Roles of ICTs in Tackling Climate Change

ICT & Climate Change Training Program

Session 2

ITU and climate change

ITU ACADEMY

Session Objectives

This session provides a comprehensive understanding of what ICTs are and how they can be used to tackle climate change. It provides an overview of the ways ICT can help with climate monitoring, energy efficiency, mitigation and adaptation. There is a special focus on ICT used to improve adaptation to climate change as this is not covered in other sessions.

STUDENTS

Session Topics

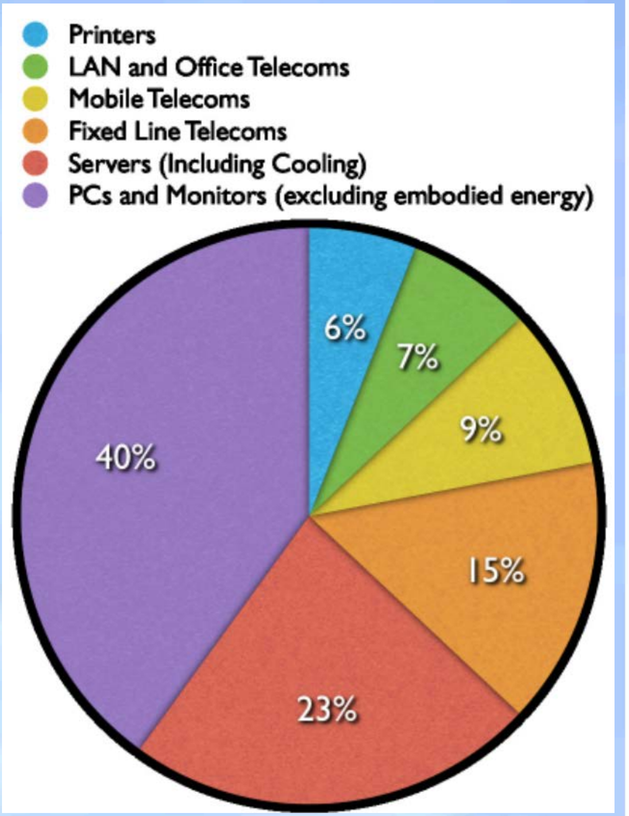
- Types of ICT Equipment.
- Energy Footprint of ICTs.
- How to reduce energy consumption of telecoms networks.
- Introduction to Mitigation against Climate Change.
- Climate monitoring using ICTs.
- Adaptation to Climate Change:
  - Need for Climate Change adaptation.
  - Impacts of acute events or shocks.
  - ICT sector responses.

Types of ICT Equipment

ICTs cover a wide range of technologies for gathering, storing, retrieving, processing, analysing and transmitting information in digital form, including:

- Telecommunications Equipment (e.g. switches, routers, mobile base stations)
- IT Equipment (e.g. Cloud Servers)
- Personal devices (e.g. TVs, laptops and iPads)
- Power supplies to telecom infrastructure (e.g. towers)

What impact do these have on GHG emissions?



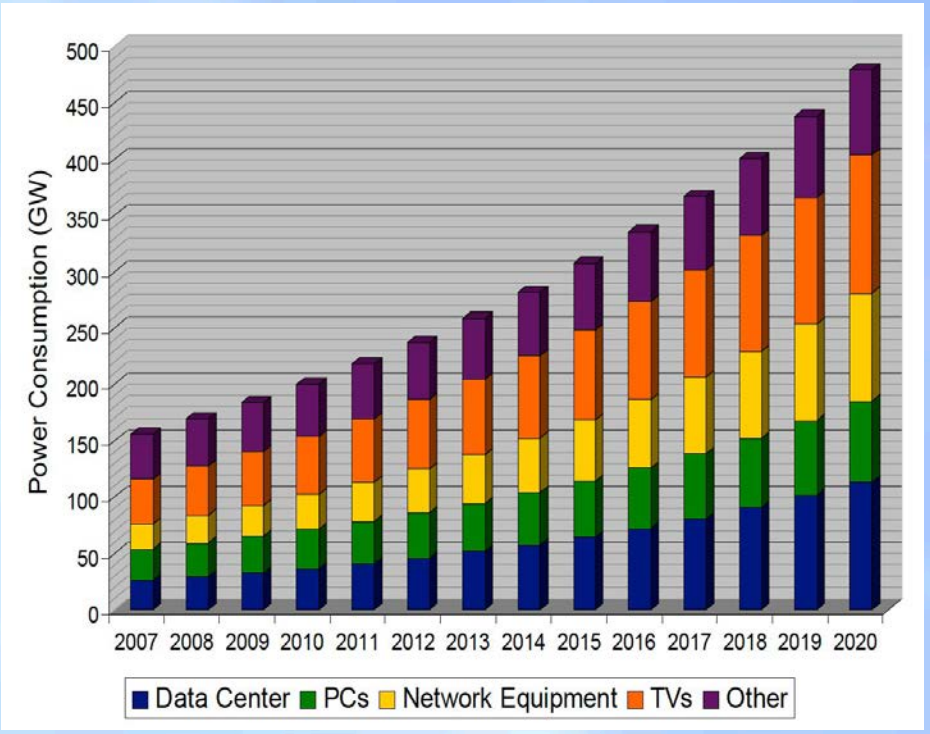
Source: http://css.escwa.org.lb/ictd/1248/25.pdf

Why consider energy saving in ICT and networks?

- Electrical energy is a limited resource
  - Mainly dependent on a mix of fossil fuels and nuclear
- Networks need electrical energy to function and are on a path of exponential growth and upgrade (like their end devices, e.g. servers, PCs, TVs)
  - Worldwide coverage needed
  - Moore's law leads to obsolescence every 2-4 years
- Every 1W saved at the edge
  - is worth one power plant worldwide
  - reduces CO_2 emissions and other waste products

Energy footprint of ICT

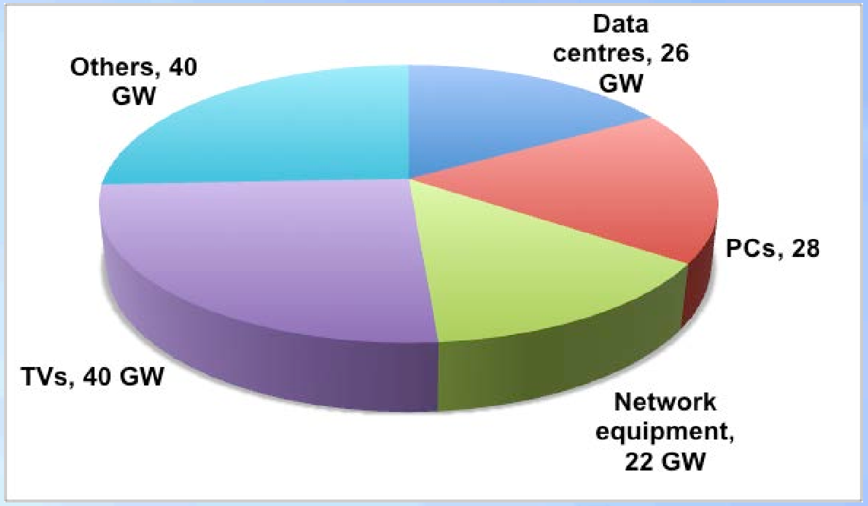
- The energy footprint of ICT is still growing due to wider use of ICTs in a range of economic sectors, even if the energy consumption of individual devices is reducing.
- Large installations of ICT for the implementation of e.g. Smart Grids and e-services will further increase emissions.



http://dmsext.itu.int/pub/itu-t/oth/33/04/T33040000020004pdfe.pdf

Energy footprint of ICTs (continued)

- Homes and Distribution grids are expected to be the most critical environments.
- There will be millions of such sites in the whole system.



An example: Future broadband network's Energy footprint estimation

	power consumption (Wh)	number of devices	overall consumption (GWh/year)
Home	10	17,500,000	1,533
Access	1,280	27,344	307
Metro/transport	6,000	1,750	92
Core	10,000	175	15

Sources: 1) BroadBand Equipment Code of Conduct V.5 (EC-JRC)
2) Telecom Italia measurements and evaluations (power consumption of metro/core network and number of devices)

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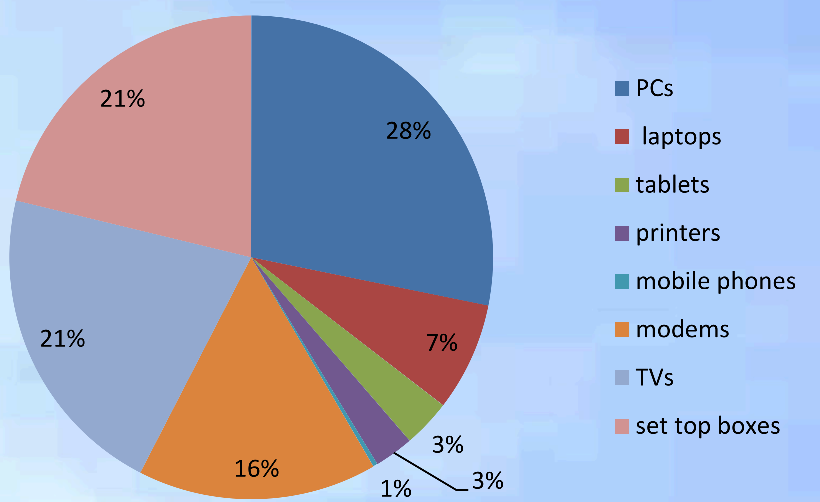
Energy footprint of ICT (continued)

Energy usage of ICT equipment in homes is increasing due to:

- more ICT devices:
  - laptops, set-top-boxes, smart phones, handhelds, tablets, … ;
- most devices are left powered on even when not used:
  - often to maintain "network presence";
- inefficient standby states.



Source: Draft Recommendation ITU-T L.1440 Methodology for environmental impact assessment of ICT at city level – will be available at www.itu.int/ITU-T/recommendations/index_sg.aspx?sg=5

Important Questions for the ICT sector regarding Energy Efficiency

- How do Telecom Service Providers (TSPs) assess their carbon footprint and set targets for reduction (if they do)?
- How are TSPs improving the energy efficiency of their equipment and services and what more could they do in the future?
- How will next generation networks reduce energy consumption?
- What is the role of the supply chain in improving energy efficiency?

Opportunities/challenges of Future Networks

- Future Networks are reducing energy consumption through:
  - a significant decrease in number of switching centres required,
  - a more tolerant climactic range for future equipment,
  - use of more advanced technologies such as VDSL2 and PONs.
- Future network providers and manufacturers should commit to reducing power consumption by:
  - maximizing network capacity,
  - improving IP systems, reducing energy requirements of VoIP services and multimedia applications while maintaining the best QoS and QoE for end user,
  - reducing the number of electronic devices required in order to reduce emissions from the manufacture and distribution of devices,
  - reducing the overall consumption of energy in data centres and developing energy efficiency servers,
  - monitoring power consumption in network devices to enable most efficient use.

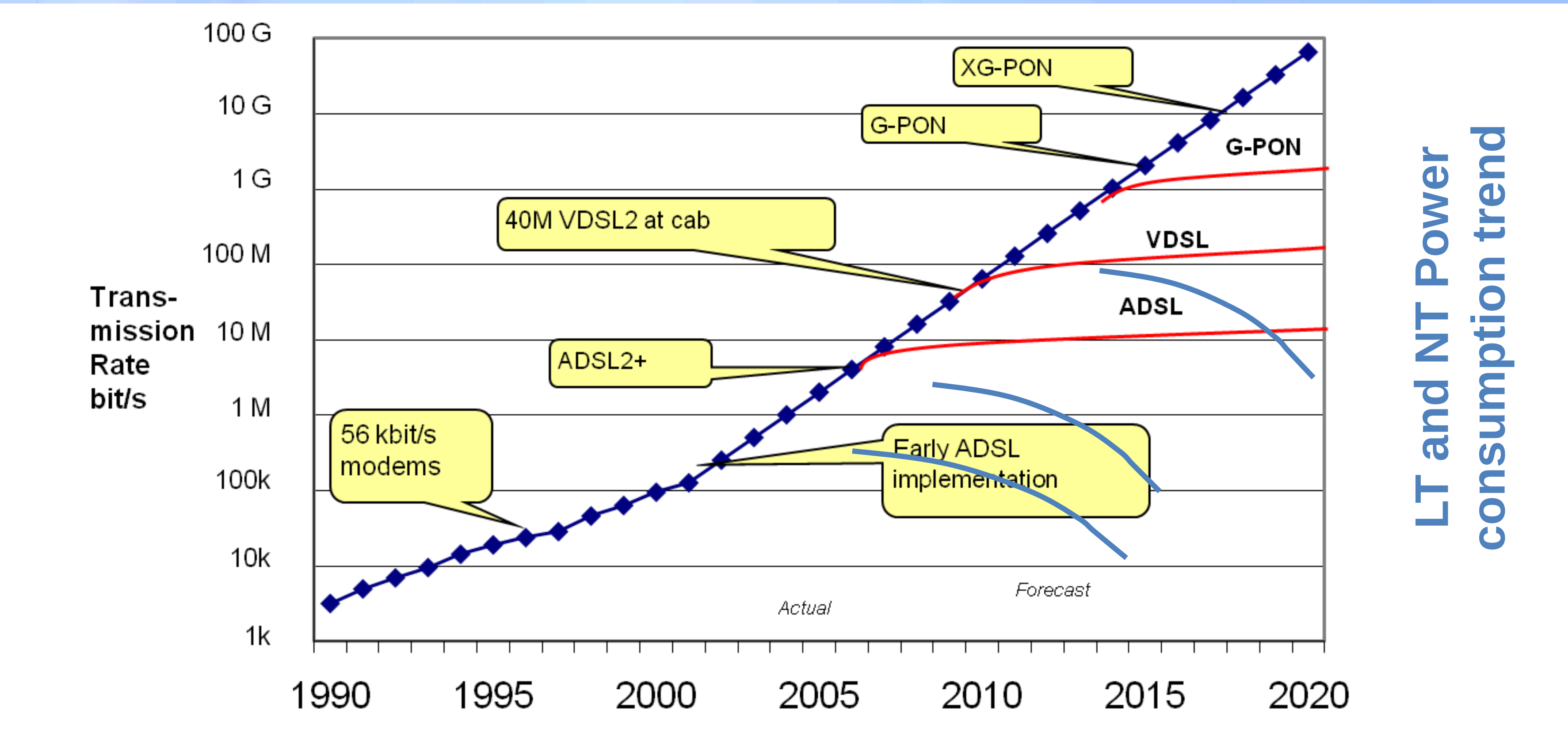
Source: ITU-T Technology Watch Report 7 “NGNs and Energy Efficiency”

Energy Efficiency: What issues should be addressed in coming years?

- HVDC and renewable energy to power telecom infrastructure.
- Most broadband access will be wireless for the foreseeable future (especially in developing countries).
- Energy per bit is quantum limited:
  - Higher speeds mean more photons will be transmitted.
  - Challenge is to do this without increasing the energy required by terminal devices.
- Where can energy savings be made?
  - Transmit only information bits with nothing during idle periods.
  - Make the transmission equipment more energy efficient.
  - Design the optical transmitters for low power modulation.
  - Minimise the need for electronic processes running at full line rate.

Broadband Modems

Bit-rate and power consumption over time

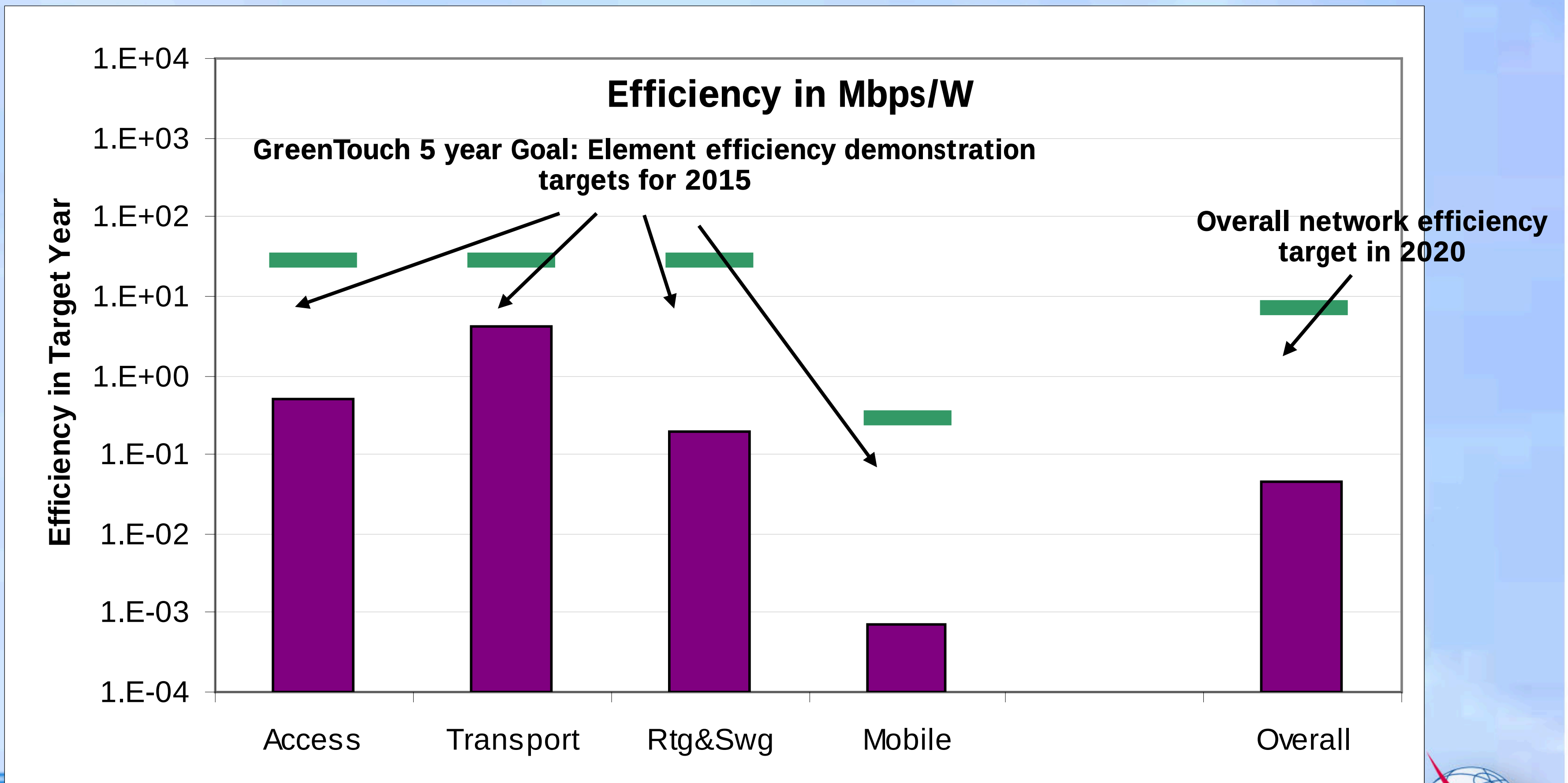


Can we increase speed while saving power?

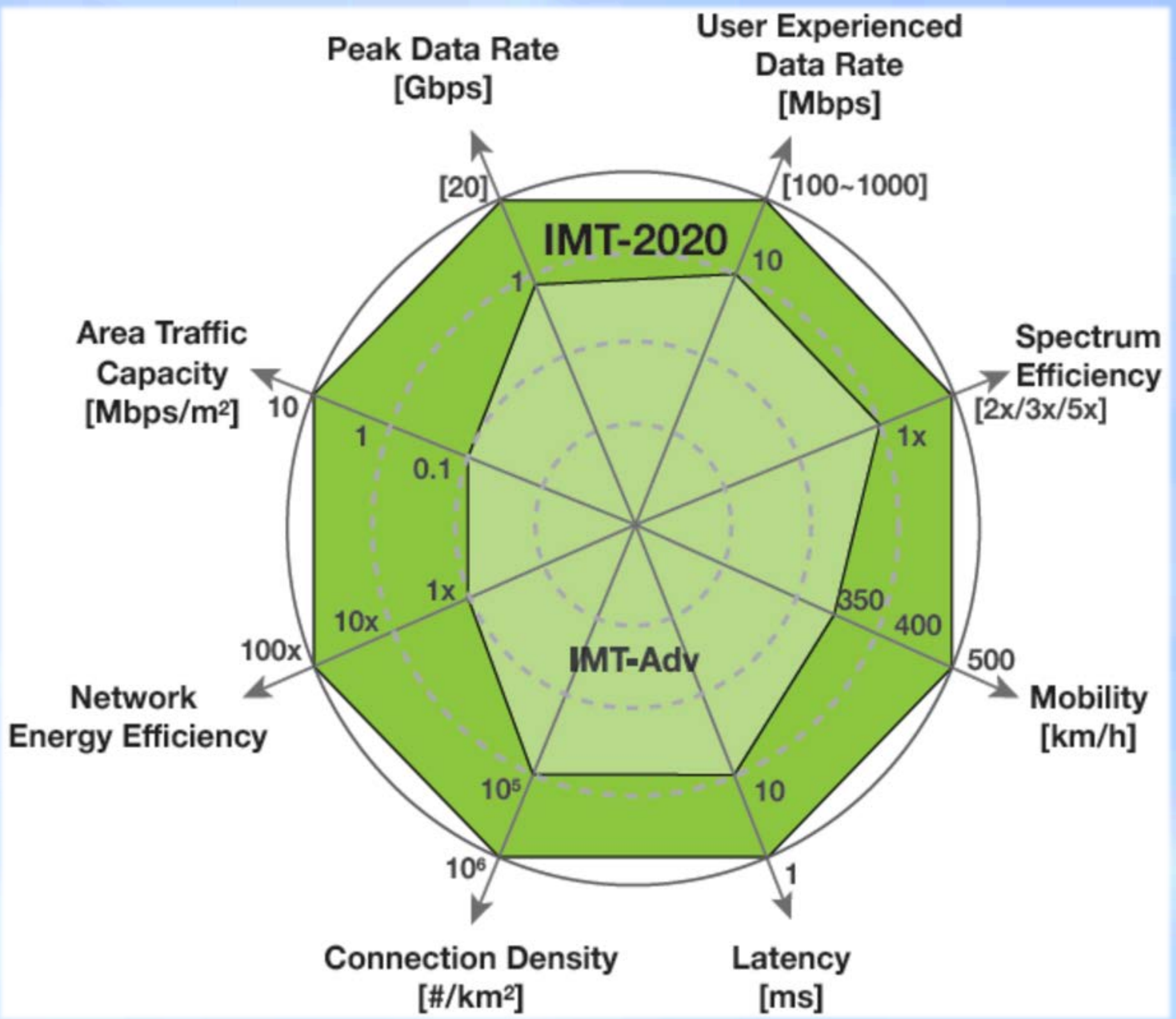
Source: www.itu.int/en/ITU-T/studygroups/com15/Documents/tutorials/tutorial_2005_10_26_faulkner.ppt

GreenTouch: Modeling Provides Clear Picture of Goals

Assumptions: Baseline year 2010, Target year 2020



IMT-2020 Requirements



Source:
Draft ITU-R M.IMT-Vision

Mitigation: Emission reductions possible in other sectors using ICTs

Categories	Effects
Consumption of materials	By reducing materials consumption (dematerialization), the environmental load related to goods production and disposal as well as waste generation can be reduced.
Power / energy consumption	By enhancing the efficiency of power and energy use to reduce consumption, the environmental load related to power generation, power transmission, etc. can be reduced.
Movement of people	By reducing the movement of people, the environmental load required for transportation can be reduced.
Movement of materials	By reducing the movement of materials, the environmental load required for transportation can be reduced.
Improved efficiency of office space	By using office space efficiently, power consumption for lighting, air conditioning, etc. can be reduced, thus reducing environmental load.
Storage of goods	By reducing storage space of goods, power consumption for lighting, air conditioning, etc. can be reduced, thus reducing environmental load.
Improved work efficiency	By enhancing work efficiency, the environmental load can be reduced.
Waste	By reducing waste emissions, the environmental load required for environmental preservation as well as for waste disposal can be reduced.

Source: ITU-T Recommendation L.1400 “Overview and general principles of methodologies for assessing the environmental impact of ICT” www.itu.int/rec/T-REC-L.1400

Examples of technologies which can be used to reduce GHG emissions in other sectors

- Smart Metering and Smart Grids
- ICT for Smart Buildings Management
- Sustainable Transport, including real time navigation (RTN) and e-logistics
- E-commerce
- E-government, including e-civil service
- E-learning
- Telepresence

More on this in Session 7 “Green ICT Technologies”.

Adaptation to Climate Change

- How is climate change monitored?
- The need for adaptation:
  - rising sea levels, flooding, increases in temperature, humidity, lightning strikes, etc.
- How are TSPs modifying their equipment and networks to take account of climate change?
- Case study on adaptation arising from the impact of Hurricane Sandy in US.

Radiocommunications and Climate monitoring

- Satellite observations of the Earth's atmosphere and surface
- Space-borne sensing (passive and active)
- Sea surface temperature (SST) is now also measured by passive microwave instruments.
- Meteorological radars are used to sense the conditions of the atmosphere for routine forecasting, severe weather detection, wind and precipitation detection, precipitation estimates, detection of aircraft icing conditions and avoidance of severe weather for navigation
- Mobile wireless systems, sensors, actuators, IoTs
- Submarine communications networks to monitor climate changes and disaster warning

Source: ITU Brochure "Radiocommunications and Climate Change": www.itu.int/pub/R-GEN-CLC-2012

Climate change monitoring

Types of Earth observation systems

Passive applications Ground-based passive sensors		Satellite remote passive sensors
Active applications	Ground- based radars	Weather radars, wind profiler radars and oceanographic radars
	Meteorological aids	Radiosondes
	Earth to space data transmission bands	Earth exploration and meteorological satellites
	Space to Earth data transmission bands	Earth exploration and meteorological satellites
	Space-based radars	Satellite remote active sensors, (altimeters, scatterometers, synthetic aperture radars, precipitation radars and cloud profile radars)

	Atmospheric variables	Oceanic variables	Terrestrial variables
D	Surface precipitation	Sea surface temperature	Lake levels
e	Upper air Earth radiation budget	Sea level	Snow cover
p	Upper air temperature	Sea state	Glaciers and ice caps
e	Upper air wind speed and direction	Sea ice	Albedo
n	Upper air water vapour	Ocean colour (biology)	Land cover (including vegetation type)
d	Upper air cloud properties	Sub-surface salinity	Soil moisture
e	Carbon dioxide		Leaf area index
n	Ozone		Biomass
t	Aerosol properties		Fire disturbance
			Fraction of absorbed photosynthetically active radiation
S	Surface air temperature	Surface salinity	River discharge
u	Surface air pressure	Surface currents	Water use
p	Surface radiation budget	Surface CO2 partial pressure	Ground water
p	Surface wind speed and direction	Sub-surface temperature	Permafrost/seasonally-frozen ground
o	Surface water vapour	Sub-surface currents	
r	Methane	Sub-surface nutrients	
t	Other long-lived greenhouse gases	Sub-surface carbon	
e		Sub-surface ocean tracers	
d		Sub-surface phytoplankton	

The Need for Climate Change Adaptation

- Changes in temperature, precipitation, wind-speeds, lightning patterns, humidity, snow and ice, among others.
- Both acute (extreme) weather events and chronic (longer term) changes in climate.
- 1.8°C to 4°C rise in temperature by 2100 if no action is taken.
- >10% increase in wind speeds and poleward shift in storm tracks.
- 10% increase in lightning activity for every 1°C increase in temperature.

Impacts of acute events or “shocks”

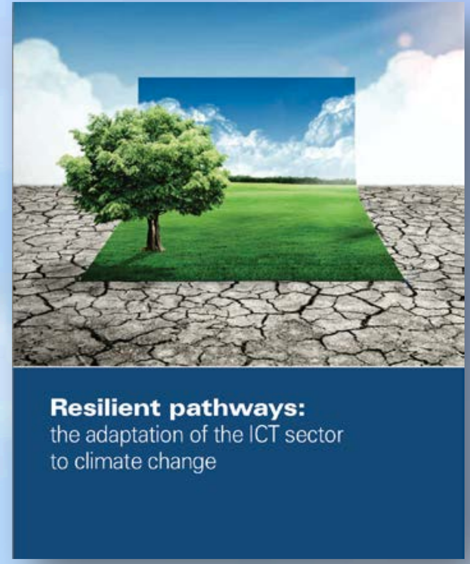
- Landslides
- Flooding
- Disruption of Transportation Systems
- Infrastructure Damage
  - Electricity
  - Telecommunications (ICT)
  - Water
  - Gas
  - …

Disruptive Effects on ICT Sector

- Accelerate degradation of physical assets and ICT infrastructure.
- Affect supply of materials, interrupt transport and logistics.
- Disrupt availability and reliability of ICT services.
- Increase operational business costs across sector.
- Reduce revenues.
- Challenge sector’s ability to conduct repairs and recover from effects of disruption.

ICT Sector Responses

- Ensure that ICT infrastructure can cope with more extreme ranges of temperature, rainfall, wind speed, etc.
- Increase resilience by adding diverse routing.
- Carry out Risk Assessments:
  - Use a Climate Adaptation Risk Assessment Checklist.
  - Agree a "Climate Change Adaptation Plan".
- Share 'know-how':
  - Best Practices (e.g. for increased resilience).
  - Risk assessment checklists and remedial actions.



www.itu.int/en/ITU-T/climatechange/Documents/Publications/Resilient_Pathways-E.PDF

Suggested Actions
Assess Risks

- Carry out periodic climate risk assessments on existing networks:
  - *Evaluate risks and cost of remedial action*
  - *Carry out remedial work if costs can be justified*

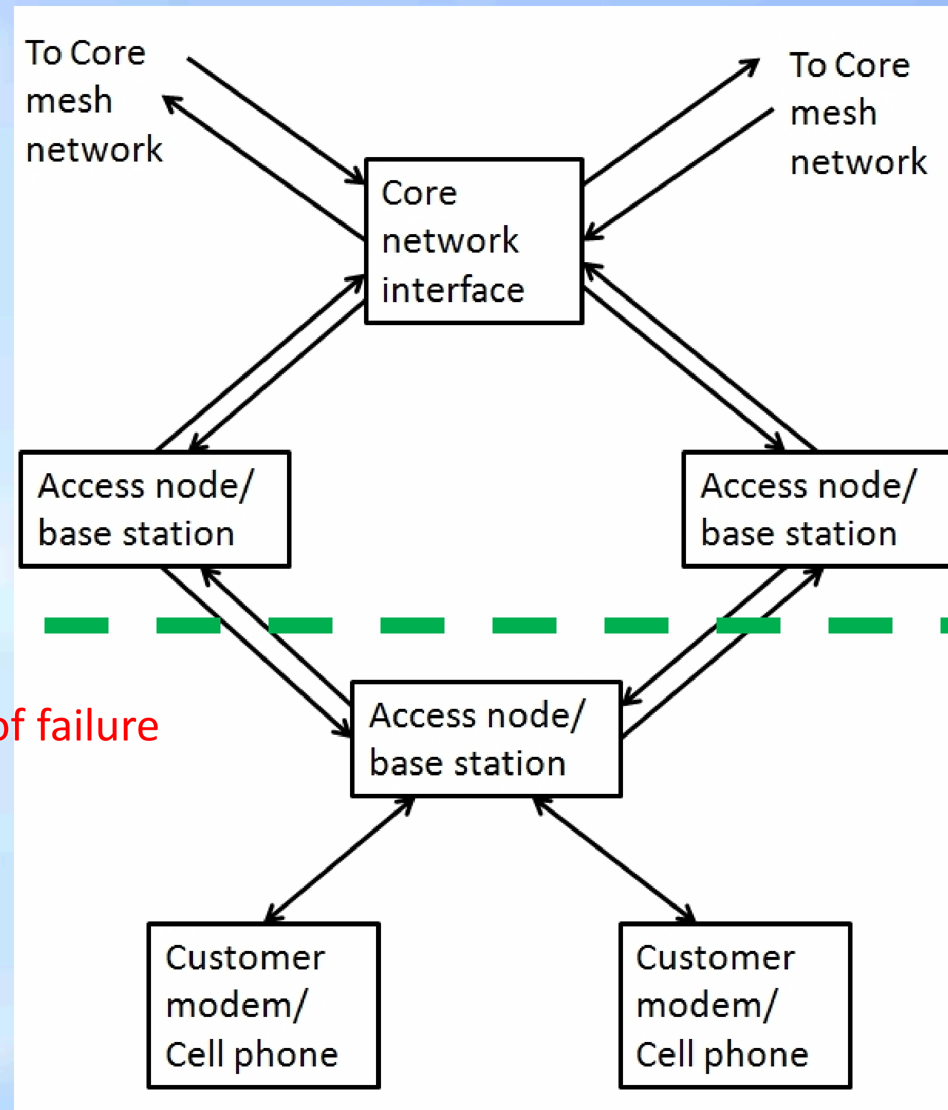
Suggested Actions
Widen device tolerances

When devices operate outside their specified environmental conditions, they are at risk of failure:

- Specifications made in the past may no longer apply because more extreme weather events are occurring.
- Widen tolerances in ‘Device Specifications’ for new and replacement components:
  - Temperature range, maximum wind speed, water resistance etc.

Suggested Actions
Increase Resilience…

Typical Network Resilience

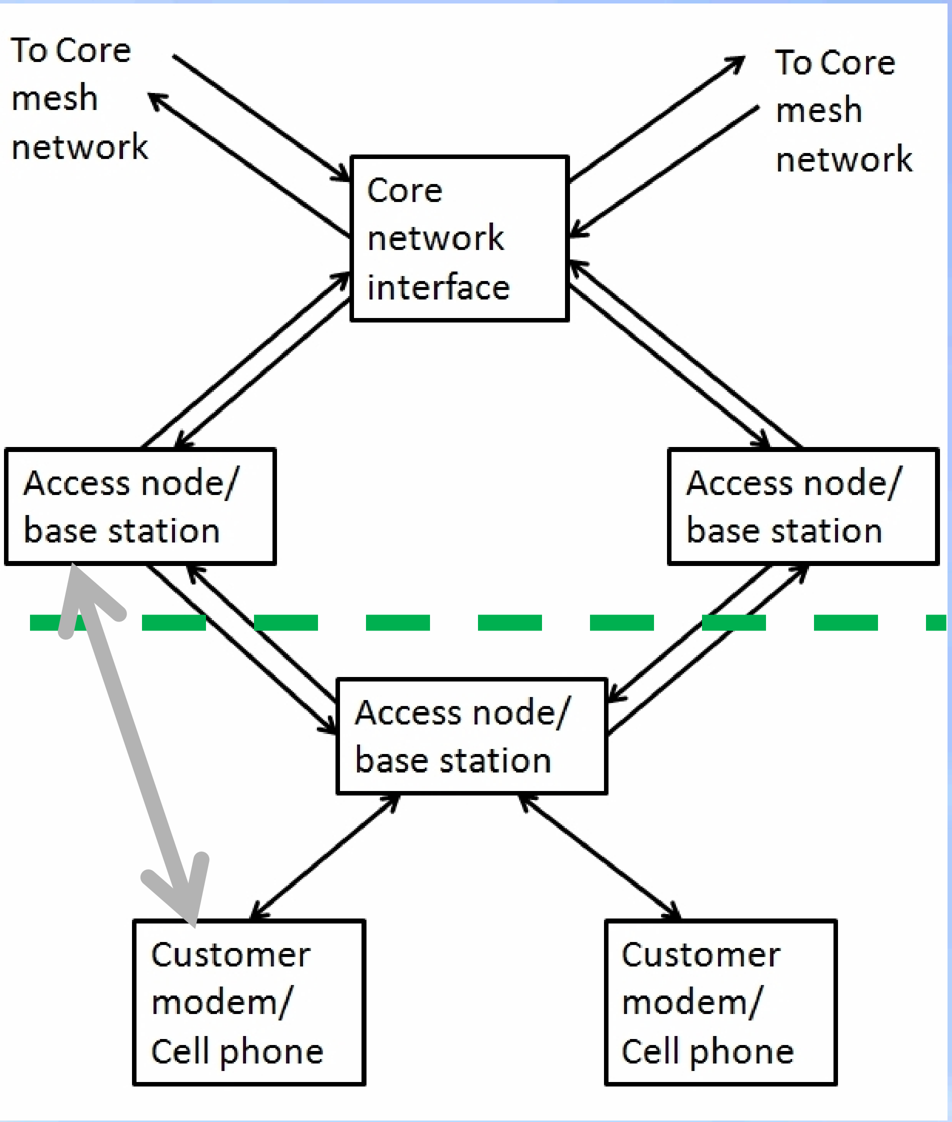


Ring structure
Protects against a single point of failure

Not Protected against a single point of failure

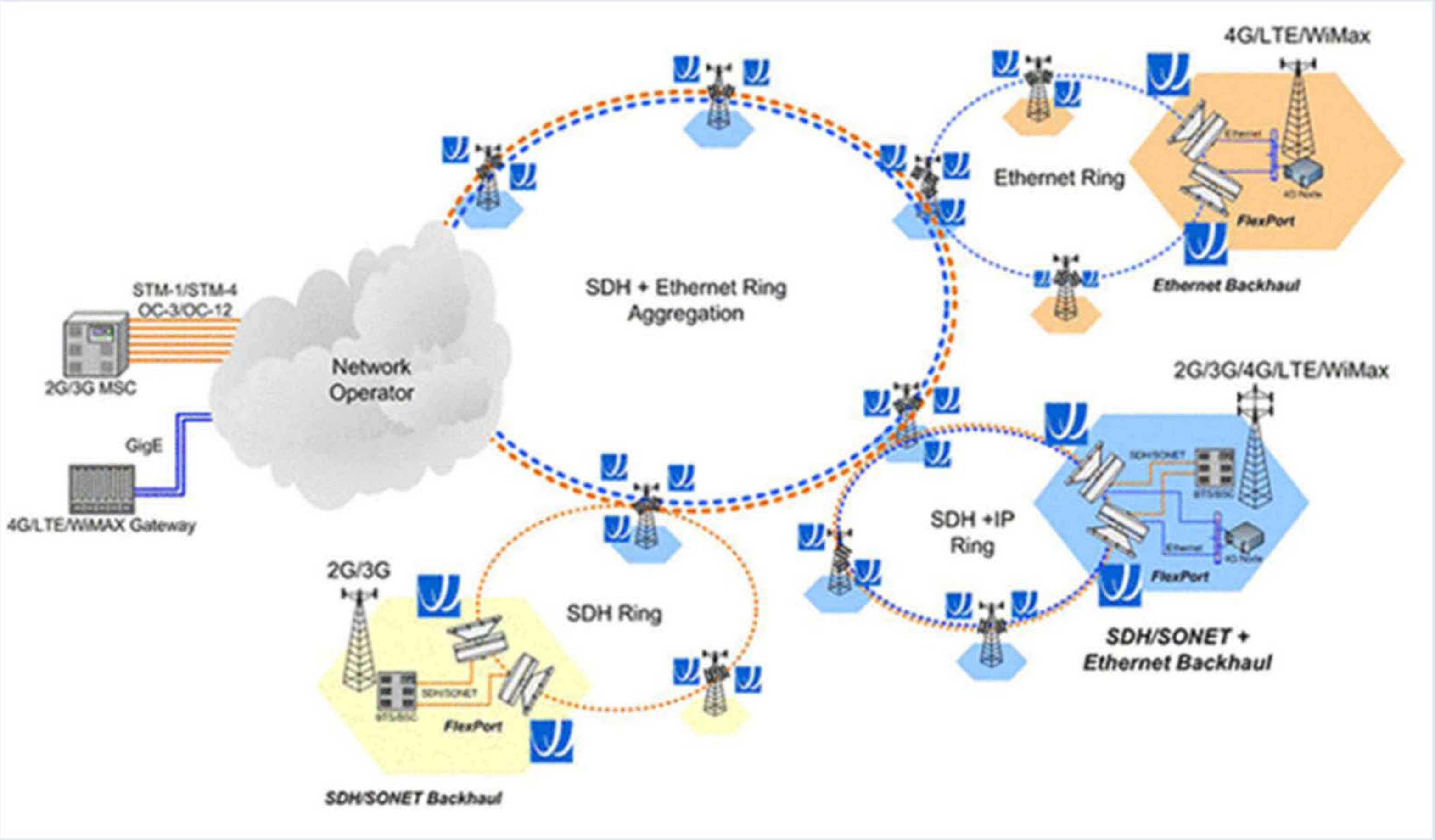
Additional Network Resilience

Ring structure
Protects against a single point of failure



- Resilience may be increased with dual access.
- Add an additional access path to a different access node.

Figure 8: Mobile network topology



Source: Bridge Wave Communications.[63]

Suggested Actions
Share Best Practices

Example from Telefónica Perú:

Preventive action to protect network sites.

- Blocking doors of network sites with sandbags on both sides of door (inside and outside room),
- Total cost of this preventive action was extremely low in comparison with potential damage to equipment and loss of service due to network failure.

Suggested Actions
Share Experiences

Example from Alcatel-Lucent:

- Telecom network equipment grounding.
- Improved grounding when soil moisture content and resistivity changes under climate change conditions.
- Impacts telecom equipment's resiliency to lightning strikes and erratic voltage/current surges occurring over electricity grids.
- Affects all telecom equipment in the affected regions.
- Equipment grounding systems needs to be tested and redesigned, if necessary, to meet higher standards and specifications.
- Continued monitoring may need to be done, so long as local soil resistivity changes continue to occur.

Suggested Actions
Develop a Network Continuity Plan

Develop strategies around

1. People
2. Location
3. Information
4. Process
5. Technology
6. Supplier
7. Transportation
8. Energy
9. Regulation

Source: ITU

Climate Change Risk Assessment: Checklists

- Categories
  - Buildings and HVAC
  - Infrastructure and Access
  - Power Supplies
  - ICT Devices and Systems
  - Routing and End-End Reliability
  - IT Services
  - Workforce
  - Vehicles
  - Propagation (wireless etc)
  - Supply Chain
  - ICT end-user services and equipment

ICT Buildings and HVAC

As stated in Section 4.2.1 of this report, an important function of ICT buildings (such as data centres and central offices) is to maintain electronics at a safe operating temperature. Heating, ventilation and air-conditioning systems (HVAC) play a key role in that regard, and should be designed and maintained to keep the ICT equipment within the temperature and humidity limits specified by the manufacturers.

Example

Climate Adaptation Risk Assessment: ICT Buildings and HVAC.

Scope: Exchanges, base stations for mobiles, data centres, repeater stations, transmitter stations.

Risk Assessment to climate extremes.

A1. Flood.

A1(i) Do you have a list of buildings which are vulnerable to flood and a Plan of Action in event of flooding?

A1(ii) Are any of your buildings near or on a slope which could subside?

A1(iii) Does your organization have measures in place to cope with extreme rainfall? (e.g. regularly inspect and clear drains).

A2. Drought

A2(i). Do you have buildings which on land which is liable to crack and become unsafe during an extended heat wave? (e.g. brick buildings)

A2(ii). Do you have sufficient off-mains water to cope with extended drought? (e.g. ponds for use by fire pumps)

A3 Extreme Heat

A3(i). Do you have ICT equipment operating in rooms with windows facing the sun?

A3(ii). Do you have blinds fitted in ICT equipment rooms with windows facing the sun?

A3(iii). Are your air-conditioning units serviced regularly?

A3 (iv). Does the power load in the equipment room exceed the capacity of the air conditioning unit to remove the heat produced?

Example of Hurricane Sandy

Box 11: Impact of extreme events on the ICT sector

"The storm surge from Hurricane Sandy has resulted in flooding at several Verizon Central Offices in Lower Manhattan, Queens, and Long Island causing power failures and rendering back-up power systems at these sites inoperable. While these sites are currently on battery power, the inevitable loss of power requires that all equipment at these sites be powered down to prevent damage. Customers that are served by these central offices will experience a loss of all services including fibre (voice, internet and video), high speed Internet, and telephone services. Some customers may experience intermittent busy signals while attempting to dial 311 service for non-emergency calls. Verizon engineers continue to assess the damage at these locations and we will post updates as additional information is available".

Source: AT&T (2012).

Check Flood Risk Zones

Map legend

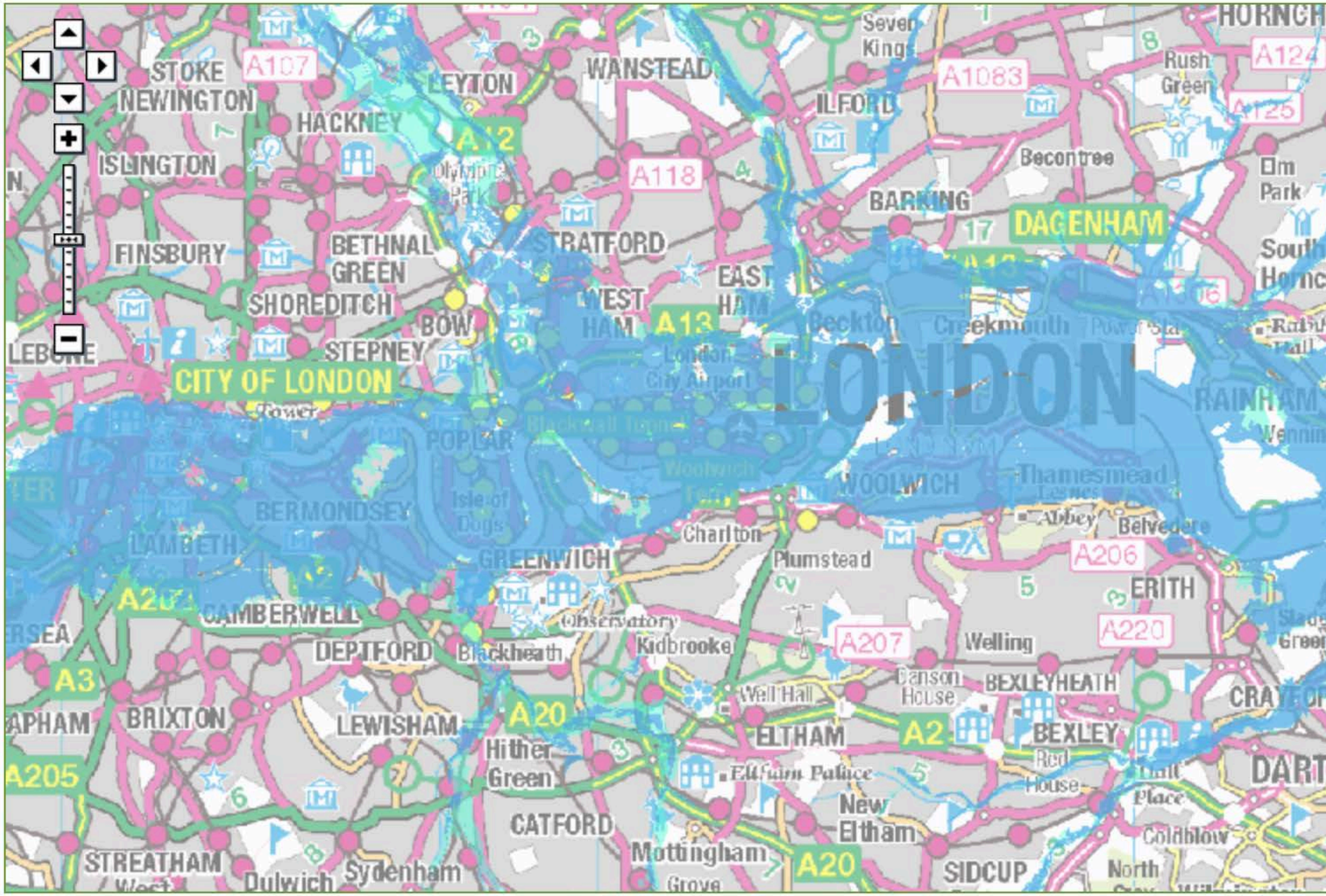
Click on the map to see what Flood Zone (National Planning Policy Guidance definitions) the proposed development is in.

Flood Map for Planning (Rivers and Sea)

- Flood Zone 3
- Flood Zone 2
- Flood defences (Not all may be shown*)
- Areas benefiting from flood defences (Not all may be shown*)
- Main rivers

X: 541,396;Y: 179,993 at scale 1:125,000

Other maps | Data search | Text only version



Conclusions on ICT and Adaptation to Climate Change

- **Adaptive practices:** part of the **'new normal'** for business operations
- **Adaptive approaches:** assessment of the potential risks and vulnerabilities, direct and indirect impacts, as well as mechanisms to tackle new business opportunities and new standards.
- **Adoption of resilient pathways***:* by going beyond generic contingency and risk management measures.

*Integrating **the attributes of resilience** can help strengthen the sector's approach to climate change adaptation by improving its ability to **cope, adjust and potentially transform**, and by enabling sector-wide strategies in the face of **short-term shocks and long-term trends**.*

Recommendations

TSPs should:

- Assess the energy consumption of network equipment and set benchmarks and targets for reductions.
- Request more energy efficient ICT products and services from suppliers in their SoRs.
- Ensure ICTs play a key role as an enabling technology to reduce GHG emissions in other sectors.
- Help to develop global standards including methodologies to assess the impact of ICTs on climate change.

Summary

- ICTs can be used to tackle climate change in a number of ways:
  - by applying ICTs to reducing emissions in other sectors,
  - by improving the energy efficiency of the ICTs themselves,
  - through climate change monitoring,
  - by improving adaptation to climate change.
- Progress is being made in each of these areas.
- Policy makers and regulators should promote and enforce the necessary actions arising from these.

References for further reading:

Energy efficiency of ICT equipment:

- ITU Technology Watch Report 7: "NGNs and Energy Efficiency".
- ITU Future Networks Focus Group Report "Overview of Energy-saving of Networks".
- ITU-T Recommendations: L.1300, L.1310
- The GreenTouch Consortium - www.greentouch.org.

Mitigation against climate change:

- SMARTer2030 "ICT Solutions for 21st Century Challenges", GeSI, 2015 – www.gesi.org/portfolio/project/82

Adaptation to climate change:

- ITU Report: "Resilient Pathways: The Adaptation of the ICT Sector to Climate Change" - www.itu.int/en/ITU-T/climatechange/Documents/Publications/Resilient_Pathways-E.PDF
- ITU-T Recommendation L.1500 "Framework for information and communication technologies (ICTs) and adaptation to the effects of climate change Adaptation"
- IPCC Special Report: "Managing the risks of extreme events and disasters to advance climate change adaptation" - www.ipcc-wg2.gov/SREX/images/uploads/SREX-All_FINAL.pdf