最后报告

ITU-D
第2研究组

第5/2号课题

将电信/ICT用于备灾、减灾和灾害响应

第6研究期
2014-2017年

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第5/2号课题：将电信/ICT用于备灾、减灾和灾害响应

最后报告

前言

国际电联电信发展部门（ITU-D）研究组提供一种文稿驱动工作的中立平台，政府、行业和学术界的专家在此聚集，制定实用的工具和导则并开发资源来解决发展问题。ITU-D成员通过ITU-D研究组的工作，研究和分析以任务为导向的具体电信/ICT课题，从而加快各国发展优先工作的进展。

研究组为所有ITU-D成员提供机会来交流经验、提出想法、交换意见，并就研究处理电信/ICT优先工作的适当战略达成共识。ITU-D研究组负责根据成员提交的输入意见或文稿来制定报告、导则和建议书。国际电联通过调查、文稿和案例研究收集的信息利用内容管理和网络发布工具公开提供，以方便成员的轻松访问。研究组的工作与ITU-D不同计划和举措相关联，以发挥协同作用，使成员在资源和专业知识上受益。与在相关议题领域开展工作的其他群体和组织进行协作至关重要。

ITU-D研究组的研究课题由四年一届的世界电信发展大会（WTDC）决定，每届WTDC为界定下一个四年的电信/ICT发展问题和优先工作制定工作计划和导则。

ITU-D第1研究组的工作范围是研究**"发展电信/ICT的有利环境"**，ITU-D第2研究组则是研究**"ICT应用、网络安全、应急通信和适应气候变化"**。

在2014-2017年研究期，由以下人员指导**ITU-D第2研究组**的工作：主席Ahmad Reza Sharafat（伊朗伊斯兰共和国）和代表六个区域的副主席：Aminata Kaba-Camara（几内亚共和国）、Christopher Kemei（肯尼亚共和国）、Celina Delgado（尼加拉瓜）、Nasser Al Marzouqi（阿拉伯联合酋长国）、Nadir A图**14**：利用**VAST**加强备灾hmed Gaylani（苏丹共和国）、王柯（中华人民共和国）、Ananda Raj Khanal（尼泊尔共和国）、Evgeny Bondarenko（俄罗斯联邦）、Henadz Asipovich（白俄罗斯共和国）和Petko Kantchev（保加利亚共和国）。

最后报告

针对**第5/2号课题：“将电信/信息通信技术用于灾害的防备、缓解和响应”**的最终报告在报告人Kelly O’Keefe（美利坚合众国）的领导下制定，参与工作的有3位副报告人：Hideo Imanaka（日本）、Richard Krock（阿尔卡特-朗讯美国公司，美利坚合众国）和Jean-Marie Maignan（海地）。ITU-D联系人和ITU-D研究组秘书处也协助他们开展工作。

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内容提要

ITU-D第2研究组很高兴介绍有关第5/2号课题“将电信/信息通信技术（ICT）用于备灾、减灾和灾害响应”的最后报告。此报告以成员国和部门成员的文稿和整个研究期内举行的互动磋商为基础，并由两个部分组成。报告的第一部分涉及将信息通信技术（ICT）用于旨在提高ICT备份和适应性的灾害通信管理、做法和系统，以及对主管部门和机构提出的在灾害各阶段部署ICT的技术和政策案例研究所做的审议和分析。报告的第二部分提供了概要介绍活动类型的应急通信核对清单和可考虑纳入国家灾时通信规划的预期决策点。

灾害既可能是自然的，也可能是人为的，会对社会产生负面影响，打乱社会和经济生活的正常运行。这些负面影响需要当局和公民的紧急应对，以便向受害者提供帮助，并重新制定可接受的幸福和生活机遇指标。灾害、脆弱性和降低潜在风险负面影响能力缺失的融合，会导致灾难的发生。由于灾难大多无法预测，备灾和风险管理成为拯救生命和保护财产的关键。还必须在无灾期间考虑到风险管理问题（如毁损缓解与防备以及早期预警/预测）。有效的规划和准备可以拯救生命。

在这种背景下，信息通信技术（ICT）可在灾害预防、缓解和管理方面发挥核心作用。有效的灾害管理有赖于不同利益攸关方之间及时和有效的信息共享，而ICT则是满足这些沟通需求的关键工具。ICT可向灾害的所有阶段提供支持，包括预测和预警（通过卫星、雷达、遥测气象学提供遥感；卫星M2M感应技术；通过广播或移动技术发布告警）；初始响应（无线电和电视广播、业余无线电、卫星、移动电话和互联网）；以及恢复（临时基站；便携应急系统）。ICT在向公众通报潜在或将临灾害的风险、灾害降临后的信息发布，以及恢复工作开始后实现商业和社会活动持续运行发面，发挥着重要作用。

由于ICT对灾害的各个阶段都具有重要意义并能满足其需求，持续运行是有关灾害通信管理的一项重要考虑。各机构利用多种技术方式和系统确保适应性与备份，并在灾害降临后促进连接的快速恢复。此外，重大灾难发生后采集的ICT网络和应用的使用和性能数据，有助于技术研发和灾害规划及程序的改进。

章节的总结

第一部分：有关ICT减灾救灾方面的经验和最佳做法的报告

第1章 简要论述了ICT在整个灾害管理流程中的作用，并研究了无障碍获取问题。

第2章 全面介绍了可用于支持不断变化的用户需求的各类现有和新兴的ICT网络、业务和应用。此章节研究的方法可确保系统的适应性和备份，实现灾后的连通。

第3章 提供了一份全研究期收到的案例研究总结表，研究了将ICT用于灾害管理不同阶段的情况。**附件**1包括对表中涉及的案例研究的总结，更详细介绍了有关灾害通信计划和

政策、部署用于灾害通信的不同类型的系统以及有助于提高灾害响应能力的新兴技术发展。此外，**附件1**还包括直通本研究期提交第5/2号课题的全套案例研究的链接。

第4章 列出了依据研究期内收到的广泛输入意见汲取的经验和发现的最佳做法。此章节还对这一可能延续的确定所有新研究领域的课题做了前景展望。

第二部分：应急通信核对清单

核对清单将提出可以纳入国家灾时通信规划的活动类型和预期决定点。制定出的这份清单可有助于制定或完善国家或区域的灾时通信管理计划，但不会在实际灾害中使用。

在整个研究期，ITU-D第2研究组研究了发达和发展中国家广泛的应急通信和救灾活动。而10年前，只有少数发展中国家具有全面应急通信规划或框架，而输入文稿显示这类规划目前已更为普及。此外，更多国家和机构正在采取开发预警系统的措施，使电信/ICT网络能够更加灵活地应对灾害风险。尽管如此，研究期的讨论确认，有必要对发展中国家灾害通信管理领域的落实工作给予进一步支持。

鉴于不可能在世界范围内消除灾害，而且每年都会有新兴的ICT研发问世，在下一个研究期，研究课题将继续研究应急通信和备灾、缓解响应和救助问题，以便在灾害出现后拯救生命。考虑到备灾的价值，课题的输出成果应聚焦落实工作，以及使发展中国家有能力利用大量有关将ICT用于灾害通信管理的现成信息。应为发展中国家之间的经验交流投入更多时间，以确定共同的挑战和成功的做法，并支持灾害通信框架、技术和规划的持续完善与落实。

第1部分 – 有关ICT在减灾和救灾方面的经验和最佳做法的报告

1 第1章 – 概览：用于灾害管理的ICT

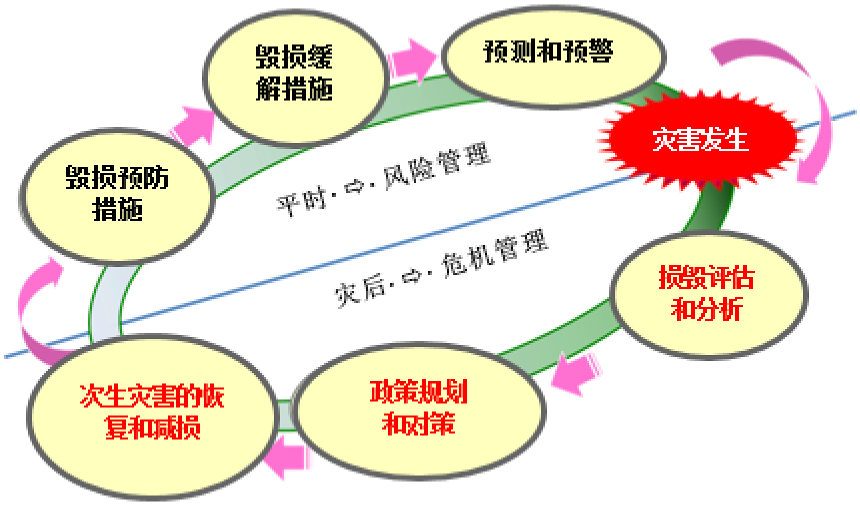
1.1 引言

有效的灾害管理取决于向需要者及时和有效的提供信息。支持灾害管理的信息类型涉及广泛的领域，例如灾害感应和报警、损毁评估、庇护所位置、后勤和供应链协调、应急医疗支持、确定家庭和朋友安全无恙以及搜寻救助。通信渠道包括公民、政府公共安全官员、救灾工作者、私营部门机构等。信息通信技术（ICT）是支持不同利益攸关方通信需求的重要工具。本章节概要介绍了在所有灾害管理阶段支持使用ICT的主要考虑。

1.2 在灾害各阶段全程使用ICT

如**图**1所示，灾害风险管理包括风险（如灾前）期间和危机（如灾后）管理阶段的多个步骤。这些阶段通常适用于自然和人为灾害。

图1：灾害风险管理流程



风险管理–灾前

– 毁损预防措施：提高ICT的复原力和备份；

– 毁损缓解措施：机构规划和政策制定；供应和设备的预先定位；培训和能力建设；

– 预测和预警：感应器和预警系统；大数据分析也能提供一般性评估。

危机管理–灾后

– 毁损评估和分析：有关灾害影响的信息采集（如毁损地点、受害者数量和/或毁损/影响分析）；对ICT网络的影响。

– 政策规划和对策：

1) 启用灾害规划，

2) 制定应对灾害毁损的对策，

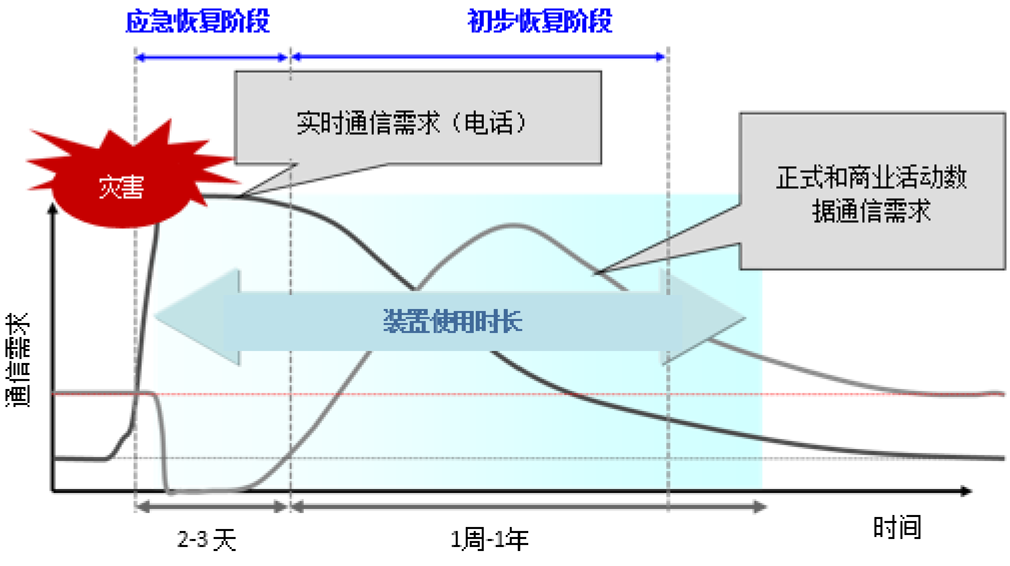
3) 向最先响应者（如当地政府职员）发出的命令和指示以及与他们的协调，以及

4) 根据需要向政府、警方、军队和救助机构发出增援要求。

– 次生灾害的恢复和减损：信息提供（如疏散中心、救灾物资）；网络恢复和基础设施重建。

ICT可通过了解用户整个灾害周期对不同类型系统、服务和应用的不断变换的需求，支持和实现所有上述灾害管理阶段的工作。**图2**显示了灾后ICT使用的总体趋势，其横轴和纵轴分别表示ICT服务的时间和需求。总之，在最初的应急响应阶段会出现对电话和电子邮件等实时通信的需求增长，此阶段的实时通信对于救援行动等拯救生命的工作至关重要。在这一时期，人们的首要ICT需求通常是确认人家、朋友、人员和财产安全无恙。重建工作在初步恢复工作之后开始。然而，恢复期的持续时间取决于灾害的烈度。**第2章**将更详细的说明可用于支持不断变化的用户需求以及确保网络复原工作的现有和新兴ICT网络、服务和应用。

图2：灾后的ICT服务需求



来源：Satoshi Kotabe、Toshikazu Sakano、Katsuhiro Sebayashi和Tetsuro Komukai：“以快速部署电话服务应对灾难性电信设施损失”，2014年3月第3期第12卷《NTT技术评论》。

1.3 用于灾害管理和智慧可持续发展的

根据联合国国际减灾战略（UN ISDR）2013年全球降低灾害风险评估报告，全球全年地震损失总额为1 000亿美元，其中热带飓风带来的损失超过800亿美元，以实际价格计算，发达国家遭受了更大的经济损失，而发展中国家则主要受到人员伤亡和无家可归的影响。《2015–2030年仙台减少灾害风险框架》和联合国可持续发展目标（SDGs）使人们重新关注可持续性、减少灾害风险和复原力的概念。国际电联电信发展局于2013年推出了可持续智慧发展模式（SSDM）举措，帮助创建一个优化发展（ICT4D）和灾害管理（ICT4DM）的ICT资源使用框架，旨在通过ICT4D和ICT4DM双管齐下地对稀有资源[1]进行有效、经济高效和及时的利用。欲获取有关《2015-2030年仙台减少灾害风险框架》的更多信息，请访问：http://www.unisdr.org/we/inform/publications/43291。

1.4 有利的政策和监管环境

虽然本报告聚焦技术考虑和案例研究，营造有利的政策监管环境也是灾害通信管理的重要组成部分。有利的政策环境包括影响到ICT总体部署和使用的一般性电信监管和政策框架，以及针对灾害情况的框架和政策制定。一般性政策考虑包括减少ICT部署的监管障碍、促进强健和灵活的ICT基础设施建设、简化许可程序和频谱管理。灾害通信框架和政策有助于在整个灾害期间提供活动、作用和职责指导，也有助于确保灾后ICT运行的持续性。对于灾害响应框架的具体ICT政策和监管考虑，可包括制定灾害期间使用的专项加速许可程序，解决应急通信设备入境可能遇到的海关壁垒，或考虑落实坦佩雷公约。一系列提交的文稿涉及了2014-2017年研究期的政府和机构政策和规划。有关案例研究的**第3章**和**附件1**、关于汲取的经验的**第4章**以及**第2部分**中的应急通信核对清单，都提供了关于政策和监管考虑的进一步信息。

1.5 人为因素和利益攸关方的协作

广泛的参与方和利益攸关方受到灾害影响，并因而卷入了灾害管理程序。任何特定灾情都可能涉及国家、洲和当地级别的不同部委和政府部门、外国的援助和救助机构、非政府组织和民间团体、私营部门实体和自愿及公民行动团体。在某些情况下，各个机构和组织都有既定的职责范围，但这些职责范围和作用往往会有重叠。所有参与响应工作的机构和组织都必须相互沟通、协调和合作，以确保灾害之前、之中和之后的有效响应。有关在灾害演习和练习当中使用ICT的培训，应包括并估计到这些多元化的利益攸关方。**第2部分**中的应急通信核对清单，就制定和落实灾害通信框架和规划所需的利益攸关方合作提供了进一步的指导。

此外，灾害的影响很少局限于一个国家，因此与邻国和在区域内开展合作是灾害通信规划和防范的重要组成部分。在整个研究期，ITU-D第2研究组收到了来自亚太电信组织（APT）和美洲国家电信委员会（CITEL）等区域性组织提供的信息，涉及支持区域性灾害通信能力建设、合作和协调的讲习班和其他活动。

[1] 有关SSDM的更多信息见：http://www.itu.int/en/ITU-D/Initiatives/SSDM/Pages/default.aspx。

除了接纳大量利益攸关方参与灾害防范工作外，还必须在制定相应规划时意识到灾害对公民个人及其家人的影响。灾害规划应考虑到，重要成员或其家人可能因为受到灾害的直接影响而无法支持响应工作。例如，灾害过后，机构应确定能够确认其职员安全无恙的机制，例如通过广播职员安全信息的安全确认和广播信息系统。

此外，所有灾害都具有局部性，即灾害降临时邻居是最初的响应者；公民要首先寻求自救。ICT能够提供满足这一实际需求的工具，使公民实现自救或互救。为此，公民和当地政府应与公民协调制定救灾路线图，预测受灾区域或疏散和庇护位置，以帮助降低灾害风险并提高公民的认知。

1.6 无障碍考虑

灾害的发生尤其对残疾人、儿童和老年人、外地务工人员、失业人员、之前因灾害导致无家可归者等弱势群体造成困难，灾害管理有必要确保具有包容性并满足他们的需求。国际电联题为“残疾人无障碍获取ICT：做好准备工作”[2]的报告提供了有关ICT在帮助获取灾害响应服务时遇到障碍的边缘化群体中可发挥的作用的信息。该报告亦包含“有关如何应对的行动导则”，为处于灾害管理各个阶段的利益攸关方提供具体建议。涉及方方面面的建议包括：

– 直接向弱势群体人员了解需求并为他们参与到灾害管理的所有阶段提供便利。

– 确保基于ICT的灾害管理流程或基于ICT的发展项目均考虑到ICT的无障碍性和使用性。

– 使用不同类型的战略和机制推广可无障碍获取的ICT，包括法律、政策、规则、许可要求、行为准则以及货币或其它激励机制。

– 通过开展提高认识项目、培训以及技能开发项目提高弱势人群在灾害中使用ICT的能力。

– 使用多种通信方式提供灾前、灾害中和灾后信息，包括采用：

  - 按照目前WCAG导则设计的无障碍接入网站和移动应用；
  - 广播和电视公众服务通知（使用视频、文本、字幕和手语翻译等无障碍获取措施）；
  - 利用短信发送通知和提醒，政府机构、援助和救灾机构以及其它各方向公民群发邮件；
  - 可访问的电子数据表格、手册和指南；
  - 包括演示、网络研讨会、网播和包含广受青睐的YouTube在内的视频等多媒体；
  - 政府和灾害响应机构设立的脸书网页和推特账户等专用社交媒体；

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[2] 国际电联2017年题为“残疾人无障碍获取ICT：做好准备工作”的报告见：https://www.itu.int/md/D14-SG02-C-0401/。

- 以公民为主的工作组和讨论论坛。

– 注意灾害状况下对弱势群体个人数据滥用的可能性并制定有关数据分享的道德规范和标准。

– 以多种无障碍方式提供不同语文的信息包、导则和手册并开展提高公众认识宣传，将这些内容传授给残疾人和其他弱势群体。

– 开发、推广和分发可用于应急情况和灾害的主流和辅助性技术，为使用者提供必要的培训。

– 为促进机构间协作和训练制定框架，同时开展旨在建立信任的举措。

– 视情况制定无障碍获取ICT基础设施规范，将其作为采购导则的组成部分。

– 确保灾后开发的所有服务、设施和基础设施具有无障碍获取和包容性。

– 以多种形式和方式提供有关恢复工作和申请救助或获取资源的信息。

– 审议灾害响应工作以确定弱势群体面临的挑战，讨论汲取的教训并为解决基于ICT的灾害管理服务所面临的任何问题开展工作。

2 第2章 – 网络适应性和用于预警、响应和恢复的ICT系统

电信和ICT为灾害各个阶段提供支持。本章提供了有关多种现有和新兴ICT网络、服务和应用的信息，以满足不断变化的用户需求。本章亦探讨了实现灾后连接需确保的系统适应性和备份。

2.1 早期预警系统

早期预警和预防包括：

– 灾害预测，包括获取和处理有关未来灾害发生概率、地点和持续时间的数据；

– 灾害探测，包括对灾害事件的可能性和严重程度的详细分析。

气象辅助工具、气象卫星以及卫星地球探测业务在以下诸多活动中起着重要作用：

– 确定危险区域；

– 天气预报和预测气候变化；

– 探测和跟踪地震、海啸、飓风、森林火灾、石油泄漏等；

– 提供此类灾害的警告/预警信息；

– 评估此类灾害带来的损害；

– 提供用于规划救灾行动的信息；以及

– 监控灾害的恢复状况。

这些服务为保持和改进天气预报准确性、监测和预测气候变化提供了尽管并非不可或缺的、但却有用的数据，并提供了有关自然资源的信息。这些服务及其相关应用所用的频率见ITU-R RS.1859建议书 – “使用遥感系统收集在自然灾害或类似紧急事件中所用数据”[3]的表1。

地面、现场（in situ）和及时的测量或观测通常比从空中进行的类似观测更加精确和准确。这些类型的观测称为“地面实况”，用于校准星载仪器。然而，当现场仪器或使用此类仪器所需的支持性基础设施未就绪或者因灾害而失效或者地面的测量不够准确时，卫星观测可以提供有助于减轻灾难影响的有益信息。在那些受灾面积广、人口密度低、技术基础设施薄弱或未得到很好发展的地区，卫星观测尤其有用。

ITU-R RS.1859建议书具体说明由卫星产生的数据如何有益于减轻自然和人为灾害的影响。

[3] ITU-R RS.1859-2010建议书 – “使用遥感系统收集自然灾害或类似紧急事件中所使用的数据”，2010年1月：https://www.itu.int/rec/R-REC-RS.1859/。

2.2 广播告警系统

广播机构的一项功能是向普通大众发布信息。一些国家中的一些市政当局可能拥有一套多播系统，针对的是其自身灾害无线电通信网络中带有扩音器的户外接收机。不过，可能很难在室内听到声音，尤其在恶劣气候条件下，如暴风雨或大雨。因此，通过广播发布的灾害警报和信息对于这种情况十分有益。

多种应急告警系统（EWS）的存在为广播网络提醒人们即将发生的灾害并为人们做好应急准备提供了可能。应急告警系统可作用数字无线电传输中特别嵌入式告警或提示信号自动打开接收设备（如有所配备）并发出应急通报，提醒人们即将来临的海啸或地震等灾害。

系统应使用相对简单的设备，并确保稳定运行。在紧急情况下，EWS控制信号（为模拟信号）自动激活具有EWS功能的接收机，即使它们处于待机状态。依赖其特性，EWS控制信号也可作为警报声引起听众/观众对紧急广播节目的关注。广播公司运营的模拟平台可发射EWS控制信号。EWS控制信号可以包括地区码和时间码，使接收机免受有意的伪控制信号的侵害。

2.3 灾害信息和救灾系统

以下提供的更多灾害信息、告警和救灾系统实例有助于向公众和/或求助人员提供关键信息，同时考虑到灾害可能造成的各类中断。

1) 移动广播告警和通知系统

为缓解网络拥塞，移动系统可利用移动广播技术在独立于话音的情况下发布通知。这些通知可同步发送至受灾地区的多部移动终端。

2) 数字指示牌

数字指示牌（DS）通过可视显示传播信息。数字指示牌通过与广播电视网络连接提供了另一条信息传播渠道，与电视和在线信息发布服务大同小异。DS从政府机构获得信息并通过早期预警系统发出通知。为缓解容量限制问题应考虑到以下各个方面：

- 新技术（可缩放矢量图形（SVG））,
- 发送信息量，及
- 预存图形的作用。

3) 灾害信息板系统

基于IP的移动信息服务使受害人得以在系统信息板上放置将发送至接收者的文本信息，将个人状况通知他人。

4) 灾害语音传送系统

一些用户更喜欢使用语音通信。IP分组网络的灾后拥塞程度低于电路交换网络，语音呼叫可利用IP网络通过打包作为通知信息发出。

5) 救灾指导系统

灾害发生时和灾后，受害者或许需要联系位置不明或不熟悉的医院以及临时庇护所。此外，因道路毁坏，可能需要了解新的和不熟悉的路线。救灾指导系统可通过显示具有关键位置和可用线路的地图提供图形指导。当受害者（通过GPS）确定了终端位置并选择了目标位置（如家、医院或庇护所）时，所选目的地的路线图便赫然在目。

6) 搜救系统

图3演示凭借双模BTS支持无人机GSM和LTE技术的搜救服务。GSM主要用于灾害总部（HQ）和受害者之间的通信，而LTE则用于灾害总部与第一响应人之间的通信。搜救涉及以下两个搜索步骤和一个救援步骤：

- **搜索和伤员分类（搜索中的第一步）**

首先，BTS在尝试GSM模式操作前通过无人机发出无线电信号。之后，当移动电话监测到无人机时，灾害总部收集所有可通达的国际移动用户身份（IMSI）和广播短信消息。请当地蜂窝服务确认收到消息后，灾害总部对移动电话予以定位。如监测到的移动电话未确认收到短信，灾害总部则考虑优先确定这些电话的位置。

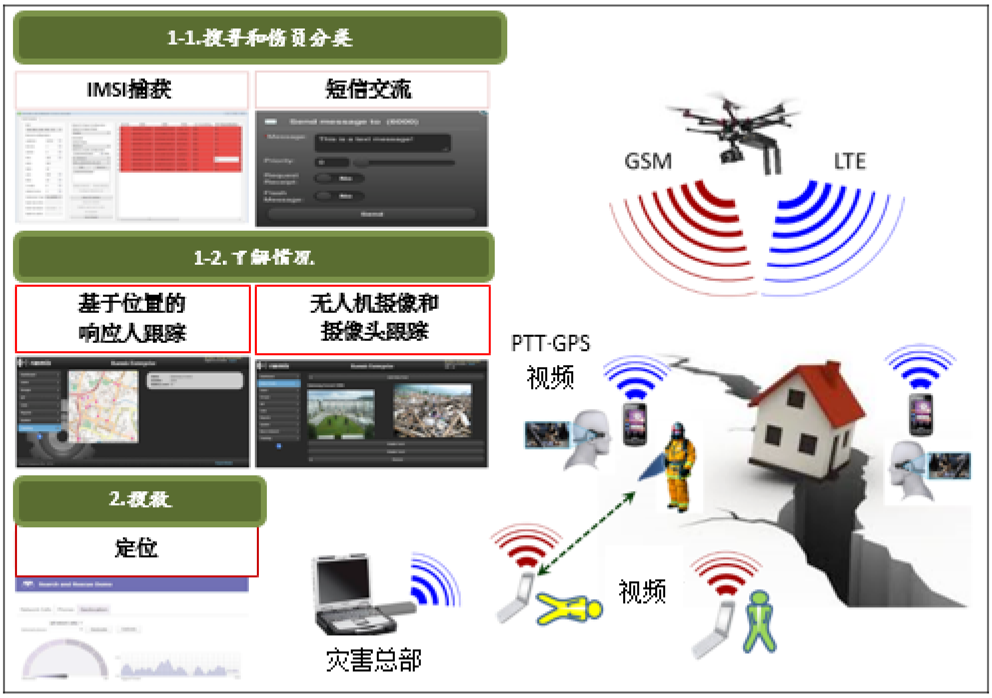
- **了解情况（搜寻过程的第二步）**

灾害总部利用LTE访问无人机摄像头和响应人终端的图像数据，以此处理每个响应人的位置并检查受灾地区状况。

- **救援**

在分析了所有收到信息后，灾害总部瞄准派遣相关响应人的IMSI。响应人使用IMSI和定向天线确定移动手机的位置。

图3：搜救服务实例



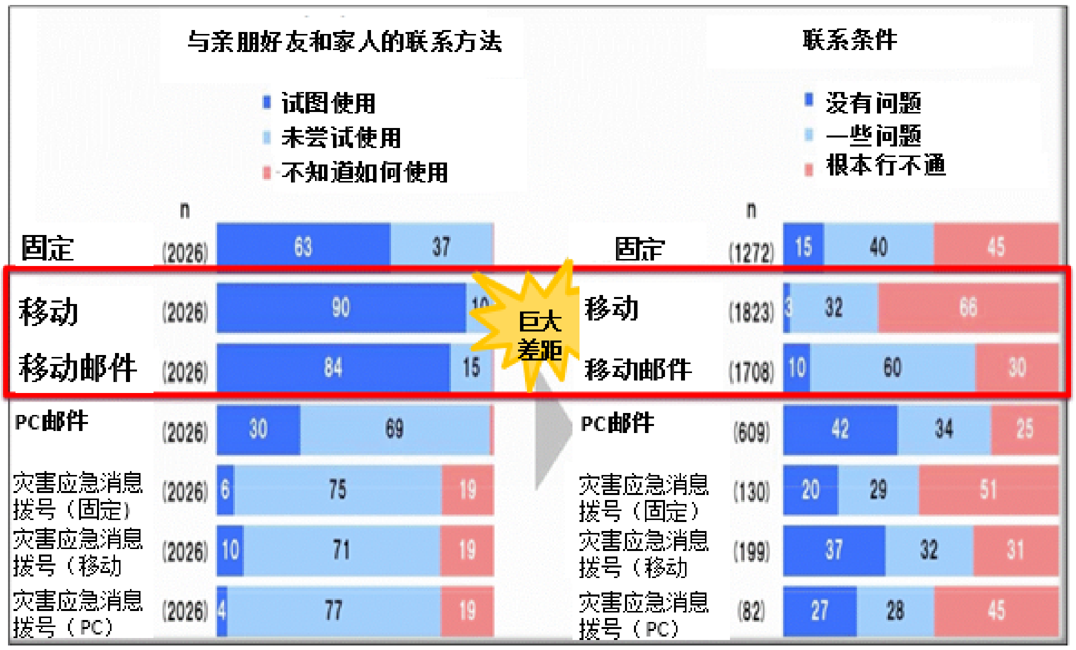
2.4 适应性网络技术

2.4.1 概况

鉴于ICT对于灾害所有阶段的重要性以及对ICT的需求，操作连续性是灾害通信管理的重要考虑。各机构使用多种技术方式和系统确保适应性和备份。

ICT的可用性或延续性受到网络遭受灾害破坏情况以及灾后网络拥塞情况的影响。**图4**显示了在2011年3月日本灾难性地震发生后采用的安全确认手段。虽然多数受灾民众试图使用公共移动网，但由于网络阻塞和基站数量有限，人们无法接通。

图4：通信基础设施的损坏

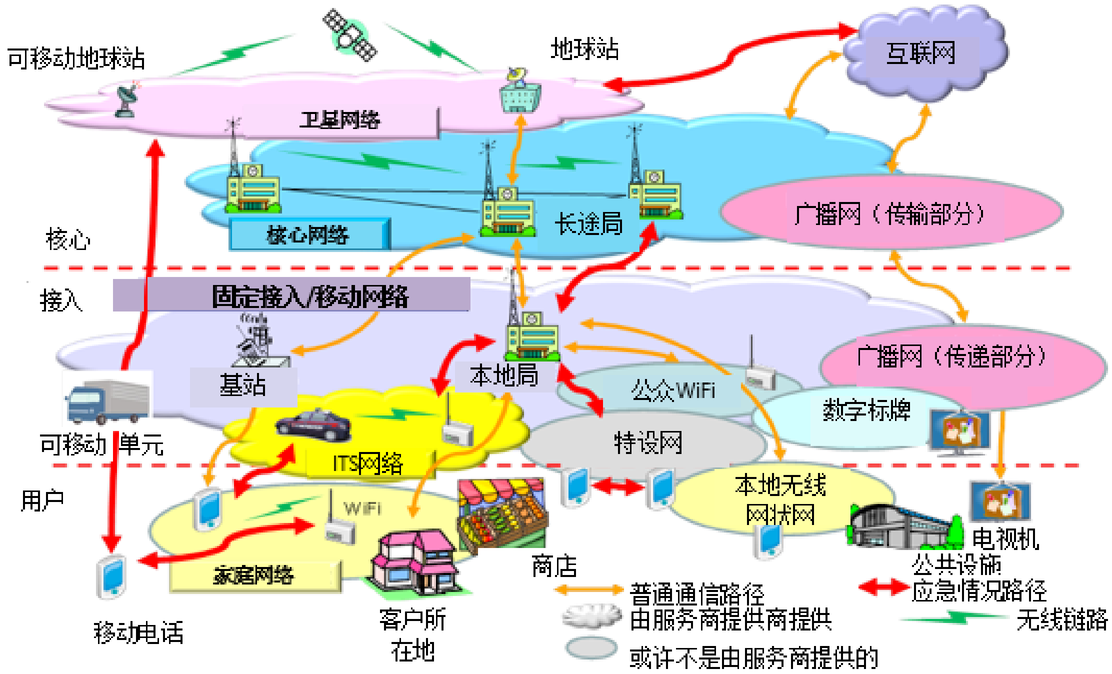


*基于内政和通信部的介绍材料创建

网络路径的多样化以及系统备份是必不可少的考虑，同时还应采取措施确保网络足以抵御在一些环境下相差无几的各类灾害的步骤。增强终端可在不同网络（固定接入网络、公众WiFi、智能传输系统（ITS）和卫星网络）上使用系统，从而使人们能够在灾害中进行通信。网络还可通过增加对不同于普通通信路径的若干通信路径的接入以及将通常独立的网络和能力（由不同组织采用不同政策拥有并/或操作）的集成得到增强。

图5显示出支持灾害响应服务的综合网络基础设施。通常，网络分两种类型（服务提供商拥有和非服务提供商拥有的网络用不同云形表示），这些网络由以下三个部分构成：核心网、接入网和用户。**图5**对应急通信路径和非应急通信路径作出比较。

图5：支持赈灾服务的网络概貌



由于核心网的损坏对于固定和移动网络具有普遍的不良影响，多数电信服务提供商采用某种形式的核心网备份以防止或减轻这种伤害。举例而言，地球周边的许多电信卫星在地面网设备遭受破坏时依然保持运行状态。因此，可用卫星和临时地球站搭建能够抵御灾害的核心网。

包括诸如光纤、铜缆等固定线路设施在内的接入网和有线网络将用户连接至核心网。然而，由于高昂的费用，接入网较少备有内置备份，因此灾害预防和恢复计划至关重要。移动网络的情况大致相同，然而，这些网络比固定接入网更加方便使用，因为用户可以移动并与其它基站连接。车载移动性和新增电信功能亦使ITS网络（车内专用接入网）在灾害期间大有所为。同样，由于多数移动终端（如PC、智能电话）配备WiFi功能，而且许多服务提供商提供公众WiFi，这些网络可在灾害期间用来发布应急信息。此外，家庭WiFi网络在灾害期间亦可对外开放。本地（专用）无线网状网是在网络部分瘫痪时实现连接的另一可能。

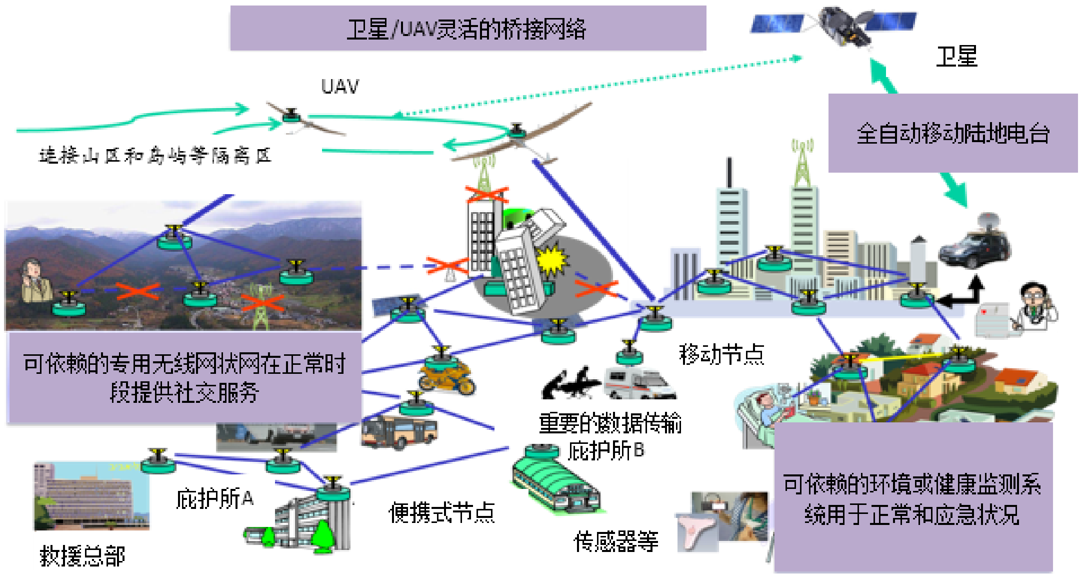
所有这些可作为受损接入和核心网替代的专设网络由若干设施组成，其中包括WiFi功能。为增强灾害期间的连通性，上述网络可加强之间的互动，例如，通常情况下，每个网络都是独立运作的，利用自己的政策不向其它网络和用户广泛传播网络信息（如流量、网络性能和资源可用性）。然而，灾害发生时，网络可以放松认证和收费政策，以便向非用户终端提供功能。网络将向终端通报这些变化（如服务可用性）并在网络之间分享网络信息和操作变更情况，从而统一协调有效的应急通信，选择备用网络或通过存活部件保持通信。

2.4.2 本地无线网状网系统

本地（专用）无线网状网基于分布式网状架构，避免整体网络因部分网络损坏而瘫痪。分布式数据库和应用技术还可大大提高网络适应性。此外，本地无线网状网通过网间节点链路提供无线局域网接入并与小型和车载卫星地球站以及由程序控制的小型无人

机（UAV）提供的移动中继器相连接。因此，这些电台和移动中继器可在基础设施恢复前快速提供隔离通信区和监测链路。

图6：本地无线网状网架构



该系统基础设施包括置于大楼顶部或地面的固定和便携式网状中继节点（见**图6**）。因此，其组件应具有以下功能：与最近的本地交换机和/或IP网络的连接能力、供电、必要的电信功能、隐私、安全和传输网络接入。

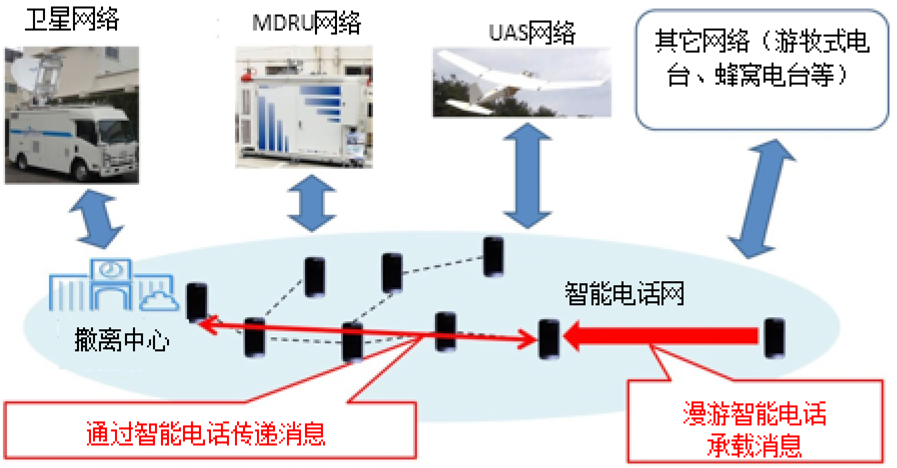
2.4.3 时延容忍网络

基于时延容忍网络（DTN）的通信系统因抵御网络中断和断开的能力而备受关注。DTN可与移动终端或游牧式电台连接，其协议架构将克服异质网络技术缺乏连接延续性的问题。

a) 具有DTN功能的移动终端

多数用户终端，如智能电话或平板设备，现均具备WiFI功能。通过创建终端可相互发送时延容忍消息的动态网络，DTN获得增强（见**图7**）。

图7：移动终端时延容忍网络的扩充



不具备物理基础设施的通用WiFi设备可实现灾害区内外之间的通信。此外，该系统方便用户、因为用户只需要在设备上打开分布式应用便可按说明使用。

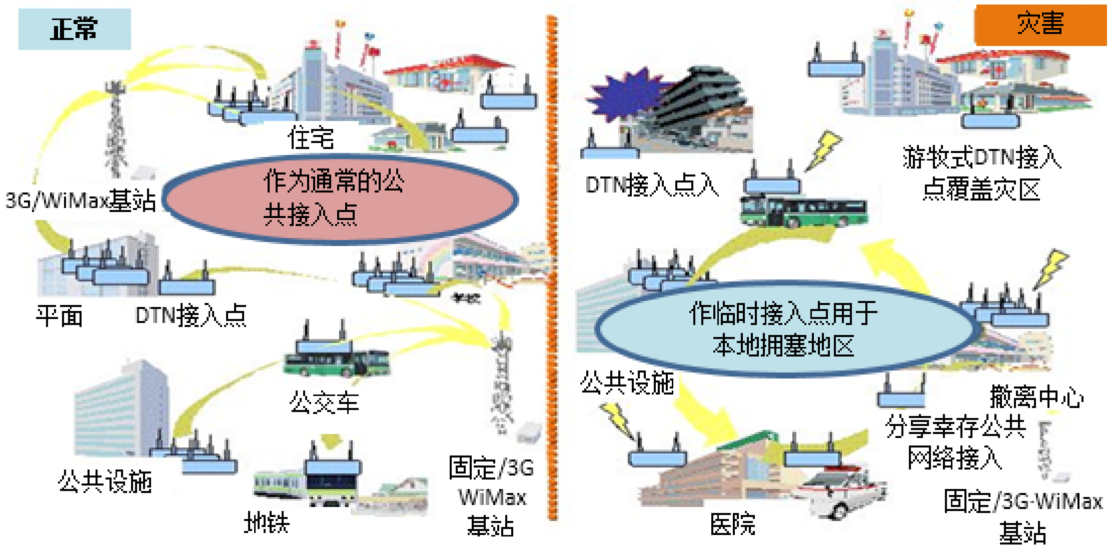
此外，DTN还可采用移动专设网络（MANET）改进消息传递性能。即使仅凭靠MANET功能，系统仍能在移动性有限的区域（如撤离中心、人口密集地区）中介节点间提高多终端消息传递效率。然而，由于MANET必须维护路由信息，系统可增强网络对开销费用的控制并降低高移动节点和低密度区域的消息传递效率。为在最大程度上增强消息传递性能，有必要实现优化，使各终端和边远控制器自动选择DTN或MANET方式。此外，由于移动终端可方便获得自动模式选择不可获取的信息（如GPS信号、三维加速测量识读并保持电池寿命），因此，这一方案备受青睐。

蜂窝网等网络技术、移动可部署资源单元（MDRU）网络、游牧式电台、卫星网络和无人机系统（UAS）方便易行。采用卫星和MDRU连接，可将消息传送至遥远的接收者，但是，如无法部署卫星电台或资源单元，无人机可作为终端将消息从受灾地区传送至其它连接地区。此外，由于通过DTN传送的消息可传播至广泛地带，因此可到达具有蜂窝连接的终端并实现蜂窝网的转接。换言之，消息可传播至WiFi连接地点或游牧式电台（撤离中心），再将消息转至灾区以外。

b) 具有DTN功能的游牧式电台

目前的WiFi技术不太适合于本地处理大量终端，因为随着终端数量的增加，性能随之衰减甚至失效。因此，开发可处理多个终端的WiFi功能游牧式电台十分有益。通常，移动终端作为临时接入点，例如，市中心和学校与公众骨干网连接后成为通用的WiFi接入点。灾害期间，电台转换为DTN模式，将信息传送至关键位置（如市政厅、医院），存储必不可少的信息，如开放的撤离中心和食物分配点并收集服务接入请求。这一程序沿用至公众网稳定为止。

图8：具有DTN功能的游牧式电台



然而，游牧式电台与公众骨干网之间存在连接问题，因为，灾害期间不可能永远保持二者之间的连接。由于切断连接时游牧式电台无法获得信息，为延续连接传统上采用安装卫星的方式，尽管卫星成本较高且带宽有限。具有DTN功能的游牧式电台不失为一项良好选择，因为DTN基于来源连接存储信息并在定位最后用户后传递信息（见图8）。

2.4.4 便携式应急通信系统

在恢复和重建阶段，便携式应急通信系统（PECS）可发挥重要的中介作用。不同PECS（如独立拖车或嵌入式工作车辆）利弊共存。尽管本报告探讨了符合军用标准的PECS，民用PECS却具有天壤之别，可能具备：

a) 用户终端

- 模拟和数字无线电：VHF、UHF、HF/SSB、DMR、P25 (APCO)、TETRA
- 移动电话：GSM、CDMA、W-CDMA、LTE等蜂窝接口
- IP电话：模拟/数字PABX电话、DECT/WiFi电话
- 卫星接口：低轨和对地轨道卫星电话

b) 基于IP的综合交换：用户终端与“综合交换机”通过接口连接，如模拟/数字无线电和可以使用户通信并进行会议电话的移动电话。

c) 天线和伪天线产品：有关频段的空中接口要求确定所使用的天线类别，例如，露天应用/操作需要包含一个或两个可扩展三脚架的天线。

d) 供电单元：轻型供电单元（如电池、折叠太阳板和发电机）提供方便的便携性。

e) 配件：可能包括线缆、电气/机械用户适配器以及电源转换器。

f) 测量和外围设备：PECS维护需要电表、SWR测量仪和变压器等测量设备。外围设备包括坚固型笔记本、智能电话以及方便通过耐用军用标准箱运输的平板电脑。

2.5 光纤链路的恢复

在远东日本发生的地震和海啸表明，光网埋设的光纤可在地面基础设施（如中继电台、交换机或交换点）受到损害时存活下来以支持至关重要的应急服务。便携式参铒光纤放大器（EDFA）可迅速将存活的光纤链路与光纤网恢复连接或提供绕过受损网络基础设施的手段（**图9**）。

图9：光纤链路的再连接

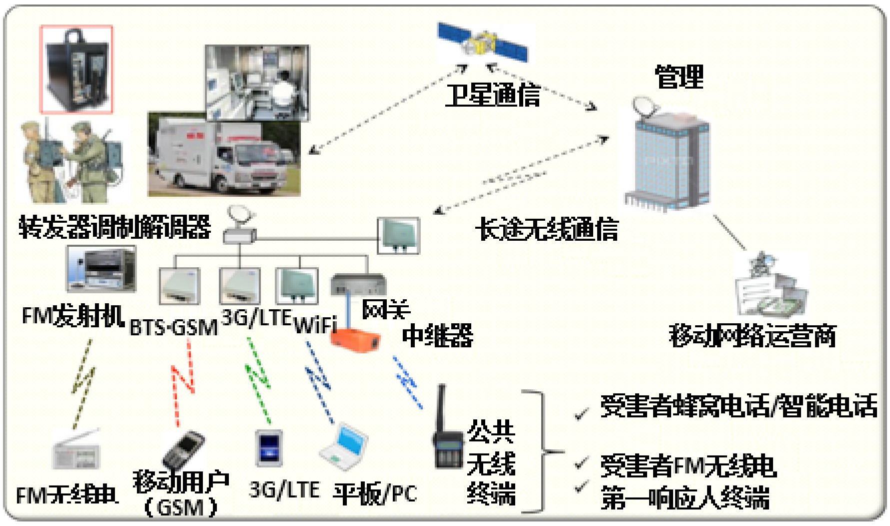
由于便携式EDFA采用电池供电，无需为远端的光放大器供电。这些EDFA的防水和防震结构方便用于恶劣环境。此外，EDFA全双工模块适用于突溢模式，因此可在无畸变或光功率波动的情况下放大突发信号。

2.6 地面系统－固定和移动

a) 应急移动网络（EMN）

自然灾害风险巨大的国家应考虑由若干种通信设备和自发电组成的应急移动网（EMN）（见**图10**）。EMN在自带设备（BYOD）的基础上向第一响应人、公共安全（如军队和警察）负责人、人道主义组织以及普通大众提供话音和数据连接。该网络意义非凡，因为市政府很难为新的设备提供资金和培训保障，而自带设备可使用户在灾害期间使用自己的设备。

图10：应急移动网的网络框图

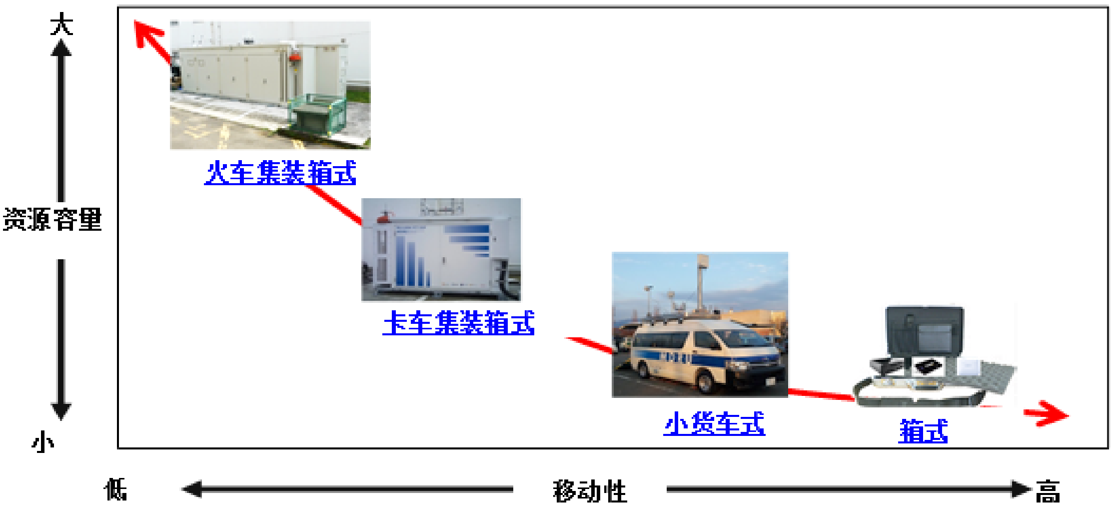


应急响应方还应采用宽带技术和支持蜂窝（GSM、3G和LTE）以及WiFi连接的智能设备加强对情况的认知。同样，ICT资源单元必须支持数据和语音传输以及国内漫游：1) 无论签约移动网络运营商（MNO）是哪家，将所有移动用户涵盖在内，2) 实现灾区与远程地点之间的通信。PECS可用来实施涵盖多种通信设备的ICT资源单元（见**图11**）。

图11：应急响应的ICT资源单元

重量和尺寸决定了ICT资源单元的便携性和有限性。在选择单元规模时应考虑可使用的运输模式。尽管ICT资源单元通常是由支持客户化的模块构成的，较大的单元更具优势（见**图12**）：更大的电池、容量和更强的功能（如卫星接入、FM无线电广播和PC服务器）。

图12：ICT资源单元的规模实施



更大容量的ICT资源单元也是半永久性使用的最佳选择，因为这些单元容量更高、功能更强，举例而言，大型ICT单元可在缺少带宽路径的情况下实现不同应用和服务。然而，更小的单元（箱式货车和箱式）具有更强的移动性。

b) 用于灾区的ICT服务功能

基于互联网的系统可为受灾地区传送宝贵的信息，包括图像、案文和视频。然而，固定和移动互联网在电信设施（如交换机和路由器）遭受破坏的情况下无法接入。

无论现有网络状况如何，ICT资源单元可利用基于WiFi的局域网通过被撤离的管理系统传送互联网流量。此外，在配备PC服务器的情况下，这些单元提供局域通信服务，如电子邮件和网络接入。然而，如没有连接的网络设施，ICT资源单元可提供临时的通信信道（如通过卫星）。如这些信道有限或不可使用，这些单元可作为独立的局域数据中心，为本地用户提供互联网类服务。

c) 本地蜂窝服务使用案例

图13：本地蜂窝服务使用案例

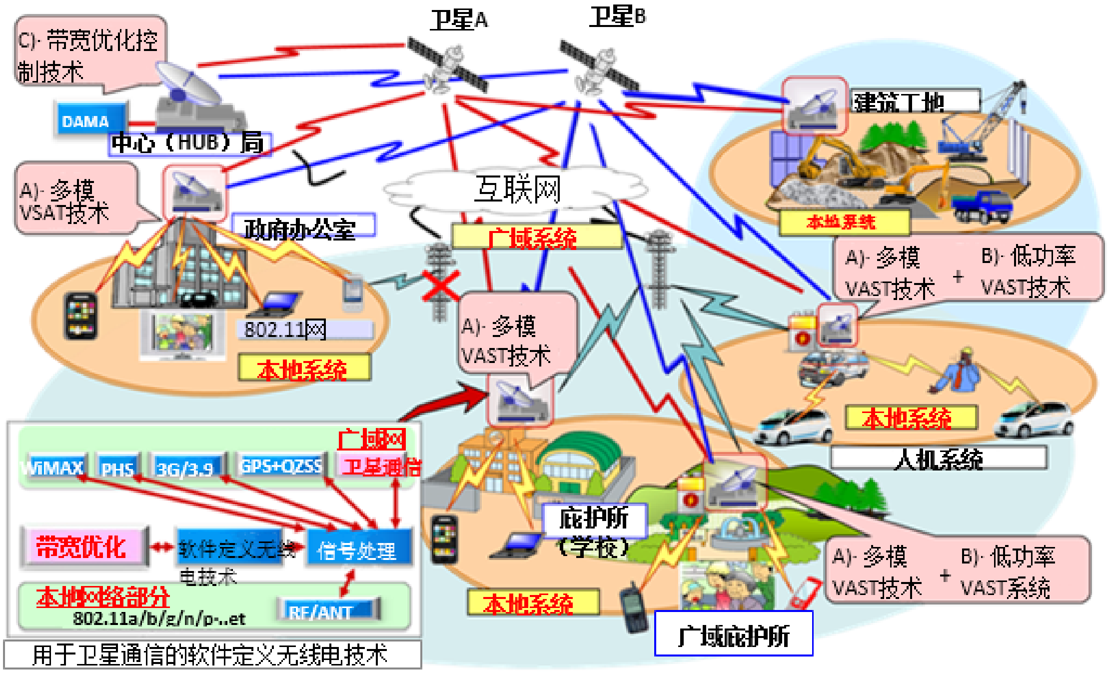
图13显示出若干本地蜂窝服务使用案例。右上角显示出蜂窝电话GSM模式支持实现受害者之间本地通话的ICT单元。右下角显示出受害者利用其蜂窝电话向第一响应人拨出的本地应急呼叫。左上图显示出LTE如何方便旨在加强情况了解的若干类图像的传输。左下角体现出旨在从空中发现受害者位置的搜救工作。

2.7 卫星通信

2.7.1 特小孔径终端（VSAT）

为实现特小孔径终端（VAST）与多种通信方式的兼容，目前正在开展研究以便确保快速解决灾害中遇到的技术问题。由于主要目标是确保卫星通信线路满足灾害摧毁通信基础设施区域的需求，这项工作侧重于解决卫星通信问题（见**图14**），其中包括：

图14：利用VAST加强备灾



– 卫星间通信

解决方案：使用如下方式在不同卫星通信系统间实现单一VAST通信：1) 软件定义无线电系统，2) 小天线，3) 算法。举例而言，如图15所示，灾后网络拥塞造成卫星通信系统A不可用时，VAST接入卫星通信系统B。

– 灾区缺少VSAT解决方案。

解决方案：多模VSAT技术可使系统承载灾害期间增加的业务量。

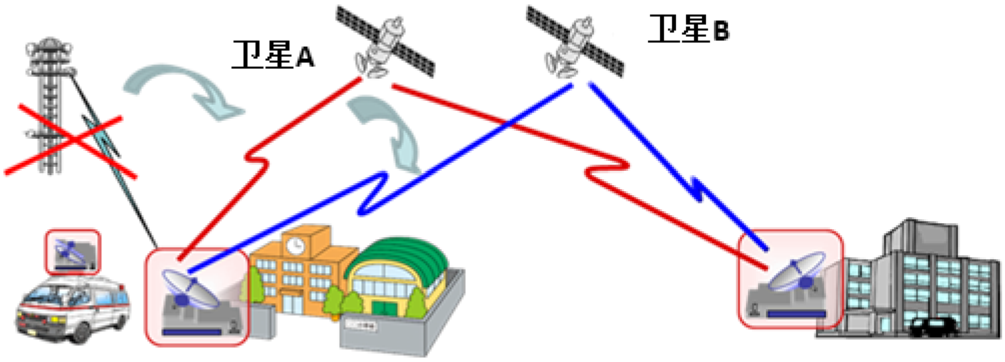
– 长时间断电造成VSAT关闭。

解决方案：低功率VSAT技术是灾害期间必不可少的通信手段，因为该技术优化功耗并将室外单元（ODU）/室内单元相互集成以便于维护。

– 卫星网络流量拥塞。

解决方案：带宽优化控制技术利用按需分配的多接入（DAMA）控制器在会话的基础上优化分配带宽。

图15：不同卫星系统之间的通信



– VSAT恢复

解决方案：相对于建立卫星链路，小型便携VAST方便新手使用。

总之，VSAT包括负责监测、控制和自动调整天线方位角、仰角以及极化角的中心电台并配备多项附加功能。

2.7.2 一键通（PTT）通信和移动卫星

为使用PTT，一方必须按键并对设备讲话。释放按键后，通信即刻发送至接收方。接收方之后通过按键回复。与全双工并允许双方同步接听的标准移动电话不同的是，PTT呼叫为半双工，仅允许一方在某一时段获得接听。然而，PTT服务具有多种优势：

– **效率：**PTT服务消除了传统无线服务的时延。举例而言，在使用蜂窝电话时，用户必须拨打号码并等待被叫方应答，而PTT服务只需用户按键并对设备讲话，消息便几乎同步得到传输。

– **清晰度：**低质量传输以及/或各方同步讲话的能力加大了不良通信的风险，因此，清晰度对于危机通信十分重要。由于PTT服务只允许一方在给定时间内讲话，被叫方必须将精力集中在唯一的来话上，消除了扰乱通信的风险。

– **耐用性：**PTT设备通常结实耐用，可抵御极端的物理条件。

– **连通性：**PTT服务允许个人对个人和个人对团组的通信，因此方便协调。与其通过不同呼叫联系不同人，PPT允许每个用户即刻与位于若干地理位置的个人进行通信。

移动卫星PTT服务在紧急状态下具备更多优势，其中包括：

– **可靠性：**地面（如蜂窝塔）电信基础设施容易受到变化的环境条件影响，卫星网络则不受自然灾害的影响，允许用户在最需要的时刻保持连接。

– **扩大的覆盖：**由于许多紧急情况发生在基础设施有限的边缘地带或地面基础设施受到影响的地区，卫星是保障可靠PTT覆盖的唯一方案。

– **互操作性：**卫星PTT服务可集成在非卫星PTT、地面蜂窝、WiFi以及其它通信网内以支持各机构使用不同通信服务满足应急管理的协调需求。

2.8 广播

多年来，无线电和电视广播一直是灾前和灾后向公众提供重要信息的主要渠道。在此情况下，无线电和电视广播通过点对面的方式向公众、第一响应人和其他各方广泛使用的接收设备传播重要信息和安全建议。在许多情况下，主要广播设施有其独立的供电设施，以便在公用电力丧失的情况下依然保持通信。

ITU-R [BT.2299-1]号报告（“用于公众告警、灾害缓解和救灾的广播”）[4]提供了有关广播服务如何用来支持应急通信的技术和操作信息并提供了案例研究，阐述了用于发布应急信息的新的广播技术和系统。

2.8.1 概况

一旦发生灾害，很多人都会立刻打开收音机和/或电视广播同时收听国家网络信息和本地信息。灾区内非广播通信链路基础设施通常出现瘫痪，但广播的架构既简单又有利。如主发射机和无线电或电视演播室依然运行，只要接收机正常工作便可实现接收。此外，小型手持和车载电视接收机迅速增加和普及，同时多数应急中心（如警察局、医院、运动场、办公楼等）使用大屏幕设备。一个国家内多个广播和电视服务的提供进一步加强了广播服务的总体耐用性。如一家或少数几家广播和电视广播机构无法提供服务或出现中断，通常其它广播信号可供使用。

无线电接收机可使用交流电、电池或手柄操作并几乎普遍安装在所有机动车内。无论在受灾地区出现任何中断，这些接收机永远具备可靠性。便携式电视接收机并不常见，但随着移动DTV接收能力延展至蜂窝电话等便携设备，情况将大有改观。

2.8.2 保障延续广播服务的操作方法

广播的关键是永不中断并可供使用，尤其是在紧急情况下。多数设施具备冗余能力和信号路径，以便保持空中激活状态。在更大规模的市场中，人们采用更为稳健的措施。这些通常使用的“加固”设施包括不同发电站提供的多重电源、全备份演播室和发射机站点的全备份发电机、从演播室至发射机站点的多信号路径、备份发射机/天线以及有线和卫星运营商的直接馈入。所有这一切将影响重要信息广播的单一故障点降至最低水平。

一些人道主义机构常备“箱式无线电”，用来在遭受破坏或损坏的情况下重建FM无线电服务。该设备联合小型汽油发电机共同使用可使FM无线电台在灾害发生后保持若干小时的空中激活状态。人们通常期待的不是重建全新的无线电台而是在FM频率上操作特别无线电服务以及无法利用自身演播室和发射机进行广播的本地伙伴电台的广播许可。

2.8.3 使用现有地面广播基础设施支持应急通信

电视广播为传播各类新闻建立了内部程序，以便以简便的方式迅速向公众提供生命和安全信息。应急告警系统将电台与州立和国家应急信息频道相连接并尽快反复播放民间和政府机构的消息。迅速部署的电子新闻收集和广播手段以外的卫星提供实时图片

[4] ITU-R BT.2299-1号报告，“用于公众告警、减轻灾害和救灾的广播”，2015年7月：http://www.itu.int/pub/R-REP-BT.2299-1-2015。

和声音。闭合字幕系统和全屏地域显示，新闻“标注”以及屏幕下方文字信息都将确保通信保持最简单的形式，如电话呼叫可作为广播信号的来源，由灾区官员或民众投放空中，将消息转接至观众和听众。

随着社会进一步走向移动化，广播机构对广播接收能力纳入移动设备赞赏有加。世界上一些地方，如欧洲，移动电话普遍具备FM无线电接收能力于，而在美国和其它国家，这项功能还不够普及。美国正在积极制定计划，鼓励移动网络提供商和电话制造商将广播信号接入纳入更多产品。

地面广播机构采用许多不同技术以辅助新闻收集和应急信息的发布：

– 现场和录制移动电话视频可置于空中，因此可使用非传统广播设备分享重要的信息；
– 广播机构正在调整小孔径卫星天线技术，以便更加方便地在本地市场部署卫星新闻收集工具；
– 分集微波接收站点可使用配备微波发射机的小型车辆驾驶并报告道路和其它条件；
– 使用直升机全面俯瞰全区域的应急情况；
– 计算机制图软件迅速记录并向公众显示紧急情况详情。

2.8.4 广播组织之间的协作

多数城市广播机构建立了协调网络，使电台可以共享用于收集新闻的有限微波信道。这些网络在紧急情况下用于向所有电台推送报道并利用微波频段以最高的效率收集新闻。此外，重叠的市场电台通常分享视频报道，许多电视台与广播电台合作，通过无线电重播电视音频，让公民使用电池供电的广播收听到新闻。这些人通常失去了供电系统，必须依赖汽车或便携广播收听新闻和信息。

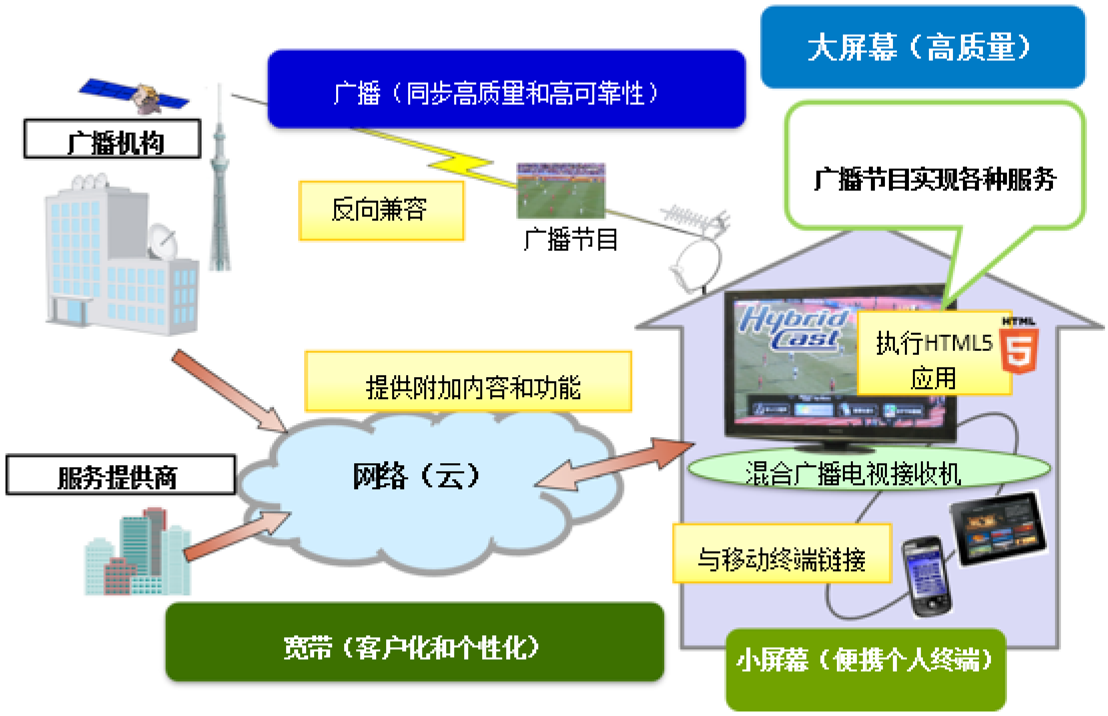
2.8.5 短波无线电

向受灾民众传播信息的最有效手段是采用多平台，但无线电是最主要的技术，尤其是在灾害刚刚发生之后。国际广播短波技术具有抵御灾害的能力，因为传输设施完全脱离受灾地区。由于短波无线电长途传播特性，采用上层大气多层反射手段，发射机可方便通达临近或更加边远的世界各地。当卫星、FM或互联网等其它平台因成本高昂、地理位置以及基础设施缺乏或限制或灾害等原因不可用时，这项技术十分重要。接收机价格合理且无接入费。

2.8.6 混合广播宽带电视系统

综合系统中的混合广播已通过日本IPTV论坛实现标准化并利用宽带加强了广播服务。广播按照用户的个人需求提供高质量内容，宽带则提供灵活的响应。这些功能使混合广播得以在灾害发生时提供可使用的先进广播服务。**图16**显示出混合广播系统的概貌。

图16：混合广播系统概貌



混合广播让用户在灾害期间获得瞬息万变的信息。

a) 实例：地震

在广播“地震早期预警”信号时，收到信号的混合广播电视接收机自动启动详细显示本地灾害信息的应用（见**图17**）。

图17：详细显示灾害信息

2.9 业余无线电

2.9.1 业余业务的性质

多数发达国家拥有稳健和活跃的业余无线电和卫星业务。许多主管部门将业余无线电业务作为备灾、灾害响应和减轻中可使用的资源。

2.9.2 业余业务在应急通信中的作用

业余业务活动范围之广和业余无线电操作员技能之强让该业务成为应急通信中的宝贵资产。几乎所有国家都有大量的业余电台，提供了一个独立于任何其他网络的健全网络。在很多情况下，在为受灾地点、国家、区域或地区的救灾行动提供帮助的同时，它会提供最初（有时也是唯一的）灾区外部链接。业余无线电应急通信业务在依靠基础设施的无线电业务不可用时提供使用。在应急通信灾害中启用的业余无线电电台不依靠基础设施，因为许多电台可以使用电池、太阳能供电和其它非依赖于基础设施的操作方式投入运行。

业余业务对应急通信提供有益补充的典型情况包括：

– 初期应急告警可能源自个人业余电台，以便向相关的正式应急业务部门通报某个事件的发生。

– 损害评定以及有关灾害范围的评定。

– 在搜救行动中，业余电台可通过其通信能力及报告观察资料增强专业团队的能力。

– 医院及类似的机构可能会在灾害发生后失联。当地业余无线电应急小组可提前为此类援助做好准备。

– 危险品（HAZMAT）和其他事件可能需要疏散居民并在灾害发生地与疏散点或庇护点之间进行协调。可要求业余应急电台建立与此类机构的通信联系。

在通信应急情况下将业余无线电业务作为资源使用的主管部门将业余无线电包含在训练和仿真应急演习中，同时将此纳入灾害规划和备灾资源。

2.9.3 用于应急通信的业余网络

业余短距离网络在灾害发生地提供与周边地区的工作或策略性通信联络。这些联络可包括固定、移动和游牧式设备，通常使用50-54 MHz、144-148 MHz和420-450 MHz频段内的频率，同时应注意到在这些频率范围上各地区和各国存在差异。

采用中继台来扩展VHF和UHF电台的通信范围。当在城市中使用时，放置在较高的位置后，这些中继台可实现被山峦或高层建筑遮挡的固定或移动业余电台之间的通信。中继台可在一个信道接收，并在另一个不同的频率上（通常两者皆在同一个频段内）发射。

业余中等距离网络通常用于提供从事故现场到组织管理中心或在邻国的反应提供者总部之间的通信连接。它们也能确保与在可用的VHF或UHF网络覆盖范围之外的车辆、船只和飞机的通信连接。在500公里以内的中等距离，可通过1 800-2 000 kHz、3 500-4 000 kHz和7 000-7 300 kHz等较低中频/高频频段的近垂直入射天波（NVIS）实现通信连接，同时应注意到各地区和各国在这些频段上存在差异。此外，几个国家的主管部门为业务无线电应急通信和相关培训分配了固定的频率（信道）。

业余远距离网络提供与国际应急和灾害反应提供者总部的通信连接。它还可以作为位于不同国家或不同洲的此类机构的指挥部之间的备用通信连接方式。业余无线电台通常可在长距离上进行通信，典型的是超过500公里，使用3 500 kHz至29.7 MHz频段中倾斜入射角天波传播。

2.9.4 业余系统的特性

ITU-R M.1732建议书（"用于共用研究的工作于业余业务和卫星业余业务中系统的特性"）[5]阐述了典型的业余系统特性。

2.9.5 培训

自我训练是业余业务的一项重要宗旨。这包括在无线电通信领域培训青年人。业余无线电爱好者可规划、设计、建造、操作并维护一个完整的无线电台，这有助于各国的电信人力资源开发工作。

许多国家的业余无线电学会针对准备参加业余许可考试的个人设计了一门或多门培训课程以及出版物。许多国家的学会提供涉及多项议题的教育课程，其中包括有关备灾、灾害响应和缓解的课程（包括损害评定）。培训资源实例见国际业余无线电联盟（IARU）网络：http://www.iaru.org/emergency-telecommunications-guide.html。

2.9.6 主管部门使用业余无线电业务无需任何成本

供应急通信使用的业余无线电业务对于地方或政府实体无成本可言。业余无线电运营商在应急通信情况下自愿提供自己的设备和服务。

[5] ITU-R M.1732建议书 – "用于共用研究的工作于业余业务和卫星业余业务中系统的特性"：https://www.itu.int/rec/R-REC-M.1732/。

3 第3章 – 案例研究

3.1 研究期内收到的案例研究总结

本节概括了2014-2017年研究期内ITU-D第2研究组第5/2号课题收到的案例研究。该节将案例研究分为四组，配合ICT在灾害管理不同阶段中的使用情况：

1) 灾前；
2) 应急初步响应阶段；
3) 努力恢复阶段；和
4) 重建阶段。

这些案例研究按照诸如政策、救灾和网络适应性等目标或主题进一步分类；案例研究概要见**表1**。该章提供的信息仅作为研究期审议议题的指南。这些案例研究总结显示在**附件1**中，其中包括提供完整案例研究案文的链路。

表1：案例研究分类

类别	灾前	灾后		
		初步响应阶段	努力恢复阶段	重建阶段
政策	网络灾害恢复计划（见**A1.1**）（GSMA）	飓风Sandy和联邦通信委员会（见**A1.4**）（美国）		
	升级技术支持和研发能力（见**A1.3**第5部分）（中华人民共和国）			
	马达加斯加灾害通信管理（见**A1.7**）（马达加斯加）			
	基于单一号码的综合应急通信和响应系统（IECRS）（见**A1.11**）（印度）			
	移动电话提供商用于备灾、缓解和响应的应急计划（见**A1.9**）（阿根廷）			
	应急通信：国家法律框架（见**A1.18**）（中非共和国）			

类别	灾前	灾后		
		初步响应阶段	努力恢复阶段	重建阶段
应急通信		加强应急通信中的指挥和调度（见**A1.3**第1部分）（中华人民共和国）		
		1.4GHz频段的划分（见**A1.3**第6部分）（中华人民共和国）		
	开发应急通信标准系统（见**A1.3**第7部分）（中华人民共和国）			
	应急通信管理系统（见**A1.3**第9部分）（中华人民共和国）	应急通信管理系统（见**A1.3**第9部分）（中华人民共和国）		
	加强国家应急预警能力（见**A1.3**第10部分）（中华人民共和国）			
		用于应急通信的多种技术手段（见**A1.3**第4部分）（中华人民共和国）	用于应急通信的多种技术手段（见**A1.3**第4部分）（中华人民共和国）	用于应急通信的多种技术手段（见**A1.3**第4部分）（中华人民共和国）
		应急通信设备（见**A1.3**第11部分）（中华人民共和国）	应急通信设备（见**A1.3**第11部分）（中华人民共和国）	
		第一响应人网络授权（FirstNet）– 国家公共安全宽带网（见**A1.5**）（美国）		
		加强公众网络/高级基站的适应性（见**A1.3**第2部分）（中华人民共和国）	加强公众网络/高级基站的适应性（见**A1.3**第2部分）（中华人民共和国）	加强公众网络/高级基站的适应性（见**A1.3**第2部分）（中华人民共和国）

类别	灾前	灾后		
		初步响应阶段	努力恢复阶段	重建阶段
网络适应性		增加应急资料储备（见**A1.3**第3部分）（中华人民共和国）		
		使用MDRU进行灾害管理 – 可行性研究（见**A1.8**）（菲律宾）	使用MDRU进行灾害管理 – 可行性研究（见**A1.8**）（菲律宾）	
		本地蜂窝（见**A1.14**）（日本）	本地蜂窝（见**A1.14**）（日本）	
		熊本地震中使用的快速ICT救灾系统（见**A1.17**）（日本）	熊本地震中使用的快速ICT救灾系统（见**A1.17**）（日本）	
早期预警	太平洋海岸海啸预警系统（见**A1.2**第1部分）（太平洋海岸）			
	不丹的冰川湖突发洪水监测及预警系统（见**A1.2**第2部分）（不丹）			
	使用大数据分析改进应急管理能力（见**A1.3**第8部分）（中华人民共和国）			使用大数据分析改进应急管理能力（见**A1.3**第8部分）（中华人民共和国）
	加强各国应急预警能力（见**A1.3**第10部分）（中华人民共和国）			
	印度的台风告警（见**A1.11**第b部分）（印度）			
	基于社区的洪水预警系统（见**A1.11**第c部分）（印度）			
	早期预警系统（见**A1.12**）（乌干达）			
	赞比亚的早期预警系统（见**A1.13**）			

类别	灾前	灾后		
		初步响应阶段	努力恢复阶段	重建阶段
救灾	遏制流行疾病（如埃博拉）（见**A1.6**）（几内亚）	遏制流行疾病（如埃博拉）（见**A1.6**）（几内亚）	遏制流行疾病（如埃博拉）（见**A1.6**）（几内亚）	
		广播应急告警系统的使用案例（见**A1.10**）（哈萨克斯坦）		
	日本熊本市的危害图项目（见**A1.16**）（日本）	日本熊本市的危害图项目（见**A1.16**）（日本）		
风险控制	为预防灾害开发的数据中心相关基础设施（见**A1.15**）（拉丁美洲和加勒比）			
能力建设	加强应急通信团队建设（见**A1.3**第12部分）（中华人民共和国）			
	使用MDRU进行灾害管理 – 可行性研究（见**A1.8**）（菲律宾）			
	日本熊本市的危害图项目（见**A1.16**）（日本）			

4 第4章 – 最佳做法导则和结论

4.1 最佳做法导则的分析和确定以及所汲取的教训

在整个研究期，随着成员交流经验和教训产生了许多共同的主题和最佳做法。

– **常备不懈：**必须坚持进行国家应急通信规划。这些规划必须不断更新并将演习和响应工作中的教训纳入其中，同时解决多方面的潜在危害。

– **练习、练习、再练习！**灾害管理计划需要练习。为测试规划并基于教训不断完善和改进规划需要定期开展练习和演习。演习应涉及多方面人员和广泛的利益攸关方，如政府、业界、人道主义机构、医院和当地社区。他们通过参与响应行动建立相互关系并测试相关程序。为提高人们的灾害预防观念，有必要为公民开展演习，使他们有能力防范损失并支持公民相互帮助。加强公民的防灾意识将减少受害者的数量。

– **防患于未然：**为濒危地区投资，提前购置设备和移动资源单元或临时基站亦有助于提高适应力并降低灾害风险。此外，限制性进出口规则、许可限制和其它问题可拖延灾区设备的筹集，影响非政府救灾机构、政府机构和私营实体的响应行动。然而，防患于未然有助于缓解这些问题并确保尽快筹措设备和其它供应品。

– **有利的环境：**监管和政策框架可减少或成为灾害期间部署ICT的障碍。政府应审查规则，包括许可程序、进出口要求和资格认证，评定是否需要修改或增加临时程序以推进快速的灾害响应。面对瞬息万变的技术和应用，确定障碍的审查尤其重要。举例而言，卫星机器对机器（M2M）服务用于跟踪应急设备或发送应急信息，这些特别受到复杂的许可程序的影响。

– **应急许可程序：**为确保在最需要的时刻提供所需要的ICT设备，简化批准程序和许可机制举足轻重。批准程序在应急响应情形下可免收海关税或签证要求或对外国运营商或服务提供商免于限制。在许可方面，ICT设备和卫星通信服务可能在应急情况下免于许可要求或享受加速的许可程序。换言之，可为临时或应急情况下的使用设定一些临时许可类别。

– **无障碍性：**灾害的发生对于残疾人、儿童和老年人等弱势群体宛如雪上加霜，因此有必要确保灾害管理具有包容性并响应这些群体的需求。

– **了解状况：**在相关利益攸关方之间交流信息有助于情况了解，从而减少重复工作并使响应工作更有针对性。灾害发生时，ICT响应方迫切需要有关ICT网络和为支持不断的通信或帮助恢复通信可能需要的ICT相关信息。报告通信中断的通用方式或术语有助于加速国际响应。

– **建立关系：**与参与响应的内外部利益攸关方建立关系和信任将推进落实工作和灾害发生时的信息交流。

– **提高公民能力：**灾害发生时，ICT对于公民而言不再是奢侈品，而是接收和分享拯救生命信息以及恢复经济活动不可或缺的手段。公众电信网应优先得到恢复，同时考虑实现移动连接的临时方案。充电站亦是一项重要考虑。

– **能力建设：**人员培训是支持落实灾害响应规划的关键并应涵盖包括设备使用在内的所有方面。国际电联提供的包括应急通信规划、预警系统部署和国家/区域研讨会等能力建设帮助有助于成员国运筹帷幄并确定轻重缓急，将通信的准备作为国家应急响应工作的组成部分。培训工作还应包括确保公民做好准备并了解灾害发生时或收到告警或预警后应如何做出响应。

– **新技术和创新：**成员国应继续将新技术和新兴技术与应用纳入应急筹备和响应规划，包括社交媒体、大数据、互联网、GIS绘图、遥感以及配备无线通信解决方案的无人机。

– **伙伴关系和协作：**为支持人道主义响应工作所需要的通信，协调正在大张旗鼓地进行，其中包括GSMA制定的“人道主义连接章程”（移动连接或人道主义响应）、欧洲卫星运营商协会（ESOA）协调的“危机连接章程”以及联合国世界粮食署（WFP）所属应急通信组（ETC）协调的全球VSAT论坛GVF危机连接章程。国际电联应急合作框架（IFCE）是又一范例。推进与技术响应方建立关系并分享信息至关重要。

– **行动后报告：**培育不断学习和改进的文化 – 跟踪并吸取教训。

4.2 用于救灾、响应和恢复的ICT

如**第2章**所述，许多救灾系统依赖于ICT。ICT瞬息万变，救灾系统亦如此，因此有必要定期重新审查系统和各种新兴手段和应用，从而缓解灾害发生时通信中断的风险，应考虑以下解决方案：

网络适应性：为防止或减少灾害发生时电信中断的风险，应通过准备备份的通信路径实现电信设备的适应性和备份。此外，必须了解减轻灾害影响的网络可用性。支持对更具适应性的网络的研究和投资，以助于确保灾害中运行的延续性。在网络受到损害时，采用不同方式的连接十分重要，包括卫星、广播和业余无线电业务。

多种多样的应急通信设备：灾害风险管理包括确保灾害发生时获得适当的设备，部署诸如卫星移动电话、可移动ICT单元、WiFi专用网、时延容忍网络、本地无线网状网和应急光纤有线等应急电信设备，尤其是在医院、地方政府、警察局和军队，以便在固定电信网受到损坏时对应急连接提供支持。此外，确保用来搜救受害者及其家人的官方和通信渠道亦十分重要。由于灾害规模不同，最好准备多种规模或类型的应急通信设备。

1) 预警

由于许多灾害无法提前预测，早期监测和预警有助于减轻破坏程度。对于海啸、洪水、泥石流和地震等自然灾害，建议采用基于ICT的早期预警系统。通过对历史灾害记录进行大数据分析亦可进行粗略预测。

2) 告警通知和撤离指导

一旦发现灾害，建议以移动电话、电视和无线电广播以及数字标牌等多种方式警告公民，使公民尽快撤离。

3)　安全确认和灾害损失的应对措施

严重灾害中会出现电信网流量阻塞情况，使公民无法向亲朋好友报安全。用于报平安的ICT系统可避免电信网流量拥塞，同时为地方官员提供评估公民健康或确定搜救重点的方式。

4)　救援

ICT可为救援提供方便，新系统改善了寻找幸存者的手段。除此之外，在部署搜救系统时，必须考虑到残疾人的无障碍性。

4.3　结论

在整个研究期内，ITU-D第2研究组审议了发达和发展中国家有关应急通信和救灾的大量活动。十年前，仅有少数发展中国家具备应急通信规划或框架，而收到的输入文稿表明，这种规划已司空见惯。此外，更多的国家和组织都在采取措施开发早期预警系统以提高电信/ICT网络抵御灾害风险的能力。正因如此，本研究期内开展的讨论确定了在灾害通信领域为发展中国家加大实施支持的必要性。

鉴于无法在全世界范围内消除灾害，新的和新兴ICT与日俱增，在下一研究期内，该研究课题可继续研究应急通信和备灾、灾害缓解、响应和救灾，从而在灾害中挽救人类生命。考虑到备灾的价值，该课题输出成果可侧重于实施以及探讨如何确保提高发展中国家的能力，使他们得益于现有将ICT用于灾害通信管理的大量信息。发展中国家还可以用更多时间交流经验，确定共同面对的挑战以及成功的做法，为灾害通信框架、技术和规划的制定乃至落实提供支持。

第2部分 – 应急通信核对清单

应急通信核对清单提出可以纳入国家灾时通信规划的活动类型和预期决定点。

I. 做好准备

a) 主管部门和责任确定

明确确定政府和利益攸关方的职责是制定灾害通信管理计划中最基本，但又最关键的部分。各机构和决策当局应确定联系人并明确主要领域职责。当一家或多家机构存在工作或责任重叠时，政府应提前明确权责以便在灾害发生时节省时间并改进整体响应情况。

政府的作用和责任

- ☐ 国家政府机构/部委在灾害管理和总体响应中承担哪些责任？
- ☐ 参与/应参与备灾和响应的有哪些其它部委？他们的作用和职责如何？通信监管部门和通信部的作用如何？通信部或监管机构是否参与国家灾害管理当局的活动？
    - o 哪些当局（立法或权能）可使各部门/机构对灾害做出某些方面的响应，以便指导确定牵头方、作用和责任？
- ☐ 灾害发生时每家机构由谁负责响应的某个方面？ 领导者是否根据灾害类型的不同而不同？在部内和组织内如何协调灾害响应？在灾害影响到领导者时，谁是后备联系人？每个联系人的权限/决策能力如何？涉及哪个领域/事宜？
- ☐ 牵头管理的部委如何与政府内其它相关部委协调？核心联系小组在两次灾害之间多久进行一次协调，召集一次会议或开展一次演习/练习？由谁维护联系人名单，该名单多久更新一次？名单中是否包含所有可用的联系人家庭和公众信息？
- ☐ 在各国灾害管理框架中如何优化电信/ICT或解决该问题？
- ☐ 中央政府和地方或省/州政府之间如何应对灾害响应管理责任或授权？

b) 外部协调

灾害响应涉及多个方面/利益攸关方，如中央政府、地方社区、州/省当局、公共安全负责人、私营部门、救灾和技术组织、医院、公民团体和民间团体组织、联合国以及外国政府。为支持有效和协调的响应行动，灾害通信计划应包含外部各方（利益攸关方），这些方面应积极参与到备灾活动中。

I.	做好准备
☐	确保协调程序到位，定义伙伴关系并与外部机构确定联系人。相关各方或许包含： • 私营电信实体（运营商和设备） • 其它部委 • 当地和州/省政府机构 • 非政府组织（NGO）赈灾组织、医院 • 联合国/国际电联 • 外国政府/军队 • 志愿者技术社团 • 业余无线电 • 公民社区团体、民间团体组织
☐	贵国哪些方面参与了或可帮助改进/实现灾害响应？哪些国外/国际方面可对响应提供支持？公民和本地社区如何参与灾害响应规划？如何向公民通报灾害响应规划？
☐	各组织有哪些联系人，政府如何与这些组织在灾前、灾害期间和灾后进行接触/交流信息？这些利益攸关方可分享哪些类型的信息或情况？可向这些利益攸关方提供哪类信息或情况以方便做出响应？
☐	在制定灾害响应计划时，应如何与这些方面/利益攸关方协调？如何与这些方面协调备灾活动？多久进行一次通信或互动？贵方的利益攸关方接触战略或计划如何？贵国政府有无有关利益攸关方接触，公众宣传或顾问委员会的要求或法律？
☐	外部国际力量是否需要进入受灾地区的资格认证或进入灾害发生国家的签证？是否已为专家和通信设备在灾害期间的进入提前制定了加速程序？
☐	残疾人和有特殊需求的人士如何参与到备灾活动中？规划内是否考虑到这些特殊需求？

c) 培训和联系

在明确了作用和责任后，开展练习是使团队为有效应对紧急情况做好准备的最佳途径。练习的设计应使团队成员协同一致对假设的事件做出响应。练习增强对规划的了解，使成员提高能力并确定改进的机遇，从而以更多的培训和教育应对实际发生的事件。

I. 做好准备

练习是实现以下各方面的良好手段：

- 评估筹备计划；
- 确定计划和程序缺陷；
- 测试或认证最近变更的程序或计划；
- 明确职责和责任；
- 获得参与方有关改进计划的反馈和建议；
- 按照业绩目标衡量改进情况；
- 加强内外部团队、组织和实体之间的协调；
- 加强培训和教育；
- 提高人们对危害可能产生的影响的认识和了解；
- 评定获得现有资源的能力并确定所需要的资源。*

I. 做好准备

需考虑的一些问题如下：

- ☐ 被指定支持响应工作的官员是否必须接受培训或认证？应考虑各类人员所需要的培训或认证类型，应多久进行一次。
- ☐ 这些活动是否包括内部和外部利益攸关方、非政府合作伙伴？应考虑如何对不同利益攸关方定期开展这项工作。开展演习的目的是否为确保公众了解灾害响应计划，使他们能够识别告警并做出反应（如预警启动后如何响应？）
- ☐ 电信/ICT演习是否单独和/或作为国家全面灾害演习的一部分进行？国家灾害演习如何将电信/ICT的作用和重要性纳入其中？
- ☐ 开展哪些通信演习？（如早期预警系统测试或区域/国家中断响应和恢复）。
- ☐ 这些演习是否适合于贵国所了解的灾害类型？（即极端天气、洪水、地震、野火、人道主义响应或网络攻击？）。
- ☐ 哪些机构或部委监督并参与有关通信的演习或练习？他们有哪些职责？地方社区或政府的作用如何？
- ☐ 通信运营商和供应商等利益攸关方以及技术组织/协会如何参与灾害响应或灾害通信练习？他们是否属于练习规划程序的组成部分？
- ☐ 是否进行了运营商中断报告练习？网络运营商是否采用统一的报告程序并了解向哪些联系人报告中断以及如何报告？
- ☐ 练习前是否为利益攸关方提供在线培训？
- ☐ 练习后如何收集反馈意见以助于改进程序或业绩？贵方从哪些利益攸关方获得反馈？是否有“行动后”报告，该报告是否分发给参与方？

d) 基础设施和技术

电信/ICT是促进灾害预警、救灾和响应的关键手段。制定灾害通信计划的一个目的就是帮助确保灾害发生时通信的延续或恢复。下文列出了备灾阶段制定和实施灾害通信管理计划考虑的有关基础设施和技术的一些方面。

I.	做好准备
☐	技术库存和评定。可以并应该使用多种技术和服务支持灾害通信响应。在制定计划时，盘点利益攸关方（政府、响应方、公民）日常通信使用的技术以及通常用于紧急情况的技术十分有益。这些技术可能包括应急调度服务、业余无线电、第一响应人系统（包括无线电和公众安全宽带）、电视和无线电广播、地面移动网络、有线话音网络、宽带网络、卫星网络和社交媒体。
☐	冗余与恢复规划；确保持续操作并为主要通信渠道的中断做好准备。
☐	电源可用和预先准备的电源（用于基础设施和个人）：可提供哪些备用电源（用于运营商？政府？响应方？公民）？恢复时如何确定这些电源的优先缓急？是否具备加速程序或方便为通信网络发电机提供燃料的程序？是否具备为关键设施提供备用电源的导则？
☐	确定并培训主要公共和私营部门人员；应定期为需要使用和维护/测试应急通信设备的人员提供培训。本地社区和当地人员亦应考虑接受有关使用和维护这些设备的培训。
☐	确定主要的恢复站点/优先站点；有哪些确定重要站点优先恢复顺序的机制？如何与这些优先站点通信并与运营商讨论？
☐	建立了解情况和报告机制（公众/私营部门合作），如成立信函通信顾问委员会。如何与政府官员交流有关业务延续性计划的信息？
☐	频谱和频率规划；许可/授权（包括加速频率和类型批准、应急频谱管理和授权、加速许可批准以及可能的临时/应急授权）。是否对救灾或网络恢复所需设备的进入和操作的监管或政策壁垒进行过评定？
☐	批准/授权的来话通信设备的优先和加速海关程序。
☐	审议国家电信发展规划（例如，宽带或基础设施发展规划）中的应急和网络适应性/备份需求/要求。

I. 做好准备

- ☐ 人为因素：备灾计划应考虑到许多人员及其家属可能直接受到灾害影响并在紧张状况下开展工作。

- ☐ "统一的"中断报告：为加深情况了解并快速确定电信/ICT恢复需要的资源或向公众提供适当的信息，主管机构可确定报告中断的术语和通用格式，确保人们对状况和要求得出统一认识。

- ☐ 使用"大数据"分析支持灾害预测或对影响或风险进行预测；支持决策和资源分配；政府或公众可使用哪些数据集帮助做出灾害响应以及灾害降低规划？确保运营商与响应方在保障响应的情况下以保护个人隐私的方式分享数据具备哪些政策？哪些合作和公众私营伙伴关系可支持改进有利于备灾的数据使用？

- ☐ 建立应急告警系统

  1) 机制和技术（广播、移动、M2M/传感网络、遥感技术、大数据、传送机制集成、社交媒体）：哪些技术和应用最适合于灾害环境、地理区域和相关类型，公民需要哪种通信方法？确保信息传递到受灾人员使用哪些平台？现有告警系统如何在确保广泛传递告警的同时适应新的技术？如何将社交媒体平台纳入其中？

  2) 告警内容（语言、CAP、无障碍考虑）：哪些官员有权利授权发送告警？应如何考虑在确保公民在避免"告警疲惫"的情况下得到通报？告警传递哪些信息，为避免混乱使用哪个标准？

  3) 有利的政策（网络运营商和广播机构的希望）：备灾、批准和传播信息所需要的政策和程序。

  4) 各国和各区域定期/正在进行的告警练习和系统测试。谁参与测试？测试多久开展一次？

  5) 公众教育：与地方社区和民间团体合作了解预警并采取行动。

  6) 告警和预警系统如何将灾害最薄弱群体考虑在内，如残疾人（无线电电视通知或通过短信、电子邮件等传送的告警和信息）。

I. 做好准备

☐ 无障碍获取方面的考虑

1) 如何向薄弱群体询问其需求？如何通过提高认识计划或培训加强薄弱群体的能力？信息资料是否包括网站或可访问的应用？

2) ICT无障碍获取和可用性是否考虑在项目中？使用哪些战略和机制促进对ICT的获取，包括法律、政策、规则、许可要求、行为准则和货币或其它激励机制？

3) 面对薄弱群体提供哪些信息资料？是否以多种接入形式采用不同语文开展了公众提高认识宣传以便向残疾人和其它薄弱群体分发信息包？

4) 灾害发生后，是否对灾害响应工作进行过评定，以便了解薄弱群体面对的挑战，讨论所汲取的教训并为解决基于ICT的灾害管理服务中出现的任何问题开展工作？

* 美国国土安全部（https://www.ready.gov/business/testing/exercises）。

II. 响应、救灾和恢复

a) 通信渠道与信息共享

电信/ICT是支持受到灾害影响的各方（包括公民和参与响应、救灾和恢复活动的各方）之间交流关键信息的手段。虽然底层技术的操作延续性和可用性至关重要，在制定响应规划时，了解通信渠道和需分享的信息类别亦十分重要。随着需求在灾害期间的变化，灵活性不可忽视。

II. 响应、救灾和恢复

☐ 传递了哪些信息？需要（可提供）哪类信息？（如网络中断情况、家人或主要人员的安全和位置、气象和地震信息、庇护所位置、损伤和基础设施评定（包括运送供应品或人员的道路或交通系统状况）、与应急设备批准和操作有关的规则和规定、响应条件（包括需要支持救灾和恢复工作的供应品或人员）和恢复工作以及由谁来提供支持？）

☐ 谁在沟通？沟通有哪些沟通渠道？谁有通信优先权？

- 政府内部的通信；
- 政府与联合国和提供赈灾响应的非政府组织（NGO）的通信；
- 政府与联合国/NGO响应方和私营部门（电信/ICT提供商）之间的相互作用；
- 政府与公众，联合国/NGO与公众；
- 公众与政府/联合国/NGO组织；
- 私营部门与公众；
- 私营部门对私营部门；
- 公民对公民。

☐ 在出现中断时是否存在备份或不同/多余的通信方式？是否考虑灾害能否造成规划通信手段不可使用以及可使用哪些备份通信手段？（如计划采用会议呼叫通信，在电话网络出现故障的情况下如何进行呼叫？），这些便携通信单元是否能够建立临时连接？

☐ 确保数据精确/核实信息。应考虑如何确认和报告/分发信息以确保最高效地使用资源并改进协调和决策。

☐ 了解文化规范和行为。不同的文化群体可能采用不同方式沟通或从不同来源获得信息。应考虑到语言和文化行为以及这些对通信的影响。

☐ 社交媒体：如何将社交媒体作为收集数据和分享双向通信信息的手段？救灾和响应机构如何回应通过社交媒体收到的帮助请求？应建立哪些伙伴关系以便最好地使用社交媒体工具？公民如何在为在灾害期间收集和交流信息而使用社交媒体，与其它手段的比较？

☐ 为与不同群体沟通建立机制；分享信息/情况/报告。

b) 基础设施与技术

在评估网络损害和重建需求时，必须在评估损害、确定优先恢复工作和指导帮助一方与提供应急通信服务的另一方之间迅速建立通信。应尽量提前做出有关技术协调和网络中断信息分享职能联系人的决定。此外，应为政府和第一响应人的使用提供备份（多余）的网络，以便为恢复工作提供便利，如专用政府通信网。

II. 响应、救灾和恢复

损坏评估/ICT评估

- ☐ 通信部/监管机构在报告公众或商用电信网损坏或中断以及实现延续性和恢复的作用，如何定义该作用（通过许可证等）？
- ☐ 谁来确定收集、分析和响应/报告/分发有关网络损坏信息的指定部委/监管机构或联系人？应从运营商获得哪些信息和分析并予以使用？这些信息需求如何事先传递给运营商？
- ☐ 对于商用或公众网络，是否存在用于提交评估的程序、格式和时间安排的报告要求？如不存在，政府能否建立协调机制并通过协调机制确定预期和接收信息？
- ☐ 通过初步损害评定能否获得灾害恢复资金？
- ☐ 对于政府网络，需要建立哪些机构间协调和信息分享程序？公众和私营网络是否更适合/可靠用于这些目标？
- ☐ 考虑通信网络状况、需求、条件和要求的政策是否存在，这些政策能否确保对以下通信能力的维护和恢复？确定各项恢复工作的优先缓急采用哪些程序？
  - 当地机构的陆地移动无线电系统
  - 应急调度服务
  - 地面系统/公众移动系统的状况
  - 无线电广播/电视台
  - 国内VSAT提供商的可用性
  - 预先布置的应急MSS设备
  - 互联网服务

II. 响应、救灾和恢复

确立应急连通性

- ☐ 灾害出现时应联系哪些应急电信伙伴？向他们提供哪些信息，如何与他们联系？
- ☐ 如何接收并处理外国政府，人道主义组织或私营部门提供的援助？
- ☐ 由谁授权进入设备或分配所需要的频率？有无确保地方运营商及时协调避免干扰的机制？
- ☐ 应事先准备哪些应急ICT资源，安置在哪些优先位置，由谁进行？谁能授权启动或分配？这些预先到位的资源如何维护和测试？对电信网的功率发电燃料供应和恢复有哪些考虑？
- ☐ 确保电信团队和中央灾害管理机构之间的协调以满足需求。考虑第一响应人最多使用的网络和通信技术（如陆地移动无线电还是移动数据业务）或公众获取应急服务的方式，以优化立即采取的恢复行动或附加维护支持。政府机构如何推进私营部门的网络恢复？
- ☐ 应首先建立哪些应急连接？考虑是否有预先确定的灾害恢复站址需要即刻得到连接或移动灾害恢复中心是否需要连接。

网络的维护和重建

- ☐ 政府机构有无在恢复政府网络和电信基础设施方面的专家建议和帮助？当政府使用专用网时，由政府还是私营部门技师恢复？考虑是否存在作为中断情况下封闭政府网络备份的商用网。政府是否具备恢复关键网络所需要的进口设备的报关或推进恢复和重建网络所需要的外部专业人才的进入的机制或应急程序？
- ☐ 是否有定期测试用于应急通信的网络的程序？
- ☐ 是否鼓励商业或公众网运营商制定业务延续计划？恢复计划多久演练和更新一次？
- ☐ 有无报告网络恢复进展规划：这些规划多久执行一次？
- ☐ 有关网络中断和恢复活动的信息是否得到适当保障和分类以缓解安全隐患？
- ☐ 与其他利益攸关方分享通信中断和恢复信息有哪个单一政府联系人？设立单一联系人可防止运营商重复工作。
- ☐ 是否已建立了用来分享信息和协调帮助的论坛？审议该组的职责范围、运行程序或导则以及使用该论坛的方式。
- ☐ 考虑是否可制定程序，允许政府与网络运营商分享敏感的威胁信息。
- ☐ 有无帮助运营商处理诸如物理接入和加速燃料提供等重要内容的程序？

Abbreviations and acronyms

Various abbreviations and acronyms are used through the document, they are provided here.

Abbreviation/acronym	Description
AC	Alternating current
AFTIC	Autoridad Federal de Tecnologías de la Información y la Comunicación (Argentine Republic)
AP	Access Point
APCO	Association of Public-Safety Communications Officials
APT	Asia-Pacific Telecommunity
AWS	Automatic Weather Stations
BDT	Telecommunication Development Bureau
BNGRC	National Bureau for Risk and Disaster Management (Bureau National de Gestion des Risques et Catastrophes) (Madagascar)
BTS	Base Transceiver Station
BYOD	Bring Your Own Device
CAR	Central African Republic
CCSA	China Communications Standards
CDMA	Code Division Multiple Access
CIP	Critical Infrastructure Protection
CITEL	Inter-American Telecommunication Commission
CO2	Carbon Dioxide
DAMA	Demand-Assigned Multiple Access
DART	Deep-Ocean Assessment and Reporting of Tsunami
DCDI	Data Center Development Index
DCnum	Number of Data Centers
DECT	Digital Enhanced Cordless Telecommunication
DHS	Department of Homeland Security (United States of America)
DIRS	Disaster Information Reporting System
DMR	Delay Measurement Reply
DOST	Department of Science and Technology (Philippines)
DS	Digital Signage
DTN	Delay Tolerant Networking
DTV	Digital Television
EDFA	Erbium-Doped Fibre Amplifier

Abbreviation/acronym	Description
EMN	Emergency Mobile Networks
ESOA	European Satellite Operators Association
ETC	Emergency Telecommunications Cluster
EWS	Emergency Warning Systems
FCC	Federal Communications Commission (United States of America)
FDI	Foreign Direct Investment
FEMA	Federal Emergency Management Agency
FM	Frequency Modulation
FWA	Fixed Wireless Access
GDP	Gross Domestic Product
GIS	Geographic Information System
GLOF	Glacial Lake Outburst Flood
GPS	Global Positioning System
GRI	Geographic Redundancy Index
GSM	Global System for Mobile Communications
GVF	Global VSAT Forum
HAZMAT	Hazardous materials
HF	High Frequency
HF/SSB	High-Frequency Single Sideband
HQ	Headquarters
IARU	International Amateur Radio Union
ICIMOD	International Centre for Integrated Mountain Development
ICT4D	ICTs for Development
ICT4DM	ICTs for Disaster Management
ICTs	Information and Communication Technologies
IDB	Inter-American Development Bank
IECRS	Integrated Emergency Communication & Response System
IFCE	ITU Framework for Cooperation in Emergencies
IMD	India Meteorological Department
IMS	IP Multimedia Subsystem
IMSI	International Mobile Subscriber Identities
IP	Internet Protocol
IPTV	Internet Protocol Television

Abbreviation/acronym	Description
IT	Information Technology
ITS	Intelligent Transport Systems
ITU	International Telecommunication Union
ITU-D	ITU Telecommunication Development Sector
IXP	Internet eXchange Point
IXPnum	Number of Internet eXchange Points
kHz	Kilohertz
LAC	Latin America and Caribbean
LAN	Local-Area Network
LEO	Low-Earth Orbit
LMR	Land Mobile Radio
LTE	Long-Term Evolution
M2M	Machine to Machine
MANET	Mobile Ad-hoc Networks
MDRU	Movable and Deployable Resource Unit
MF	Medium Frequency
MHz	Megahertz
MIC	Ministry of Internal Affairs and Communications (Japan)
MIIT	Ministry of Industry and Information Technology (People's Republic of China)
MMS	Multimedia Messaging Service
MNO	Mobile Network Operator
MWE	Ministry of Water and Environment (Uganda)
NDR	Network Disaster Recovery
NDRI	Natural Disaster Risk Index
NGO	Non-Governmental Organisation
NOAA	National Oceanic and Atmospheric Administration MetSat operator for the United States
NPSBN	National Public Safety Broadband Network
NTT	Nippon Telegraph and Telephone Corporation (Japan)
NVIS	Near-Vertical-Incidence Sky-wave
NWP	Numerical Weather Prediction
ODU	Out-Door Unit
OPM	Office of the Prime Minister

Abbreviation/acronym	Description
PABX	Private Automatic Branch Exchange
PC	Personal Computer
PECS	Portable Emergency Communication Systems
PSAP	Public Safety Answering Point
PTT	Push-To-Talk
R&D	Research and Development
ROI	Return On Investment
SATCOM	Satellite Communication
SDGs	Sustainable Development Goals
SMS	Short Message Service
SSDM	Smart Sustainable Development Model
ST3	Special Task Group
STA	Special Temporary Authority
SVG	Scale Vector Graphics
SWR	Standing Wave Ratio
TC	Tropical Cyclone
TETRA	Terrestrial Trunked Radio System
TRAI	Telecom Regulatory Authority of India
UAS	Unmamed Aircraft System
UAV	Unmanned Aircraft Vehicle
UCC	Uganda Communications Commission
UHF	Ultra-High Frequency
UN ISDR	United Nations International Strategy for Disaster Reduction
UNCTAD	United Nations Conference on Trade and Development
UPS	Uninterruptible Power Supply
VHF	Very High Frequency
VSAT	Very Small Aperture Terminals
W-CDMA	Wideband Code Division Multiple Access
WAN	Wide Area Network
WCAG	Web Content Accessibility Guidelines
WFP	World Food Program
WINDS	Wideband Internetworking engineering test and Demonstration Satellite
ZICTA	Zambia’s Telecommunication Regulatory Authority

Annexes

Annex 1: Case study summaries

A1.1 Network disaster recovery plans (GSM Association)

To remain competitive and ensure sustainability, firms are focusing more heavily on disaster risk management. Additionally, as company disaster recovery plans become more detailed, they force similar effects through their suppliers via audits and management practices. While at a high level this appears to be a business continuity and revenue protection issue, it also has much broader implications for sustainable development globally. Countries that are attempting to climb out of poverty are often held back by frequent natural disasters. This case study from the GSMA Disaster Response program details AT&T's Network Disaster Recovery Plan, focusing on its extensive reach and rigorous procedures.[6]

The AT&T Network Disaster Recovery (NDR) team has 29 full-time staff members but a total of 100 people in the expanded emergency management team dealing with business continuity and emergency management. As with any disaster response or business continuity team, the team is made up of people with different skills, drawn from different business units across the company. The part-time team is deliberately populated by staff from a wide variety of disciplines to ensure that the NDR team is expert on everything from core network to radio frequencies to location and geography of each central office and network location.

Regular disaster exercises gives NDR staff experience of reacting to disasters, working in often harrowing conditions and training in what the requirements are. Furthermore, the exercises strengthen partnerships across the departments within the mobile operator and those partnerships with external agencies such as the fire department and police service. These exercises also give the NDR team management observations and data which they can feed back into their existing plans to fine tune them for efficiency.

The extensive investment poured into the hardware, equipment and assets used by the NDR team is unparalleled. AT&T have preparations made for the recovery of large switching centres and IP hubs through the development of other extensive recovery equipment. Given the requests from emergency responders, the humanitarian community and the clients of telecommunications firms to play an increasing role in disaster response, it has never been more pressing for the mobile operators to help change the face of disaster response.

A1.2 Satellite based machine-to-machine technologies in early warning systems

1) Case study: Pacific coast tsunami warning system

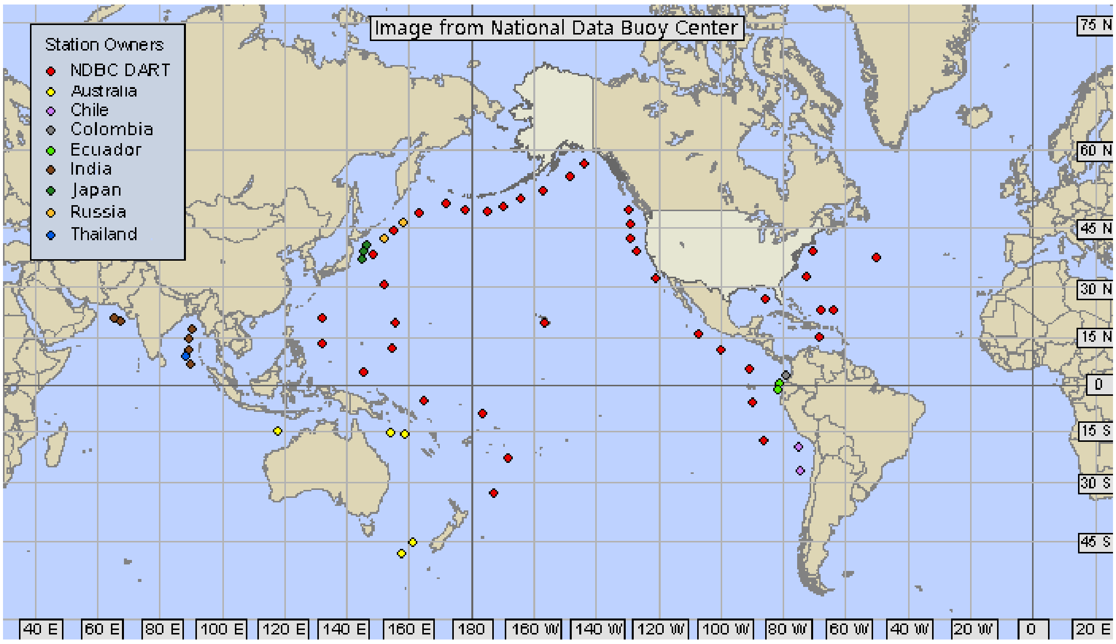
For the last decade, buoys known as Deep-Ocean Assessment and Reporting of Tsunami (DART) have measured tsunami waves. Following tsunamis in 2004 and 2011, scientists have increased global cooperation by refining ways to measure waves and to convert these measurements into meaningful forecasts for shore. This model is used in the Atlantic Ocean, Pacific Ocean, and Indian Ocean, but is also being considered for use in the Mediterranean Sea.[7]The DART system consists of pressure-sensitive tsunameters on the ocean floor and buoys on the surface. The buoys are equipped with

[6] Document 2/239, "GSMA Case Study of AT&T's Network Disaster Recovery Plan", GSMA, AT&T (United States of America).

[7] Document 2/243, "Applications of satellite based machine-to-machine technologies in early warning systems", Iridium Communications Inc. (United States of America).

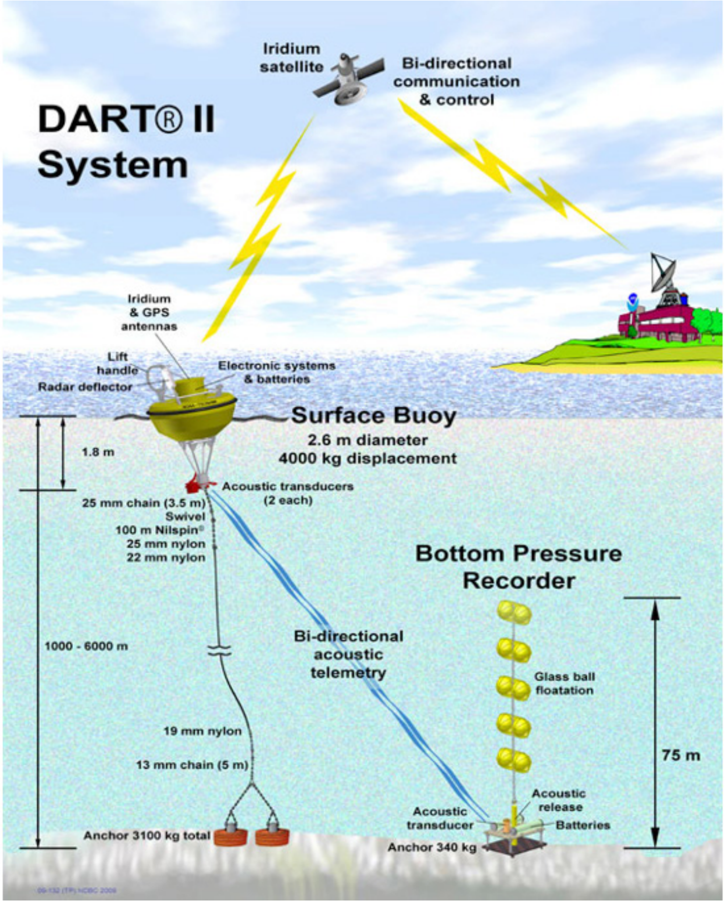
an acoustic modem that receives data from the tsunameter sensors and a small data modem that transmits pressure measurements.

Figure 1A: Locations of DART®II Tsunami Warning Buoys



Using this data, scientists issue appropriate warnings to areas that may be affected. Since DART leverages global mobile satellite coverage, the warning system itself is global. Since the system offers two-way communication, NOAA officials can upgrade buoy software, perform tests, or reboot stations when equipment is not working properly. The data transmitted to the tsunami warning centers can be used to issue warning guidance, provide hazard assessment, and coordinate emergency response.

Figure 2A: Diagram of tsunameter mechanism



System Components

- Anchored seafloor BPR – Bottom Pressure Recorder
- Acoustic link transmits data from BPR to buoy
- Moored surface buoy
- Real time communications
- 2-way data transmission
- Data directly routed to NOAA
- Dedicated path mitigates latency
- Global coverage (pole-to-pole

This technology has produced meaning results for Pacific communities. Following the magnitude-9 earthquake off Japan in 2011, the NOAA issued a tsunami alert to Japan minutes after the earthquake struck, which gave residents an early warning to evacuate to safer ground. The NOAA was also able to accurately model the wave coming from Japan and provide targeted warning to certain areas of the US West Coast before it made landfall.

2) Case study: Glacial lake outburst flood monitoring and warning system in Bhutan

When lake water dammed by a glacier or glacial debris suddenly breaks through, glacial lake outburst flood (GLOF) occurs.[8] GLOFs in Bhutan cause massive loss to property, livestock, and life. After the 1994 GLOF claimed 22 lives, the government of Bhutan sought to establish an early warning system to give downstream inhabitants time to evacuate.

In 2004, the government implemented a basic warning system but it relied on manual readings of gauges installed at remote glacial lakes and was susceptible to radio communication failure. The majority of the sensors were only accessible via a nine-day trip on a pack animal.

[8] Document 2/243, "Applications of satellite based machine-to-machine technologies in early warning systems", Iridium Communications Inc. (United States of America).

Figure 3A: GLOF Early Warning Station

In light of these challenges, in 2010 the government sought to establish a system with two-way communications, remote diagnostics, back-up sensors, and dataloggers into the system, allowing for remote updates to software. Likewise, two-way communication with the control center enabled remote diagnostic and battery monitoring for the sirens. The use of a LEO global mobile satellite system further meant that data delays between the remote hydro-met station and the control station in Wangdu are virtually unnoticeable. The GLOF early warning system consists of 6 sensors and 17 siren stations connected to one central control station. The sensors collect and transmit water level and outflow data to the control center through Iridium telemetry. The siren stations, positioned near the population centers, are powered by 80W solar panels with 75Ah 12V batteries to ensure continuous operation. With the GLOF fully operational in 2011, this is the first system of many for Bhutan.

A1.3 Case studies from the People's Republic of China (People's Republic of China)

China promotes the development of emergency telecoms industry actively

1) Government support and guidance

The State Council issued a policy to accelerate the development of emergency industry, focusing on: "develop the products of rapid acquisition of emergency information, emergency telecoms, emergency command" and so on, the scale of the emergency telecoms industry will significantly expand by 2020, the basic emergency telecoms industry system will be formed.[9] Government departments are focusing on the following areas to increase support and promote:

a) Increase the support and investment guidance in the construction of public emergency telecoms, and support the construction of satellite mobile communications systems, broadband satellite communications systems, broadband trunked communications network, emergency telecoms vehicles, emergency telecoms equipment, to promote industrial development vitality.

b) Increase support for emergency telecom research through the national science and technology projects. Guide the advanced units including production enterprises, universities, R&D units, to actively participate in emergency telecoms technology research and development, to promote related key technology research and innovation for the development of the industry.

[9] Document 2/456, "China actively promotes the development of emergency telecommunications industry", People's Republic of China.

c) Develop emergency telecoms product guide catalogue, and attract social resources to invest in emergency telecoms industry. Try to set up emergency industry demonstration base, to enlarge the scale of emergency telecoms and other related industries.

2) Industry organizations play a key role

- In 2015 under the guidance of the Ministry of Industry and Information Technology, the emergency telecoms industry alliance was established, which is a non-profit organization with hundreds of enterprises and institutions as members, to promote the development of emergency telecoms industry. The alliance builds a communication platform between government, business and users, to strengthen the guidance of industry chain.
- The alliance is currently carrying out related research and activities in some important fields, such as standardization, high altitude platform communications system, equipment miniaturization, broadband trunked communications and so on.
- Once a year the alliance carries out emergency telecoms industry development summit forum with significant influence, around the industrial policy, information technology, cross technology integration and other aspects.
- In order to strengthen the standardization work in the field of emergency telecoms, China Communications Standards Association (CCSA) set up a Special Task Group (ST3) to strengthen the work of emergency telecoms standards. The ST3 focus on comprehensive, managerial, and framework study of standards about emergency telecoms, including policy support standards, network support standards and technology support standards.
- At present, the ST3 has finished several standards, such as Technical requirements of short message service for public early warning, Basic service requirements of public emergency telecoms in different emergency circumstances, Technical Requirements of Emergency Sessions Services based on the Unified IMS, Technical Requirements of Common Alerting Protocol, Ad hoc networks for Emergency telecoms, Technical requirements for priority calls in public telecommunication network, etc.

3) Related enterprises actively participate

Under the joint efforts of the government and industry organizations, related enterprises show high enthusiasm, and actively participate in development process of emergency telecoms industry.

a) Telecom operators actively deploy the applications of new emergency telecoms technology, such as satellite mobile communication network, Ka broadband satellite communication network, super base stations, and emergency telecom vehicles.

b) Manufacturing enterprises accelerate to carry out transformation researches about equipment's miniaturization, centralization and integration, in order to adapt to the needs of special emergency environments. There have been some achievements in the small base station, portable satellite antenna, self-organizing network equipment, satellite handheld terminal, and air base station currently.

c) Social capital continues to focus on the field of public emergency telecoms, actively invest in public broadband network and other aspects construction. Through Public-Private Partnership mode, the emergency telecoms industry gain more capital support.

In summary, under the initiative of the government, the related industry organizations, operating enterprises, manufacturing enterprises, social capital enterprises play their own advantages, to form a better emergency telecoms industrial ecosystem, and to steadily promote China's emergency telecoms industry more and much stronger, so as to provide better support for emergency telecoms guarantee work.

Enhancing command and dispatch in emergency telecommunications

In China, when a disaster strikes, relevant departments will immediately start to implement predefined plans, create steering groups, initiate consultations and allocate tasks. The Ministry of Industry and Information Technology (MIIT) uses video conference lines set up for continuous communications to command vehicles set up at the disaster site by the local telecommunication administrations and operators through the "National command and dispatch system for emergency telecommunications"[10]. These video conference lines facilitate all disaster reaction planning after they are setup.

1) Strengthening resilience of public networks

One approach to resiliency is increasing the capacity of key base-stations. These "super base-stations" are designed with higher construction standards, stronger power supply, and increased configuration capacity. When coupled with satellites, super base-stations are resistant against many disasters. Another approach is to ensure that wired connections are properly mixed with wireless connections to ensure constant connection through a variety of disruptions.

China has deployed more than 1500 super base-stations with various resiliencies ranging from anti-seismic, anti-flood, anti-typhoon, anti-ice and snow, and comprehensive super base-stations in disaster prone areas. All types of super-base stations are enhanced by: strengthening the anti-disaster ability of optical transmission system and through empowering and protecting the emergency power supply. Specific improvements for different disasters are below.

- Anti-seismic super base-station: improving the satellite transmission and backup system, better site selection strengthening materials, and improving seismic capacity.
- Anti-flood super base-station: improving the satellite transmission and backup system and better site selection.
- Anti- typhoon super base station: strengthen the feeder and enhance wind resistance.
- Anti-ice and snow base station: strengthen the feeder.
- Comprehensive disaster super base station: built to be resilient to combined disasters.

2) Increasing emergency material reserves

Additionally, having satellite phones in disaster prone locations is helpful for reporting first-hand information to the steering center and increases survival chances.

3) Multiplying technical means for emergency telecommunications

Different stages and types of emergency require different enhancements to telecommunications. At the reporting stage, easy-to-use and satellite telephones using the Beidou Satellite will work. However, at the relief stage, vehicle-mounted and portable devices will be required to ensure voice, data, and video communications for the steering centres of different levels. This supports the larger amount of coordination efforts in the area at the time. At the final support stage, devices on vehicles play a role to connect affected areas. If terrestrial communications are severely damaged, a mobile communication platform should be provided for temporary use.

The Internet and mobile communications play an ever-increasing role in disaster response. After an earthquake, information regarding the disaster situation, relief situation, and lifesaving actions are sent quickly through the instant message service WeChat. Mass media will use Weibo, the Twitter-like mini blog service, to publish authenticated information.

4) Upgrading technology support and R&D capability

People's Republic of China's emergency telecommunications plan, standards, and R&D system have taken shape over many years. The Telecommunication Standardization Association of China

[10] Document 2/181, "Summary of experience of emergency telecommunications in China", People's Republic of China.

has implemented standards that take into account how public telecommunications networks support emergency communications. Additionally, the Association set up an Ad Hoc Emergency Telecommunications Group that focuses on the further study and development of relevant standards of emergency telecommunications.

5) Allocating 1.4GHz frequency band

In traditional narrowband communications systems in China, wireless private network communications spectrum is allocated separately by industry. For example, government, public safety, power, and other key industries have their own wireless private networks, spectrum resources, and independent industry professional networks. The 4G mobile broadband trunked communications system provides a basis for mobile communications, through the 1.4GHz band[11]. Since 2012, there have been 1.4GHz TD-LTE private network tests in Beijing, Tianjin, Nanjing, Shanghai and Guangdong in succession. Additionally, TD-LTE broadband trunked communications played a major role in the 2014 Nanjing Youth Olympics and in the Yunnan Ludian earthquake.

According to "People's Republic of China Radio Frequency Allocation Provisions" and the actual spectrum usage in China plans to allocate the 1447-1467 MHz band to digital broadband private trunked communications systems. Considering the nature of these systems and the requirements for coexistence and compatibility with other radio uses, they are recommended for shared networks in big-medium cities. The provincial radio regulatory agency should make suggestions for spectrum based on the actual needs and the application characteristics of their local areas.

6) Developing emergency communications standards system

Emergency communications technology research, development, and support integration capabilities have been improved through work by research institutes, universities, and enterprises[12]. Ad hoc networks, the regional space communications systems, digital broadband trunked systems and other 20 industry standard systems have been developed in recent years.

7) Using big data analysis to improve emergency management capabilities

Big data has brought new opportunities to emergency management innovation and enhancement. Big data assists prediction in the early stages of a disaster to improve emergency response capabilities and can sift through risk points. Statistical and correlational analysis on data identified key crisis elements which allow response teams to control them. It also accelerates emergency decision procedures.

Big data analysis aids the allocating of funds in the post-event stage for rescue and rebuilding operations. In city traffic accidents, outbreaks of mass epidemics, city floods caused by snow, and rain and other natural conditions, big data analysis helps rescue route design, staff arrangement, and material disposition through an emergency management platform. It also provides personalized data, tracks personalized needs for stakeholders, and targets assistance and services.

8) Emergency communication management system

People's Republic of China has established an emergency management system with unified leadership, comprehensive coordination, and classification management[13]. People's Republic of China also established a set of emergency communications working systems suitable for People's Republic of China's national conditions, in order to effectively prevent and properly handle all kinds of public emergencies. Depending on the situation, MIIT introduces emergency communications management, emergency supplies reserves, emergency communications professional team management, and other departmental rules and regulations.

11 Document SG2RGQ/136, "Initiative technologies and application in emergency communications", People's Republic of China.
12 Document SG2RGQ/136, "Initiative technologies and application in emergency communications", People's Republic of China.
13 Document 2/347, "Experience of emergency telecommunications in China", People's Republic of China.

The National Communications Security Emergency Plan System is based on the National communication emergency plan and includes the national plan, department plans, local plans and, business plans.

9) Enhancing national emergency early warning ability

The National emergency warning information release system has four levels: the national, provincial, municipal, and county level. The system releases unified meteorological, marine, geological disasters, forest and grassland fire, heavy pollution weather warning information, etc. The information can be transmitted by TV, radio, mobile, internet network, etc.

Figure 4A: National emergency warning information release system

10) Emergency communication equipment

The emergency communications equipment series covers vehicle, portable, handheld, and other devices. It includes optical transmission, microwave, satellite, mobile, data, and other technologies-mixing fixed and mobile communications. It can transmit voice, data, video, and other services with different capacity/capability levels.

Figure 5A: Emergency communication equipment

11) Strengthening the construction of emergency communication team

There are 29 professional emergency communications teams in China operated by China Telecom, China Unicom, China Mobile and China SATCOM.[14] The telecom operators also have business needs-based emergency teams setup around the country. China's emergency communications security teams contain full-time and part-time staff. Training ensures the staff are familiar with the theory and operation of emergency communications. Multiple cross regional large-scale emergency communication exercises are used to improve the team's emergency response capacity.

A1.4 Hurricane Sandy and the Federal Communications Commission (United States)

Hurricane Sandy was a Category 3 Atlantic hurricane that caused billions of dollars of damage in the US and Canada in October 2012.[15] It was the second-costliest hurricane in US history. The storm created major communications system outages in the United States.

Around the time that Sandy was named a Tropical Storm, the FCC began mapping critical US communications assets along the East Coast from Florida to Massachusetts. The FCC Operations Center also reached out to 911 coordinators and state Emergency Operations Centers to advise them directly of how to contact the FCC in case there were any issues with communications after landfall. FCC also issued a public notice informing licensees and the public safety community how to contact the FCC Operations Center 24x7 for any assistance.

The morning of expected landfall, the Disaster Information Reporting System (DIRS) was activated and outage reporting was requested from industry so that an outage snapshot could be provided hours after landfall. Once the storm hit, the FCC began assessing the status of commercial communications infrastructure to identify needs. Reports came in through DIRS, and the Commission reached out directly to dozens of entities, including 911 call centers, satellite providers, broadcast associations, carriers, telecommunications relay service administrators (services for deaf/hard of hearing) and undersea cable landing operators.

Over the next several days, the FCC worked a large number of issues, in coordination with FEMA, DHS and the affected states. Issues included contacting state/local officials about debris removal to support communications restoration, working fuel issues for generators, making referrals to incident response leadership on the ground, and issuing Special Temporary Authority (STA) to licensees to support disaster recovery. For example, during Sandy, STA was issued to energy companies that have repair crews coming from out of state and for broadcasters to exceed normal power limits to extend their broadcasts at nighttime to relay emergency information. Early outages were mostly due to lost transport, but as time went on, power outages became the primary cause of communications degradation (with prolonged electric grid outage and limited liquid fuel supply, generators at telecommunication sites began to run out of fuel or in some cases break).

A1.5 First Responder Network Authority (FirstNet) and stakeholder consultation (United States)

In 2004, the "9/11 Commission Report" found that first responder coordination during and after the terrorist attacks against the United States on September 11, 2001 was hindered due to communications system failures.[16] The Report recommended that Congress enact legislation to assign spectrum specifically for public safety purposes and develop a single interoperable broadband network for first responders. The Middle Class Tax Relief and Job Creation Act of 2012 (the "Act") created FirstNet with the mission to ensure the building, deployment, and operation of a nationwide, interoperable wireless broadband network dedicated to public safety.

[14] Document 2/347, "Experience of emergency telecommunications in China", People's Republic of China.
[15] Document 2/42, "The Federal Communications Commission's role in incident response", United States of America.
[16] Document 2/197, "First Responder Network Authority (FirstNet)- Considerations for building a nationwide public safety broadband network", United States of America.

The Act provides the framework for the organization and structure of FirstNet and made FirstNet the exclusive license holder of the 700 MHz D Block (20 MHz) spectrum. The National Public Safety Broadband Network (NPSBN) is a network that public safety can switch to with urban and rural coverage in all states and territories; priority and pre-emption services to public safety users; hardened, secure, resilient, and reliable network infrastructure; and commercial standards-based technologies to drive innovation throughout the network and related equipment, devices, applications and other services. The NPSBN will start as a mission-critical data network with non-mission critical voice capabilities, complimentary to current Land Mobile Radio (LMR) systems.

To determine potential user needs and system requirements and specifications for the NPSBN, the United States has been engaging in extensive open and transparent consultative processes with a variety of stakeholders, including federal, state, local, and tribal public safety entities; local, state, territory, and federal government agencies; federally recognized tribes, and commercial technology providers. As part of FirstNet's "State Consultation" process, each state and territory received a package of materials, including a questionnaire to gauge the state or territory's current capabilities and readiness for FirstNet. This process involved in-person meetings, webinars, conference calls, and other direct communications to address the design of the NPSBN.

A1.6 Combating epidemic diseases with ICTs (such as Ebola) (Guinea)

Throughout the Ebola epidemic in Guinea, information and communication technologies (ICTs) circulated real-time information for patient care and treatment decision-making. ITU provided support in setting up an IT application (Ebola-Info-Sharing), a contribution reinforced by applications already used by the ICT ministry.[17]

1) Health information system

Most of the country's hospitals operate on the basis of non-automated processes which are hard to access. Automation is necessary for the operation and expansion of cyber health and e-health initiatives, with pilots underway at the University of Dhonka. In order to improve the health systems and overcome the deficiencies in the sector, ICT can be used at different stages, including:

- Decision-making at all levels of public health to improve management of health system programs and projects among institutions;
- Raising awareness in the private sector in order to promote improvements in quality of care and follow-up;
- Encouraging widespread use of cyber health and ICTs, while ensuring access to health care and capacity building in health care and academic institutions.

2) General information on the existing system in Guinea

Most of Guinea's hospital infrastructure does not met international standards, due to shortages of equipment and the geographical distribution of staff. There is currently no connectivity and very little information sharing between the various health sector structures, resulting in deficiencies in health services in remote or isolated areas.

How can outbreaks of disease be prevented?

Timely health information helps anticipate and prevent potential epidemics. Systems that operate on data indicators of pathologies and syndromes likely to lead to epidemics are necessary.

Available systems include the following IT applications:

- The health surveillance system;

[17] Document 2/170, "ICTs, e-health and cyber health to combat epidemic diseases (such as Ebola)", Republic of Guinea.

- Sharing and dissemination of health information by SMS, audio or audio/visual means;
- The mobile application "Ebola-Info-Sharing''.

3) ITU and big data use for mitigating Epidemics

In implementing the ITU Plenipotentiary Conference Resolution 202, (Busan, 2014) a successful Ministerial meeting was held in Sierra Leone resulting in a declaration calling for continued efforts to use big data for combating the scourge of Ebola and other epidemics. Fifteen Ministers from both the ICT and Health sectors and more than 430 delegates participated. The ITU launched a big data project based on the analysis of Sierra-Leone's Call Data Records. The project evolved to include two other countries; Sierra Leone, Guinea, and Liberia. Two missions to these countries to train staff from both regulatory authorities and mobile network operators to anonymize, analyse, visualize data, and interpret the results were carried out. The project involves all mobile network operators and helps track the movement of subscribers in order to contain infectious diseases spread by humans. An added feature is that of tracking cross-border movement of persons. The success of this project could be replicated in other countries for other use such as road planning, public transportation investment, hospital establishment, etc.

Data anonymization at the source ensures a balance between public benefit and safety/privacy.

A1.7 Disaster communications management in Madagascar (Madagascar)

Madagascar falls victim to natural disasters including floods and cyclones every year, making it necessary for the country's authorities to introduce a rational system for natural disaster prevention, management and response.[18]

A National Bureau for Risk and Disaster Management (BNGRC) has been set up as part of the Ministry of the Interior and Decentralisation. It is responsible for:

– Coordinating programmes and activities relating to emergency response and relief;
– Preparation and prevention for disaster mitigation;
– Gathering post-hazard data, by telephone, SSB radio and written reports;
– Evaluating different aspects relating to food, sanitation, equipment available in places of shelter, and medical assistance.

Nevertheless, the means available to the Bureau for dispatching emergency communications are restricted, as it uses only simple technologies such as telephony offering a single function and low efficiency. It therefore seeks strong collaboration with the country's telecommunication operators in order to obtain the necessary communication facilities. In addition, in order to educate the public on the origins and key aspects of disasters, the Bureau is launching a campaign through the country's TV and radio stations.

The country's Sectoral Group on emergency telecommunications and new technology has a vital role as the body responsible for ensuring continuity of telecommunications by facilitating efforts to provide mobile communications capacity that can temporarily take over from any network (mobile, Internet, etc.) as a result of disaster damage or because a region has been cut off.

The group sees its role in terms of contributing at a number of stages in disaster response:

– Understanding risks;
– Improving resilience;
– Early warning systems;

[18] Document 2/406, "Organizing the use of ICTs to save lives", Republic of Madagascar.

– Mechanisms for repair and recovery.

Using the databases available to it and meteorological data, the Sectoral Group ensures that any given telecommunication/ICT system is operating and that the aforementioned four phases are better organized.

The sectoral group uses all the available services of the four telephone operators and two data operators to relay information to all sectors of the disaster risk management system:

– Telephony (with a free emergency number available to all operators);
– SMS (periodic messages regarding the current situation, and so on;
– Data transmission (images from satellites or agents on the ground, specific difficulties likely to affect rescue measures, and so on).

Local FM broadcasts are used to relay information directly to homes.

A1.8 Disaster management with MDRU – Feasibility study (Philippines)

Because of its location, typhoon-fed storms and high water are the biggest problems for the Philippines' government and residents. In November 2013, the Visayas region of the Philippines felt the full force of Super Typhoon Haiyan. Typhoon-fed storm surges grew to several meters high along the coast and caused widespread devastation that resembled tsunami damage. Additionally, the subsequent communication blackout impeded evacuation efforts resulting in 6,300 deaths, 28,689 injuries, and 1,061 missing persons.

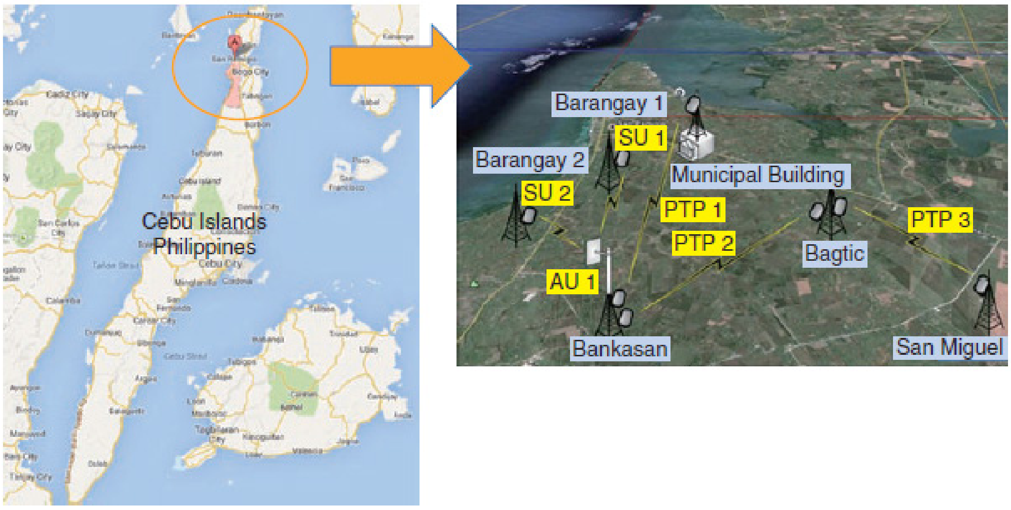
Japan and the ITU are collaborating to assist in telecommunication restoration on one of the islands that Haiyan hit hardest. On May 13, 2014, Japan's Ministry of Internal Affairs and Communications (MIC), the Philippines' Department of Science and Technology (DOST), and the ITU launched this project after finalizing a cooperation agreement for a feasibility study on MDRU use to restore connectivity.[19]

1) Summary of the project

In May 2014, the ITU began the ***Feasibility Study of Restoring Connectivity through the Use of the Movable and Deployable ICT Resource Unit*** in order to study the effectiveness and viability of the MDRU as a communication solution for damaged communications infrastructure and IT (Information Technology) facilities in areas like Cebu, Philippines where Haiyan had caused the most damage. The MDRU feasibility study took place in Cebu Island's San Remigio municipality which has about 64,000 residents and 27 barangays (i.e. districts). Because Haiyan had destroyed all of Cebu's communication networks (see **Figure 6A**), onsite disaster reports were compiled manually. Post-typhoon, the Mayor's satellite phone was the only means of communications with the government.

19 Document SG2RGQ/138 (Rev.1), "Proposal for adding the results of MDRU experiences into document for ICT experiences in disaster relief", Japan.

Figure 6A: Location of San Remigio municipality in the Philippines and depiction of wireless network in San Remigio before the typhoon. (The network was destroyed by the typhoon.)



The scope of the feasibility study includes technical testing, sustainable operation and management, local staff training, and local communities' improved disaster management planning.

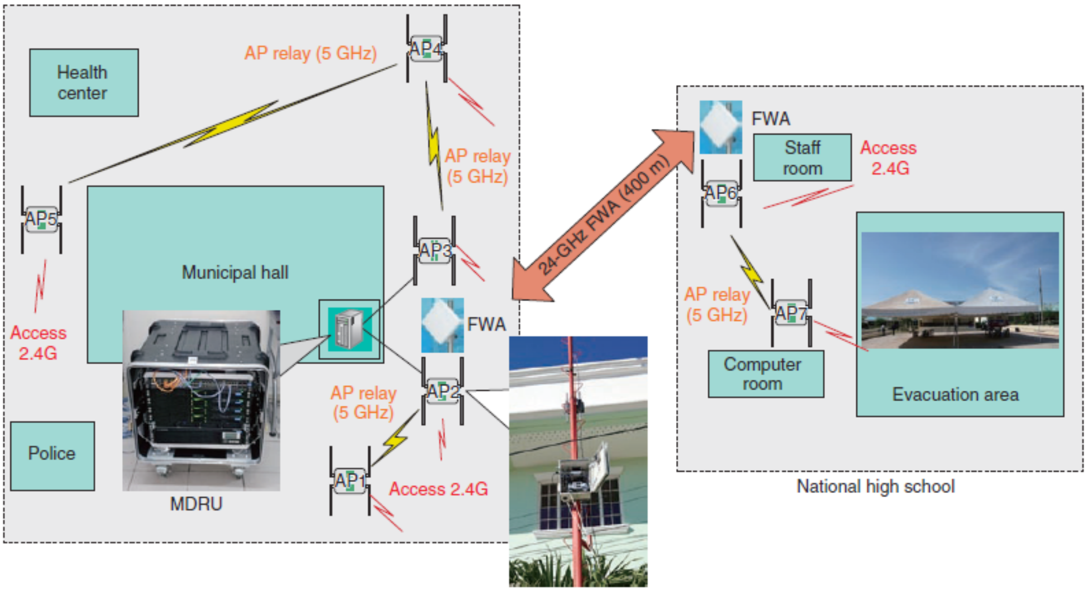
Table 1A: Summary of project

Project scope	Test the feasibility of installing the newly developed MDRU in disaster-affected areas. Adequately train local key personnel for sustainable MDRU network operation and management. Improve local communities' disaster management planning structure to facilitate increased disaster preparedness. Seek feedback from government organizations and local communities on MDRU-powered services. Monitor and evaluate the installed MDRU in order to provide government organizations with project feedback.
Project management	Because the ITU is the project lead, the ITU Project Manager collaborates with MIC and DOST to provide overall management and project administration. A steering committee was also established immediately after the signing of the cooperation agreement.
Monitoring	The ITU will use key performance indicators and project expectations to monitor and evaluate the project.
Term	May 2014 – March 2016

2) System configuration

Figure 7A shows the MDRU server unit and wireless system that are being used in the project. The unit and system were installed in December 2014 in San Remigio Municipal Hall and an evacuation centre, respectively. The two locations were connected by a communication link vis-a-vis point-to-point wireless equipment. The MDRU team also used Access Point (AP) to access point connections to establish a 1) wide area Wi-Fi network and a 2) 24-GHz FWA (Fixed Wireless Access) connection between the evacuation centre and municipal hall. Despite differences between Japan and the Philippines, the feasibility study showed that the MDRU operated effectively in the latter.

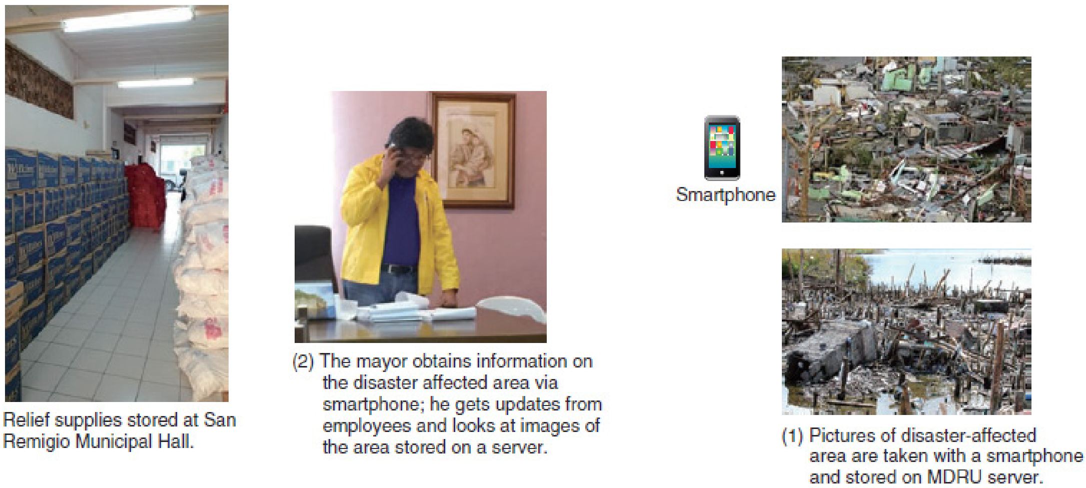
Figure 7A: MDRU and wireless equipment installed at San Remigio Municipal Hall and at a high school



3) Results of the feasibility study

Figure 8A shows an example of a use case during a disaster. Here, the mayor first placed phone calls to municipal employees to get information about the disaster. Next, municipal employees used smartphones to photograph the disaster area and then saved these to the MDRU's server. This enabled the mayor to look at the stored pictures to gain a visual understanding of the disaster. Ultimately, the mayor instructed municipal hall employees to provide relief goods to the affected area before he reported the situation to the central government.

Figure 8A: Use case of MDRU: Investigating the extent of damage from the typhoon



The plan is to conduct a feasibility study of each use case in order to 1) meet municipal employees' and local residents' need and 2) continue to improve MDRU operation rules, connectivity, and specifications.

4) Training on installing and running MDRU applications

Although there is a plan to confirm MDRU feasibility and review the units' rules of operation with residents, a training session (see **Figure 9A**) was held for San Remigio residents on installing and running MDRU applications on smartphones. More than 90 per cent of the 30 attendees said that the

MDRU phone was "easy" or "very easy" to use just as the MDRU feasibility study has demonstrated. At an the earlier briefing session in San Remigio, project participants discussed the technologies used in the MDRU project as well as the feasibility study's importance of the MDRU feasibility study with the engineers. Additionally, to facilitate operation of MDRU applications, the unit will need to be equipped with a power although some MDRUs have already been equipped with Uninterruptible Power Supplies (UPS).

Figure 9A: Training session for residents of San Remigio

A1.9 Mobile telephony providers' contingency plan for disaster preparedness, mitigation and response (Argentina)

After a series of floods affected more than 500,000 people in La Plata, the capital of the Province of Buenos Aires, Argentina, Argentina's Communications Secretariat (Telecommunication/ICT enforcement/regulation agency) approved Resolution 1/2013 in April 2013 to facilitate the city's use of mobile communications for disaster preparedness.[20]

1) Content of the standard on ICTs for emergency and disaster situations

Among its main provisions, this standard addresses operations of mobile communications providers following a disaster including requirements for back-up energy supplies, priority for emergency services, and mobile contingency units to enable continued service at sites that cannot be restored.

Providers had 45-days from publication of the rules and regulations to submit contingency plans to Argentina's communication control entity, *Autoridad Federal de Tecnologías de la Información y las Comunicaciones* (the Federal Authority for Information and Communication Technologies and formerly *Comisión Nacional de Comunicaciones).*

2) Implementation of the infrastructure required by the standard

[20] Document SG2RGQ/84, "Argentina and the implementation of the mobile telephony providers' contingency plan for disaster preparedness, mitigation and response", Argentine Republic.

In Resolution 34 of WTDC 2014, the ITU invites "Sector Members to make the necessary efforts to enable the operation of telecommunication services in emergency or disaster situations, giving priority, in all cases, to telecommunications concerning safety of life in the affected areas, and providing for such purpose contingency plans". To this end, Argentina completed internal work at its supervisory telecom organization ***Autoridad Federal de Tecnologías de la Información y la Comunicación*** (AFTIC) and held a national forum on these topics.

Argentina has now begun to implement a series of measures for due compliance with the rules and regulations. For example, AFTIC now requires the distribution of sample technical reports and acts among all inspectors as well as an explanation of the different procedures. Additionally, every inspection must check that the radio base station's battery bank is in perfect condition so that it provides a permanent direct current supply for the stations' operation. Since approving the Contingency Plan and issuing criteria definitions, Argentina completed 419 nationwide inspections in 2014 alone.

3) Response in recent emergency and disaster situations

At the beginning of August 2015, floods caused serious damage to cities in the province of Buenos Aires including Luján, San Antonio de Areco, and Salto. The floods required the evacuation of approximately 10,000 people. Immediately after the disaster, AFTIC control teams visited the affected areas to check the status of mobile telephone networks, but found no evidence of massive service interruption.

A1.10 Use case of emergency warning system over broadcasting (Kazakhstan)

The use of telecommunications/ICTs for natural disaster preparedness, mitigation and relief

Kazteleradio is using broadcasting resources (e.g., analogue and digital TV, FM broadcasting systems) in its development of a nationwide emergency warning system for Kazakhstan.[21] Kazteleradio will receive alerts from the authorities responsible for directing residents during emergencies and then use satellites to broadcast this information locally via regional and national radio/TV stations that have active transmission systems. The appropriate departments and offices within the Ministry of Emergency Situations will determine each alert's level.

The entire alert system will operate over national territory with due regard to the geographical disposition of radio/TV stations for which the transmissions are intended. However, radio and TV stations in regions that the emergency has not affected will continue normal broadcasting. The system should be ready for full-scale testing by the end of 2016.

It should also be noted that Communications Law No. 567 of 5 July 2004 requires owners of communication networks and assets to give absolute priority to: 1) any announcements concerning the safety of human life at sea, on land, in the air and in space, 2) urgent measures in the sphere of defence, 3) national security and law enforcement, and 4) emergency alerts. By the same token, communication operators are required to provide the "112" traffic control service at no cost to assist in caller location and short text message circulation during any state-of-emergency declaration that is of a social, natural and/or technological nature.

A1.11 ICT applications for disaster prediction case studies in India (India)

a) Single number based Integrated Emergency Communication & Response System (IECRS)

In India, there are multiple helpline numbers for emergencies. For example, "100" is for police assistance, "101" for fire brigade service, "102" for ambulance, etc.[22] Because it is difficult to

[21] Document SG2RGQ/107, "Contribution from Kazakhstan", Republic of Kazakhstan.

[22] Document SG2RGQ/122, "The role of Information and Communication Technology (ICT) in disaster mitigation, prediction and response", Republic of India.

remember multiple numbers during emergencies, TRAI intends to facilitate the establishment of a "Single Number based Integrated Emergency Communication & Response System" (IECRS) in India. Accordingly, TRAI has identified '112' as the single emergency number through which all emergency calls will be routed. The system will prioritize calls made to the single emergency number. These calls from fixed or mobile phone/devices will be routed to a Public Safety Answering Point (PSAP) which will obtain subscriber-related details (e.g., location) so that help can be sent as to the location as quickly as possible. This system is still being implemented.

b) Cyclone warning in India

Over the years, the India Meteorological Department (IMD) has constructed a dependable Cyclone Warning System that uses advanced technologies like Automatic Weather Stations (AWS), Satellites, Radars, Numerical Weather Prediction (NWP) models, and telecommunication systems. In the event of an approaching Tropical Cyclone (TC), IMD informs and warns relevant government sectors, local residents, and media through various communication channels.[23]

Components of TC early warning systems include:

- Monitoring and prediction;
- Identification of a warning organization;
- Generation, presentation, and dissemination of the warning;
- Coordination with disaster management agencies;
- Public education and outreach;
- Post-disaster reflection.

All these components are standardized in IMD to improve the system's efficiency.

c) Community-based flood early-warning system

To improve the resilience of the 45 communities located in the Indian Himalayan region[24],[25] vulnerable to glacier lake flood surges, a team of experts from International Centre for Integrated Mountain Development (ICIMOD) and Aaranyak, a leading NGO for preservation and restoration of environment and related issues, have installed the Community-Based Flood Early-Warning System. This solution consists of two units – a transmitter and a receiver. The transmitter is installed along the riverbank and the receiver is installed at a house near the river. The transmitter's attached flood sensor detects rising water levels and communicates with the receiver when the water reaches a critical level (i.e. levels that local communities helped to identify). The flood warning is then disseminated via mobile phone to relevant agencies and vulnerable communities downstream.

A1.12 Early warning system in Uganda (Uganda)

Uganda Communications Commission (UCC) and ITU in collaboration with Office of the Prime Minister (OPM), the Ministry of Water and Environment (MWE) and District Local Government of Butaleja jointly implemented a pilot project on setting up two flood early warning systems along R. Manafwa in Butaleja district in the Eastern region of Uganda. This case study described the project, including the technical aspects, and provided lessons learned.[26]

Factors that led to the successful implementation of the project:

[23] http://www.rsmcnewdelhi.imd.gov.in/images/pdf/sop.pdf.
[24] http://unfccc.int/secretariat/momentum_for_change/items/8688.php.
[25] http://www.icimod.org/?q=10925.
[26] Document SG2RGQ/28, "Installation of Flood Early Warning Systems in the Eastern Region of Uganda", Republic of Uganda.

1) Availability of the funds to implement the project.
2) Selection of the right entities to participate in the implementation of the project.
3) Putting in place a Memorandum of Understanding that articulated the roles of each of the entities involved in the project.
4) Implementation of community awareness activities to raise awareness among stakeholders and address community concerns.
5) In order to eliminate misunderstandings between Butaleja Local Government and the owners of the land at which the siren components were installed, land use agreements were put in place.

Challenges faced during the project:

– Despite the fact that the flood early warning systems were to be used for humanitarian purposes, the Uganda Revenue Authority levied taxes on them, an additional unplanned cost to project.
– Installations were carried out during the rainy season. This therefore brought about interruptions in the installation that therefore led to delays in carrying out civil works and reduction of time for other activities such as testing of the equipment and training of stakeholders.
– A few of the items were stolen by the residents that were living within the vicinity of the siren site. Fortunately, the items were recovered quickly by the leadership of the Community.

In the month of September 2014, the flood early warning installed at Namulo Primary School was activated to warn the community about possible flooding event of the downstream area of R.Manafwa. A number of people in the community were able to run to higher grounds for safety. The installation of the flood early warning systems has brought hope to the people of Butaleja because they are now able to save their lives and properties in time before the floods occur.

A1.13 Early warning system in Zambia (Zambia)

Co-financed by Zambia's Telecommunication Regulatory Authority (ZICTA) and ITU/BDT, two flood early warning sites were established in Zambia for dissemination of flood and mudslide alerts.[27]

A1.14 Local cellular services (Japan)

A single base station and core network function can provide local cellular services that are not being used for search and rescue efforts. This system provides excellent portability because it can be installed anywhere.[28]

[27] Document SG2RGQ/231, ITU/BDT.
[28] Document 2/323, "Introduction of a local cellular service for Emergency Response", Panasonic Corporation (Japan).

Figure 10A: Local Cellular System (GSM)

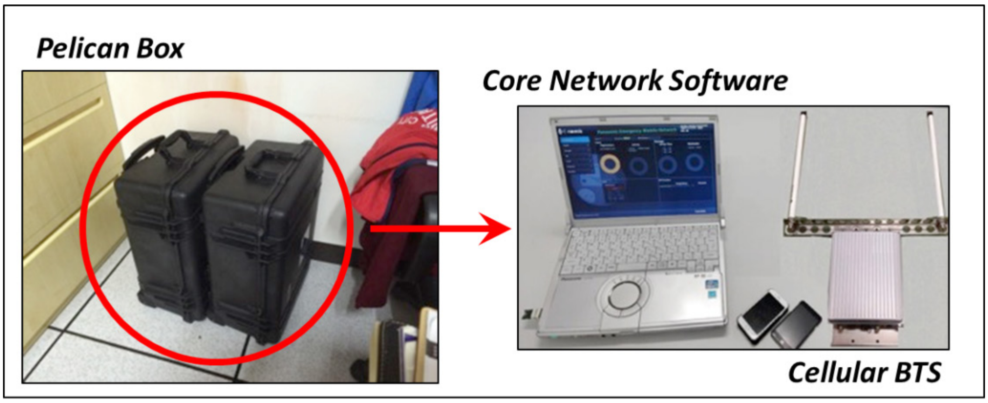


Figure 10A shows equipment for the GSM service's local cellular system which can always be stored in a pelican box. This box can be taken to disaster sites to provide local cellular services. LTE service can also be provided if the BTS mode is changed accordingly.

Figure 11A: Local Cellular System (LTE and GSM)

Figure 11A shows an example of a local cellular system for GSM and LTE services. This system provides GSM and LTE services via one PC-installed core network function.

Figure 12A: Multi mode BTS

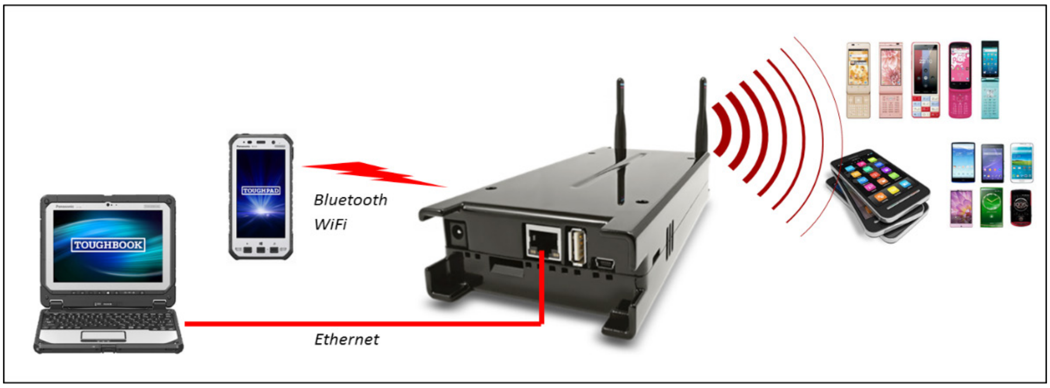


Figure 12A shows multi-mode BTS being used for IMSI capturing to support search and rescue efforts. The BTS can be small and lightweight for installation into emergency vehicles, ambulances, and drones. Additionally, it may have Bluetooth/WiFi/Ethernet interfaces that can be used for installation and monitoring purposes.

A1.15 Data center related infrastructure development for disaster prevention (Latin America and Caribbean)

1) Background

The Inter-American Development Bank (IDB) and NEC Corporation had jointly studied about data center and related infrastructures in the Latin America and Caribbean (LAC) region. Many LAC countries have high levels of natural disaster risk and disaster prevention is one of their big issues. By analysis in the study, it was recognized that for ramping up efforts to reduce vulnerability and disasters risk for "sustainable growth", IDB member countries should develop data centers and related infrastructures e.g., Internet Exchange Points and broadband.

2) Analysis method of data centers/related infrastructure

Today's global industry chains demand Productivity, Business Continuity, Environmental-friendliness and Agility. Business continuity includes disaster preparedness, mitigation and response to the countries. Critical Infrastructure Protection (CIP) is a concept that relates to the preparedness and response to serious incidents that involve the Critical Infrastructure and it is one of the highest priorities for governments. Data centers and broadband are a part of fundamental infrastructures for "sustainable development and growth" to protect Critical Infrastructure and information for society and industry.

IDB and NEC jointly designed the "Data Center Development Index" (DCDI), which is shown in Annex 2, and analyzed the current status of IDB LAC member countries from an infrastructure perspective. The aim of DCDI is not for ranking countries, but for maximizing development effectiveness, minimizing risks to "sustainable development and growth" in international regions, it is to understand and analyze indicators relevant to data centers. All indicators are taken from publically available, open data that is basically available for all 26 countries in the study. The data is absolute value except the Natural Disaster Risk Index of the UN University.

DCDI consists of main five pillars, which are used to compute DCDI value, and one auxiliary pillar. Five main pillars describe various aspects of a country development related to data centers including industry electricity prices, CO_2 emissions, network connectivity indicators, data centers and IXPs and natural disaster risk and prevention by networks of data centers.[29]

A1.16 Hazard map project in Kumamoto-city in Japan (Japan)

1) Introduction and background

From the lessons learned from flood damages in July 2012, the local government of Kumamoto-city promoted a project to develop a hazard map system for disaster risk reduction by utilizing ICTs, which aimed to educate citizens about disaster risk reduction.

2) Overview and system configuration of Kumamoto project

This hazard map system consisted of Geographic Information Systems (GIS), located on the data center, and hazard map systems, located on community sites, shown in **Figure 13A**. Citizens investigate their own town by foot and point out critical locations for the case of disaster. Based on their investigations, citizens entered critical locations and evacuation routes with some other information such as photos and historical information into hazard map system through an electronical white board system. This information is sent to the local government, and then the local government staff updates its official hazard maps. Public GIS updates hazard map information reference to government GIS to be accessed the latest hazard map by citizens from PC or smart phones via the Internet.

[29] Document 2/366, "Analysis Method of Data Center Related Infrastructure Development for Disaster Prevention and Growth of Economy in the Country and International Sub Region", NEC Corporation (Japan).

Figure 13A: System configuration of the hazard map system for disaster risk reduction

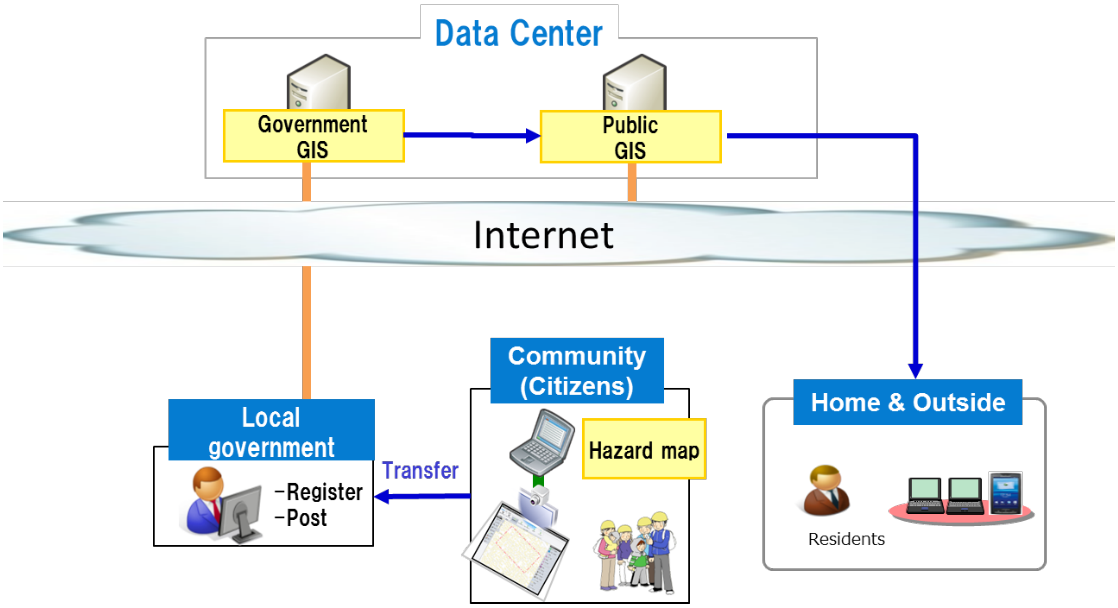


Figure 14A shows the hazard map creation process with citizens' participation, which consists of planning session, study session and town walk, preparing hazard map and completion map. In the planning session, local government explains citizens lived in the local town the goals of this project. At the study session and town walk process, citizens investigated several critical locations, evacuation routes and historical hazard information, which could only be known by citizens. There are around 900 local towns in Kumamoto-city, so the local government aims to expand this hazard map activities for all towns.

Figure 14A: Map creation process with citizens' participation

3) Expected benefits for developing countries

In order to reduce the number of victims in the event of a disaster, even in developing countries, it should be required to educate citizens for disaster risk reduction, to perceive critical locations and width of hazard in advance, and to examine or drill for evacuation periodically.

A1.17 Rapid ICT-relief system used at Kumamoto earthquakes (Japan)

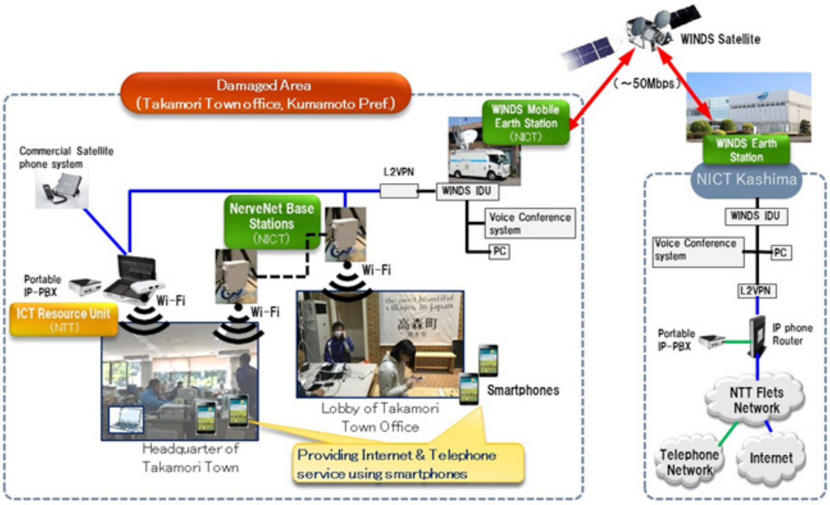
A series of intense earthquakes began on April 14, 2016 and continued subsequently at the areas centered near Kumamoto City in Kyushu Island, Japan. Serious damage including a death toll of 50 and complete destruction of over 8,000 houses was reported.[30]

The rapid ICT-relief system consisting of the wireless mesh network nodes and portable ICT resource unit (both technologies are described in 2.1 and 2.3, respectively) was transported with an on-vehicle satellite earth station for Kizuna (WINDS: Wideband Internetworking engineering test and Demonstration Satellite). When the rapid ICT-relief system arrived at Takamori Town on April 18, cellphone and Internet access were not completely restored. The ICT-relief system was set up at Takamori Town Office with the network configuration shown in **Figure 15A**. Through the satellite link of Kizuna, telephone and internet access services were provided at the Town Office. The companion earth station of the satellite link is Kashima Space Technology Center of NICT, far outside the affected area and connected to Internet and telephone lines there.

A portable ICT resource unit was also used outside the town office building with connection to the mobile satellite terminal. A merit of using a portable ICT resource unit with connection to a mobile satellite terminal was that user-owned smartphones could be used in the area covered by Wi-Fi (no need to use it near the mobile satellite terminal).

The ICT-relief activity at Takamori Town had been carried out for two days, during which period the ordinary ICT infrastructure was almost restored by ICT operators even in non-normal configuration (using means such as cellphone base stations using satellite backhaul). In ICT-relief activity, the quicker the deployment the more helpful and valuable it is to affected areas' staff and residents.

Figure 15A: Rapid ICT-relief system deployed in an area affected by the Kumamoto Earthquake



A1.18 Emergency telecommunications: National legal framework (Central African Republic)

The use of telecommunications/ICTs in disaster preparedness, mitigation and response is becoming an imperative. This was the thinking behind Central African Republic's Presidential Decree No. 16.380 of 5 November 2016 regarding the organization and functioning of the Department of Posts and Telecommunications, which established the Emergency Telecommunications Service in response to

[30] Document 2/454, "Practical application of a rapid ICT-relief system providing telephone and internet access",National Institute of Information and Communications Technology (Japan).

that need.[31] This department cooperates closely with the competent services and the authorities responsible for disaster management, prevention and mitigation, namely:

– The General Directorate for Civil Defence established under Decree No. 01.041 of 9 February 2001 within the Ministry of the Interior, Public Security and Territorial Administration. Its main remit is to devise and implement appropriate measures in the event of accidents, disasters and other such destructive events (PLAN ORSEC).
– The Ministry of Defence.
– The Ministry of Communication and Information.
– The Ministry of Social Affairs and National Reconciliation.
– The Police.
– The Gendarmerie.
– The Fire Service.
– The National Red Cross.
– International organizations.
– Non-governmental organizations.

For two decades the Central African Republic has experienced military and political crises. During the events of 2013, we saw the destruction of operators' telecommunication/ICT infrastructure. Such acts of vandalism disrupted the national communications system and drastically affected coordination of the urgent humanitarian assistance for the population badly affected in the country's interior.

Aware of the crucial role of telecommunication/ICT assets in facilitating operations on the ground, CAR in 2014 asked ITU for help with its emergency telecommunications. As a result, fixed and mobile satellite phones were provided to help the country surmount the difficulties of communication in affected areas. These tools were also used to cover the organization of the double elections (for the legislature and President) of 2016.

Given the many consequences of this problem, the Department of Posts and Telecommunications is planning the following major projects:

a) Ratification of the Tampere Convention;
b) A draft National Plan for Emergency Telecommunications;
c) A project to develop a Geographical Information System (GIS) of at-risk areas.

[31] Document 2/431, "Utilization of telecommunications/ICTs for disaster preparedness, mitigation and response: The case of the Central African Republic", Central African Republic.

Annex 2: Data Center Development Index, Geographic Redundancy Index and specific information

A2.1 Definition of Data Center Development Index

The Inter-American Development Bank and NEC jointly designed the "Data Center Development Index" (DCDI) and analyzed the current status of IDB LAC member countries from an infrastructure perspective. The aim of DCDI is not for ranking countries, but for maximizing development effectiveness, minimizing risks to "sustainable development and growth" in international regions, it is to understand and analyze indicators relevant to data centers. All indicators are taken from publically available, open data that is basically available for all 26 countries in the study. The data is absolute value except the Natural Disaster Risk Index of the UN University.

Many factors should be taken into account when constructing a data center. These factors are crucial for maximizing the Return On Investment (ROI) and meeting customer's requirements for computation power and quality services. According to an IDB partner, the three main factors to optimize construction and sustaining costs of a data center while meeting internal customers' computing and services requirements are:

1) Environment conditions: the region's climate and history of natural disasters;
2) Wide Area Network (WAN): the availability and cost of fiber and communication infrastructure;
3) Power: availability and cost of electric power infrastructure.

The "Power" and "WAN" factors directly correspond to "Energy infrastructure" and "ICT infrastructure", respectively. The "Power" / "Energy Infrastructure" factor is addressed in this study by analyzing the electricity prices in each country. The "WAN" / "ICT infrastructure" factor is considered through analysis of upload speed, network latency, fixed and mobile broadband penetration rates, and international Internet bandwidth. The "environment condition" factor in this study is considered from the point of view of natural disaster risk and geographic redundancy. Therefore, when talking about "Environment condition", it was considered how likely it is that a natural disaster will occur in a certain country, and how much redundancy there is within the national data center infrastructure to withstand the disaster strike.

The Data Center Development Index consists of main five pillars, which are used to computed DCDI value, and one auxiliary pillar. Five main pillars describe various aspects of a country development related to data centers. The auxiliary pillar contains indicators to transform original indicators into "per capita" and "per unit of area" formats. (All pillars and corresponding indicators are presented in Table of DCDI Pillars and Indicators). During the data cleansing phase, correlation between listed indicators was checked.

The value of indicators are computed with the following rule; the value of "1" means good and "0" means poor among the countries. To understand the level of data center development, all 26 countries have been segregated into four groups. These are low (values 0.00-0.25), moderate (0.26-0.36), high (0.37-0.42) and very high (>0.42) development level. These intervals are selected in accordance with variability of pillar values.

Computation of DCDI, Geographic Redundancy Index (GRI) and specific information can be found in the following sections.

It is necessary to build a network of data centers to have data duplicated at different locations. Network of data centers provides the Geographic Redundancy and reduces the risk of data loss. To evaluate and compare levels of geographic redundancy, the Geographic Redundancy Index is employed. The idea behind the GRI is to provide multiple locations of data centers and evenly distributed the data centers across those locations. The GRI value ranges from 0 (low or no redundancy) to 1 (high redundancy). To compute GRI, the number of data centers and number of areas where data centers are deployed, are used. GRI is computed as ratio between actual and maximum entropy. Adjusted GRI is adjusted for country area and population size.

One way to measure how likely natural disasters, such as earthquakes, tsunamis, typhoons, etc., are in a region is to use the Natural Disaster Risk Index (NDRI) which is published annually by the United Nations University for Environment and Human Security.

Industry Electricity prices are one of the most impact factors for the Opex of data centers. Thus Industry Electricity price is on Pillar 2. A data center exhausts large volume of CO_2 but it reduces total volume of CO_2 emission if individual offices move ICT in the office to a data center. CO_2 emission is on Pillar1.

Network connectivity indicators are on Pillar3. Pillar4 is related to data centers and IXPs and Pillar 5 is related to natural disaster risk and prevention by network of data centers.

Table2A: DCDI Pillars and Indicators

Table: DCDI Pillars and Indicators	
Indicator	**Source**
Pillar 1: Economic Development	
GDP per capita	World Bank,2014
Foreign Direct Investment (US$ in mil.)	UNCTAD, 2014
CO_2 emission (t per capita)	World Bank,2011
Pillar 2: Fundamental Infrastructure	
Industry Electricity prices	IDB and other sources, 2011
Telco Opex/revenue	GSMA Intelligence, 2Q 2015
3G network coverage, population	GSMA Intelligence, 2Q 2015
4G network coverage, population	
Pillar 3: Connectivity	
Median fixed upload speed	2014, Cisco Global Cloud Index2015
Median fixed latency	
Median mobile upload speed	
Median mobile latency	
Fixed broadband penetration	2014, ITU Measuring the Information Society Report2015
Mobile broadband penetration	
International Internet bandwidth	
Pillar 4: Data Center Infrastructure	
Number of Secure Servers per mil.	World Bank, 2015
Number of Data Centers	DataCentermap.com accessed on May/2016
Number of Internet eXchange Points (IXPs)	Packet Clearing House accessed on May/2016

Table: DCDI Pillars and Indicators	
Indicator	**Source**
Pillar 5: Critical Infrastructure Protection	
Number of Data Center Locations	DataCentermap.com accessed on May/2016
Adjusted **Geographic Redundancy Index**	Using DataCentermap.com accessed on May/2016, Designed by NEC
Natural Disaster Risk Index	2013,United Nations University for Environment and Human Security2014
Auxiliary Pillar	
Land area	World Bank,2015
Population size	World Bank,2014
Percentage of Individuals using the Internet	2014, ITU Measuring the Information Society Report2015
	designed by Inter-American Development Bank and NEC

A2.2 Computation of Data Center Development Index

To compute DCDI value it is necessary to make two following steps. Step 1 is to compute intermediate values for each pillar. Step 2 is to compute weighted average of pillar values; this value is for IDB's request.

Step 1) Values of all indicators within each pillar are normalized using normalization formulas. Mainly formula (1.1) is used:

$$x_{normalized} = \frac{x_{country} - x_{min}}{x_{max} - x_{min}} \qquad (1.1)$$

Where xcountry is original value of an indicator for a given country, xmin and xmax are min and max values of the indicator across the selected countries, and xnormalized is normalized value of an indicator for a given country. This normalization implies that the high the value of original indicator the better. For example, the higher the network coverage or broadband penetration rates the better.

On the other hand, for indicators such as Electricity Prices, Natural Disaster Risk, CO2 emission per capita and Telco Opex per Revenue, the lower the value the better it is. Therefore for these four indicators, normalization is done in accordance with formula (1.2).

$$x_{normalized} = 1 - \frac{x_{country} - x_{min}}{x_{max} - x_{min}} \qquad (1.2)$$

Normalization should be applied to each indicator in a pillar. Since values of GRI and NDR originally belong to interval [0, 1], values of these indicators are not normalized. After all indicators are normalized, pillar value for each county is computed as average of normalized values. For example, according to Table of DCDI, Pillar 1 contains three indicators: GDP per capita (GDP), FDI and CO_2 emission per capita (CO_2).Pillar value for a given country is computed as:

$$Pillar1\_Value\ (country) = [GDP_{normalized}(country) + FDI_{normalized}(country) + CO2_{normalized}(country)]/3$$

Step 2) After all pillar values are computed for each country, final DCDI value for a given country is computed as weighted average of pillar values (formula (1.3)):

$$DCDI(country) = 0.1*Pillar1\_Value(country) + 0.1*Pillar2\_Value(country) + 0.2*Pillar3\_Value(country) + 0.3*Pillar4\_Value(country) + 0.3*Pillar5\_Value(country) \quad (1.3)$$

A2.3 Computation of Specific Indicators for number of data centers, IXPs and Geographic Redundancy Index

Original values of Number of Data Centers (DCnum) and Number of IXPs (IXPnum) are referenced to the land area (area), population and Percentage of Individuals using the Internet (Internet). Geographic Redundancy Index (GRI) is referenced only to the land area (area) and population. Before normalization, original values of these indicators are transformed as follows.

$$DCnum_{referenced} = DCnum*Internet_{normalized} / (area_{normalized}*population_{normalized})$$

$$IXPnum_{referenced} = IXPnum*Internet_{normalized} / (area_{normalized}*population_{normalized})$$

$$GRI_{Adjusted} = DCnum_{referenced} * GRI$$

A2.4 Computation of Geographic Redundancy Index

Geographic Redundancy Index (GRI) is designed to illustrate how actual distribution of data centers at various locations across the country is different from the uniform distribution of data centers among given locations. Number of locations is described by indicator Number of Areas. GRI is computed is a ratio between entropy of actual distribution (Entactual) of data centers across the existing location vs. entropy (Entmax) uniform distribution given number of locations (formula (2.1)). Entropy of actual distribution is computed in accordance of formula (2.2) .Portion of data centers at a given location p_i is computed using formula (2.3). Entropy of actual distribution is computed in accordance of formula (2.4).

$$GRI = \frac{Ent_{actual}}{Ent_{max}} \quad (2.1)$$

$$Ent_{actual} = -\sum_{i=1}^{Locations\_num} p_i \log_2(p_i) \quad (2.2)$$

$$p_i = \frac{DCnum\ at\ location\ i}{DCnum} \quad (2.3)$$

$$Ent_{max} = \log_2(Locations\_num) \quad (2.4)$$

A2.5 Computation of Adjusted Geographic Redundancy Index

Geographic Redundancy Index (GRI) allow to understand how different actual distribution of data centers from the uniform distribution within a single country. Across the countries number of locations, total number of data centers and number of data centers at each location. GRI itself may be not suitable measurement to compare situation in different countries. Therefore, Adjusted GRI has been designed. Adjusted GRI is computed as multiplication of GRI value for a given country and referenced value of DCnum (formula (2.5)):

$$GRI_{Adjusted} = DCnum_{referenced} * GRI \tag{2.5}$$

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