European Utility Telecom Council

Radio Spectrum Strategy Group

WHY UTILITIES NEED ACCESS TO RADIO SPECTRUM

SUMMARY

- Most utilities in Europe use radio communications to monitor and control their networks, and for voice communications with their workforce. In some cases, use of radio dates back over 60 years.
- The focus on reducing carbon emissions through extensive deployment of renewable energy, demand management and increased energy efficiency requires more extensive communications than previously necessary.
- Ambitious target dates for the achievement of specific energy policies will require much of the increase in communications to be delivered by radio.
- The characteristics of utility communications networks differ from public networks, specifically in terms of resilience, security, longevity and geographic coverage.
- Although many utility telecommunications requirements can be met by public mobile operators' networks, a set of critical core requirements are likely to be met only by specialised networks for which dedicated radio spectrum will be needed. Utilities also take into account additional strategic considerations such as intellectual property rights, standardization and the potential eco-system to prevent a lock-in situation.
- To obtain resilience and geographic coverage, radio spectrum below 1 GHz is needed, supplemented in some cases by spectrum in the range 1-3 GHz for capacity.
- Developed nations are increasingly dependent on reliable utility services for their economic and social well-being.
- Reliable electricity is more important to economic growth than digital communications: reliable electricity supplies need resilient communications to support them.
- The role of radio spectrum in facilitating the introduction of 'smart' utility networks is recognised in Article 7 of the European Radio Spectrum Policy Programme.
- Utility data requirements are intrinsically different to public mobile data networks in that their requirements include:
  - Data rates much less than consumer data rates (typically 9.6 kbits/s rising to 2 Mbits/s, although some applications operate at rates as low as 50 bits/s;
  - Enhanced resilience to enable networks to operate in the absence of mains electrical power for an extended period;
  - Geographic coverage to include less populated areas if they contain significant utility infrastructure;
  - Exacting availability, latency, jitter and synchronous requirements;
  - Upload-centric as opposed to download centric for public data networks;
  - High levels of security to prevent malicious disruption of utility operations; and
  - Longevity of product support in recognition of longer investment cycles.
- Harmonisation of spectrum allocated to utilities on a European basis will bring industrial support benefits, reduction in cross-border interference and lower costs to energy consumers.

Detail

What do utilities use telecommunications for?

1. Electric utilities are the dominant users of utility telecoms. For transmission and distribution companies, for Smart Grid and Smart Metering purposes, this includes:

- Teleprotection to isolate part of the network when a fault is detected, whilst at the same time avoiding interruptions to other users of the network. These systems operate before the fault currents reach the level at which protective circuit breakers operate, minimising disruption to supplies and reducing the risk of damage to infrastructure through excessive current flows.
- Supervisory Control and Data Acquisition (SCADA) systems to monitor voltage, current, temperature levels and switch positions throughout the network, with the opportunity to reconfigure the network remotely in response to changing demand and faults in the network.
- Remote smart metering to monitor consumption, electricity supply quality and demand management as mandated by EU regulation.
- Distributed Automation whereby monitoring and control functions can be embedded in the network to remotely control equipment and reconfigure the network automatically without operator intervention, reporting the actions of the automation system to the control room.
- Dynamic Asset Management to continuously monitor the condition and loading of assets to enable them to manage system parameters on a dynamic basis to increase capacity, avoiding the need to re-enforce assets and bring extra capability more rapidly; as well as predicting failures before breakdown.
- Mobile voice communications systems to allow communications between the control room and field staff for routine operations, safety and emergency restoration of supplies.

Dynamic asset ratings may be able to permit networks to carry up to twice the load possible with static asset ratings.

- Closed-Circuit TeleVision (CCTV) to monitor remote sites for security, safety and remote monitoring of assets.

2. Gas transmission and distribution makes extensive use of SCADA to monitor and control their networks. Losses in gas networks are proportional to pressure, thus the lower the pressure that can be maintained throughout the network whilst still maintaining adequate pressure at the outlets, the greater the efficiency. Mobile voice and data networks are also used to manage field staff to respond to leakage reports in the most effective manner.

3. Energy supply requires telecommunications to facilities management of smart meters, dynamic tariffs, demand management and off-supply detection.

4. Water companies use extensive SCADA systems to manage supply of clean water and removal of waste water and sewerage, plus control of flooding. The SCADA systems control the network to minimise pressure whilst maintaining a fixed minimum, thereby reducing energy usage and leakage; and monitor water quality to guarantee the safety of public drinking water.

5. New technologies and requirements are emerging which will require additional telecommunications provision, for example:

- In electricity, devices called ‘synchrophasors’ which will enhance network stability as more distributed generation is incorporated into electricity networks, thereby reducing the likelihood and severity of catastrophic cascade failures.
- In gas, networks will incorporate a wider range of gases from diverse sources requiring more complex control to maintain calorific value and flame quality.
- In water, increasingly stringent environmental standards and challenges to water management brought about by climate change will require more extensive SCADA.

Why do utilities need to use radio solutions?

6. Utilities make extensive use of fixed network solutions, using commercially sourced telecom facilities, their own copper and fibreoptic cables; and in the case of electricity, transmission of signalling along power cables used for transmission and distribution.

7. However, radio provides supplementary communications because:

- The telecoms architecture can be designed for communication needs rather than following the physical infrastructure of the electricity grid;
- With radio numerous geographically spread (decentralised) assets can be reached easily and quickly.
- Radio systems are better able to withstand weather related incidents which disrupt and destroy physical infrastructure;
- When fixed infrastructure is damaged and needs repairing, the priority is restoring the primary service, leaving the telecoms support structure unmended;
- If an embedded telecoms cable fails, the primary service can often not be interrupted to repair the telecoms element;
- Radio can be deployed rapidly in response to changing requirements and serve remote areas, whereas fixed telecom cables may not serve remote parts of the networks and cannot be relocated easily; and
- Radio is essential to maintain communications with the mobile and repairing the network.

Monitoring and control of underground assets using radio telemetry.

8. Overall, the timescales for energy and environmental policy do not permit the deployment of significant additional fixed telecoms infrastructure, necessitating the deployment of radio solutions if the agreed policy goals are to be achieved.

What are the special characteristics of utility telecommunications requirements?

9. Although recent developments in IP (Internet Protocol) and MPLS (Multi-Protocol Label Services) networks facilitate carriage of utility communications over commercially available networks, utilities retain a number of uniquely demanding requirements.

- Whereas commercial and domestic requirements are moving past the EU requirement for 2 MBits/s to all European households by 2015, towards 30 MBits/s and possibly ultimately 100 MBits/s, many utility requirements are currently met with 9.6 kbit/s per site, potentially growing to 2 MBits/s per site – although some applications only require data rates as low as 50 bits/s.

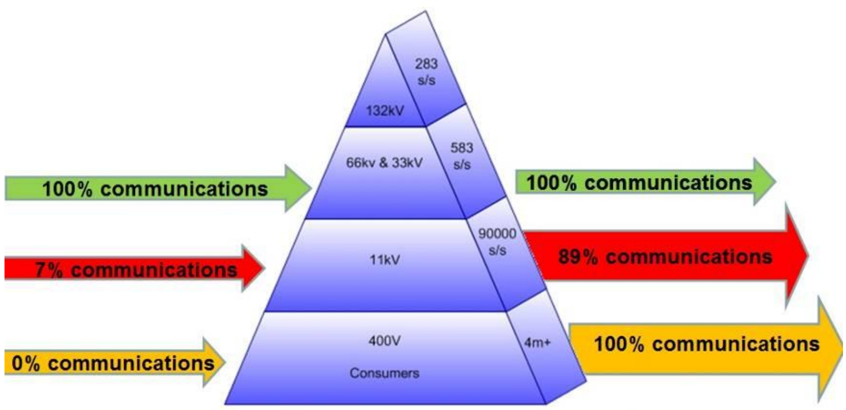
- Utility telecommunications growth will come from increasing geographic coverage of the monitoring networks, and speed of response, rather than increased data rates as in other sectors.
- Enhanced resilience to enable networks to operate in the absence of main electric power for an extended period, which may extend from a few minutes to 72 hours, and in extreme cases 7 days.
- Geographic coverage to include less populated areas is often important to utility companies where power lines traverse remote regions where there is little population to attract commercial operators. Renewable energy and water resources are also often in remote locations requiring monitoring and control.
- Latency and asymmetry requirements in the electricity industry tend to be linked to voltage levels, requiring latencies as low as 6mS with associated asymmetry of less than 300 uS if the protection systems are to function correctly at the highest voltage level. These requirements emerge from the need to compare 'in cycle' values across an electricity network in real time where the duration of a half-cycle is 10mS in order to maintain stability and identify fault conditions.
- Whereas commercial networks are inherently download-centric (hence the widespread deployment of Asynchronous Digital Subscriber Line (ADSL)), utility networks are upload-centric with a small number of control rooms remotely monitoring large geographic areas, utility growth arising from an increase in the number of monitoring points.
- Utilities need high levels of security for their telecoms networks, not only in terms of integrity to prevent malicious disruption of utility operations; but also guaranteed access where denial of service occurs either from network congestion or malicious intent, denying the utility visibility of its network.
- Consumer telecom product cycles have been decreasing to the extent that products can be obsolete within a year, whereas utility infrastructure can have a life of up to 50 years. As telecoms equipment may be embedded in large structures operating continuously, replacing obsolete equipment is a major exercise, completely different to replacing a mobile phone or home WiFi router.

What number of connections will be required?

10. A study by consultants in the UK devised the following representation of utility asset management for a typical distribution company with 4 million customers serving an area of 29,000 km^2 through a network of 80,000 km of underground cables and 48,000 km of overhead lines.

11. Compared to 2011, the increase in connected end points was forecast to grow by 775% by 2021 and 1199% by 2013.

Increase in connection nodes for electricity distribution networks



	Quantity of sites requiring comms (% increase over 2011)	
	2021	2031
Total	775%	1199%

12. Although the degree of connectivity required at the 11kV level (or alternative equivalent Medium Voltage (MV) level) is still uncertain, most commentators consider it will have to be between 50% and 100% of all end points, plus monitoring in real-time of many distributed assets to deliver the capacity increases required by low-carbon energy solutions.

13. Since this model is typical of most electricity distribution networks across Europe, it can provide a first level approximation of the increase in connections that will be required. European data indicates approximately 200 million households across Europe, and although this does not precisely mirror the data above, it can be scaled to suggest 4.5 million assets at Medium Voltage level across the EU, indicating:

- 2011: connectivity of 315,000 units
- 2021: connectivity of 2.4 million devices
- 2031: connectivity of 4 million devices

Do all utilities have the same requirements?

14. As well as the obvious differences between gas, water and electricity infrastructures, utilities operate in different physical environments with different legacy asset bases. For example:

- A utility operating in a dense urban area will have a large amount of underground infrastructure, but also potentially several commercial telecoms providers; whereas a rural utility will have a large amount of 'above ground' infrastructure, but most probably fewer commercial telecoms options.
- Some utilities have substantial investments in fibreoptic cables, others have significant investments in radio towers. This influences the way in which new telecom facilities can be provided.

How much bandwidth is required?

15. Work in the European Utility Telecom Council is continuing to identify precisely how much bandwidth might be required to support these requirements, but emerging requirements are focusing on a total of 16 MHz of dedicated spectrum, specifically:

- 2 x 3 MHz in the 450-470 MHz band.
- 10 MHz in the 1.5 GHz region.

16. This spectrum is in addition to deregulated spectrum in 870-876 MHz for Smart Metering, VHF spectrum for wide-area voice communications, plus access to commercial microwave and satellite spectrum sourced in the bands shared throughout the industry.

17. EUTC's bid for the above spectrum is consistent with other allocations being considered for Smart Grids elsewhere in the world, for example:

- Allocation of 30 MHz in the 1800 MHz band by Industry Canada.
- Shared access in the USA to 30 MHz in the 700 MHz band for 'public safety' which may be used by utilities.

18. 16 MHz for operational utility requirements represents only 1.3% of the 1200 MHz of spectrum identified in the European Radio Spectrum Policy Programme to meet the increasing demand for wireless data traffic to allow the development of commercial and public services.

Why are these frequency bands required?

19. Ideally, utilities would have all their requirements met with spectrum below 1 GHz, harmonised in the main area used by utilities between 450 and 470 MHz. However, acquiring 16 MHz of spectrum in this space is unlikely to be possible in the time frame required for its use to fulfil European Energy policy objectives.

20. The requirement for low frequency spectrum arises from the need to be:

- Relatively immune to severe weather events;
- Able to cover adverse terrain and obstructed paths;
- Capable of covering large geographic areas to reduce the amount of infrastructure to facilitate enhance resilience for both base station power back-up and backhaul redundancy.

21. This part of the frequency spectrum is ideal for the lower data rate requirements of utilities compared to commercial operators, and enables high gain antennas to be used for effective frequency re-use and excellent discrimination against unwanted interference.

Can this spectrum be shared with other users?

22. Utilities do not have any substantive objections to sharing spectrum or networks with other users, but any such sharing must be able to support the utility requirements, especially for guaranteed access to the network within the specified parameters. However, it should be noted that where teleprotection systems and SCADA operate continuously, sharing has to be on a geographic basis of separation between utility and other systems.

What is the commercial value of this spectrum?

23. It should be noted that the relatively small amounts of spectrum required by utilities in non-internationally harmonised bands have, if auctioned at all, not attracted very high prices.

What is the timescale for this requirement?

24. Deployment of ‘smart’ utility networks is driven by energy and environmental policy goals rather than commercial requirements. The immediate challenge is EU 2020 agenda:

- 20% cut in emissions of greenhouse gases by 2020, compared with 1990 levels;
- 20% increase in the share of renewables in the energy mix; and
- 20% cut in energy consumption.

25. In order to achieve these goals, progress towards accessing the spectrum identified above will be required by 2015, with access to the full amount identified above by 2020.

What happens if this requirement is not met?

26. Unless access to suitable spectrum can be made on a timely basis by 2015, it is difficult to see how the above EU targets can be met; and in the case of electricity networks, the risk is increasing instability of the networks, raising the prospect of spectacular cascade failures as occurred in the US in August 2003 and across Europe in November 2007.

Use of temporary tanks to supply drinking water to customers when the public water supply fails.

Adrian Grilli
EUTC, Brussels
14 March 2013