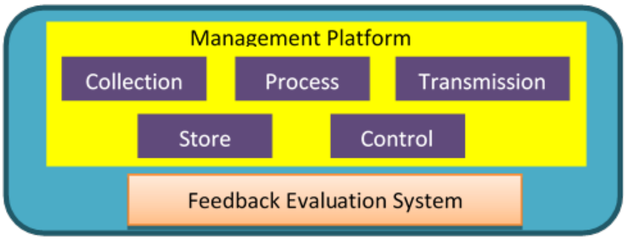
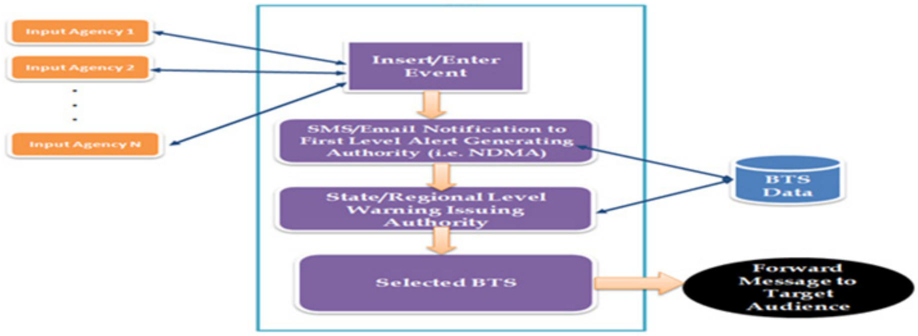
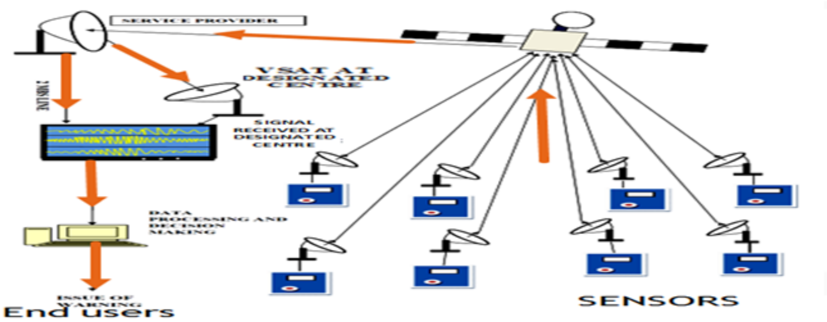


Figure 18A: Management platform



In terms of information flow (see **Figure 19A**), the Static Disaster Management Software Platform framework has been incorporated into the national network and plans are to integrate it with the National Disaster Management Authority. Disaster areas are identified using geofencing. Manual alarms are pushed using a two-tier approach to nationwide telecom networks able to send SMS automatically to marked areas.

Figure 19A: Common alerting system – Flow of information*



* The arrows indicate the direction of sensor signals received at the designated centre, data processing and issue of warnings to end users.

A1.3.2 Implementing a CAP trial (India)[65]

(1) CAP and its use in early-warning systems

ITU-T X.1303 Common alerting protocol establishes a common standard-oriented platform instead of a separate public warning system for each particular type of emergency and for each particular communication medium.

Trials of CAP use in early-warning systems are constantly being carried out in India. ITU-T X.1303 provides a detailed description of CAP features, as summarized below:

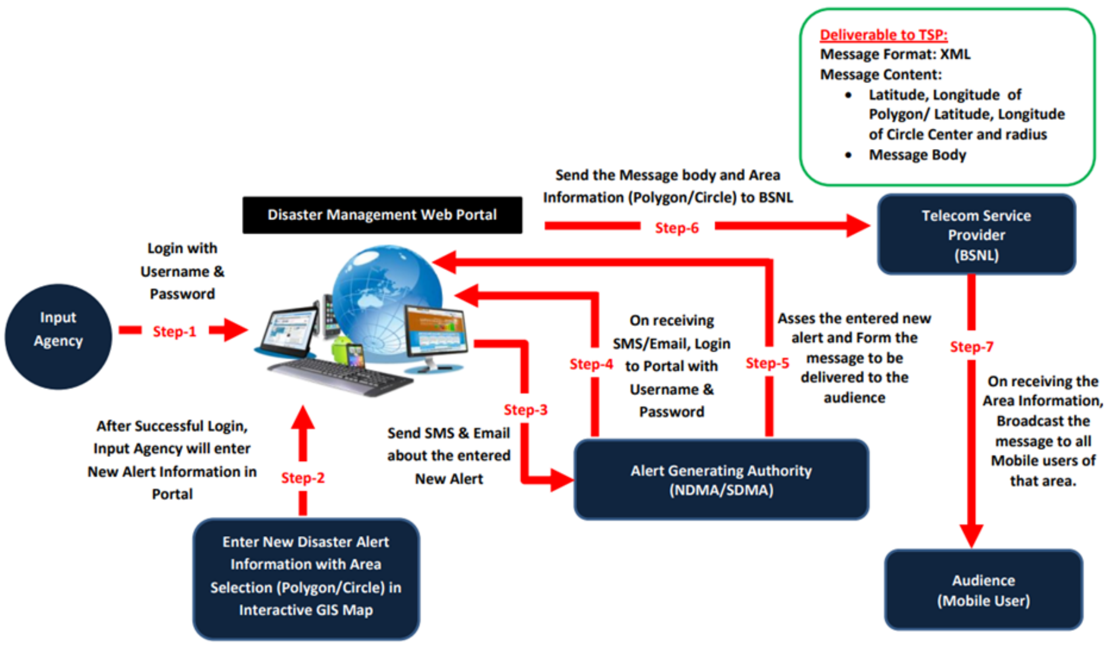
- the CAP allows a warning message to be consistently disseminated simultaneously over many warning systems;
- standardized alerts can be received from many sources and configured for applications to process and respond as desired;
- flexible geographic targeting using latitude/longitude boxes, polygons or circles and other geospatial representations in three dimensions;
- facility for digital images, audios and videos.

International organizations such as UNDP, ITU and WMO are urging nations to implement the CAP as an essential communications formatting step for emergency early warnings.

(2) Recent trial run of CAP implementation carried out in India

Figure 20A depicts the workflow of a CAP trial carried out in different Indian states.

Figure 20A: CAP trial workflow



The CAP trials are run through the portal developed by the Centre for Development of Telematics (C-DoT), a government-owned telecommunication research and development centre.

65 ITU-D SG2 Document SG2RGQ/77 from India.

Access to the portal has been given to alerting agencies, the National Disaster Management Authority, the state disaster management authorities of different states in India, State Governments and the Department of Telecommunications. The portal is presently connected to telecommunication service providers through the Internet or multiprotocol label switching virtual private networks, so that alerts can be passed on to telecom service users. Customers are identified through the call detail records (last six hours) or network visitor location register and the warning SMS are sent to them. The SMS are also sent by cell broadcast from the base stations lying in the polygons identified.

The CAP trial runs are summarized in Table 1A.

Table 1A: CAP trial runs

Date	Area selected	Number of recipients
7 June 2018	Small area of Marina Beach Chennai	5 181
8 June 2018	Nungembakkam, Chennai	2 768
8 June 2018	Idduki, Kerala	883
13 June 2018	Vijaywada, Andhra Pradesh	4 125
13 June 2018	Begumpet Airport, Hyderabad	3 796
14 June 2018	Dehradun, Uttarakhand	1 386
18 June 2018	Civil Secretariat Srinagar and Amarnath Yatra Route	1 001
20 June 2018	Secretariat, Dispur, Assam	2 295
29 June 2018	Bhopal, Madhya Pradesh	4 474
3 July 2018	Guwahati, Assam	7 252
25 July 2018	Dharamshala, Nahan, Reckon Peo, Chota Shimla, Himachal Pradesh	56 772

The telecom service providers involved in the trial runs were BSNL, Airtel and Reliance Jio.

The agencies involved in the trial runs were the National Disaster Management Authority; the state disaster management authorities of Tamil Nadu, Kerala, Andhra Pradesh, Uttarakhand, Jammu and Kashmir, Assam, Madhya Pradesh and Himachal Pradesh; the India Meteorological Department; State Governments; the Department of Telecommunications; and C-DoT.

During Amarnath Yatra, a total of 200 399 SMS were sent in respect of six different events between 28 June 2018 and 25 July 2018 to customers of BSNL and Reliance Jio through the C-DoT CAP early-warning platform. The SMS contained information about weather conditions so that pilgrims and government authorities could take timely precautionary action. They were also delivered to all Airtel customers using cell broadcast.

(3) Conclusion: experience gained and way forward

The trial run was initially conducted in experimental conditions and later in real conditions. The following observations were made:

- during the actual run of the CAP early-warning system, authorities, agencies and pilgrims responded well, suggesting that the system should be regularly deployed in the future;
- it took considerably longer to send SMS from mobile networks using 2G/3G (20 to 60 minutes) than from 4G networks (3 to 5 minutes);
- efforts are being made to optimize the response times, especially in 2G (which predominates in rural areas) (3G is gradually being replaced by 4G);
- smartphones club message parts if the message size exceeds the prescribed limit; normal phones do not have this facility, and efforts are being made to overcome the issue;
- the trial runs used messages in English only; efforts are being made to introduce vernacular languages for better and effective outreach.

A1.3.3 ICT disaster preparedness (China Telecom, China)[66]

(1) Disaster preparedness

There are many aspects to disaster preparedness.

- Publishing early-warning information: The ability and means to publish disaster warning information must be organized before a disaster occurs. Warnings of imminent danger should reach every customer in the designated area within 10 minutes.
- Making suggestions on the LTE SMS cell broadcasting network, terminal support and deployment, researching the specifications and requirements already in place and deployed on both the network and terminal sides of LTE SMS medium and small cell broadcasting, and putting forward relevant requirements in network planning and construction; sending early-warning information to users through various just-in-time mobile Internet means of communication (such as WeChat) (operator networks interconnected with just-in-time mobile Internet communication systems send early-warning information promptly).
- Carrying out multiple optical cable route deployments, formulating plans to transform the optical fibre cable lines on single routes or vulnerable routes in the light of the damages sustained in recent years. Employing optical fibre cable fast recovery technology such as erbium-doped fibre amplifiers in emergency communication repairs.
- Satellite transmission: scenarios and recommendations regarding the use of Ka high throughput satellites, Ku and C band satellites, various middle and low orbit satellites in emergency communications; using Ka high throughput broadband satellites to provide 4G services to mobile emergency communication vehicles, islands and remote base stations, and engaging in research on the use of Ku and C band satellites for high-definition video transmission and low orbit satellites for satellite IoT.
- Miniaturization and portability of VSAT devices, and scenarios and suggestions for their application in emergency communications: keeping track of the development of miniaturized and portable VSAT devices in various frequency bands and making it possible for a single person to carry the devices on foot to the disaster areas to open up services.
- The application scenarios and recommendations regarding short wave transmission in emergency communications: studying the application of short wave in emergency communications on account of its long transmission distance and strong damage-resistant characteristics.
- Deployment and testing of 4G/5G in emergency communication vehicles: researching the deployment of 4G equipment and the application of some 5G technologies in emergency

[66] ITU-D SG2 Document 2/56(Rev.1) from the China Telecommunications Corporation (China Telecom) (China).

communication vehicles. The application of spherical antennas and various new types of antenna in emergency communications has resulted in a multifold increase in capacity or directional transmission distance. Research has also been conducted on emergency communication vehicle-supported IoT applications, namely deploying narrowband-IOT equipment in emergency communication vehicles to support IoT applications.

- Studying the use of various satellite telephones and the application of satellite telephone positioning, data and SMS in emergency communications: The positioning information return, data service and SMS functions of satellite telephony are used to position and rescue people and vehicles in distress beyond mobile signal coverage.
- Researching UAV-borne base stations and the results of application scenario study, testing and field operation of tethered UAVs, wingspan UAVs, airships, helicopter-borne LTE base stations and other equipment in emergency communications: research on providing 4G services with the LTE base stations on board tethered UAVs used wireless ad hoc network devices (mesh) carried by tethered UAVs to examine how to apply the transmission relay to provide fixed and vehicle-borne base station services that are able to recover damaged transmissions and promptly access current networks to deliver 4G services during a disaster. The LTE base station satellite transmission or microwave equipment on board stratospheric airships is able to connect with current networks to offer 4G services to remote areas.
- Researching the use of mesh technology to rapidly re-establish network connections damaged by the disaster and the joint employment of mesh and UAV to commence 4G services: Wireless ad hoc network (mesh) devices serve to quickly open up the last 10 kilometres.
- Studying the specifications of the emergency command and dispatch system based on Internet+ emergency communication, with the system applied in vehicle positioning, disaster warning, resource scheduling, command and dispatch, task management and so on: The emergency vehicle location and tracking function, by providing information on real-time vehicle location, monitoring and control, vehicle status, etc., mobilizes vehicles and personnel in the vicinity to participate in disaster relief efforts as required. The system is able to display specific information on wind, rain, haze and other weather disasters, and on typhoons and earthquakes, collected from professional Internet websites at high frequencies, on the GIS map at different levels, facilitating the deployment of advance personnel with targeted early-warning information to the areas concerned. The emergency task command has put in place flat, streamlined and close-looped process monitoring to keep track of task execution. With the implementation of vehicle/personnel location and tracking, and the adoption of command and dispatch visualization, the system takes overall responsibility for managing emergency personnel, vehicles, equipment/supplies, spare parts, circuits, satellite bandwidth, and so on, thus achieving intensive emergency resource management and optimization of resource allocation, dynamic tracking of resource distribution, a fully controlled and visualized resource allocation process and whole-process management of equipment and other resources.
- Conducting research on sending the disaster scene video back to the command centre or accessing the video via Internet: By way of satellite, 4G and other means, the video of the disaster site is returned to the command centre or accessed through online terminals, personal computers, mobile phones, and so on. Examination and analysis of the quality of video service transmitted by satellite has resulted in indications of the time delay and jitter of image transmission.
- The storage and allocation of emergency supplies such as generators: keeping in reserve all kinds of fuel generator, such as 5 kW light generators, 10-12 kW generators, 30-50 kW generator vehicles, and 100-500 kW large generator vehicles for different application scenarios.
- Drills organized on the basis of real emergency situations: Based on real and simulated emergency scenarios, drills have been conducted of rapid relief team assembly and dispatch at short notice. The teams provided all kinds of emergency services in designated areas, building a well-trained and skillful corps of relief personnel.

- Training: Establishing training requirements for emergency response personnel and developing graded training content and materials.
- Studying the emergency plan preparation; formulating emergency plans in response to various disaster scenarios, defining the types and focus of the plans and conducting drills accordingly; testing the contingency plans for the command system, circuit scheduling, line repairs, emergency power supply, service launch on board emergency communication vehicles, etc., in the wake of disasters such as earthquakes, typhoons, floods and mudslides in totally cut-off areas.

(2) Disaster mitigation

Disaster mitigation also has a number of different aspects.

- Mitigation of floods: Moving low-lying machine rooms to higher ground, elevating generators and other equipment, adopting protective measures for outdoor equipment before rainstorms.
- Typhoons: Delivering generators and other emergency materials and equipment in advance to disaster areas.
- Building a robust disaster fighting network based on the disaster damage data collected over the years.

(3) Response

Disaster response also comprises a number of different aspects.

- The process of making use of the mobile phone positioning function to rescue trapped people; selectively calling and positioning mobile users in disaster areas; sending the relevant information to the rescue team to facilitate relief efforts.
- Conducting big-data analyses through mobile network-related network management and based on customer information (i.e. of damage location, number of victims and/or damage/impact/repairs), and informing the relevant government agencies of the results for use in disaster relief command.
- Following the emergency plan to rapidly restore communication services in disaster-stricken areas.

A1.3.4 Implementation of emergency alerts (Brazil)[67]

(1) Model implemented

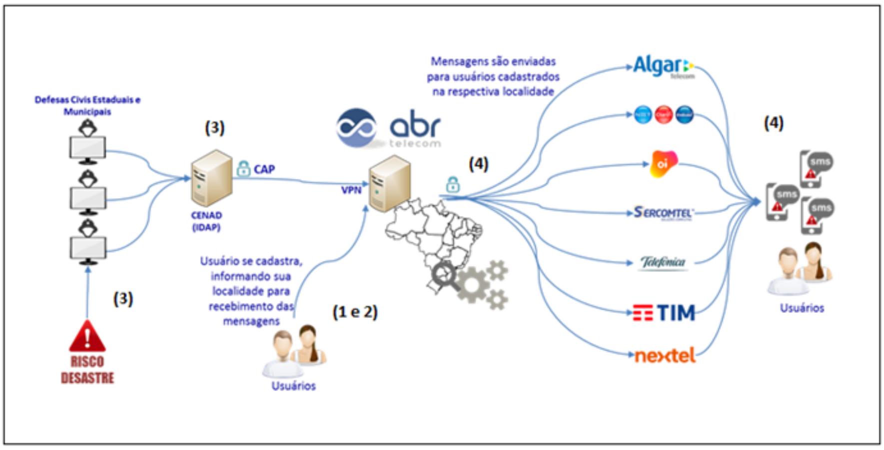
The working group of the main stakeholders in the process (regulatory agency, telecommunication operators and civil defence organizations, represented by national and some state bodies) decided to prioritize the delivery of alerts to mobile phone users, who are more numerous than pay-TV costumers.

The regulations do not limit the technological possibilities that can be used in emergency situations, and the working group judged that the technology with the greatest reach, considering the terminals used by the Brazilian population, would be SMS, which could be implemented more quickly and at lower costs, without prejudice to future developments in other technologies such as cell broadcasting.

The first step taken by the working group was to establish the process (see **Figure 21A**).

[67] ITU-D SG2 Document SG2RGQ/33 from Brazil.

Figure 21A: Establishment of the process to send SMS alerts



Legend:
Defensas civis estaduais e municipais: State and municipal civil defence
Risco desastre: Disaster risk
Usuário se cadastra, informando sua localidade para recebimento das mensagens: Users register, indicating their location for receiving messages
Usuários: Users
Mensagems são enviados para usuários cadastrados na respective localidade: Messages are sent to registered users in the location concerned
(1 e 2): (1 and 2)

The procedure consists in identifying an imminent disaster, mapping the area at risk and determining the content of the message to be sent. Then civil defence organizations access a web portal to record the event and request delivery of the message. The system platform receives the request and identifies operators in the region at risk and consumers enabled to receive the messages, which are then triggered by a concentrator agent (ABR) contracted by the operators for that purpose (broker).

The process has four main steps:

1) the campaign: inform the population that the alert service will be available in a given region, and make available to the interested parties the option of joining the service;
2) registration and emergency database: build a database of the cell phone numbers of the people interested in receiving civil defence alerts, using the postal code(s) of the places indicated during the registration process;
3) Civil defence alert: determine the region at risk, the submission period and the text of the alert message to be forwarded;
4) Alert message: the IDAP system (public alert interface) and the web portal automatically send registered alerts to the concentrator agent, which uses the database to convert the georeferenced polygon into a list of terminals for the alert message (based on the postal codes in that polygon) and each user's mobile operator.

Before the process could be implemented nationally, it was important to test the platform and the communication protocols between the various civil defence agents and telecommunication operators. Functional tests were thus conducted in 20 municipalities of Santa Catarina state starting on 7 February 2017 and in five municipalities of Paraná state starting on 13 June 2017. On 16 October 2017, the service began to be expanded first to all municipalities of those two states, then to other states, according to the schedule indicated in **Table 2A**.

Table 2A: Schedule for deployment of the emergency alert model

Start data	State/federative unit
16 Oct. 2017	Santa Catarina and Paraná (other municipalities)
16 Nov. 2017	São Paolo
18 Dec. 2017	Rio Grande do Sul, Rio de Janeiro and Espírito Santo
15 Jan. 2018	Minas Gerais, Matto Grosso do Sul and Goiás
19 Feb. 2018	Distrito Federal, Matto Grosso and Tocantins
19 March 2018	Bahia, Sergipe, Alagoas, Pernambuco, Paraíba, Rio Grande do Norte, Ceará, Piauí, Maranhão, Pará, Amapá, Acre, Amazonas, Rondônia and Roraima

One of the aspects of great importance for successful implementation was how the population was informed, with the regulatory agency taking active steps to distribute the schedule and forms of operation through national and local media. Whenever the service was about to expand to a particular federative unit, the agency repeated its communication with the local media for the entire population.

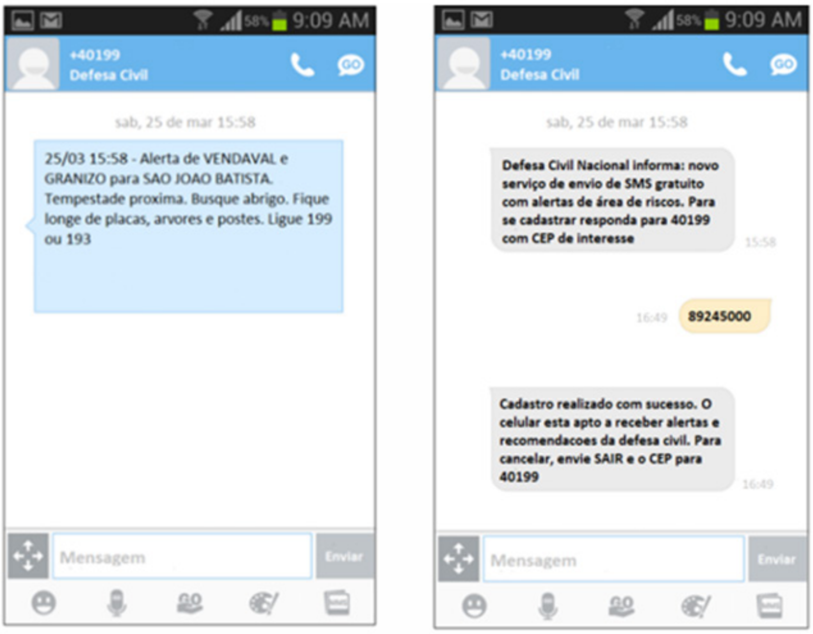
The service is free, so messages can be sent and received even if the user's phone has no credit or Internet access – suffice it for interested people to register to receive emergency alerts.

One of the project's limits is that users have to first register. This can be done in one of two ways:

1. When the service is provided in a municipality, the users of that municipality will receive a text message (SMS) from the number 40199 inviting them to register. In this case, the user simply responds to the message with the postal code(s) of their regions of interest. There is no limit to the number of individual postal codes per user.
2. Users who do not receive the text message (SMS) informing them about the start of the registration phase can, at any time, send a text message (SMS) to the number 40199 with the postal codes of interest.

In both cases, the user will receive a reply via text message (SMS) indicating if the registration was successful. The process is illustrated in **Figure 22A**.

Figure 22A: Registration and sending of alerts to citizens



(2) Civil defence organizations

In Brazil, disaster monitoring and preparation activities are headed by the Ministry of National Integration, whose National Centre for Risk and Disaster Management (CENAD) receives and consolidates information from various federal government agencies responsible for forecasting weather and temperature; assessing geological conditions in hazardous areas; monitoring the movement of tectonic plates; monitoring river basins; controlling forest and other fires; and transporting and storing hazardous products.

The agencies concerned include the National Centre for Natural Disaster Monitoring and Alerting, the Brazilian Geological Survey, the Brazilian Institute for the Environment and Renewable Natural Resources, the National Agency of Water, the Brazilian Intelligence Agency, the Centre for Weather Forecasting and Climate Studies, the National Institute of Meteorology, the Centre for Amazonia, the Armed Forces and other organizations of the Federal Executive Branch.

The data are evaluated and processed at the CENAD and forwarded to the civil protection and defence organizations of at-risk states and municipalities.

Law No. 12,608/2012, on the National System for the Protection of Civil Defence, establishes the roles of the union, states and municipalities in terms of national protection and civil defence policy. The result is a trustworthy ecosystem of public institutions and a set of voluntary initiatives integrating the common goal of preventing and mitigating the effects of natural disasters.

In disaster situations, the response is usually coordinated by the local civil defence agency; all those involved must act jointly, hence the need for local bodies to be well structured.

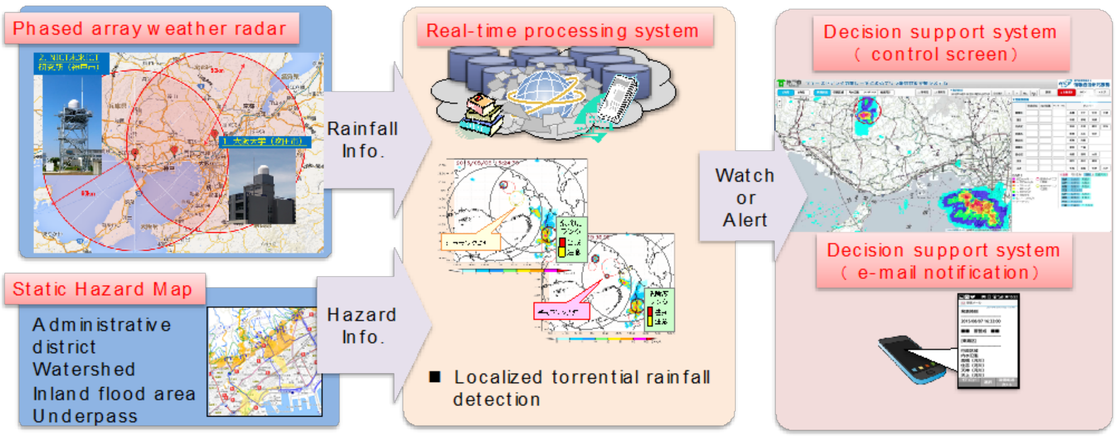
Further studies should include contributions or suggestions from Question 5/2 participants about the types of early-warning system used by developing countries and how to provide services to citizens and visitors (international and regional), so that they receive early-warning messages.

A1.3.5 Early warning and the collection of disaster information (NICT, Japan)[68]

(1) Torrential rainfall short-term early warnings using phased array weather radar

An increase in localized torrential rainfall events has recently been observed in urban areas in Japan. To prevent the damages caused by this kind of event, the NICT has developed phased array weather radar (PAWR). PAWR can observe three-dimensional rainfall information (radar reflectivity and Doppler velocity) every 30 seconds. It can therefore detect locally and rapidly developing cumulonimbus at an early stage. The NICT has also developed a system to monitor localized torrential rainfall using the early detection algorithm of baby rain cells. The cells are first extracted using three-dimensional radar reflectivity. The target area is covered by two PAWR, so it is less susceptible to rain attenuation. Secondly, the vertical vorticity in the baby cell is calculated using the Doppler velocity. Finally, a cell with a vertical vorticity above a threshold value is determined to develop into heavy rainfall on the ground. For the decision-support system, a dynamic hazard map (see **Figure 23A**) with location-dependent degree-of-risk information is produced by integrating the early detection of baby rain cells into the localized torrential rainfall and local static hazard map. The dynamic hazard map is displayed on the control screen and the warning information distributed by e-mail to a limited number of authorized staff. Real-time demonstrations were conducted in Kobe between August and October 2016. The entire system is operated using SNS data stripped of private information purchased by the NICT from third parties.

Figure 23A: Example of a dynamic hazard map produced using the PAWR

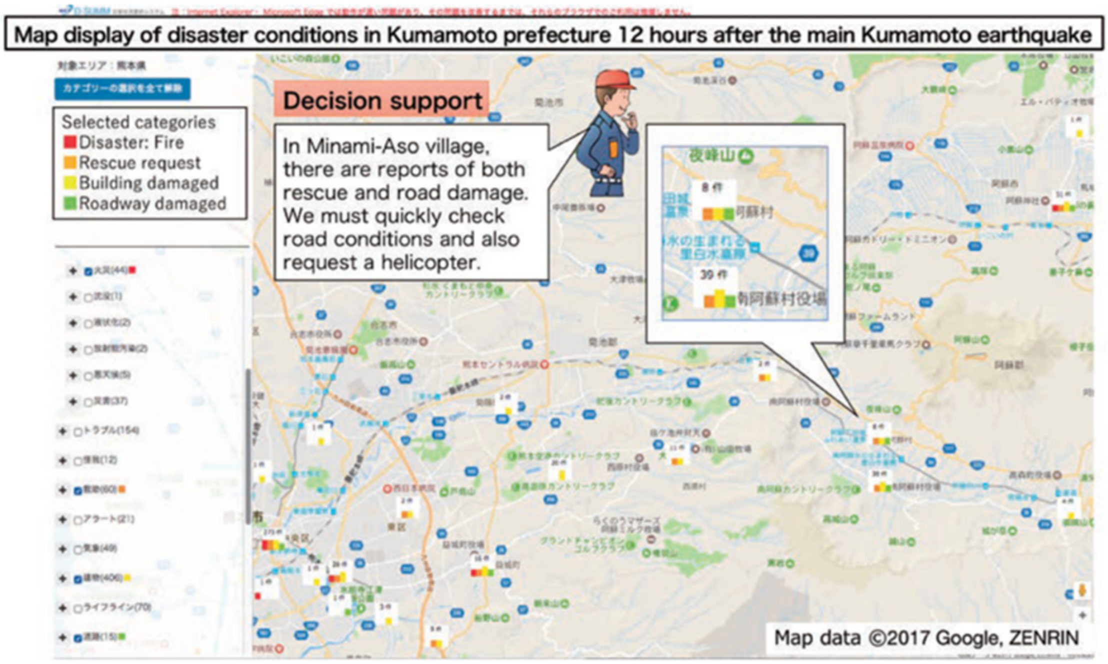


(2) Disaster data analytics systems

The NICT has developed two data analytics systems: the Disaster information SUMMarizer (D-SUMM) and the DISaster information ANAlyser (DISAANA) (for information on what the systems do, see **Section 3.6** of this report). The systems are used to obtain an overview of disaster conditions, as shown on the map in **Figure 24A**.

[68] ITU-D SG2 Document SG2RGQ/60 from the National Institute of Information and Communications Technology (NICT) (Japan).

Figure 24A: Example of an evacuation map generated by D-SUMM



A1.3.6 Advanced early-warning technologies (Japan)[69]

(1) Background

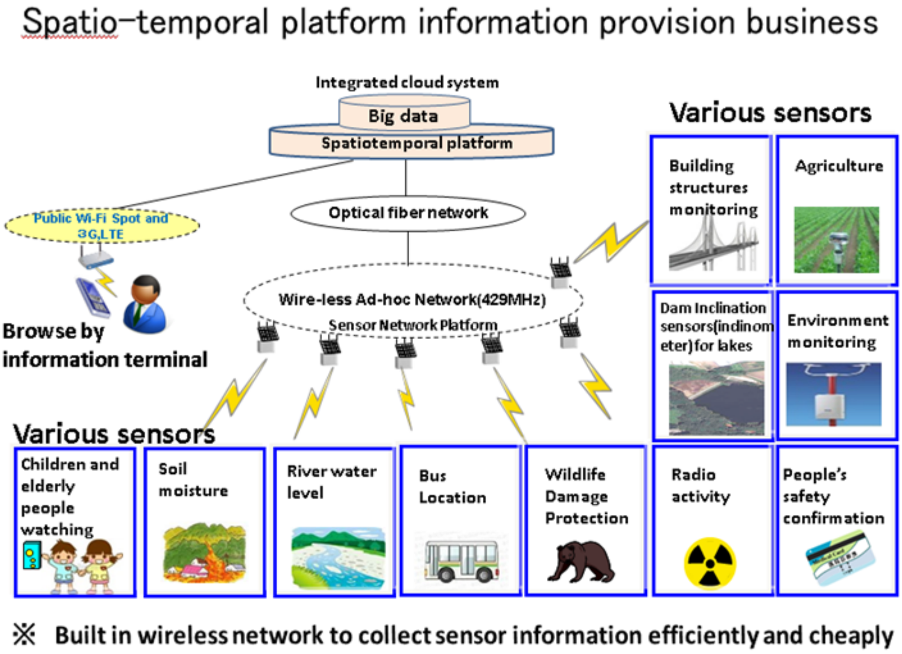
In 2000, Shiojiri municipality started to build an autonomous optical fibre network of 90 km (later extended to 130 km) and 75 public facilities in the city are now connected by gigabit ether network. The network is interconnected with upper-layer service providers. The municipality then established an information and incubation plaza for the IT-literate population. It built a low-power wireless area network with an ad hoc network configuration at 429 MHz. The 640 wireless repeater stations distributed are powered by solar panels and self-sustaining, thanks to their low cost and efficiently interconnected IoT sensors.

Japan is one of the first countries to experience a fall in population numbers and a declining birth rate – a serious and accelerating social phenomenon. In the coming 50 years, the population's age composition will change again, a source of further social concern. The effect on the country's rural municipalities is remarkable. The aim of building a smart society using ICT is to improve the lives of rural community dwellers and thus help suppress migration from rural to urban areas or even promote migration in the opposite direction. The IoT sensor network is partially government subsidized; Shiojiri has promoted the development of ICT-related devices and application software by small and medium-sized enterprises and the region's academic institutions (university, college and technical high school), establishing an incubation plaza where they can collaborate on ICT development. It recently invested in building a network of IoT sensors (see **Figure 25A**) that reaches every corner of the region and automatically collects environmental data that are then exchanged among the organizations concerned for the benefit of community dwellers. In order to meet individual household and ICT network power demands, Shiojiri invested in a biomass power plant to supply low-cost, eco-friendly and carbon neutral power to the region's 67 000 residents. The investment will contribute to

[69] ITU-D SG2 Document SG2RGQ/28+Annex from Japan.

regional socio-economic development in the forestry and related industries, and create job opportunities. It is expected to drive a marked improvement in the quality of life of the region's residents in the coming years.

Figure 25A: Shiojiri's environmental information data-collection platform and IoT sensor network



a) Watching children and elderly people

The network of sensors watches and locates children going to and from school and elderly people walking outside in remote communities, detecting the signal emitted by the active tag with embedded button battery that they carry.

b) Soil moisture

Sensors detect soil moisture content at 20-cm increments to predict landslides or mudslides. They send out alerts when the moisture level exceeds the threshold or safety announcements when the level goes down.

c) River water level

Sensors measure the water level of lakes and rivers. They send out alerts when the water level exceeds the threshold, so that the community can evacuate to a shelter before being hit by floods or debris.

d) Bus location

Sensors inform users of the location of buses on routes through the city every 30 seconds. In remote areas of Shiojiri, buses run every one or two hours, so this service is for the convenience of residents in remote areas.

e) Wildlife damage protection

Sensors are used to protect villagers or farmers in rural and remote areas in the suburbs of Shiojiri from wildlife such as boar and monkeys. They detect wildlife movements with a view to reducing the damages the animals cause.

f) Radioactivity

The network of sensors protects people from radioactive pollution by detecting the level of aerial radioactivity in the city.

g) Safety confirmation

Sensors locate residents when they evacuate to community shelters and compile the number of people in each shelter, confirming their safety to family and relatives.

h) Structure monitoring

Sensors monitor the age deterioration of public structures, in particular bridges, detecting abnormalities in their characteristics with a view to taking measures to suppress further deterioration.

i) Agricultural sensors

Sensors track the long-term behaviour of farmers, and agricultural and environmental data such as temperature, humidity and solar radiation, which may be useful for predicting massive insect infestations. They store expert agricultural know-how in digitized format, so that it be easily passed on to new farmers.

j) Dam inclination sensors (inclinometer) for lakes

Sensors record the micro inclinations of dam lakes over the long term; the digitized difference may indicate a dangerous change resulting in the dam bursting.

k) Environment monitoring

The environmental data such as temperature, humidity, wind direction, wind speed, solar radiation and rainfall obtained from the sensors can be digitized and stored in the cloud, for use in combination with other data.

(2) Platform for analysis of unique data collected from various IoT sensors

The unique data collected can be analysed in combination with other data obtained at other times and locations to obtain valuable information of importance for regional economic development.

(3) Case studies

a) Data such as temperature, humidity and solar radiation can be used to predict insect infestations or to reduce the amount of agricultural chemicals needed. Indeed, it may be possible to reduce pesticide use by at least one-fifth, thus lowering costs and easing environmental destruction.
b) The conventional method of gauging the risk of mud- or landslides was to draw on expert knowledge of rainfall amounts and duration. Now that soil moisture levels are detected by IoT sensors, alerts can be sent automatically to the Shiojiri municipality risk manager when the level exceeds a certain digital value. The alerts can be switched on/off automatically and accurately.

c) In the past, it was difficult to predict serious frost damage to crops. Thanks to the IoT sensor network, however, frost warnings can now be issued according to temperature and moisture levels at the sites.

A1.3.7 Emergency alerts using the Tuibida service (China)[70]

(1) Background

Because they provide the widest coverage and most effective means of reaching subscribers, mobile intelligent terminals are the most important channels for delivering emergency alert messages. As major methods of reaching target groups via terminal devices, SMS and push notifications still pose problems. While they may be highly reliable in terms of real-time messaging, SMS can only transmit text messages containing a limited number of characters and no audiovisual content; they also feature deep service entrance, and emergency alerts sent by SMS are very likely to be buried in large amounts of junk text messages. While push notifications can initiate the relevant application, pushing value-added information such as excavation maps or weather trends to subscribers, the sending of emergency alerts is affected to some extent by issues such as low reachability and a low rate of real-time delivery.

Developed jointly by the China Academy of Information and Communications Technology with China Unicom, China Mobile and China Telecom, the Tuibida service delivers the push experience via highly reliable signalling pathways provided by telecom operators. Tuibida is based on the signalling network and features capabilities, such as Quick Apps (click-to-run services, including Google's instantApp/PWA), installed on the terminal device. If the app has not been installed on the terminal device, the service offers the click-to-run function instead, ensuring that subscribers can obtain the relevant service by pushing the Tuibida notification on the terminal device.

(2) Tuibida helps deliver emergency alerts

By integrating Tuibida into the distribution of emergency alerts, longstanding problems in the delivery of emergency alerts, such as monotonous text messaging, a lack of interaction and follow-up service, and insufficient use of the capabilities of the subscriber's terminal device, can be fixed. Use of Tuibida can accelerate the transition from distributing simple text messages to emergency alert services based on mutual interaction.

Message reliability ensured by signalling and pathways

The Tuibida service employs highly reliable signalling pathways to push messages. In contrast to conventional push notifications, Tuibida has some obvious advantages. Close cooperation with telecom operators can ensure instantaneous information delivery. By classifying information so as to give emergency alerts high priority, and by connecting to the relevant signalling pathways of telecom operators, critical/red alerts can be distributed in timely fashion.

From message delivery to reaching the target audience

Currently, emergency alerts are distributed mainly via SMS text messages. One weakness of SMS is that they can only deliver text messages, whereas emergency-related services often have

[70] ITU-D SG2 Document 2/157(Rev.1) from China.

more valuable information to deliver to the subscriber, e.g. an excavation map in the case of an earthquake, the scope of a tsunami or the path of a typhoon.

Tuibida has a 100 per cent delivery guarantee and, thanks to better integration with instant apps, can trigger the clink-to-run function when an app is not installed on the subscriber's device. Subscribers will thus not only be informed of upcoming disasters or emerging events as they happen, they will also be provided with a variety of useful information in real time. This can have a big impact in terms of maintaining social order and strengthening public confidence in the area when a disaster or emergency happens.

From one-way broadcast to two-way interactions

At present, the distribution of emergency alerts is mainly based on one-way broadcasts. In an enduring disaster, however, two-way interaction is of huge importance, as it will not only provide substantial support for more accurate delivery of emergency alerts in follow-up efforts, it will also help subscribers help themselves. For example, conventional SMS cannot provide feedback on location information. In contrast, since the Tuibida service can invoke the QuickApp, it can obtain the subscriber's location information during an emergency and provide support for rescue efforts by fully utilizing the capabilities of the subscriber's terminal device. Such two-way interactions are of great value and significance with respect to disaster assistance and emergency relief operations.

A1.3.8 The status of remote-sensing activities (United States)[71]

(1) Early warning and prevention

Early warning and prevention include:

- disaster prediction, including the acquisition and processing of data concerning the probability of future disaster occurrence, location and duration; and
- disaster detection, including the detailed analysis of the topical likelihood and severity of a disaster event.

Meteorological aids, meteorological-satellite and Earth exploration-satellite services play a major role in activities such as:

- identifying areas at risk;
- forecasting weather and predicting climate change;
- detecting and tracking earthquakes, tsunamis, hurricanes, forest fires, oil leaks, etc.;
- providing alerts/warning information of such disasters;
- assessing the damage caused by such disasters;
- providing information for planning relief operations; and
- monitoring recovery from a disaster.

These services provide useful if not essential data for maintaining and improving the accuracy of weather forecasts, monitoring and predicting climate change, and furnishing information on natural resources. The frequencies used by these services and their associated applications are summarized in Table 1 of Recommendation ITU-R RS.1859.

[71] ITU-D SG2 Document SG2RGQ/150 from the United States.

On-the-ground, at-the-spot (in situ), at-the-time measurements or observations are usually more precise and more accurate than similar observations made from space. These kinds of observations are known as "ground truth" and are used to calibrate space-borne instrumentation. However, when in situ instrumentation or the supporting infrastructure needed to use such instrumentation is not in place or has been disabled by the disaster, or the ground measurements are not accurate enough, space-borne observations can provide useful information for alleviating the effects of disasters. Space-borne observations are particularly useful in vast areas with low population densities, and when the technical infrastructure is vulnerable or not well developed.

(2) ITU-R activities

Recommendation ITU-R RS.1859 has been revised to add examples of how space-borne sensors can help identify areas at risk by using synthetic aperture radar (SAR)-generated digital elevation models to locate low areas subject to flooding, or by using SAR-generated bathymetry to identify ocean bottom structure that might worsen an incoming tsunami or storm surge. It also demonstrates how satellite-based remote sensors have proven useful in providing an overall assessment of drought conditions or have identified nearby, previously unrecognized areas having much better-than-average crops. Such information enabled quick yet inexpensive relief to be provided, since transportation time and costs were minimized (i.e. using nearby trucks instead of distant airplanes). After a major earthquake, the sooner an accurate damage estimate is made, the sooner the appropriate rescue assets can be mobilized. Interferometric SAR (InSAR) observations pinpoint the location of earthquake epicentres far more accurately than remote seismographs, thus enabling more precise damage estimates on which to base relief efforts. Recent launches of fleets of SAR-equipped satellites (COSMO-SkyMed (ASI), TDX and TSX (DLR), the Sentinel–1 series (ESA), and the upcoming RADARSAT constellation (CSA)) have made these assessments more readily available than in the past. Precipitation radars flown on NASA's Global Precipitation Mission provide 3-dimensional images of the rainfall from severe storms. The mission includes passive instruments which provide complimentary storm information extending beyond the swath of the radar.

Table 3A indicates for which type of disaster a particular technology may provide useful data.

(3) Obtaining remote-sensing data

To gain the maximum benefit from remote-sensing data, a local emergency management agency is needed to direct the appropriate information to people in the field who need it. UN-SPIDER is focused on helping nations develop the capacity to manage disasters. While UN-SPIDER helps organize relief organizations and train their personnel, other organizations are more data-oriented.

The WMO Observing Systems Capability Analysis and Review Tool includes a table showing all known past, current and future satellites for meteorological and Earth observation purposes. The table can be used to identify additional sources of data.

Another source of analysed remote-sensing data is UNOSAT, a United Nations programme created to provide the international community and developing nations with enhanced access to satellite imagery and GIS services.

Table 3A: Satellite-based technologies for managing natural disasters

Objective / Technologies	SAR Imagery	In SAR Imagery	Active microwave imagery	Radar altimetry	Radar scatterometry	Precipitation radar	GPS radio occultation	Passive microwave imagery	Passive microwave sounder	Geographic visual and infrared imagery	Optical imagery	Multispectral optical imagery	Infrared imagery
Coastal hazards	x										x		
Drought	x		x	x	x			x		x	x	x	
Earthquakes	x	x					x				x		
Extreme weather					x	x	x	x	x	x	x		
Floods	x		x		x	x	x	x	x		x		
Landslides	x	x									x	x	
Ocean pollution	x											x	
Pollution											x	x	
Sea/lake ice	x							x			x		
Volcanoes	x	x						x			x	x	x
Wildland fires								x			x	x	x

A1.3.9 Monitor and accurately predict the path of cyclones (India)[72]

(1) Background

India has adopted a "Zero Casualty" policy to the management of disasters like cyclones, and its federal and state governments are now better prepared in terms of early-warning systems, evacuation plans, rescue and rehabilitation. Disaster drills help prepare for disasters, but the real test comes only when disaster actually strikes, in all its fervour and intensity. Recently, in May 2019, an extremely severe cyclone, Fani, struck Odisha state, on India's eastern coast. It was almost as severe as the "super cyclone" that hit the same state in 1999, killing more than 10 000 people. In the last two decades, India has prepared well to deal with disasters, including cyclones. As a result, Fani caused only 64 fatalities, despite its intensity. The United Nations Office for Disaster Risk Reduction praised the accuracy of the India Meteorological Department's early warnings, which helped the authorities in Odisha evacuate people and minimize the number of deaths.

(2) Cyclones/hurricanes/typhoons

Cyclones, hurricanes and typhoons are types of storms caused by atmospheric disturbances, wherein the air rotates cyclically around a low-pressure centre called the "eye". In the northern hemisphere, winds rotate counter-clockwise, and in the southern hemisphere, clockwise. Cyclones of variable intensity are born almost every year in the seas off India, during the months of June and July. Fani occurred in May, which is rare.

[72] ITU-D SG2 Document SG2RGQ/147 from India.

Cyclonic disturbances are classified depending on the wind speed around the centre. Satellite imagery of clouds and other meteorological features is used to estimate the intensity and wind speed of these intense systems. Satellite cloud configurations, expressed as "T" numbers, have a unique relationship with the wind field of a cyclonic disturbance. **Table 4A** below shows the categories of cyclones. The strong winds, heavy rains and large storm surges associated with tropical cyclones are the factors that eventually lead to loss of life and property.

Table 4A: Categories of cyclonic disturbances

Categorisation of Cyclonic Disturbances

S. No.	Intensity	Strength of wind Satellite	'T' No.	condition of Sea	Wave Height (m)
1	Depression (L)	31- 49 kmph (17-27 knots)	1.5	Moderate to Rough	1.25-2.5 2.5-4.0
2	Deep Depression (DD)	50 – 61 kmph (28-33 knots)	2.0	Very Rough	4.0-6.0
3	Cyclonic Storm (CS)	62 – 87 kmph (34-47 knots)	2.5-3.0	High	6.0-9.0
4	Severe Cyclonic Storm (SCS)	88-117 kmph (48-63 knots)	3.5	Very High	9.0-14.0
5	Very Severe Cyclonic Storm (VSCS)	118-166 kmph (64-89 knots)	4.0-4.5	Phenomenal Over	14.0
6	Extremely Severe Cyclonic Storm (ESCS)	167-221 kmph (9--119 knots)	5.0–6.0	Phenomenal Over	14.0
7	Super Cyclonic Storm (SuCS)	222 kmph and more (120 knots and more)	6.5 and more	Phenomenal Over	14.0

Source: http://www.rsmcnewdelhi.imd.gov.in

(3) Early-warning models adopted by the Indian Meteorological Department

The India Meteorological Department translates observational data into numerical weather prediction models. The information is collated and analysed with that of other countries. The Department refers to 10 different numerical models every day. These models ingest the current observations and are applied in different physical principles and mathematical equations. With the help of high-powered computing systems, experts solve and analyse these equations to obtain actual observations. They then issue a prediction for different days. Forecasters go through all the models developed every day to find out whether any low-pressure system is developing anywhere offshore. Based on the observations, scientists discuss the models and arrive at a consensus and then decide to issue warnings and predictions. Warnings have the following components: warning generation; warning product presentation; warning dissemination; coordination with emergency response units; post-event review; pre-season exercise; and public education and outreach.

(4) Four-stage warnings for states

Warnings are issued to states in a cyclone's path in four stages.

The first-stage warning, the **Pre-Cyclone Watch**, is issued 72 hours in advance. It warns that a cyclonic disturbance is developing in the Indian Ocean/seas.

The second-stage warning, the **Cyclone Alert**, is issued at least 48 hours in advance of the expected commencement of adverse weather over the coastal area. It contains information on the location and intensity of the storm, its likely direction and intensity, coastal districts likely to experience adverse weather and advice to fishermen, general public, the media and disaster-management agencies. It is issued by the Area Cyclone Warning Centres (ACWCs), Cyclone Warning Centres (CWCs) and Cyclone Warning Divisions (CWDs) concerned.

The third-stage warning, the **Cyclone Warning**, is issued at least 24 hours in advance of the expected commencement of adverse weather over the coastal area. The point of landfall is forecast at this stage. Third-stage warnings are issued by the ACWCs, CWCs and CWDs at three-hour intervals, giving the cyclone's latest position and intensity, the likely point and time of landfall, associated heavy rainfall, strong wind and storm surge, along with information on potential impact and advice to the general public, the media, fishermen and disaster managers.

The fourth-stage warning, the **Post-landfall Outlook**, is issued by the centres at least 12 hours in advance of the expected time of landfall. It gives the cyclone's likely direction after landfall and indicates the adverse weather likely to be experienced in the interior.

Different colour codes are used to denote the stages of cyclone warning bulletins. Cyclone alerts are **yellow**, cyclone warnings are **orange** and post-landfall outlooks are **red**.

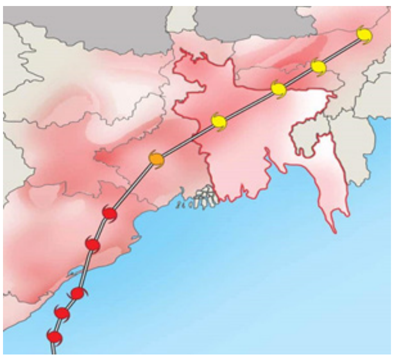
(5) ICTs used to issue early warnings in India

The following ICTs are used to send early-warning information: mobile phones, VSATs, satellite phones (Inmarsat), interactive voice response systems, LAN and virtual private networks, radio, TV, web media, loudspeakers and the national knowledge network.

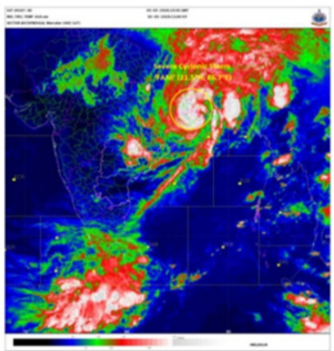
(6) Cyclone Fani

Cyclone Fani, a rare summer cyclone in the Bay of Bengal, hit eastern India on 3 May 2019. It was one of the strongest cyclones to reach India in the last 20 years. Fani was an Extremely Severe Cyclonic category storm. It crossed the temple town of Puri in Odisha state (see **Figure 26A**) at a speed of 175 to 185 km/h, gusting to 205 km/h, resulting in widespread loss of property. The fact that loss of human lives and livestock was significantly reduced can be credited to a number of things: the effective early-warning system; the availability of adequate infrastructure; the timely evacuation of millions of people; better coordination between federal and state governments; the deployment of national disaster relief forces; India's Zero Casualty approach; and the Meteorological Department's improved model for predicting cyclone paths and landfall accurately and with minimum errors.

Figure 26A: Cyclone Fani



(a) Path of Cyclone Fani



(b) Winds along the path

(7) Steps taken to reduce loss of lives during Cyclone Fani

As mentioned above, the Government's Zero Casualty approach to natural disasters and the improved accuracy of the India Meteorological Department's early-warning system helped reduce the number of deaths during Cyclone Fani.

A record 1.2 million people (equal to the population of Mauritius) were evacuated in less than 48 hours, and almost 7 000 kitchens, providing food for 9 000 shelters, were made functional overnight. This mammoth exercise involved more than 45 000 volunteers. Thanks to this timely action, Fani resulted in about 60 fatalities.

(8) Comparison with other cyclones/hurricanes

The statistics are striking when compared to the impact of big weather events around the world. When Hurricane Maria hit Puerto Rico in 2017 with wind speeds of 175 miles per hour, it caused a death toll of 2 975. The same year, Hurricane Harvey struck Texas with winds of 130 mph, causing devastating flooding. Texas reported USD 125 billion in damages and at least 68 direct storm-related deaths. Cyclone Idai hit Mozambique in March 2019; after it ripped through Madagascar, Malawi and Zimbabwe, more than 1 000 people were feared dead.

Thus, Odisha's ability to put such an effective disaster-management plan in place and save thousands of lives is a template that the world can learn from.

(9) Key takeaways from the Fani response

Build relief infrastructure and establish a clear command-and-control structure

Until 1999, when it was hit by a super cyclone, Odisha did not have a well-laid-out plan for disaster management. Two months after the cyclone hit, the Odisha state Disaster Management Authority was set up and plans put in place. Around 900 cyclone shelters were built in vulnerable pockets of the state, with systems in place for the evacuation of hundreds of thousands of people.

There is a clear command-and-control structure for disaster relief and there are clear protocols in place for carrying out relief operations. These were successfully used in the response to Cyclone Phailin in 2013 (a storm five times the size of Hurricane Katrina), Cyclone Hudhud in 2014 and Cyclone Fani in 2019.

Accuracy of early-warning systems

The India Meteorological Department has built an effective service able accurately to predict when a cyclone will form in the Bay of Bengal and when it will make landfall along India's coastline. This early-warning system promotes disaster readiness and minimizes loss of lives. It is then crucial that people follow the protocols in place when the warnings come in.

Clear communication plan

Roughly 6.5 million text messages were sent to locals and farmers in clear language before Cyclone Fani hit, alerting those potentially affected. People were repeatedly advised over all media not to panic and given clear "do and don'ts". This helped in the record evacuation of 1.2 million people to safe buildings.

Effective coordination of groups

Preparations to fight the onslaught of Fani involved a number of government agencies, local community groups and volunteers working together. The government's disaster-response forces were pre-positioned in vulnerable locations and food packets were made ready for air force helicopters to drop to people. Senior state officials and police officers were sent to the districts affected to coordinate the efforts of various agencies.

A1.3.10 Alert and warning systems (United States)[73]

(1) Introduction

Mitigation is the effort to reduce loss of life and property by lessening the impact of disasters.[74] Timely and effective alert and warning systems strengthen mitigation and community resilience by informing citizens of risks they may face and recommended actions to save lives and protect property. Development of better alert and warning capabilities helps to mitigate hazards and lessen the impact of disasters.

Proper authorities, policy and governance are critical foundational elements for the development of an alert and warning system, especially to prioritize personnel and resource justifications. The United States established the IPAWS as a unique, multi-hazard, multi-user alert and warning infrastructure that the US Federal Emergency Management Agency (FEMA) makes available for use by its constituents – federal, state, local, tribal and territorial entities – across the country. The IPAWS uses technology and information standards to join multiple private sector communication technology infrastructures, providing the ability to deliver a single emergency message simultaneously to multiple public dissemination pathways (e.g. radio, TV, mobile devices and Internet-connected systems, websites and applications). Authorized public Alerting Authorities (AAs) draft tailored messages to send alerts and warnings to citizens, residents and visitors in their jurisdiction. Using the IPAWS helps the constituent AAs to communicate information about an emergency situation to the greatest number of people in the shortest amount of time by leveraging local private sector ICTs to disseminate alerts and warnings. Distributing the same message across multiple sources increases the likelihood that people will receive it and will take timely action consistent with the threats or emergency situation.

FEMA's IPAWS Programme Management Office works to sustain and enhance the platform's unique abilities by continuously interfacing with industry to track and ultimately develop or interface new and emerging ICTs and thus expand the number of systems available for distribution of alerts and warnings using the same standards-based format (electronic road signs, sirens, smart kiosks, etc.). This is done by working hand-in-hand with the Federal Communications Commission (FCC), the United States regulatory body, and private industry partners. To date, this alliance has enabled the IPAWS to help over 1 300 AAs send emergency messages to the public using radio, television and cell phones in the United States.

(2) The IPAWS architecture

The IPAWS architecture was and is designed to support interoperability with any alert and warning system in the nation that employs the same standards. IPAWS-OPEN is the infrastructure that routes authenticated alert and warning messages to the public using the radio and television

[73] ITU-D SG2 Document SG2RGQ/152+Annex from the United States.
[74] United States Government. FEMA. FEMA's Mitigation Directorate fact sheet.

systems in the Emergency Alert System, Wireless Emergency Alerts to cell phones, NOAA Weather Radios and other communication systems.

The first critical step in initiating this design solution was to use the CAP and other technical standards. When alert and warning services are made CAP-compliant and integrated with the IPAWS, the platform acts as a mediator, authenticating messages from authorized users disseminating authentic emergency information to people in a specific geographic area quickly through multiple dissemination pathways. Information from a single source about a single incident can thus reach the public via radio, television, wireless phones, Internet services and future CAP-compliant IPAWS-connected technologies. The standards-based approach enables a national alert and warning architecture to adapt to and leverage future technologies. Making use of multiple dissemination pathways for public alerts significantly increases the likelihood that the message will reach its target. In addition, disseminating a single CAP alert message simultaneously via multiple pathways reduces the time needed to send alerts and the workload on emergency managers, who would otherwise have to prepare and send multiple separate channel-specific formatted alerts. The IPAWS standards-based approach speeds the delivery of critical, life-saving information.

Use of the open CAP standard enables industry partners (i.e. Internet, carriers, software vendors, broadcast) to develop technology and/or devices that can be used by individuals with disabilities, and others with access and functional needs, to receive alerts and warnings. Thanks to standards-based interoperability, the CAP enables the transport of rich multimedia attachments and hyperlinks in all alert and warning messages. The IPAWS adopted the Emergency Data Exchange Language (EDXL) CAP, which is developed and maintained by the Organization for the Advancement of Structured Information Standards (OASIS). It continues to work with the OASIS Standards Committee to adapt changes to the CAP standard specifications for IPAWS-OPEN. The current system utilizes the CAP v1.2 Standard and the CAP v1.2 IPAWS USA Profile v1.0. The IPAWS does not provide an alert origination tool; instead, it works with more than 25 different alert origination tool vendors to ensure that their products are compliant with the CAP v1.2 Standard and United States profile specification. Constituent AAs can find the tool that best fits local operations. The IPAWS engages and provides training to AAs and tool vendors, and encourages them to adopt the system for their alert and warning needs.

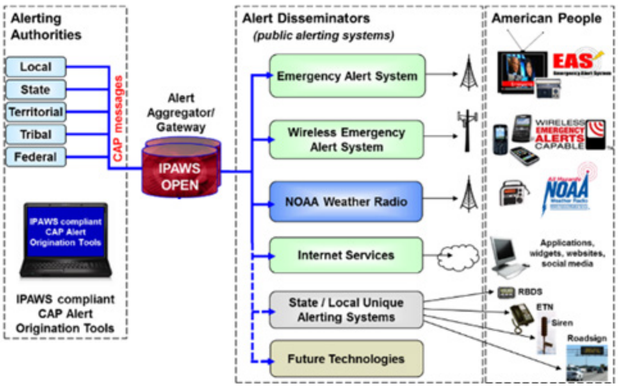
Together with the Alliance for Telecommunications Industry Solutions (ATIS), a United States-based technical and operational standards and solutions development organization for the ICT industry, the IPWAS developed and adopted standards used for wireless emergency alerts in the United States. ATIS addresses common, critical priorities and shares resources, efforts and costs to develop large-scale, interoperable solutions. It is accredited by the American National Standards Institute. The IPAWS actively participates in ATIS meetings with cellular service providers and partners to continuously update wireless emergency alert capabilities.

The IPAWS liaises and collaborates with relevant professional associations, including the National Association of Broadcasters, the NCTA Internet & Television Association (formerly the National Cable & Telecommunications Association), the National Emergency Management Association and the International Association of Emergency Managers. In addition to working with standards institutes and various associations, the IPAWS, in coordination with FEMA headquarters, actively engages with the FCC and Congress to update laws and regulations and thus improve alert and warning capabilities. It worked with committees of the National Research Council and The

National Academies Press to develop published workshop reports on the Public Response to Alerts and Warnings on Mobile Devices[75] and Geotargeted Alerts and Warnings[76].

Thanks to its regular use and development of standards, and participation in associations, the IPWAS participates proactively in operational tests, training, exercises and evaluations of new and emerging technologies. These activities enable progress toward the integration of additional and new technologies into the national alert and warning interoperability backbone, and encourage industry and other private sector innovators to meet the mitigation risk reduction and risk management needs of the emergency management community at large. The IPAWS architecture is shown in **Figure 27A**.

Figure 27A: IPAWS architecture



Source: FEMA

(3) Using IPAWS capabilities

The original requirement for the IPAWS was to provide the President with a means of warning the public of impending disasters and attacks. At present, however, the national IPAWS is used daily by local emergency managers in a very wide variety of situations that threaten public safety and property. Local authorities have used it to issue emergency messages related to chemical spills, child abductions, dam failures, the availability of disaster recovery resources, earthquakes, evacuations, flash floods, gridlocked traffic, hurricanes, large-scale power outages, law enforcement operations, nuclear facility accidents, roadway closures, shelter-in-place orders, snowstorms, tornados, toxic plumes, volcano eruptions, wildfires and water contamination. Details can be obtained from the IPAWS website.

(4) Alerting Authorities

Over 1 300 constituent AAs use CAP-based alert origination tools to create alerts and warnings that are compatible with the national architecture. In the United States, depending on constituent policies, AAs can include, but are not limited to, government agencies at all levels, fire and police departments, military bases, colleges and universities, nuclear power plants and hospitals. All AAs requesting use of the IPAWS platform must independently acquire software compatible with the IPAWS CAP specifications and sign a memorandum of agreement with FEMA. Each memorandum dictates the development of effective local alert and warning practices and

[75] Sub-title: "Summary of a Workshop on Current Knowledge and Research Gaps". Computer Science and Tele-communications Board, National Research Council, The National Academies Press, Washington, DC, 2011.

[76] Sub-title: "Report of a Workshop on Current Knowledge and Research Gaps". Computer Science and Tele-communications Board, National Research Council, The National Academies Press, Washington, DC, 2013.

procedures, requires completion of FEMA IPAWS training, and stipulates monthly training to demonstrate that the AA can react and send a properly formatted alert and warning in a test environment. All emergencies are local, and each area threatened by a disaster or emergency is unique, which is why AAs have the freedom and autonomy to determine message content and when to send alerts and warnings.

(5) Success stories

– Wildfires: During the Southern California wildfires of 2017, the Governor's Office of Emergency Services warned seven counties to stay alert and listen to authorities during periods of strong winds. Winds did in fact spread fires, at times over more than one acre per second. Wildfires burned over 307 900 acres and forced the evacuation of over 230 000 people, but only one civilian death was recorded, thanks in part to advance notification. In 2018, many wireless and Emergency Alert System alerts were sent during a wildfire that burned in four counties for 54 days. Media reports indicate that many people were evacuated on time as the public seemed very receptive to the alerts.

– Bomb threat: New York City Emergency Management sent a wireless emergency alert in the form of an electronic wanted poster to identify the suspect in connection with bombings in Manhattan and New Jersey in 2016; the suspect was captured within hours. This was the first widespread effort to transform the citizens of a major American city into a vigilant eye for authorities. "This is a tool we will use again in the future… This is a modern approach that really engaged a whole community," said Mayor Bill de Blasio.[77]

– Tornado alert: In 2016, the groom at a wedding reception in Ohio received a tornado alert on his phone. The phones of family members in attendance from New York, New Jersey, South Carolina and even Canada immediately received the same alert. Even when the guests and family members in attendance are from different geographic areas, wireless emergency alerts can reach any cell phone using a specific tower, including those in moving vehicles.[78]

– Child abduction/Amber Alert: On 31 December 2016 in Sharpsville, Pennsylvania, an armed and dangerous adult male abducted his eight-month-old daughter. An off-duty security worker in Reading, Pennsylvania, received an Amber Alert on his phone and noticed a vehicle matching the description provided in the alert. He provided 911 dispatchers with information that allowed police to find the vehicle. The child was found safe less than an hour after the Amber Alert was issued.[79]

A1.4 Drills and exercises

A1.4.1 Emergency telecommunication drills (China)[80]

This case study introduces the purpose, types and requirements of emergency telecommunication drills. It suggests further strengthening emergency telecommunication drills and experience

[77] J. David Goodman and David Gilles. Cellphone Alerts Used in New York to Search for Bombing Suspect. The New York Times, 19 September 2016.
[78] Samuel Reed. Wedding almost a disaster – literally. Sidney Daily News, 13 September 2016.
[79] CBS News. Report: Pa. man who saw Amber Alert helped find infant abducted by murder suspect. 3 January 2017.
[80] ITU-D SG2 Document SG2RGQ/61 from China.

sharing in the field of telecommunications/ICT for disaster preparedness, mitigation and response.

(1) Purpose of emergency telecommunication drills

Exercises are a great way to:

- Evaluate the preparedness programme and identify planning and procedural deficiencies: Preparedness programmes may be untested, not updated or unable to adapt to new situations. Emergency telecommunication drills can reveal shortcomings in the programme, check its adaptability to unexpected situations and gauge the need for modifications and improvements.
- Improve capabilities to respond to real events: Emergency telecommunication drills can help verify new technology application and information communication resources, assess new equipment capabilities and enhance emergency telecommunication support capability. They can provide indications of the capabilities of existing resources and identify resource gaps.
- Improve coordination between internal and external teams, organizations and entities, and boost the level of cross-regional support: Drills serve to strengthen the coordination ability of multi-department and rapid response operations, and to improve communication and coordination between emergency organizations and personnel.
- Train the emergency telecommunication team: Emergency drills help improve the team leader's ability to analyse, make decisions, organize and coordinate. They help telecommunication personnel understand onsite roles and responsibilities. They can also help heighten awareness and understanding of hazards and their potential impact, reduce panic and promote cooperation with the government and its departments, in order to improve the overall social emergency response capacity.

Figure 28A: Emergency telecommunication drill

(2) Types of emergency telecommunication drill

Different types of drill can be used to evaluate programme plans, procedures and capabilities.

- Emergency telecommunication drills that focus on **organization** include tabletop exercises and actual-combat drills. In tabletop exercises, team members use maps, sand tables, flowcharts, computer simulations, video conferencing and other means to discuss their roles and responses during an emergency situation. Such exercises are usually conducted in rooms. In actual-combat drills, the participants use the emergency equipment and materials available to simulate pre-set emergency scenarios and subsequent development scenarios through actual decision-making, action and operations. Such drills are usually conducted in specific locations.

- Emergency telecommunication drills that focus on **content** include single and comprehensive drills. A single drill involves only one specific emergency response function in the emergency plan or a series of emergency response functions in the onsite plan. It focuses on specific units and functions. Comprehensive drills involve multiple or all emergency response functions in contingency plans. They emphasize testing of various links and functions, especially the emergency mechanism and joint response capability of different departments.
- Emergency telecommunication drills that focus on **purpose and function** include test drills, demonstration drills and research drills. Test drills test emergency plan feasibility, emergency preparation, emergency mechanism coordination and the ability of relevant personnel to take their places. Demonstration drills are a kind of performance drill carried out in strict accordance with the emergency plan to demonstrate emergency ability or instruct observers. Research drills are organized to study and solve the key difficulties of emergency plan activation and to test new schemes, technologies and equipment.
- Emergency communication drills that focus on **notification** include notification and script-free drills. Notification drills follow a script and check the emergency communication support according to the plan of action. In double-blind emergency telecommunication drills or flight inspections without script or notification, the drill time and place are not announced in advance. The emergency telecommunication equipment and personnel are temporarily deployed to the drill site, where the equipment is assembled; both are then dispatched to an actual-combat simulation drill in a certain area.

Different types of drill can be combined: table-top drill, integrated table-top drill, demonstration of single drill, demonstration of integrated drill, and so on.

The general emergency telecommunication drill is a comprehensive drill. The drill scenario might be as follows: a simulated earthquake causes business disruptions; a group organized via a remote emergency rescue and disaster relief drill in neighbouring provinces comprises seven teams; 24 emergency vehicles, 24 sets of equipment and 78 drill personnel are sent in; topics covered in the drill include coverage of the UAV base station, Wi-Fi coverage of Ku and Ka portable stations, a C network base station with satellite circuit, optical fibre fusion, emergency power supply and other business subjects.

Figure 29A: Emergency telecommunication drill

A1.4.2 Exercise to simulate the implementation of the civil security plan for telecommunications (Algeria)[81]

In order to strengthen disaster preparedness for emergency telecommunication resources, the Ministry of Post and Telecommunications of Algeria, in cooperation with the Algerian Space Agency, the General Directorate for Civil Protection and the telecommunication operators organized a partial civil security (ORSEC) simulation exercise for the telecommunication module on 24 October 2020 in the wilaya of Boumerdes located 45 kilometres to the north-east of the nation's capital city.

(1) Legal framework

Operators who hold licenses for setting up and operating public telecommunication networks (fixed and mobile) have certain obligations under their licensing terms. In particular there is an article relating to emergency calls:

- to elaborate, in concert with the officials in charge of disaster relief and the local authorities, plans and preparations for the provision and rapid restoration of a minimum level of emergency telecommunications, and to implement them at their own initiative or upon a request from the competent authorities;
- to reserve equipment that is mobile, transportable and suitable for response work and participate in exercises organized by the responsible public bodies.

(2) Objective of the simulation exercise

The principal objective of this simulation exercise was to test the continuity of operations of telecommunication services, particularly with regard to the command structure and the population, and to permit Civil Protection to evaluate the effectiveness of the emergency measures put in place on the operational level.

Accordingly, it aimed to first, strengthen coordination between the different operators in the telecommunication sector and to ascertain their readiness and effectiveness in a disaster situation; and second, employ the resources of Algeria's ALCOMSAT-1 satellite in cooperation with the Algerian Space Agency (ASAL) and Algérie Télécom Satellite (ATS). ALCOMSAT-1 was launched in December 2017 and is the country's first telecommunication satellite.

(3) Scenario of the simulation exercise

The simulation manoeuvres were based on "an earthquake of magnitude 6.8 on the Richter scale, with the epicentre located 8 km to the north of the town of Boumerdes, leading to loss of life and major damage to urban areas, infrastructure and residences. The zone most heavily affected is that of the communes of Boumerdes and Zemmouri, with total disruption of the telecommunication networks."

For the links and telecommunications module, the scenario had two aspects:

- Operational aspect: telecommunication links were provided by ASAL with the installation of mobile and fixed VSAT stations to enable VoIP, data and videoconference transmission between the various command sites managed by Civil Protection via ALCOMSAT-1, complementing the voice-only VHF relays and terminals;

[81] ITU-D SG2 Document SG2/384 from Algeria.

- Civil aspect: (Deployment exercise) involving telecommunication operators for fixed and mobile telephony so as to maintain service continuity in the affected zone and provide telecommunication services to the population.

(4) Human and material resources

This large-scale exercise involved some 100 participants from such telecommunication players as ASAL, ATS, the *Agence Nationale des Fréquences* (ANF), Algérie Télécom (AT), Algérie Télécom Mobile (ATM Mobilis), Wataniya Télécom Algérie (WTA-OOREDOO) and Orascom Télécom Algérie (OTA-Djezzy), as well as Civil Protection members at various levels.

With regard to the telecommunication resources deployed for the simulation exercise, Civil Protection and ASAL, as well as the telecommunication operators, made available some major technical equipment, including:

- Civil Protection: VHF stations, relays and terminals;
- ASAL: six VSAT station, including two mobile (van and 4x4 vehicle), one portable and three fixed;
- AT: two eNodeB trailer-mounted 4G stations with built-in generator sets, one mini eNodeB 4G station, two complete DRSS links, and five 25 kVA generator sets;
- ATM: one trailer-mounted 2G/3G/4G-compatible station with built-in generator set and VSAT antenna;
- OTA: one trailer-mounted 2G/3G-compatible station with an Outdoor generator set;
- WTA: one mobile lorry-mounted 2G/3G-compatible station with built-in generator set;
- ATS: two VSAT stations (for Mobilis, the VSAT station is already integrated), six satellite modems and two 1.8-metre antennas;
- ANF: two spectrum monitoring units.

(5) Conduct of the simulation

The simulation exercise took place on the five following sites:

- **Sites 1 and 2**: two zone command posts (PCZ), located in the affected zones;
- **Site 3**: an operational command post (PCO) for representatives of the executive bodies under the authority of the Civil Protection for coordinating the rescue efforts;
- **Site 4**: a fixed command post (PCF) at the Wilaya headquarters for the officers in charge, under the authority of the wali or a representative;
- **Site 5**: the headquarters for the General Directorate for Civil Protection, simulating the interministerial crisis cell.

Operational portion

At the different sites involved ASAL deployed fixed VSAT stations, a mobile station (van), a VSAT station and a 4x4 vehicle equipped with a VSAT link for transmitting imagery filmed by a camera mounted on a Civil Protection helicopter and providing the different mobile-mode transmission services to remote sites. Voice and videoconference transmission between those sites was tested successfully, as was the reception of aerial images and videos of the affected areas transmitted by the Civil Protection helicopter. Transmission was done via ALCOMSAT-1. In addition, all of the sites were interconnected by the Civil Protection VHF network for the provision of voice transmission.

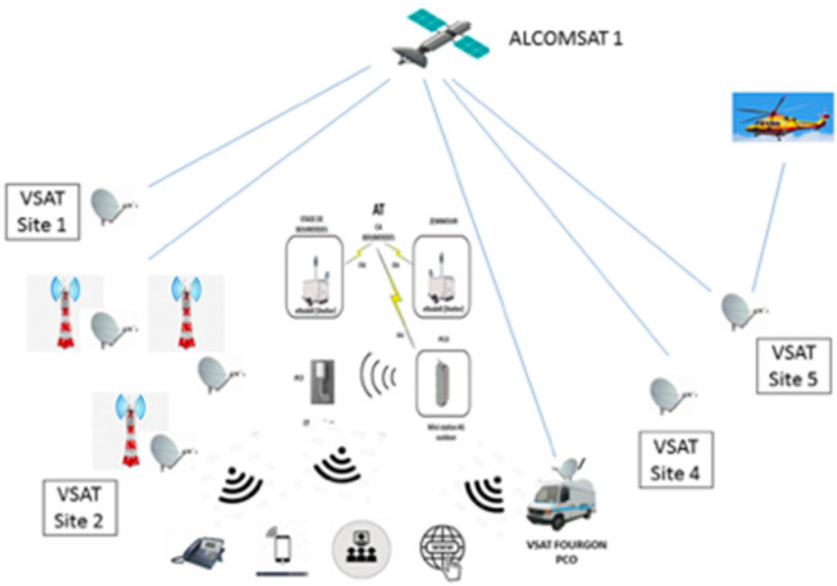
Civil portion

Coverage of the affected areas was provided by the three mobile telephony operators and by the incumbent fixed telephony operator AT.

The topology of the networks deployed on the day of the simulation was organized around the following points:

- AT deployed two trailer-mounted 4G stations, one mini 4G station at the PCO, with the installation of 4G CPE, one Outdoor CPE unit and videoconference equipment at the five sites. Tests for voice, data and video were successful and transmission was provided by the 800 Mbit/s DRSS links;
- the mobile operators deployed three trailer-mounted stations in the affected area to provide voice coverage for the population with a 2 Mbit/s VSAT satellite link by ATS for each operator;
- ANF put up two spectrum analysers to monitor and verify the quality of the signal and frequencies used.

Figure 30A: Emergency telecommunication drill



(6) Conclusion

Thanks to the different tests performed on the day of the simulation, it was possible to obtain information on the resources available from each operator and establish direct contact with the different players. In the same framework, future simulation days organized annually across the entire country should lead to improvements at the organizational and procedural level, while preserving the dynamic interaction and coordination between the players as regards the civil security plan and providing solutions for the different technical and organizational problems that simulation operations invariably bring to light.

The tests also contributed to informing the vision of Algeria's Ministerial Department with regard to the preparation and elaboration of a national emergency telecommunication plan, in accordance with Target 3.5 defined in the strategic plan for the period 2020-2023 in Resolution 71 (Rev. Dubai, 2018) of the Plenipotentiary Conference of the International Telecommunication

Union: ***"By 2023, all countries should have a national emergency telecommunication plan as part of their national and local disaster risk reduction strategies"***.

These national plans will make it possible to bring together all of the players so as to examine the disaster-management cycle, define the ICT capabilities needed to deal with emergency and elaborate a governance framework allocating roles and responsibilities.

A1.5 Others

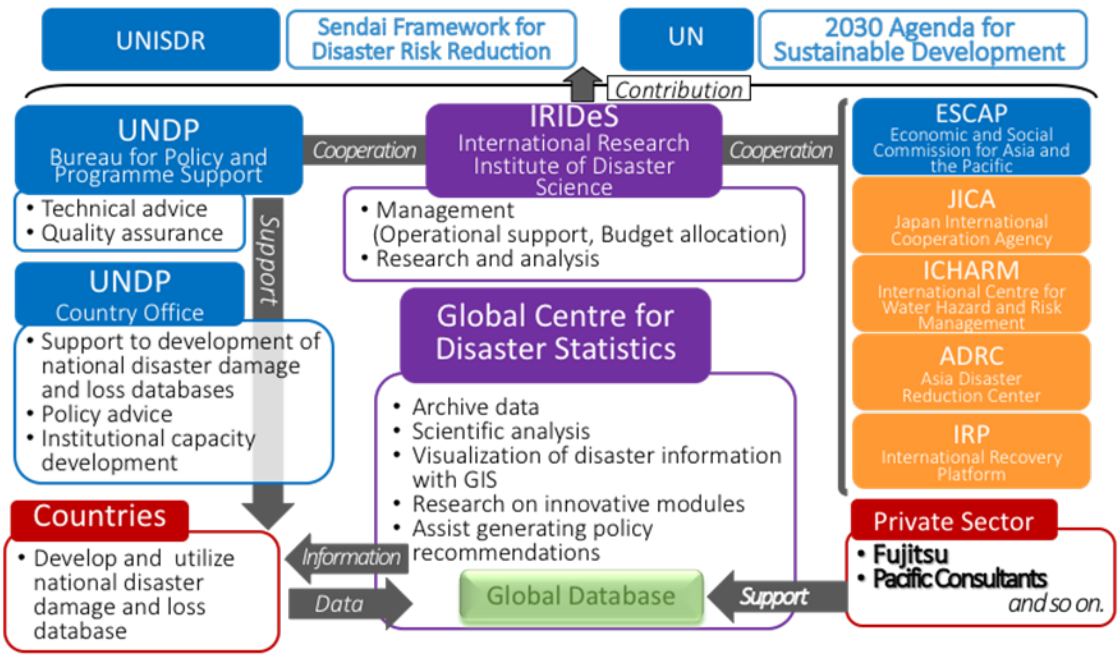
A1.5.1 Global disaster statistics (Japan)[82]

The Global Centre for Disaster Statistics (GCDS, see **Figure 31A** for a detailed scheme) was established in partnership with the International Research Institute for Disaster Science (IRIDeS) at Tohoku University, Fujitsu, and other organizations with a view to implementing the Sendai Framework for Disaster Risk Reduction 2015-2030 and achieving the Sustainable Development Goals. The following outputs are expected:

i) national capacities to produce disaster statistics are strengthened;
ii) a global information platform is developed for the analysis of disaster statistics; and
iii) independent scientific analyses are conducted of progress towards achievement of the Sendai Framework global targets and the Sustainable Development Goals.

In terms of academic contributions, the GCDS will publish a special issue of the *Journal of Disaster Research* on the development of disaster statistics.

Figure 31A: Detailed scheme of the GCDS



A pilot phase started in 2017, with UNDP and IRIDeS working with Cambodia, Indonesia, the Maldives, Myanmar, Nepal, the Philippines and Sri Lanka, which had been selected by the UNDP Asia-Pacific Hub, to increase their capacities in disaster statistics and convening regular

[82] ITU-D SG2 Document SG2RGQ/74+Annex from Japan.

meetings to share experiences. In terms of ICT, Fujitsu has developed a global database to store disaster loss and damage data. The GCDS has started to collect and store data from the pilot country governments. **Table 5A** shows the progress made in that respect.

Table 5A: Data collection progress

Indonesia	The API* developed by the BNPB** is stored in the database (22 442 data).
Myanmar	The GCDS has commenced proceedings to collect data to store in the database.
Philippines	The GCDS has commenced proceedings to collect data to store in the database.
Cambodia	The GCDS has commenced proceedings to collect data to store in the database.
Sri Lanka	The GCDS has commenced proceedings to collect data to store in the database.
Nepal (Republic of)	The GCDS plans to commence proceedings in this fiscal year to collect data to store in the database.
Maldives	The GCDS plans to commence proceedings in this fiscal year to collect data to store in the database.

*API: Application Programming Interface
**BNPB: National Agency for Disaster Management in Indonesia

Consultations with UNDP regional hubs have resulted in the countries listed in **Table 6A** being nominated as priority countries for GCDS implementation.

Table 6A: Priority countries for GCDS implementation

Africa	Uganda, Mozambique, Rwanda, Niger, Angola
Arab States	Djibouti, Egypt, Iraq, Lebanon, State of Palestine under Resolution 99 (Rev. Dubai, 2018), Somalia, Sudan, Tunisia
Central Asia	Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan, Georgia, Armenia
Latin America and the Caribbean	Peru, Paraguay, Chile, Cuba, Ecuador, Mexico, Nicaragua, Dominican Republic

The GCDS is now planning to take advantage of Fujitsu's Cloud Service K5. Needless to say, ICT is vital to connect numerous stakeholders. The GCDS mission will be achieved all the more effectively and efficiently in that it goes beyond various resource restrictions.

A1.5.2 Pre-positioned emergency telecommunication systems (Japan)[83]

When disaster strikes, damaged telecommunication equipment may lead to telecommunication blackouts or telecommunication traffic may become congested. When this happens,

[83] ITU-D SG2 Document SG2RGQ/188(Rev.1) from Japan.

emergency telecommunication systems prepared in advance can rapidly restore important telecommunication services, e.g. for the police, fire department, local government and hospitals. They can also send safety confirmation messages to people in disaster areas. Using the systems in normal times, i.e. not in a disaster, can avoid problems such as system unavailability. In addition, emergency telecommunication systems can provide communication services in rural areas where service would otherwise be insufficient.

The Japanese Government Cabinet Office's Strategic Innovation Programme plans to implement research results society-wide. One of its projects was a field trial of an MDRU initially designed as a disaster communication tool in the Republic of Nepal in February 2019.

The Republic of Nepal is a rugged country that is over 60 per cent hills and mountains. Many schools in remote villages in the hills and mountains have few resources and learning materials. Schools are closed for long periods during the monsoon and winter seasons because teachers and students cannot reach them. Remote education is one way to overcome the geographical conditions in Nepal, serve areas that are hard to access and encourage the participation of students and other stakeholders in education.

With the assistance of Japan, Educating Nepal, a Nepalese NGO, conducted a field trial in which an MDRU was used to provide remote education in the rural community of Jholunge, Indrawati Rural Municipality, in the hilly region of Sindhupalchowk District, roughly 85 km from Kathmandu.

The MDRU was used to connect the elementary school and two nearby villages, as shown in **Figure 32A**. The school was the main venue, while the two other locations were remote venue A and remote venue B. **Figure 33A** shows the geographical conditions of the trial.

Figure 32A: Testing remote education in the Republic of Nepal

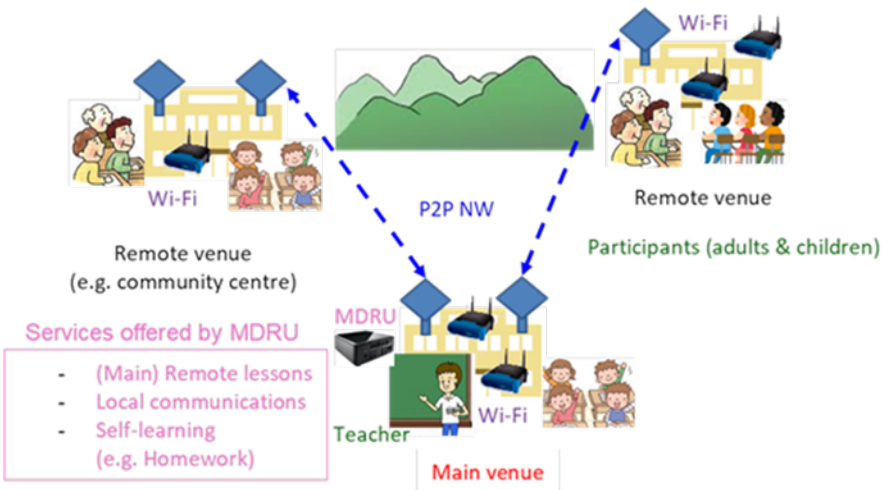


Figure 33A: Geographical conditions of Jholunge village

During the trial, remote teaching and learning were demonstrated to elementary school pupils, and remote consulting and agricultural support were tested for adults, especially farmers.

The results of the trial were evaluated by means of a questionnaire and interviews of key participants and observers. They show that the MDRU was very effective for remote education at a general level. Adult remote learning received the highest scores, followed by overall self-learning and then student remote learning. The MDRU user experience in terms of effectiveness, relevance and innovation received higher scores, while MDRU convenience and suitability for daily use received lower scores. The MDRU is therefore an effective tool for remote education that should be installed in various places to provide effective education through distance or e-learning.

The results also showed that it can be useful to redesign the dedicated user application or interface for remote learning, since the current application was fully tailored for disaster communication and was therefore at one point a little inconvenient to use for remote education. Apart from that one niggle, the MDRU obtained commendable test scores for its effective use in remote education.

Disaster-management solutions such as emergency telecommunication systems can be used for remote education in rural areas without enough telecommunication infrastructure in ordinary times. This has the added advantage of ensuring that children and farmers will know how to use the emergency telecommunication system when disaster strikes, as they will have been "trained" in its use in ordinary times.

A1.5.3 Fighting the Ebola virus disease (Democratic Republic of the Congo)[84]

Telecommunications are being used in the Democratic Republic of the Congo (DRC) to fight an outbreak of Ebola virus disease in the province of North Kivu in the east of the country and a threatened outbreak in the neighbouring countries of Rwanda and Uganda. The Democratic

[84] ITU-D SG2 Document 2/252 from the Democratic Republic of the Congo.

Republic of the Congo is affected by different kinds of disaster, the most common being those related to illnesses such as cholera and Ebola.

The main participants in the fight against Ebola are:

- the Office of the President of the Republic, through the anti-Ebola technical committee;
- the Ministry of the Interior and Security, through the DRC National Police, which provide security at sites and centres where patients are treated and cared for;
- the Ministry of National Defence, through the DRC Armed Forces, which are pursuing the armed groups that operate in the eastern part of the country and regularly attack medical and other health-care personnel, hospitals and members of the public;
- the Ministry of Health;
- the Ministries of Humanitarian Affairs and of Social Affairs;
- the Ministry of Posts and Telecommunications, through the regulatory authority;
- NGOs active in the field of humanitarian and health services;
- civil society, for public education and outreach campaigns;
- religious communities, in particular the Catholic Church (assistance is provided by the Vatican).

Given that armed groups are operating in the area where the Ebola epidemic has taken root, in the east of the Democratic Republic of the Congo, and that the epidemic has reached alarming proportions, with more than 2 000 cases, the Government has launched an epidemic response strategy, one of the pillars of which is telecommunications. Thanks to telecommunications, people in epidemic-affected areas can inform friends and relatives, the public authorities and humanitarian associations about the onset of disaster, the public authorities can issue alerts and plan relief operations, and rescue teams can coordinate their operations from the initial alert to the intervention process.

The telecommunication sector of the Democratic Republic of the Congo, which was opened to competition under the framework law of 16 October 2002, currently comprises the following:

- four mobile telephone operators (Vodacom Congo S.A, Airtel Congo S.A, Orange and Africell);
- one wired fixed telephone operator (the public/incumbent operator);
- one wireless fixed telephone operator (Standard Telecoms);
- about 20 Internet service providers;
- over 150 radio stations and about 60 television channels across the country, in urban and rural areas;
- over 10 national digital terrestrial TV channels;
- private telecommunication networks (operated by private organizations and NGOs).

Other forms of communication being used in the fight against Ebola include visual media such as banners, streamers, posters and T-shirts displaying public health advice.

In short, there are two types of telecommunication network being used in the fight against Ebola:

- **public networks**: mobile telephone networks, fixed telephone networks, radio and television broadcasting networks and Internet access networks;
- **private networks**: private companies, NGOs, etc.

These various telecommunication networks enable and facilitate:

- early warnings for prevention or intervention;

- the circulation, exchange and sharing of information and data among the different players involved;
- prompt decision-making so as to reduce the threat of the disease;
- planning and coordination of relief operations on the ground.

Are there specific regulations governing the use of telecommunications in the event of disasters in the Democratic Republic of the Congo?

While the answer to that question is "No", the Government has established provisions in the licensing agreements for telephone operators requiring them *inter alia* to help relief teams use their networks free of charge in their operations. To that effect, holders of licences for a public telecommunication service are required to organize free-of-charge emergency call services, in particular for the national police and relief services in the operating area of the service licensed.

In addition, the general regulations on telecommunications grant favourable terms for the possession, movement and use of satellite terminals such as Thuraya, Iridium and so on by NGOs. By virtue of agreements signed with the Government, NGOs are also exempt from any and all taxes and levies on telecommunication equipment and materials that they have and use for the fulfilment of their mission. All these various measures serve to increase and reinforce the relief capabilities of NGOs.

The mobilization of significant telecommunication resources has led to an improvement in the management of the Ebola epidemic in recent months, as confirmed by the encouraging results reported by medical sources. As control over Ebola is established, the number of positive diagnoses is decreasing and there are even cases of recovery.

A1.5.4 Disaster Maps programme (Facebook, United States)[85]

(1) Introduction

The enormous number of people using social networks such as Facebook means that extensive geospatial information is available on connectivity that is difficult to capture quickly through conventional methods. Many apps rely on location services data collected via smartphones. In the case of Facebook, people have the option to provide this information. Location data are used to provide myriad features, such as targeted alerts and prompts to check in as "safe" after a hazard event to allay the concerns of friends and family. In addition to powering product crisis response features, location data, when aggregated and anonymized, can provide insights into how populations are affected by crisis events.

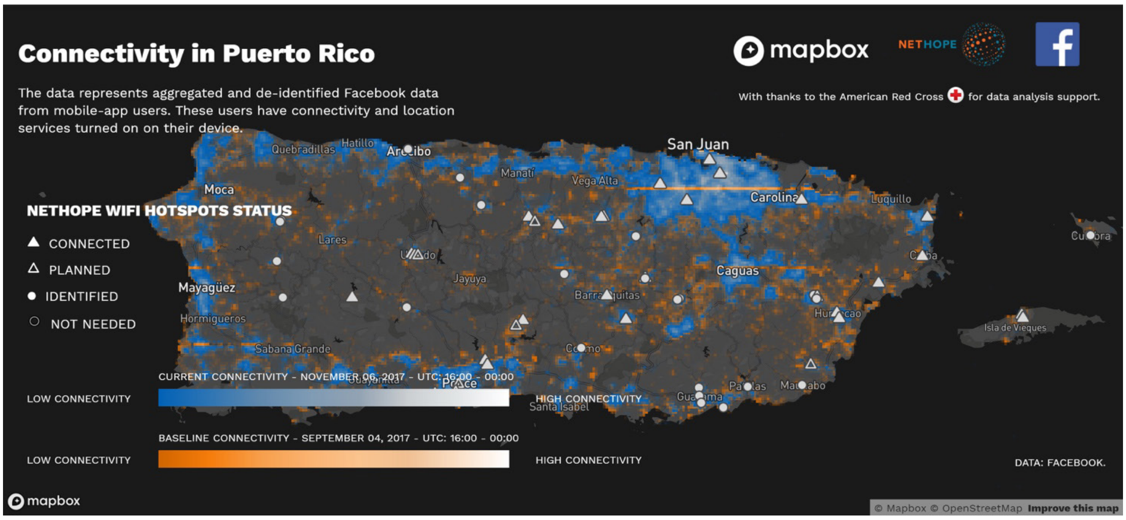
Beginning in 2017,[86] Facebook began providing aggregated geospatial data sets to crisis response organizations and researchers to help fill information gaps in service delivery. These Disaster Maps utilize information about usage in areas impacted by natural hazards, producing aggregate pictures of how the population is affected by and responding to the crisis. The maps include insights into evacuations, cell network connectivity, access to electricity and long-term displacement. Since their launch, Disaster Maps have been activated for over 500 crisis events and made available to over 100 partner organizations. The connectivity maps in particular have proven to be instrumental in aiding emergency communication efforts.

[85] ITU-D SG2 Document 2/308 from Facebook (United States).
[86] Molly Jackman. Using Data to Help Communities Recover and Rebuild. Facebook Newsroom, 7 June 2017.

(2) Case Study: Hurricane Maria

In the aftermath of Hurricane Maria in Puerto Rico in 2017, response organizations were in desperate need of information for rescue operations and aid coordination. The storm had knocked out the majority of communication services, including cellular Internet service, on the island. NetHope crews were quickly deployed and worked to restore connectivity, to enable responding organizations to coordinate rescue and aid efforts. Their challenge was how to target efforts to the areas of highest need. As shown in **Figure 34A** below, Disaster Maps data were used to show drops in connectivity on a daily basis by comparing the aggregate number of users connecting to Facebook before the storm and the number able to connect in the days after the hurricane.[87] The data helped NetHope identify the areas of greatest need and efficiently prioritize its relief efforts.

Figure 34A: Example connectivity map generated with Facebook Disaster Maps data by NetHope



The Disaster Maps programme was developed in a cross-functional effort by research, design, engineering, legal and policy teams to ensure that useful data are reliably provided to vetted NGOs and research organizations. The programme is ongoing and seeks to reach more people in need after a crisis, increase the data types surfaced in each Disaster Map and improve the accuracy of existing Disaster Maps data sets. Of particular note is the emphasis on ensuring that the privacy-protecting methods (such as aggregation and spatial smoothing) used in Disaster Maps are published openly. Companies in the tech sector draw on a wide range of privacy-protecting methods when considering how to share data, and these must be weighed against both technical limitations and legal requirements. These considerations require considerable effort and time. By publishing the solution that works for it, the company has dramatically reduced the barrier of entry for other entities to provide similar data sets in order to create a more complete picture for crisis response organizations.

(3) Facebook's data-sharing approach

Facebook generates and shares Disaster Maps as part of its Data for Good programme, which shares data sets externally with humanitarian response organizations while preserving user

[87] NetHope Blog. Unlocking insights from data: Collaboration with private sector creates cutting-edge maps for disaster response, 9 October 2018.

privacy. While building these efforts, the company developed key lessons and resources that can lower barriers for other companies to participate in similar crisis response data-sharing efforts.

- Facebook published the privacy protection methods it uses in Disaster Maps, which include aggregation, spatial smoothing, dropping small counts, and other techniques, as part of the proceedings of the 16th International Conference on Information Systems for Crisis Response and Management, in May 2019.[88] This open publication represents a critical contribution made in order to stimulate other private sector companies to consider providing similar data sets to crisis response organizations. Determining an acceptable privacy protection threshold in geospatial data sets is a complex undertaking, and it is Facebook's hope that by openly publishing its methods, it will lower barriers to entry for other private sector agencies to move forward with similar data-sharing efforts.
- The company launched improved displacement maps at the October 2019 NetHope Global Summit in Puerto Rico. These maps help non-profit and research partners better understand the volume of people displaced after a natural disaster and where they have been displaced.
- The company launched simplified and improved network connectivity maps in December 2019 based on feedback from existing emergency communication partners wishing to better understand where network connectivity was completely out following a natural disaster rather than simply reduced. These new network connectivity maps show where users have cellular connectivity of a 2G, 3G or 4G connection type based on the speed and latency of data being sent between the user's device and the servers hosting the mobile app.

(4) A collaborative approach

The goal of the Disaster Maps programme is to empower crisis response organizations and researchers with data that improve delivery of life-saving interventions while preserving user privacy. The programme also seeks to drive innovation in crisis response and emergency communication efforts that extends beyond the company. To date, Facebook has partnered with over 100 NGOs and research organizations through Disaster Maps, and a number of its NGO partners also work to share derivative products with broader coalitions of response agencies, including federal, state and local entities. These crisis response organizations are experienced in engaging government agencies and providing them with geospatial data. The company's programme model is to empower such partners with new data sources rather than displace their role in coordinating with governments directly. This has proven very successful and scalable. All Facebook partners complete a data license agreement in order to be granted access to Disaster Maps data.

When specific crisis response data gaps emerge, the company seeks organizations to work with closely, to guide its research and development of new or improved data sets. For example, the methodology for the improved displacement maps released in October 2019 was co-created by Facebook and the Internal Displacement Monitoring Centre (IDMC), which works on measuring numbers of internally displaced people. The company's Data for Good team continues to work with the IDMC to compare the insights derived from displacement data from recent crises in 2019, such as Cyclone Idai in India/Bangladesh and Typhoon Hagibis in Japan, and to compare displacement data with more traditional sources in order to refine and educate ongoing development efforts.

[88] Paige Maas et al. (Facebook). Facebook Disaster Maps: Aggregate Insights for Crisis Response and Recovery. WiPe Paper – Social Media in Crisis and Conflicts (ID 176), in Zeno Franco et al. (Eds). Conference Proceedings, 16th International Conference on Information Systems for Crisis Response and Management. Valencia (Spain), 19-22 May 2019, pp. 836-847.

Collaboration with crisis response organizations in the emergency communication space has also led to new network connectivity maps. A specific example is the collaboration and feedback received from NetHope and its member organizations on the need to simplify the nature of coverage map generation for efficient operational decision-making. Critical questions facing these organizations included whether people had cellular connectivity, where drops in cellular connectivity had been observed in disaster-impacted areas, and how certain they could be that there had been a drop in cellular connectivity in a disaster-impacted area. To answer the first question, Facebook developed a simple coverage map showing the grid tiles that had network coverage on a given date. To address the second question, it surfaced a map that shows which grid tiles had not seen network connections on that date but had coverage during the 30-day baseline period. The company's teams addressed the third question by publishing the probability of a grid tile receiving network coverage on that date based on 30-day baseline observations.

(5) Testing and usability

All Disaster Maps undergo testing with users in order to ensure that new data sets are clear to understand and fit within the workflows of crisis response organizations. The company's Data for Good team has invested heavily in usability research with organizations across the spectrum of geospatial experience. For example, research with advanced users was a key part of refining and improving the format of data set files to enable customized analysis methods across a range of GIS applications. This research also included one-on-one interviews with novice users of Disaster Maps, to test early prototypes and determine the best means to visualize complex displacement data in vector format. Based on this feedback, the company's Data for Good team updated visualizations to allow for filtering by outbound or inbound displacement for a given location. In addition, the team improved the depth of documentation on the statistical methods used to compare pre-crisis connectivity levels with those observed in real time.

(6) Creating an enabling policy and regulatory environment for sharing information during a disaster

Facebook supports policies that protect and promote user privacy, especially during times of increased vulnerability such as following an emergency crisis. It recognizes that protecting privacy while improving the effectiveness of potentially life-saving response efforts requires concerted efforts and time by technical and programmatic teams.

The company and its partners encourage other entities from across the public and private sector to share geospatial data sets that preserve user privacy. A variety of collaborative approaches, including data governance frameworks, should be considered for scaling data-sharing efforts across private sector companies, so as to avoid overwhelming response organizations with additional data. The Data Collaboratives framework provided by GovLab has proven extremely useful in helping to ensure that decision-makers are able to be more data-driven and collaborative with the private sector.

Collectively, the emergency response community should advance policies and programmes that encourage a transparent approach to privacy protection and afford continued collaboration for improved humanitarian operations.

A1.5.5 ICTs in the fight against the COVID-19 pandemic (China)[89]

(1) Introduction

In the face of the COVID-19 pandemic, China has launched emergency communication measures to fight the pandemic from the perspectives of government and companies. First, more resources have been provided, to help telecom operators meet people's needs for more broadband Internet connectivity and telecommunication services. Second, during the pandemic, some countries have adopted measures to reduce and abolish telecommunication fees, cancel the upper limit of fixed broadband or mobile Internet access, abolish all telecommunication late payment fees, provide free calls or increase the data flow of tariff packages, so as to ensure the normal use of the telecommunication lifeline by users. The third is to provide decision-making support in the form of big-data analysis. The fourth is to develop new applications and launch a number of cloud services, which have played an important role in supporting services.

(2) Network guarantee

The Chinese Government has provided overall guidance to operators to ensure the construction of designated high-quality hospital communication networks within the shortest possible time. The operators completed the construction of telecommunication facilities at Huoshenshan, Leishenshan and shelter hospitals in Wuhan, overcoming various difficulties, and put into operation the 5G base station in Huoshenshan Hospital within 36 hours, providing full coverage of 4G/5G signals. The network deployment at Leishenshan Hospital was completed within 24 hours and can meet the concurrent telecommunication needs of 30 000 people. The wireless network coverage and optimization of Wuhan shelter hospitals was completed within 48 hours.

(3) Service guarantee

At the request of the joint prevention and control regime and relevant departments, the Chinese Government has organized operators to send tens of billions of public short messages on pandemic prevention and control, effectively supporting prevention and control efforts in various places. In areas where the situation was severe, operators offered convenient services, such as non-stop service and emergency start-up, and services enabling users to handle telecommunication issues without leaving home. Some areas connected people with the health and pandemic prevention agencies, and reduced the telephone charges for medical staff lending a hand in Hubei Province. Internet companies have been helped and encouraged to give full play to their respective advantages and provide public services such as online diagnosis and treatment, an e-commerce platform, teleworking and online education, so as to help realize "working without going to work, schooling without going to school", contributing greatly to the fight against the pandemic.

(4) Big-data analysis application

China can provide strong, accurate and comprehensive decision-making support for real-time pandemic prevention and control by using telecommunication big-data analysis. Since the outbreak, it has organized industry experts to carry out big-data analyses and established a telecom big-data analysis model for the pandemic.

[89] ITU-D SG2 Document SG2RGQ/220(Rev.1) from China.

The sharing and combining of big data on communication with data from health and disease control and prevention centres are important sources of support for the advance study and assessment of pandemic spread and prevention trends, contributing to dynamic prediction and early warning of the overall pandemic situation.

Telecommunication administrations of all provinces (autonomous regions and municipalities) have actively communicated with local COVID-19 prevention and control organizations, trying to understand the local needs for big data on pandemic prevention and control, organizing local operators to carry out big-data analyses, and providing detailed data support for pandemic prevention and control from the source and at grass-roots level, and for accurate government policy formulation.

Drawing on mobile user data, operators have cooperated with relevant departments on joint prevention and control, focusing on the dynamic analysis of people flows in key areas such as designated hospitals, fever clinics and points of assembly, and providing big-data analysis support services for population flows related to pandemic prevention and control. The results of big-data analyses related to pneumonia research released by Internet companies independently have also provided a useful reference for relevant government agencies in their decision making.

(5) Development of new applications and services

To fight the pandemic and help people resume work, production and school, Chinese operators have launched a number of cloud services that have played an important support role. In terms of cloud command, operators are free to launch "cloud conference" services for hundreds of parties online, for an unlimited number of times and for extended periods, thereby meeting the needs of governments at all levels, medical institutions and other agencies fighting COVID-19 in terms of command, dispatch and videoconferencing.

To facilitate cloud health care, the medical cloud system has been successfully applied in many areas during the pandemic. For example, China Mobile helped the General Hospital of the People's Liberation Army in Beijing and the Huoshenshan Hospital in Wuhan make the first critical remote diagnosis: medical experts at the General Hospital were kept on alert with the "5G telemedicine system" 24 hours a day. By using two medical trolleys in the infection division, Huoshenshan Hospital achieved interconnection and interoperability with the General Hospital wards using cloud video equipment and thus enjoyed real-time, professional and efficient diagnosis and treatment of difficult and severe cases at a distance of 1 200 kilometres, fully demonstrating the benefits of smart medicine. The successful application of the medical cloud system will facilitate the improvement of smart medicine and its widespread use in China.

To help people return to work and production, the information and communication industry has made full use of its technological advantages, fully promoted "cloud" services and helped enterprises to overcome difficulties, so as to ensure that both pandemic prevention and work can be carried out without delay. During the pandemic, many teleworking software and cloud services (e.g. collaborative offices, videoconferencing, document collaboration and equipment management) were launched, providing strong support enabling enterprises to quickly resume their work and production. In order to fully cooperate with COVID-19 prevention and control agencies and speed up the resumption of work and production, the Ministry of Industry and Information Technology made rapid arrangements for the China Academy of Information and Communications Technology and three operators, namely, China Telecom, China Mobile and China Unicom, to jointly launch the Telecommunication Big Data Travel Card, which uses communication big-data technology. Under strict provisions for the protection of personal information, domestic mobile phone users can check information on places they have visited (including overseas countries or regions) in the past 14 days for free, through SMS, mobile apps, the WeChat miniprogram, webpages and others. At the same time, the Telecommunication Travel Card app, which uses internationally accepted Bluetooth technology, alerts close contacts of confirmed COVID-19 patients, providing strong support for pandemic prevention and control.

In order to help students return to school, the Ministry of Industry and Information Technology, together with the Ministry of Education, made arrangements to network school operations and thus support "schooling without going to school" during the pandemic prevention and control period. Services across the country covered nearly 180 million primary and middle school students learning at home. The Ministry of Education has launched the national primary and secondary school network cloud platform. Baidu, Alibaba, China Mobile, China Unicom, China Telecom, Network Host and Huawei have provided technical support and coordinated the deployment of 7 000 servers with a bandwidth of 90 TB, enough to support 5 000 students going online at the same time, ensuring a smooth online learning experience.

A1.5.6 COVID-19 response (United States)[90]

(1) Introduction

To support COVID-19 response efforts, the United States Congress made available funds from the Coronavirus Aid, Relief, and Economic Security (CARES) Act for the COVID-19 Telehealth programme and the Education Stabilization Fund, to help students learn from home during the pandemic. The CARES Act, passed by Congress in March 2020, provides over USD 2 trillion in economic assistance to American workers, families and small businesses, to preserve jobs and help the economy during the COVID-19 emergency. The independent and collaborative efforts undertaken by the Federal Communications Commission (FCC) to maintain communications, provide important information to the public and support public health providers are summarized below.

(2) FCC actions in response to the COVID-19 pandemic in the United States

The COVID-19 pandemic has significantly increased voice and Internet traffic globally as lives and economies around the world move online. Teleworking, distance learning, online commerce and e-governance all rely on the availability of robust broadband and mobile technologies. Governments have had to quickly develop and implement strategies to ensure broadband availability as a cornerstone of economic life.

In the United States, the FCC took a number of actions to help keep consumers online and address the digital divide. FCC actions in this regard helped wired and wireless networks handle the surge without significant service disruptions or declines. Throughout the pandemic, the FCC helped increase national broadband penetration and provide additional support to consumers, businesses, schools and health-care providers.[91]

The FCC COVID-19 broadband strategy was largely based on three principles. First, anticipating that a large portion of American life would be moved online, the FCC determined that access to the internet would be the top priority. Second, the FCC determined that it would secure

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[90] ITU-D SG2 Document SG2RGQ/283 from the United States.

[91] See the coronavirus page on the FCC website.

market participation before using government mandates. And third, the FCC took action to expedite existing FCC processes and partner with other agencies to develop new initiatives. Using these principles as a foundation to build upon, the FCC was able to help keep the United States population connected, help the health-care sector remain effective and efficient, and protect consumers.

(3) Keeping Americans connected

In March 2020, FCC Chairman Ajit Pai announced the Keep Americans Connected Pledge. Under this initiative, broadband and telephone service providers were called on to enter into a voluntary commitment to: (1) not terminate service to any residential or small business customer because of an inability to pay bills due to the disruptions caused by the coronavirus pandemic; (2) waive any late fees that residential or small business customers incurred because of their economic circumstances related to the coronavirus pandemic; and (3) open their Wi-Fi hotspots to any American who needed them.[92] More than 800 service providers agreed to the voluntary terms and took the pledge, with several going above and beyond the original request. One company, for example, provided unlimited Internet data to all customers with home Internet; another offered four months of free broadband service for new customers with telehealth, education and work-from-home needs; while others offered free Internet service and installation for certain low-income families with students, or families living in rural areas where Internet service was unavailable. Actions taken pursuant to the pledge were in effect through 30 June 2020. Thereafter, the FCC encouraged broadband and telephone service providers to take additional steps to help American consumers and small businesses stay connected. Several companies agreed to place customers into pro-rated payment plans for up to 12 months, defer device payments, waive a portion of unpaid balances or, in cases of extraordinary hardship, work with customers on an individual basis. Many also agreed to provide free service to customers in low-income housing through the end of July and to keep Wi-Fi hotspots open until the end of 2020.

As the pledge was nearing expiration, the FCC Chairman sent a letter to Congress seeking to collaborate on legislation to help consumers and small businesses stay connected. He informed Congress that the public-private partnership reflected in the pledge had been critical to maintain connectivity for American consumers and access for low-income families, teleworkers, veterans, and students participating in remote learning. He requested Congress to provide additional funding for telehealth expansion, broadband mapping and an end to American reliance on manufacturers posing a threat to the integrity of the ICT supply chain.

In addition to working with communication providers to secure the pledge in March 2020, the FCC simultaneously took measures to make sure that carriers had sufficient spectrum to meet the anticipated spike in demand for mobile and broadband services caused by quarantine. It issued special temporary authority licences granting mobile carriers access to additional spectrum to serve Puerto Rico and the U.S. Virgin Islands,[93] help Americans participate in telehealth, distance

[92] Statement of Chairman Ajit Pai, Federal Communications Commission, Hearing on the Oversight of the Federal Communications Commission Spectrum Auctions Program, Fiscal Year 2021, before the Subcommittee on Financial Services and General Government, U.S. Senate Committee on Appropriations, 16 June 2020.

[93] FCC. News Release. FCC Grants AT&T Temporary Spectrum Access for Puerto Rico and U.S. Virgin Islands to Meet Growing Broadband Needs during Covid-19 Pandemic. 26 March 2020.

learning and telework, and meet the needs of first responders[94]. The FCC also granted a number of such licences to wireless Internet service providers in rural communities and elsewhere.

The FCC also took action to ensure that Tribal lands in the United States remained connected. In March 2020, it granted special temporary authority licences for 2.5 GHz of spectrum to the Zuni Pueblo Tribe[95] and the Navajo Nation[96]. Additionally, the FCC partnered with the Institute of Museum and Library Services to support using USD 50 million in funding from the CARES Act to work towards bridging the digital divide during the pandemic. Both agencies worked together to inform libraries and Tribal organizations of the funds and resources available to them. They also ensured that libraries across the country were aware that community use of Wi-Fi networks supported by the FCC's Universal Service Fund E-Rate programme was permitted during library closures.[97] The goal of these partnerships was to make sure that rural communities, the Tribes, and organizations serving and representing Native Hawaiians had the resources to respond to the pandemic in ways that met the immediate and future needs of the communities they served.

(4) Public safety and health-care support

Those teleworking, attending class from home or working in the health-care sector need immediate and continued access to mobile and broadband services. Additionally, individuals have increased their reliance on connected care to get virtual medical attention and consultation. To assist with health-care support, the FCC implemented the COVID-19 Telehealth programme, which provided USD 200 million in funding[98] for Americans to safely access vital health-care services. This funding helps health-care professionals provide connected care services to patients at their homes or mobile locations. It provides immediate support to eligible health-care providers responding to the COVID-19 pandemic by fully funding their telecommunication and information services, and devices necessary to provide critical connected care services. The FCC approved 539 funding applications in 47 states, Washington, DC, and Guam, which included recipients in both urban and rural areas of the country, and from coast to coast.[99] To further ensure that health-care providers had the resources they needed, the FCC adopted an order to fully fund all eligible Rural Health Care programme services for the current funding year.[100] The order will enhance connectivity and promote telehealth solutions for patients during this global health emergency.[101]

The FCC also implemented changes to the Rural Health Care[102] (RHC) and E-Rate[103] programmes, to make it easier for broadband providers to support telehealth and remote learning efforts during the pandemic. It waived certain rules to allow service providers to offer, and RHC and

[94] FCC. News Release. FCC Provides T-Mobile Temporary Access to Additional Spectrum to Help Keep Americans Connected during Coronavirus Pandemic. 15 March 2020.
[95] FCC. News Release. FCC Grants Temporary Spectrum Access to Support Connectivity on Tribal Reservation during Covid-19 Pandemic. 30 March 2020.
[96] FCC. News Release. FCC Grants the Navajo Nation Temporary Spectrum to Meet Increased Wireless Broadband Needs during Covid-19 Pandemic. 30 March 2020.
[97] FCC. News Release. FCC Partners with Institute of Museum and Library Services to Address Digital Divide during COVID-19. 21 May 2020.
[98] Funding appropriated by Congress as part of the CARES Act.
[99] FCC. News release. FCC Approves Final Set of COVID-19 Telehealth Program Applications. 8 July 2020.
[100] FCC. News Release. Chairman Pai Welcomes Increase in Rural Health Care Funding. 13 March 2020.
[101] Ibid.
[102] The Rural Health Care programme provides funding to eligible healthcare providers for the telecommunication and broadband services needed to provide healthcare.
[103] The FCC's E-Rate programme makes telecommunication and information services more affordable for schools and libraries by providing discounts for telecommunications, Internet access and internal connections to eligible schools and libraries.

E-Rate programme participants to solicit and accept, improved connections or additional equipment for telemedicine or remote learning during the outbreak, thus ensuring that telehealth and remote learning efforts remained available and accessible.[104] In addition to providing support for telehealth services, the FCC and the Department of Education announced efforts to promote remote learning using funds from the CARES Act Education Stabilization Fund.[105] Through this effort, the agencies will work with governors, states and local school districts to leverage funding to help students learning from home during COVID-19. Funding from this initiative may also be used to finance educational technologies, including, hardware, software and connectivity.[106]

As part of utilizing pre-existing programmes to manage the crisis, the FCC took steps to help ensure that no American would be involuntarily removed from the Lifeline programme during the coronavirus pandemic. This programme provides a monthly discount on either a wireline or a wireless service. Lifeline also supports broadband Internet access service and broadband-voice bundles to low-income consumers.[107] To keep consumers connected, the FCC waived several rules that would have otherwise removed subscribers from the programme. The order also waived the programme's usage requirements and general de-enrollment procedures, and extended a recent waiver of its recertification and reverification requirements initially until 29 May 2020 and then until 30 November 2020.[108] The FCC stated that it would continue to monitor the situation to determine whether any additional extension of these waivers was appropriate. Ensuring that individuals already enrolled in the Lifeline programme remain, along with extending access to those recently affected by the pandemic, provides relief to millions of Americans who otherwise would have lost mobile and/or broadband services.

Since the start of the pandemic, many private and public sector employees have been working from home and students have shifted to taking classes online. Employees and students alike have had to rely heavily on platforms that host videoconference services to attend meetings and classes. Under normal circumstances, the sharp increase of users on these platforms would have caused additional rules to be placed on the companies that host them. To mitigate this, the FCC specifically issued a temporary waiver of its access arbitrage rules[109] for one of the telecommunication companies that hosts the traffic for two of the nation's largest conference calling providers. This waiver prevents companies that host applications for videoconferencing from facing financial consequences under the rule. Prior to the waiver, the massive increase of users on applications like Zoom and WebEx would have caused the companies who host these service providers to be deemed an "access-stimulating" carrier under the FCC's rules. Normally, if triggered, this would add additional financial burdens that could impede their ability to host companies providing such video services.[110]

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104 FCC. News Release. FCC Waives Rural Health Care and E-Rate Program Gift Rules to Promote Connectivity for Hospitals and Students during Coronavirus Pandemic. 18 March 2020; see also FCC. Order. E-Rate and RHC COVID-Related Waivers Extended. 3 September 2020.

105 USD 16 billion in funding is to come from the CARES Act and was announced in April 2020.

106 FCC. News Release. FCC and U.S. Department of Education promote remote education so students can continue learning. 27 April 2020.

107 FCC. Consumer Guide. Lifeline Support for Affordable Communications. Accessed 27 August 2020.

108 FCC. News Release. FCC Acts to Keep Low-income Americans Connected during Coronavirus Pandemic. 30 March 2020; see also FCC. Order. WCB Extends Lifeline Program Waivers Due to COVID-19., 17 August 2020.

109 The FCC's arbitrage rules are aimed at preventing telecom companies from exploiting the intercarrier compensation system by generating inflated call volumes to pad their bottom lines.

110 FCC. News Release. FCC Waives Rules to Ensure Consumers Can Continue Accessing Conference Calling Services From Zoom And WebEx During The Covid-19 Crisis. 27 March 2020.

(5) Consumer protection and safety

To maintain relay services for individuals who are deaf, hard of hearing, deaf-blind or have a speech disability during the pandemic, the FCC granted temporary waivers to Telecommunications Relay Service (TRS) providers allowing American Sign Language interpreters to work from home.[111] As a result of the pandemic and states' responsive emergency regulations, traffic levels have increased, challenging the ability of TRS providers to properly staff call centres and answer and process TRS calls. Temporary emergency waivers of the FCC's speed-of-answer requirement, at-home video relay service (VRS) call-handling rules, VRS subcontracting restrictions and provisions of the emergency call handling rule have given TRS service providers greater flexibility to provide valuable services during the pandemic.

Broadcasters have also contributed substantially by making voluntary public service announcements in English and Spanish about social distancing, airing educational programming to help with distance learning, expanding the news coverage of COVID-19, and holding fundraisers to help those facing financial hardship due to the virus.[112] Broadcasting companies have also offered teaching services and tools for students in grades 6-12 along with special programming on the coronavirus. The National Association of Broadcasters offers a coronavirus toolkit in both English and Spanish.

Unfortunately, scams related to Coronavirus fears have increased in the United States and around the world. To combat this, the FCC is raising awareness of the dangers of these fraudulent activities, and of how consumers can mitigate home network and mobile device security issues. It is keeping Americans informed about the types of schemes being used, and how to identify and avoid them. The FCC's Coronavirus Scam webpage identifies text messages, robocalls and contact tracing as the three such schemes used most often to target individuals who may be considered at risk of the virus. The FCC also provides information to consumers through its Consumer Help Center and through the FCC Scam Glossary. In partnership with FEMA, it offers tips for communicating during an emergency, including how to prepare for a power outage. Finally, the FCC has issued guidance on how to optimize the performance of consumer home networks and how to safely sanitize mobile devices.[113]

In a collaborative effort with the Federal Trade Commission (FTC), the FCC has worked to protect consumers from robocalls and provided important information on the dangers of contact tracing scams. On 20 May 2020, both agencies required gateway providers allowing COVID-19-related scam robocalls to cut off this traffic or phone companies would be allowed to block all traffic from those gateway providers' networks. Scams being routed to American consumers included fake COVID-19 refunds, Social Security Administration COVID scams, and Loan Interest Rate Reduction scams. Within 24 hours of the notice, three gateway providers had complied with the demands. This came after a similarly successful push in April 2020 from the agencies that effectively terminated other robocallers' access to American phone networks.[114] Additionally, the FCC has worked hard to inform the public about the dangers of giving information to individuals falsely claiming to be involved in contact tracing. Both the FCC

[111] FCC. News Release. FCC grants flexibility to relay service providers to preserve communications access for Americans with disabilities. 16 March 2020.
[112] For example, one company raised USD 275 000 for a relief fund for COVID-19 related economic hardship and another raised USD8 million for coronavirus relief via a virtual music concert.
[113] See FCC. Consumer. Home Network Tips for the Coronavirus Pandemic. Updated 1 July 2020.
[114] FCC. News Release. FCC, FTC demand robocall-enabling service providers cut off COVID-19-related international scammers. 20 May 2020.

and FTC warn consumers that contact tracing is typically carried out by state health departments and is not a federal programme. These initiatives help prevent users from falling victim to one of these scams.

Finally, the FCC's Broadband Deployment Advisory Committee (BDAC), which is a multistakeholder committee that provides advice and recommendations to the FCC on how to accelerate the deployment of high-speed Internet access, was called upon to provide support for COVID-19 relief initiatives. The BDAC Disaster Response and Recovery Working Group is comprised of representatives from across a broad spectrum of public and private organizations, and includes individuals from states and localities, industry, and consumer and community organizations.[115] In April 2020, it was tasked with assisting the BDAC in documenting the various strategies and solutions being developed and implemented by public and private stakeholders to address the deployment-related challenges presented by the pandemic. The Working Group will use the data collected to report on best practices and lessons learned from the response in order to prepare for and respond to any comparable future crises. The first report and recommendations of the current Working Group were presented to and approved by the full BDAC on 27 March 2020, outlining the strategies for emergencies related to planning, responding and restoring communication access.

[115] FCC Public Notice. DA 20-420. FCC Tasks BDAC Working Group with Addressing COVID-19 Challenges. 16 April 2020.

Annex 2: ITU intra-Sector and inter-Sector mapping

A2.1 Collaboration with other Questions in ITU-D Study Groups 1 and 2

This section provides a list matching ITU-D Question 5/2 to other Questions being examined by ITU-D Study Groups 1 and 2. The list was reviewed and discussed at Question 5/2 meetings, after which the table below was agreed without any further comments.

Table 7A: Matrix of ITU-D Study Group 1 and 2 intra-sector coordination

	Q1/1	Q2/1	Q3/1	Q4/1	Q5/1	Q6/1	Q7/1	Q1/2	Q2/2	Q3/2	Q4/2	Q6/2	Q7/2
Q5/2	X	X	X	X	X			X	X	X		X	

A2.2 Mapping of ITU-T and ITU-D Questions

Based on ITU study group activities, with the assistance of the three Bureaux the ITU General Secretariat has developed mapping documents[116], including the mapping of ITU-D and ITU-T Questions.[117]

[116] ITU. Inter-Sector Coordination Group (ISCG) documents. Mapping Tables.
[117] ITU. ISCG. Mapping of ITU-D SG1 and SG2 Questions to ITU-T Questions.

Table 8A: Matrix of ITU-D Question 5/2 and ITU-T Questions

		Q5/2
ITU-T SG2	Q1/2	
	Q3/2	X
	Q5/2	
	Q6/2	
	Q7/2	
ITU-T SG3	Q1/3	
	Q2/3	
	Q3/3	
	Q4/3	
	Q6/3	
	Q7/3	
	Q9/3	
	Q10/3	
	Q11/3	
	Q12/3	
	Q13/3	
ITU-T SG5	Q1/5	
	Q2/5	
	Q3/5	
	Q4/5	
	Q6/5	X
	Q7/5	
	Q8/5	
	Q9/5	X

		Q5/2
ITU-T SG9	Q1/9	
	Q2/9	
	Q4/9	
	Q5/9	
	Q6/9	
	Q7/9	
	Q8/9	
	Q10/9	
ITU-T SG11	Q1/11	
	Q2/11	
	Q3/11	X
	Q4/11	
	Q5/11	
	Q6/11	
	Q7/11	
	Q9/11	
	Q10/11	
	Q11/11	
	Q12/11	
	Q13/11	
	Q14/11	
	Q15/11	

		Q5/2
ITU-T SG12	Q2/12	
	Q3/12	
	Q4/12	X
	Q5/12	
	Q6/12	
	Q7/12	
	Q8/12	
	Q11/12	
	Q12/12	
	Q13/12	
	Q16/12	
	Q18/12	
	Q19/12	
ITU-T SG13	Q1/13	
	Q5/13	
	Q6/13	
	Q7/13	
	Q16/13	
	Q17/13	
	Q18/13	
	Q19/13	
	Q20/13	
	Q21/13	
	Q22/13	
	Q23/13	
ITU-T SG15	Q1/15	X
	Q11/15	
	Q12/15	
	Q16/15	X
	Q17/15	X

		Q5/2
ITU-T SG16	Q8/16	X
	Q13/16	
	Q14/16	X
	Q21/16	
	Q24/16	
	Q26/16	X
	Q27/16	
	Q28/16	
ITU-T SG17	Q1/17	
	Q2/17	
	Q3/17	
	Q4/17	
	Q5/17	
	Q6/17	
	Q7/17	
	Q8/17	
	Q9/17	
	Q10/17	
	Q11/17	
	Q13/17	
ITU-T SG20	Q1/20	
	Q2/20	X
	Q3/20	X
	Q4/20	X
	Q5/20	
	Q6/20	
	Q7/20	

A2.3 Mapping of ITU-R and ITU-D work

The mapping with ITU-R[1] is detailed below:

Table 9A: Matrix of ITU-R working parties and ITU-D Question 5/2

R\D	WP 1A	WP 1B	WP 1C	WP 3J	WP 3K	WP 3L	WP 3M	WP 4A	WP 4B	WP 4C	WP 5A	WP 5B	WP 5C	WP 5D
Q5/2		X	X					X	X	X	X	X	X	X

R\D	WP 6A	WP 6B	WP 6C	WP 7A	WP 7B	WP 7C	WP 7D
Q5/2	X	X	X			X	

1 ITU. ISCG. Mapping of ITU-D SG1 and SG2 Questions to ITU-R Working Parties.

Annex 3: Information from ITU-T and ITU-R

A3.1 Framework of disaster management for network resilience and recovery (ITU-T Study Group 15)

ITU-T Study Group 15 provided information on the establishment of the supplement ITU-T L.Sup35, Framework of Disaster Management for Network Resilience and Recovery, which summarized several architectural frameworks for network resilience and recovery aimed at ensuring continuity of communications as much as possible in the event of a disaster.

A3.2 Informative update in the area of disaster communications (ITU-R Disaster Relief Liaison Rapporteur)

The ITU-R Disaster Relief Liaison Rapporteur frequently provided updated information related to disaster communications in ITU-R and other organizations.

The Liaison Rapporteur provided a comprehensive and informative update of the disaster communication activities, reports, resources, deployments and programmes of ITU-R and numerous ITU, regional and industry partners through October 2017, including a comprehensive update on known Caribbean hurricane responses.

The Liaison Rapporteur also provided a comprehensive list of recent disaster-related activities noted across ITU Sectors, in regional organizations and in industry-specific groups.

The Liaison Rapporteur further provided information about a revision of Question ITU-R 77-8/5, on the needs of developing countries in IMT development and implementation.

Lastly, the Liaison Rapporteur provided a comprehensive overview of recent developments relating to emergency communications. The overview included WRC-19 outcomes, ongoing work in ITU-R and ITU-T and various activities by BDT to help countries prepare for and respond to disasters. It also stated that ITU had joined the Crisis Connectivity Charter, a mechanism created between the satellite industry and the wider humanitarian community to make satellite-based communications more readily available to humanitarians and communities in times of disaster.

A3.3 Remote-sensing systems (ITU-R Working Party 7C)

ITU-R Working Party 7C submitted a report on remote-sensing systems in which it noted that ITU-R was updating Recommendation ITU-R RS.1859, on the use of national remote-sensing systems for data collection in the event of disaster. The update would be finalized and sent to the parent group, ITU-R Study Group 7, in September 2018.

A3.4 Country national emergency telecom systems (ITU-T Study Group 2)

ITU-T Study Group 2 sought the review and comments of the Question 5/2 team on the contribution from Benin on improving the emergency telecom system in Benin, which proposes that a new work item be created in ITU-T on developing country national emergency telecom systems. The idea is to define norms and practices regarding countries and their level of development and to work on developing emergency telecommunication infrastructure.

A3.5 Terms and definitions for disaster relief systems, network resilience and recovery (ITU-T Study Group 2)

ITU-T Study Group 2 provided information on its work on E.TD-DR, Terms and definitions for disaster relief systems, network resilience and recovery.

ITU-T Study Group 2 also provided information about the finalized ITU-T Recommendation E.102 (ex E.td-dr), Terms and definitions for disaster relief systems, network resilience and recovery, and E.100-series Supplement 1 (ex. E.sup.fdr).

A3.6 Framework of disaster management for disaster relief systems (ITU-T Study Group 2)

ITU-T Study Group 2 informed the Question 5/2 meeting about E.SUP.FDR, Framework of disaster management for disaster relief systems. It was noted that section 6 of this supplement ("Overview of early-warning and disaster relief systems") is relevant to Question 5/2.

ITU-T Study Group 2 also informed the meeting that a new Focus Group on Artificial intelligence for natural disaster management (FG-AI4NDM) has been established under ITU-T SG2. The background and practical information can be found on the group's homepage: http://itu.int/go/fgai4ndm .

A3.7 Global broadband Internet access by fixed-satellite service systems (ITU-R Working Party 4A)

ITU-R Working Party 4A provided information on progress on Recommendation ITU-R S.1782, Possibilities for global broadband Internet access by fixed-satellite service systems.

A3.8 The fast deployment emergency telecommunication network (ITU-T Study Group 11)

ITU-T Study Group 11 provided information on its progress in drafting Recommendation ITU-T Q.ETN-DS, Signalling architecture of the fast deployment emergency telecommunication network to be used in a natural disaster, which focused on a number of emerging technologies.

ITU-T Study Group 11 reported that Recommendation ITU-T Q.3060 (former Q.ETN-DS) had been consented at its meeting in July 2020.

It was noted that the corresponding completed work item should be removed from the mapping table between ITU-D and ITU-T.

A3.9 Fixed wireless systems for disaster mitigation and relief operations (ITU-R Study Group 5)

ITU-R Study Group 5 provided information on its update of Recommendation ITU-R F.1105, Fixed Wireless Systems for disaster mitigation and relief operations.

A3.10 Satellite systems (ITU-R Working Party 4B)

ITU-R Working Party 4B, on interrelated activities of ITU-R and ITU-D, noted the update of Report ITU-R M.NGAT-SAT, on Key Elements for Integration of Satellite Systems into Next Generation Access Activities. It also provided information on the update of Recommendation ITU-R S.1782, Possibilities for Broadband Internet Access by Fixed Satellite Service Systems.

A3.11 Public protection and disaster relief (ITU-R Working Party 5A)

ITU-R Working Party 5A provided information on several ITU-R Recommendations and Reports that could be relevant to work on Question 5/2. All ITU-R Recommendations and Reports on PPDR, including those related to the role of the amateur service in disaster relief, are included in section 6 of the document entitled 'Guide to the use of ITU-R texts relating to the land mobile service, including wireless access in the fixed service'. Recently updated publications include Recommendations ITU-R M.2009 and ITU-R M.2015 and Reports ITU-R M.2377 'Radiocommunication objectives and requirements for Public Protection and Disaster Relief (PPDR)' and ITU-R M.2415 'Spectrum needs for Public Protection and Disaster Relief'.

A3.12 IMT Public protection and disaster relief (ITU-R Working Party 5D)

ITU-R Working Party 5D informed the Question 5/2 meeting that Report ITU-R M.2291, which addressed the use of International Mobile Telecommunications for broadband PPDR and had originally been completed by Working Party 5D in 2013 before being updated in 2016, had been updated again in March 2021. This report describes the benefits of using LTE to support PPDR radiocommunications. The current update addresses the use of IMT 2020 to support PPDR radiocommunications.

Annex 4: Information on workshops and panel sessions

A4.1 Panel session on early-warning systems[2]

Geneva, Switzerland
8 May 2018

Summary

Introduction

As part of the work of **ITU-D Study Group 2** on **Question 5/2,** and with the support of the administrations of Japan and the United States, the Question 5/2 meeting organized a **panel session on early-warning systems, including safety confirmation**, on 8 May 2018. The session was an opportunity to present a high-level introduction to numerous stakeholders involved in early warning, with activities including disaster prediction and detection, alerts, emergency information and safety confirmation. The discussion focused on identifying the lessons learned from the experiences of a diverse group of stakeholders. The discussion results were to be considered for further study as the Question turned to early warning in 2018, with key findings incorporated into the annual report of Question 5/2 for 2018 on early warning.

Session details

The session was opened by **Hideo Imanaka, Vice-Rapporteur of Question 5/2, NICT, Japan,** who briefly explained the background and objectives of the panel session.

Cosmas Zavazava, Chief, Project Support and Knowledge Management, BDT, delivered opening remarks on ITU activities on disaster relief. Panel sessions and workshops were very important for exchanging information and experience within ITU-D, with other ITU sectors and with other organizations. The conclusions and best practices from the panel session would be valuable for the work on Question 5/2.

Discussion

The panel session, led by **Joseph Burton, Co-Rapporteur for ITU-D Study Group 2 on Question 5/2, Department of State, United States,** discussed both current and emerging technologies for early-warning systems. The experiences of government, industry and research institute stakeholders in planning and preparation for detecting disasters and issuing alerts must continuously evolve based on lessons learned from previous disasters.

Xu TANG, Weather and Disaster Risk Reduction Service Department, WMO, briefly explained WMO activities that can benefit national early-warning and alert activities, including the Multi-Hazard Early-Warning Systems Checklist and the Climate Risk and Early-Warning Systems Initiative. WMO had also adopted the CAP (ITU-T X.1303) and the alerting platform called Alert Hub. The Global Multi-hazard Alert System aimed to provide authoritative information and advice for the operational and long-term decision-making processes of United Nations agencies and the humanitarian community.

[2] For further information, see the panel session webpage.

Imani ELLIS-CHEEK SY, Federal Communications Commission, United States, provided an overview of the modernization of United States alerting systems, including the Emergency Alert System and Wireless Emergency Alerts. The Emergency Alert System delivered alert messages by broadcast radio and television, cable television and direct broadcast satellite. Wireless Emergency Alerts sent alert messages to mobile phones in targeted areas. It could also send Child Abduction Alerts.

Azar ZARREBINI, Iridium, United States, shared information about the importance of early-warning systems using satellite technologies. Satellites could provide timely emergency communications in the event of a disaster, but emergency deployments of satellite equipment were often hindered by licensing or regulatory issues. In the future, communication policy-makers should consider policies that would enable, and not delay, the use of M2M-based disaster detection applications, which had implications for early warning.

Yulia KOULIKOVA, EMEA Satellite Operators Association (ESOA), Belgium, introduced the activities of the ESOA Multi-hazard Early-Warning System. ESOA had a programme called SATLAS, which was co-funded by European Space Agency Advanced Research in Telecommunications Systems (ARTES). SATLAS was an incubator for developing satellite communication applications. Its target market was the Middle East and Africa, plus Europe. As with the flood early-warning system, the ESOA stand-alone flood monitoring solution used BGAN M2M, which could also be used to create a tsunami early-warning system whereby sensors monitored real-time changes in sea level and other parameters. The resulting data could be sent via specific platforms to systems able to trigger sirens to alert citizens to an emergency situation. The system was being tested in Thailand.

Yoshiaki NAGAYA, Ministry of Internal Affairs and Communications, Japan, briefly introduced the latest research activities on early warning in Japan. Real-time big-data analysis could be used to detect localized torrential rainfall. 3-D images captured by newly developed radars were analysed in a very short time and alert messages sent 20 minutes before the rainfall started. Analysing SNS messages could be helpful for disaster detection. The DISAANA (DISaster information ANAlyzer) system developed by NICT could analyse SNS (e.g. Twitter) messages, which were available in extremely large numbers and contained non-structured data. The outputs of DISAANA could be used to assess victim needs and monitor disaster-affected areas.

Conclusions and best practices

During the panel discussion, the representatives of Sudan, Niger, Benin, ATDI, Côte d'Ivoire, the United Republic of Tanzania, South Africa and Ghana engaged in an active discussion with the panellists and BDT. The following items were recognized as best practices (see **Section 7.1(A)** of this report for a complete description of each item):

- keep developing country needs in mind;
- ensure flexibility;
- ensure regulatory flexibility;
- adapt emergency alert systems;
- ensure connectivity;
- build capacity;
- develop enabling policies;
- continuously improve emergency procedures;
- be alert to technological advances;

Other areas for consideration were as follows:

- advance training on satellite systems;
- last-mile warning messages from local government to citizens, and the capacity of satellite systems;
- the ongoing pursuit of disaster risk knowledge, which can be expanded by systematically collecting data and assessing disaster risks (detection, monitoring, analysis and forecasting of hazards and possible consequences) and thus enable the communication of timely, accurate, relevant and actionable warnings with information on likelihood, impact and recommended action;
- the need for ongoing stakeholder coordination.

Contributions to Question 5/2 in 2018 that took early-warning system experiences and needs into account would be valuable for further consideration.

Sanjeev BANZAL, Co-Rapporteur of Question 5/2, Telecom Regulatory Authority of India, India, summarized the outcomes of the panel discussion, which had covered everything from regulatory issues to emerging technologies such as M2M and SNS, and the importance of the Multi-Hazard Early-Warning Systems Checklist. Early-warning systems were clearly of great interest to participants, who were encouraged to engage in further information exchanges, in particular by submitting contributions providing specific examples of the application of technologies to specific areas of early-warning systems, and of enabling policies, to the October 2018 meeting on Question 5/2.

Ahmad R. SHARAFAT, ITU-D Study Group 2 Chairman, Islamic Republic of Iran, closed the session by thanking the Question 5/2 management team, BDT, the panellists and the participants for their fruitful discussions.

A4.2 Session on disaster drills and emerging technologies on disaster management[3]

Geneva, Switzerland
3 October 2018

Summary

Introduction

As part of the work of **ITU-D Study Group 2** on **Question 5/2**, the Question 5/2 meeting organized a **session on disaster drills and emerging technologies on disaster management** on Wednesday, 3 October 2018. The session consisted of three detailed workshops and aimed to present and exchange information on disaster drills, exercises and emerging technologies. The discussion focused on identifying lessons learned based on the experiences of a diverse group of stakeholders. The discussion results would be considered for further study as the Question turned to disaster drills in 2019, with key findings incorporated into the annual report of Question 5/2 for 2019 on disaster drills using ICTs.

Note: All presentations for this session are available on the event website.

[3] For further information, see the panel session webpage.

Session details

The session was opened by **Sanjeev Banzal, Co-Rapporteur for Question 5/2, India**, who welcomed participants, then briefly explained the background and objectives.

Workshop 1: Experiences of disaster drills using emergency telecommunication systems

Workshop 1 was moderated by Hideo Imanaka, Vice-Rapporteur for Question 5/2, NICT, Japan. Its objectives were:

- to explore experiences of actual disaster drills using ICTs;
- to consider the lessons learned from those experiences and the effectiveness of the drills in emergency situations;
- to discuss the key objectives of drills, and how stakeholders were involved.

Lars Bromley, United Nations Institute for Training and Research (UNITAR), presented UNITAR's role in disaster preparedness and drills, briefly explaining UNITAR and UNOSAT activities for disaster drills and assessment of disaster-affected areas using satellite imagery analysis technologies. The Triplex exercise, a large-scale field simulation exercise focusing on strengthening preparedness and response in regard to coordination and effective emergency response held in Norway in 2016, had simulated hurricanes and floods and been attended by over 100 participants from several organizations, including UNOSAT, which had hosted the Virtual Onsite Operations Coordination Centre. The exercise had shown that frequent drills were important for ensuring that emergency systems were available and operational when needed.

Jeffrey Llanto, Central Visayas Information Sharing Network Foundation (CVISNet), Philippines, gave a remote presentation on the Use of emergency telecommunication systems in disaster-management drills: the case of the Philippines, which provided an overview of CVISNet's emergency telecommunication drills, exercises and training courses in the Philippines. MDRUs had been used in ITU projects in the Philippines in 2014. Because of the dual benefits of regularly utilizing this technology and bringing connectivity, CVISNet was considering using MDRUs to provide connectivity between disasters.

The representative of **India** asked how MDRUs connected with communication networks. **Mr Llanto** responded that MDRUs had interfaces with ordinary telephone networks and the Internet.

Hiroshi Kumagai, NICT, Japan, gave a presentation on Emergency communication drills in metropolitan areas, which introduced MDRUs, the "NerveNet" (ad hoc network system) and actual disaster drills using ICTs held in Japan. The lessons learned from the drills were that the battery capacity of ICT equipment was a significant factor; that it was important to ensure a power supply in disasters; and that NerveNet and MDRUs could be utilized in disasters.

The representative of **India** asked how big the MDRU was. **Dr Kumagai** responded that there were several types of MDRU, some as large as containers, others fitting into attaché cases (the moderator showed the participants an actual attaché case-type system). No additional equipment was needed when MDRU software was installed on smartphones. In reply to a question from the representative of the **United States**, he said that MDRUs could be pre-positioned before a disaster and deployed post-disaster.

Akihiro Nakatani, Astem, Japan, gave a presentation on Disaster relief applications for broadcasting services, introducing an IPTV-based translation system for persons with impaired hearing, called "Eye Dragon", which combined sign language and captions with live terrestrial TV programmes to assist persons with disabilities. The system could provide significant information to such persons in the event of a disaster. Thanks to the system and to the experience of disaster drills, the lives of persons with disabilities had been saved during the Great East Japan earthquake and the tsunami of March 2011.

In reply to a question from the representative of **Nigeria**, Mr Nakatani said that IPTV broadband networks were needed to receive sign language translation for live television; the service could not be provided on over-the-air television (terrestrial TV).

Workshop 2: Emerging technologies on disaster management

Workshop 2 was moderated by **Abdulkarim Ayopo Oloyede, Vice-Rapporteur for Question 5/2, Nigeria**. The discussion points were as follows:

- understand how technologies are being applied;
- policies that enable the advancement and deployment of evolving technologies;
- explore examples and types of new emerging disaster-management technology, including recent and expected technological evolutions.

Emily Yousling, Google, United States, gave a presentation on The role of the Loon project in disaster risk reduction. She explained how Google Loon had been used after Hurricane Maria in Puerto Rico and floods in Peru, and how it could be used around the world to provide access to telecommunication services before, during and after a disaster. It was important to pre-position communication capacity, and not wait until disaster struck to take action to ensure communication redundancy, as it took some time to restore network infrastructure.

The representative of **India** asked whether Loon's altitude (20 km above ground) posed flight path issues, how licensed spectrum for LTE services would be obtained for deployments, and how power was supplied to Loon (which was considered a "base station-in-the-sky") in the rainy season and at night, given that Loon was solar powered. **Ms Yousling** responded that due care was taken to ensure that the Loon network did not interfere with flight paths and that the spectrum utilized was that of existing telecom operators for whom Loon had been deployed. Regarding power supply, the fact that multiple Loons were deployed enabled consistent service.

Salma Farouque, Emergency Telecommunications Cluster (ETC), WFP, gave a presentation on the Practical use of drones in disaster response and recovery. The ETC was the part of the United Nations Cluster System responsible for telecommunications. In certain disasters, it could provide secure communications through VHF and Internet connectivity thanks to quick deployment of satellite terminals and Wi-Fi. It could also provide user assistance and help support communication coordination and information management. Other potential services included liaison with government authorities, preparedness assistance and services for communities, including drone coordination. Drones could be used for multiple humanitarian purposes, including mapping, monitoring, search and rescue, delivery, and providing communication during the response and recovery phases.

Yuichi Ono, Tohoku University, Japan, gave a presentation on the Global Centre for Disaster Statistics. He described the use of big data in emergency situations, noting the need for statistics/record keeping on the impacts of disasters in different countries of the world. The data collected could be used by a country during the recovery process. The Centre had helped different countries to prepare and plan in order to shorten the recovery process and mitigate future disasters.

Vanessa Gray, ITU/BDT, gave a presentation on Disruptive technologies and disaster management. ITU supported Member States with capacity-building assistance to promote preparedness and post-disaster recovery. Technology should be used to assist in all phases of disaster management. ITU was putting together a disaster-management toolkit and drafting guidelines for emergency communication planning that could be adapted by Member States.

Workshop 3: Disaster management and drills using ICTs

Workshop 3 was moderated by **Joseph Burton, Co-Rapporteur of Question 5/2, United States**. The objectives were as follows:

- provide examples of the range, scope and frequency of emergency communications exercises and drills;
- understand how exercises and drills can increase preparedness, and ways to increase the effectiveness of drills;
- how to tailor drills and exercises to national conditions and complex emergencies;
- identifying potential participants and enabling robust stakeholder engagement;
- discuss the use of innovative technologies in preparedness exercises and of old technologies in innovative ways to support preparedness and response.

Salma Farouque, Emergency Telecommunications Cluster (ETC), WFP, gave a presentation on Coordinating communications drills and exercises – setting the stage. She discussed the range of communication exercises that might be considered, from a table-top exercise to a functional exercise, to perform a full-scale drill like WFP's "opEx Bravo". The purpose of an exercise was to test procedures and enhance preparedness, by documenting and verifying existing procedures and identifying and addressing gaps. Among the factors and steps to consider when planning an exercise, it was important to set objectives in advance, and to hold not only a debriefing or an after-action, but also to draft an action plan to address and fix any issues identified. Exercise participants might include the regulator, the Ministry of Communications, the national disaster-management agency, meteorological and geophysics departments (or other hazard-warning entities), communication service providers, power utilities, humanitarian organizations and community stakeholders.

Rod Stafford, International Amateur Radio Union (IARU), gave a presentation, Communications drills and exercises – the amateur radio perspective, in which he described the use and application of amateur radio in a range of communication drills. When communication infrastructure was down, amateur radio might be the only way to communicate in certain areas. It was therefore important to incorporate amateur radio, which might provide communication redundancy, into drills and exercises. Communication technologies used by amateur radio included HF, VHF, microwave frequencies and amateur radio satellites.

The representative of **Japan** noted that amateur radio enabled SIDS to communicate across many islands and great distances. Many participants agreed that young people were often unaware of the existence of amateur radio; that generation gap should be overcome. **Ahmad Sharafat, Chairman of ITU-D Study Group 2, Islamic Republic of Iran**, suggested that the IARU submit a white paper on the benefits and operational modes of amateur radio.

Preeti Banzal, India, gave a presentation on India's experience executing a mega drill in the Western Himalaya region, to provide the perspective of communication officials coordinating part of a national disaster (earthquake) exercise. The scenario had enabled a detailed review of preparedness, training and coordination between national and state officials. The exercise had not only tested the response capabilities of various agencies across all levels of government, it had also identified gaps in policies, procedures and training for further action, and helped facilitate preparation of response plans at all levels of government.

The representative of **Intel** stressed the importance of educating people about back-up/ redundant means of communication.

Conclusions and best practices

Sanjeev Banzal, Co-Rapporteur for Question 5/2, India, summarized the outcomes of the workshop discussions in terms of lessons learned and best practices related to disaster drills and exercises, and the use of emerging technologies for disaster management (see **Section 7.1(B)** of this report for a complete summary). He thanked all the speakers, moderators, participants, BDT staff and interpreters for their active support and contributions.

A4.3 Session on conducting national-level emergency communications drills and exercises: Guidelines for small island developing States and least developed countries[4]

Geneva, Switzerland
7 October 2019

Summary

Introduction

The session on national emergency ICT drills and exercises was held on Monday, 7 October 2019, in conjunction with the Question 5/2 Rapporteur Group meeting on Utilizing telecommunications/ICTs for disaster risk reduction and management.

The session was opened by **Doreen Bogdan-Martin, Director, BDT, ITU,** who had just returned from the Bahamas, where she had witnessed the devastating damage in Abaco and Grand Bahamas caused by Hurricane Dorian. ITU had identified numerous opportunities to provide disaster preparedness capacity-building support to the Bahamas and other Member States, including for the advance consideration of policies/regulations to enable roaming in disasters, the implementation of the ITU Global Guidelines for Drafting National Emergency Telecommunications Plans, and guidance from ITU partners on the conduct of ICT drills and exercises. ICT preparedness planning was a universal need, hence the importance of holding continued ICT preparedness-focused workshops. She thanked the panellists for coming to Geneva, highlighted the importance of drills and exercises for testing and refining policies and plans, and outlined the session programme and objectives.

Session methodology

The session featured three workshops, each moderated by Question 5/2 Co-Rapporteur Joseph Burton. Workshop 1 featured presentations by Vanuatu and Haiti, followed by a guided table-top exercise. In addition to a presentation by each panellist, an open discussion among panellists was held in Workshops 2 and 3, which reflected the phases of drills and exercises, from planning to after-actions and translating lessons learned into updated policies.

4 For further information, see the panel session webpage.

The session then introduced capacity-building resources and tools that BDT had recently developed in coordination with partners such as the Emergency Telecom Cluster, to help Member States develop a robust emergency communication framework and preparedness programme, including NETPs and ICT drills and exercises.

The outcomes of the discussions would be incorporated into the annual report by Question 5/2 on guidelines for conducting ICT drills and exercises.

Workshop presentations

Workshop 1. Small island developing State and least developed country experiences of planning disaster drills

- **John Jack, Office of the Government Chief Information Officer**, Vanuatu, gave a presentation on Vanuatu's experience of exercises and drills.
- **Gregory Domond, Conseil National des Télécommunications (CONATEL)**, Haiti, gave a presentation on earthquake and tsunami drills and exercises in Haiti.
- **Joseph Burton, Cyber and International Communications and Information Policy**, United States, led participants through a table-top simulation exercise developed by the ETC and ITU for the 2019 Global Symposium for Regulators, on the role of the regulator in disaster management.

Workshop 2. Conducting drills: a guided discussion with panelists and participants

- **Antwane Johnson, FEMA**, United States, gave a presentation on IPAWS and the use of alert and warning in drills and exercises.
- **Rod Stafford, International Amateur Radio Union**, gave a presentation on Amateur radio – prepared for drills and exercises.
- **Justin Williams, Network Disaster Recovery, AT&T, United States**, gave a presentation on Leveraging ICTs for disaster and response: what have we learned.
- **Dulip Tillekeratne, Mobile for Humanitarian Innovation, GSMA**, gave a presentation on engaging with mobile network operators on drills and exercises.

Workshop 3. The wrap-up: capturing and turning lessons learned into action

- **Ria Sen, Emergency Telecommunications Cluster (ETC), WFP**, introduced the ETC-ITU table-top simulation exercise guide, which was soon to be finalized.
- **Maritza Delgado, BDT, ITU,** presented the range of available ITU capacity-building assistance. BDT developed information resources to increase overall ICT preparedness and response coordination, including by utilizing the recently developed *Guidelines for national emergency telecommunication plans*, in addition to other preparedness services developed in partnership with the ETC for Member States.

Note: Most of the presentations for this session are available on the event website. Best practices and lessons learned from presentations (and workshop discussions) will be reflected in the Question 5/2 session outcome document on guidelines for conducting national ICT drills and exercises.

Session outcomes

Preparations for the session resulted in a draft outcome document containing guidelines for conducting national ICT exercises and drills that could be tailored to meet the unique needs of SIDS and LDCs. Co-Rapporteur Joseph Burton presented the draft in Document SG2RGQ/TD/12 during the Rapporteur Group meeting for Question 5/2 held on 8 October 2019. The guidelines will be updated with key learnings, including lessons learned and best practices from workshop discussions. Input from workshop participants is welcome. The final draft of the guidelines will be incorporated into the annual report of Question 5/2 on ICT drills and exercises. (See **Section 7.1(C)** of this report).

A4.4 Public webinar on enabling policy environment for disaster management, including for COVID-19 response[5]

Virtual meeting
14 July 2020

During the study period, Question 5/2 conducted a public webinar, Enabling Policy Environment for Disaster Management, including for COVID-19 response, chaired by Ahmad Reza Sharafat, Chairman of ITU-D Study Group 2. The main objectives of the webinar were to:

- discuss the constituent elements of an enabling policy environment for increasing emergency telecommunication preparedness, network resilience, disaster risk reduction and disaster management;
- provide examples of policies that enable flexibility when deploying emergency communication equipment and successful disaster preparedness and response with respect to telecommunications and ICTs;
- share ITU member experiences and lessons learned in developing and implementing enabling policies and NETPs.

During the webinar, expert panellists discussed the importance of implementing measures and polices that would ensure the continued functioning of communication networks during disasters, such as declaring telecommunication networks as essential services or performing organized drills. The webinar also featured examples of policies for preparedness and different responses observed around the globe during the COVID-19 pandemic.

Juan Roldan, Luxon Consulting Group, initiated the presentations by discussing the challenges that come with developing an NETP. An effective NETP accounted for multiple hazards, used multiple technologies, contained multiple phases and was supported by multiple stakeholders. NETPs needed political will and support, and governments must clearly identify which specific department or agency was responsible for emergency telecommunications.

Continuing on the theme of cross-sectoral collaboration, **Chris Anderson, CenturyLink Global Network**, advocated for public-private partnerships, declaring them to be necessary for effective disaster management. Such partnerships should always be assembled during the "blue sky scenario", meaning before disaster actually struck, since it was much harder to bring the necessary people together during a crisis.

Concluding the first segment of the webinar, **Paul Margie, *Télécoms Sans Frontières* (TSF)**, explained that, while disaster management was never one-size-fits-all, commonalities could be observed in the countries where TSF worked. These included training beforehand, formally recognizing ICTs as critical infrastructure, publicly identifying points of contact for ICT response, developing procedures so that experts could enter quickly, and adopting mechanisms within the telecom regulator to speed decision-making. In that respect, special temporary authorities could enable rapid changes to be made when they were most needed.

[5] For further information, see the webinar webpage.

COVID-19 responses from around the globe

The second segment of the webinar focused on COVID-19 responses observed in different countries worldwide. **Maritza Delgado, ITU Programme Officer,** explained that tracking and analysing such responses was one of the main objectives of REG4COVID, an ITU initiative designed to help communities stay connected during crises and to prepare medium- and long-term recovery measures. The Global Network Resiliency Platform was just one example.

Kathryn O'Brien, Chief of Staff, International Bureau, Federal Communications Commission (FCC), United States, shared some of the FCC's guiding principles, the first being to set clear priorities. It was also important to work with the private sector. Technology must go hand-in-hand with policy to produce effective disaster responses.

Ryosuke Shibasaki, professor, University of Tokyo, Japan, focused on information on people flows and population density statistics for better-informed decision-making. Open-source analysis software could use big data from mobile serial data to support COVID-19 responses by measuring movements. The software's development had originally been triggered by ITU in 2015, and it was now in operation in several African countries.

Funke Opeke, MainOne CEO, Nigeria, shared the challenges faced by developing countries in coping with COVID-19.

Rahul Vatts, Chief Regulatory Officer, Bharti Airtel Limited, India, explained that traffic had surged by up to 50 per cent during the pandemic, creating infrastructure challenges for India at a time when maintenance staff found it difficult to move because of lockdowns. Telecommunication service providers had overcome the challenge thanks to the special permissions from the Government and the regulator to move telecom staff across critical sites. To address maintenance concerns, the telecommunication service providers worked with over-the-top providers, as network optimization was an ongoing necessity. The Government had directed providers to change the ring-back tone and ringtone of all landlines – nearly 987 million working phones – to a special COVID-19 message asking subscribers to stay home and practice social distancing.

Lessons learned: Enabling policy today saves lives tomorrow

Access to a robust, resilient and secure ICT infrastructure worldwide is critical in a pandemic and in any kind of disaster. ICTs are essential for power, security, health and sanitation – essential services in a global emergency. However, their ability to perform as needed required an enabling policy environment able to do many things, from granting temporary authority for additional spectrum use to giving complimentary recharge margins for emergency calls.

Among the many other lessons learned from the COVID-19 pandemic was the fact that the world's telecommunication networks and digital infrastructure must be better prepared for disasters of all kinds. Collectively, drills had to be carried out and rapid response measures prepared, since future disasters – including pandemics – could occur anytime, anywhere, and with little to no warning.

Any negative consequences of disasters could be diminished if robust and resilient networks and disaster-management tools were in place well ahead of time.

(See **Section 7.1(D)** of this report)
Note: All presentations for the webinar are available on the event website.

Annex 5: List of contributions and liaison statements received on Question 5/2

Contributions on Question 5/2

Web	Received	Source	Title
2/420	2021-03-15	Co-Rapporteurs for Question 5/2, Vice-Rapporteur for Question 5/2	Proposed liaison statement from ITU-D Study Group 2 Question 5/2 to ITU-R Working Party 5D on the Output Report on Question 5/2
2/419	2021-03-15	Co-Rapporteurs for Question 5/2, Vice-Rapporteur for Question 5/2	Proposed liaison statement from ITU-D Study Group 2 Question 5/2 to ITU-R Working Party 5A on the Output Report on Question 5/2
2/418	2021-03-15	Co-Rapporteurs for Question 5/2, Vice-Rapporteur for Question 5/2	Proposed liaison statement from ITU-D Study Group 2 Question 5/2 to ITU-T SGs, ITU-R SGs, UN organizations and external organizations on the Output Report on Question 5/2
2/410	2021-03-03	Inmarsat	Input Contribution to the Draft Output Report on Question 5/2
2/401	2021-03-02	National Institute of Information and Communications Technology (NICT) (Japan)	Proposal of communication technologies and its use case of an autonomous distributed information and communications system "Die-Hard Network" for disaster countermeasure
2/397 (Rev.1)	2021-03-15	Co-Rapporteurs for Question 5/2, Vice-Rapporteur for Question 5/2	Proposed liaison statement from ITU-D Study Group 2 Question 5/2 to ITU-T Study Group 2 and FG-AI4NDM on the Output Report on Question 5/2 and future of the Question
2/TD/36	2021-02-23	Co-Rapporteurs for Question 5/2, Vice-Rapporteur for Question 5/2	Proposed liaison statement from ITU-D Study Group 2 Question 5/2 to ITU-T Study Group 2 and FG-AI4NDM
2/391 +Ann.1	2021-02-17	EMEA Satellite Operators Association (ESOA/GSC)	Proposed observations and suggestions for final report
2/388	2021-01-28	BDT Focal Point for Question 5/2	ITU-D activities in disaster risk reduction and management
2/384	2021-01-28	Algeria	Exercise to simulate the implementation of the civil security plan for telecommunications
2/383	2021-01-28	China	Suggestions for adding ICT to respond to major epidemics in the new research period Qx/2 subject

(continued)

Web	Received	Source	Title
RGQ2/TD/29	2020-10-15	Algérie Télécom SPA (Algeria)	Proposed liaison statement from ITU-D Study Group 2 Question 5/2 to ITU-R Working Party 5B on utilizing telecommunications/ICTs for disaster risk reduction and Management
RGQ2/TD/24 (Rev.1)	2020-10-14	Co-Rapporteurs for Question 5/2	Proposed liaison statements from ITU-D Study Group 2 Question 5/2
RGQ2/283	2020-09-22	United States	FCC Actions in Response to COVID-19 in the United States
RGQ2/279 (Rev.1)	2020-09-22	BDT Focal Point for Question 5/2	ITU-D activities in disaster risk reduction and management
RGQ2/262	2020-09-20	National Institute of Information and Communications Technology (NICT) (Japan)	Proposal for case studies of a chatbot system "SOCDA" for disaster countermeasure
RGQ2/237	2020-08-20	EMEA Satellite Operators Association (ESOA/GSC)	Satellite Connectivity for Climate Monitoring & Early Warning
RGQ2/228	2020-08-16	China	Considerations and practices related to disaster preparedness, reduction, and response from an Operator's perspective
RGQ2/222	2020-08-07	Burundi	The contribution of ICTs in managing the effects of floods in Burundi
RGQ2/220 (Rev.1)	2020-08-06	China	Contribution of ICT to the fight against the COVID-19 pandemic
RGQ2/207 +Ann.1	2020-05-05	AASCTC (Sudan)	Global Open Science Cloud for Disaster Risk Reduction (GOSC-DRR)
2/TD/33	2020-02-27	Co-Rapporteurs for Question 5/2	October workshop concept for discussion: "The Enabling Policy Environment Increased Emergency Telecommunication Preparedness, Network Resilience, Disaster Risk Reduction and Disaster Management"
2/TD/32	2020-02-26	Co-Rapporteurs for Question 5/2	Draft guidelines for conducting national level emergency communications drills and exercises for Small Island Developing States (SIDS) and Least Developed Countries (LDCs)
2/TD/31	2020-02-26	Co-Rapporteurs for Question 5/2	Updated Document: Draft annual report of Question 5/2 on Early-Warning Systems, including Safety Confirmation

(continued)

Web	Received	Source	Title
2/327 (Rev.1)	2020-02-11	Loon LLC (United States)	Regulatory considerations when enabling innovative preparedness and emergency communications solutions
2/310	2020-01-24	BDT Focal Point for Question 5/2	ITU-D activities in disaster risk reduction and management
2/309	2020-01-27	Japan	Proposal for case studies of locally accessible cloud system for disaster countermeasures
2/308	2020-01-24	Facebook	Sharing Mobile Application Data to Empower Disaster-Response Organizations
2/277	2020-01-03	China	Use of telecommunication/information and communication technology (ICT) for disaster prevention, mitigation and response
2/269	2019-12-31	India	The role of social media platforms in disaster mitigation, response and relief
2/252	2019-12-16	Democratic Republic of the Congo	Utilizing telecommunications/ICTs to manage Ebola virus disease in the Democratic Republic of the Congo
RGQ2/TD/12	2019-10-07	Co-Rapporteur for Question 5/2	Draft guidelines for conducting national level emergency communications drills and exercises for Small Island Developing States (SIDS) and Least Developed Countries (LDCs)
RGQ2/190	2019-09-23	World Food Programme	Standardization forum: emergency telecommunications
RGQ2/188 (Rev.1)	2019-09-24	Japan	Proposal for case studies of e-education in rural areas through ordinary use of emergency telecommunication systems
RGQ2/183	2019-09-23	China	Analysis of emergency communication key service requirements and technology development
RGQ2/182 +Ann.1-2	2019-09-23	World Food Programme	ETC-ITU Emergency Telecommunications Preparedness Checklist
RGQ2/152 +Ann.1	2019-08-22	United States	Integrated Public Alert and Warning System Open Platform for Emergency Networks (IPAWS-OPEN) on standards-based alert and warning
RGQ2/150	2019-08-22	United States	Remote-sensing activities in ITU-R
RGQ2/148	2019-08-22	BDT Focal Point for Question 5/2	ITU-D activities in disaster risk reduction and management
RGQ2/147	2019-08-21	India	Importance of ICT early-warning system for saving life and property: case of extremely sever Cyclone 'Fani'

(continued)

Web	Received	Source	Title
RGQ2/145	2019-08-21	New Zealand	Implementation of Common Alerting Protocol (CAP) in New Zealand
RGQ2/121	2019-07-09	Haiti	Emergency telecommunication system in Haiti
2/216	2019-03-12	Co-Rapporteurs for Question 5/2	October workshop concept for discussion: "Guidelines for Conducting National Level Emergency Communications Drills and Exercises for Small Island Developing States (SIDs) and Lesser Developed Countries (LDCs)"
2/212	2019-03-12	BDT Focal Point for Question 5/2	ITU-D activities in disaster risk reduction and management
2/184	2019-02-12	Co-Rapporteurs for Question 5/2	Output Document: Draft annual report of Question 5/2 on Early-Warning Systems, including Safety Confirmation
2/176	2019-02-07	Co-Rapporteurs for Question 5/2	Proposed revised work plan for study Question 5/2
2/159	2019-02-05	China	Development and practices of intelligent emergency telecommunications
2/158	2019-02-05	China Telecommunications Corporation (China)	Thinking and Practices of Operator's Disaster Preparedness, Disaster Reduction and Disaster Response
2/157 (Rev.1)	2019-02-05	China	Disseminating emergency alerts via new signalling pathways
2/134	2019-01-11	Cameroon	Support for regional implementation of the National Emergency Telecommunications Network project
RGQ2/ TD/7	2018-10-01	Russian Federation	ITU-D SG1 and SG2 coordination: Mapping of ITU-D Study Group 1 and 2 Questions
RGQ2/83	2018-09-18	BDT Focal Point for Question 5/2	ITU-D activities in disaster risk reduction and management
RGQ2/78	2018-09-18	India	The role of Information and Communication Technology (ICT) in disaster mitigation, prediction and response
RGQ2/77	2018-09-18	India	Trial runs for implementation of Common Alert Protocol-based early-warning system
RGQ2/74 +Ann1.1	2018-09-18	Japan	Global Centre for Disaster Statistics - a joint initiative with UNDP contributing to the Sendai Framework for Disaster Risk Reduction and SDGs
RGQ2/61	2018-09-13	China	Emergency telecommunication drill

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Web	Received	Source	Title
RGQ2/60	2018-09-13	National Institute of Information and Communications Technology (NICT) (Japan)	Early warning and early data collection of disaster information; recent development in Japan
RGQ2/33	2018-08-16	Brazil	Emergency, public calamity and disaster alerts using telecommunication services - Brazil's implementation
2/TD/4	2018-04-27	WMO	Multi-Hazard Early-Warning Systems: A Checklist
2/93 (Rev.1)	2018-04-24	BDT Focal Point for Question 5/2	ITU-D activities in disaster risk reduction and management
2/70	2018-04-23	India	The role of information and communication technology (ICT) in disaster mitigation, prediction and response
2/59	2018-03-23	United States	Draft work plan for Question 5/2
2/56 (Rev.1)	2018-03-21	China	Operators' consideration of disaster preparedness, disaster reduction and disaster response
2/50	2018-03-21	China	Further enhanced studies on emergency telecommunications as well as related knowledge and experience sharing
2/36	2018-02-19	India	Implementing a common alert protocol-based Earthquake Early-Warning system in North Region of India

Incoming liaison statements for Question 5/2

Web	Received	Source	Title
2/422	2021-03-15	ITU-R Working Party 5D	Liaison statement from ITU-R Working Party 5D to ITU-D Study Group 2 Question 5/2 on utilization of telecommunications/ICTS for disaster preparedness, mitigation and response
2/365	2021-01-12	ITU-T Study Group 2	Liaison statement from ITU-T Study Group 2 to ITU-D SG1, ITU-SG2 Question 5/2 and Question 6/2 on establishment of a new ITU-T Focus Group on Artificial Intelligence for Natural Disaster Management (FG-AI4NDM) and first meeting (Virtual, 15-17 March 2021)
2/362	2020-11-20	ITU-T Study Group 11	Liaison statement from ITU-T Study Group 11 to ITU-D SG2 Q5/2 on Disaster Relief Use Cases
2/361	2020-11-23	ITU-R Working Party 5B	Liaison statement from ITU-R Working Party 5B to ITU-T Study Group 11 (copy to ITU-D SG2 Q5/2) on Disaster Relief Use Cases
2/359	2020-11-04	ITU-R Disaster Relief Liaison Rapporteur	Report from the ITU-R Disaster Relief Liaison Rapporteur
2/357	2020-10-21	ITU-R Working Party 5D	Liaison statement from ITU-R Working Party 5D to ITU-T Study Group 11 (copy to ITU-D SG2 Q5/2) on Disaster Relief Use Cases
2/355	2020-10-21	ITU-R Working Party 5D	Liaison statement from ITU-R Working Party 5D to ITU-D SG2 Q5/2 on utilization of telecommunications/ICTs for disaster risk reduction and management
RGQ2/286	2020-07-14	ITU-R Working Party 5D	Liaison statement from ITU-R Working Party 5D to ITU-D SG2 Q5/2 on utilization of telecommunications/ICTs for disaster risk reduction and management
RGQ2/225	2020-08-07	ITU-R Working Party 5A	Liaison statement from ITU-R Working Party 5A to ITU-D SG2 Q5/2 on utilization of telecommunications/ICTs for disaster risk reduction and management
RGQ2/224	2020-08-07	ITU-R Working Party 5A	Liaison statement from ITU-R Working Party 5A to ITU-D SG2 Q5/2 on Disaster Relief Use Cases
RGQ2/211	2020-07-17	Disaster Relief Liaison Rapporteur	Report on Disaster Relief
RGQ2/206 +Ann.1	2020-03-25	ITU-T Study Group 11	Liaison statement from ITU-T SG11 to ITU-D SG2 Q5/2 on disaster relief use cases

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Web	Received	Source	Title
2/256	2019-12-05	ITU-R Study Group 5	Liaison statement from ITU-R SG5 to ITU-D SG1 and SG2 on consideration of the needs of developing countries in the development and implementation of IMT
2/245 +Ann.1	2019-11-22	ITU-T Study Group 11	Liaison statement from ITU-T Study Group 11 to ITU-D Study Group 2 Question 5/2 on disaster relief use cases
RGQ2/130 +Ann.1	2019-07-22	ITU-T Study Group 15	Liaison statement from ITU-T SG15 to ITU-D SG1 and SG2 on inter-Sector coordination
RGQ2/124 (Rev.1)	2019-07-18	ITU-R study groups - ITU-R Working Party 4B	Liaison statement from ITU-R WP4B to ITU-D SG1 and SG2 on interrelated activities of ITU-R and ITU-D in response to Resolution ITU-R 69 (RA-15)
RGQ2/120	2019-07-09	ITU-R study groups - ITU-R Working Party 4B	Liaison statement from ITU-R WP4B to ITU-D SG1 and SG2 on interrelated activities of ITU-R and ITU-D in response to Resolution ITU-R 69 (RA-15)
RGQ2/116 +Ann.1-2	2019-05-29	ITU-T Study Group 20	Liaison statement from ITU-T SG20 to ITU-D SG1 and SG2 on ITU inter-sector coordination
RGQ2/114 +Ann.1-2	2019-06-12	ITU-T Study Group 5	Liaison statement from ITU-T SG5 to ITU-D SG1 and SG2 on ITU inter-sector coordination
RGQ2/112	2019-04-19	ITU-R Disaster Relief Liaison Rapporteur	Report from the ITU-R Disaster Relief Liaison Rapporteur
2/TD/18 +Ann.1	2019-03-20	ITU-T Study Group 11	Liaison statement from ITU-T SG11 to ITU-D SG2 Q5/2 on disaster relief use cases
2/TD/13	2019-03-15	ITU-T Study Group 2	Liaison statement from ITU-T SG2 to ITU-D SG2 Q5/2 on Terms and Definitions for Disaster Relief Systems and Framework of Disaster Management
2/183	2019-02-11	ITU-R Study Group 5	Liaison statement from ITU-R Study Group 5 to ITU-D Study Group 2 Question 5/2 on Recommendation ITU-R F.1105-4 (Fixed wireless systems for disaster mitigation and relief operations)
2/124	2018-11-09	ITU-R study groups – ITU-R Working Party 5A	Liaison statement from ITU-R SG5 WP5A to ITU-D Study Group 2 Question 5/2 on disaster relief systems
2/120	2018-10-30	ITU-R Disaster Relief Liaison Rapporteur	Report from the ITU-R Disaster Relief Liaison Rapporteur

(continued)

Web	Received	Source	Title
RGQ2/TD/3	2018-09-28	ITU-R study groups – ITU-R Working Party 7C	Liaison statement from ITU-R WP7C to ITU-D SG2 Q5/2 on utilization of telecommunications/ICTs for disaster preparedness, mitigation and response
RGQ2/17 +Ann.1	2018-08-02	ITU-T Study Group 11	Liaison statement from ITU-T SG11 to ITU-D SG2 Q5/2 on disaster relief use cases
RGQ2/14 +Ann.1	2018-07-18	ITU-R study groups – ITU-R Working Party 4A	Liaison statement from the ITU-R WP 4A to ITU-D Study Group 1 and 2 on interrelated activities of ITU-R and ITU-D in response to Resolution ITU-R 69 (RA-15)
RGQ2/12 +Ann.1	2018-07-18	ITU-T Study Group 2	Liaison statement from ITU-T SG2 to ITU-D SG2 Q5/2 on E.sup.fdr "Framework of disaster management for disaster relief systems"
RGQ2/11 +Ann.1	2018-07-18	ITU-T Study Group 2	Liaison statement from ITU-T SG2 to ITU-D SG2 Q5/2 on E.td-dr "Terms and definitions for disaster relief systems, network resilience and recovery"
RGQ2/10	2018-07-17	ITU-R study groups – ITU-R Working Party 4B	Liaison statement from ITU-R WP 4B to ITU-D SG1 Q1/1 and Q2/1 and SG2 Q1/2 and Q5/2 on interrelated activities of ITU-R and ITU-D in response to Resolution ITU-R 69 (RA-15)
RGQ2/2	2018-05-23	ITU-R Disaster Relief Liaison Rapporteur	Report from the ITU-R Disaster Relief Liaison Rapporteur
2/32	2017-11-24	ITU-R Disaster Relief Liaison Rapporteur	Report from the ITU-R Disaster Relief Liaison Rapporteur
2/31	2017-11-24	ITU-R study groups - Working Party 7C	Liaison Statement from ITU-R Working Party 7C to ITU-D Study Group 2 Q5/2 on the utilization of telecommunications/ICTs for disaster preparedness, mitigation and response
2/20	2017-11-24	ITU-T Study Group 2	Liaison Statement from ITU-T SG2 to ITU-D SG2 Question 5/2 on national emergency telecommunication system in developing countries
2/16	2017-11-24	ITU-R Disaster Relief Liaison Rapporteur	Report from the ITU-R Disaster Relief Liaison Rapporteur
2/15	2017-11-22	ITU-T Study Group 15	Liaison Statement from ITU-T SG15 to ITU-D Study Group 2 Q5/2 on new Supplement on the framework of disaster management

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