White Paper
UTCAL

RADIO SPECTRUM FOR UTILITIES IN BRAZIL

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Utilities Telecom & Technology Council América Latina™

Radio spectrum for utilities in Brazil

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1. Introduction

Since the 1950s, electricity, water and sanitation and gas companies (utilities and critical infrastructure) have used the radio spectrum in communications to monitor and control their networks, as a way of guaranteeing the quality, safety and reliability of their services. Voice communication with field personnel has always been a priority to ensure this quality, always focusing on the end customer. With the current need for sustainability, a third dimension came to be considered by utilities in the provision of services – safety, reliability and sustainability.

Brazil has recently started a major transformation in its electricity infrastructure. This vast infrastructure upgrade - stretching from homes and businesses to substations and power plants, affecting almost anything and everyone - is critical to national efforts to increase energy efficiency, reliability, and safety; transition to renewable sources (wind and solar) of energy; reduce greenhouse gas emissions; and building a sustainable economy that guarantees future prosperity. These and other potential benefits of "smart" electric power grids are being pursued around the world.

Focusing on reducing carbon dioxide emissions through widespread deployment of renewable energy, managing demand and increasing energy efficiency requires communications systems with more geographic coverage than existing ones. Moreover, this transformation of the country's aging electricity grid into an advanced digital infrastructure will require additional capacity for two-way, real-time connectivity to send information, control equipment and distribute energy. Although public communications networks can support some of utilities' telecommunications needs, utilities deploy, operate, and maintain their own private internal communications networks for their mission-critical utility applications. Utilities require access to dedicated spectrum for implementing wireless systems capable to support their mission-critical operational requirements.

Spectrum below 1 GHz is suitable for obtaining better geographic coverage, penetration into residential/commercial structures and communication system resilience, and, in some cases complemented by frequencies in the 1-3 GHz range for greater data transmission capacity.

Voice communications are important, but the data requirements demanded by the various applications, existing and future in utilities segment, are intrinsically different from the resources offered by public mobile data networks:

- Typical data rates require much less than consumer internet data rates and range from 2.4 Kbps to 10 Mbps.
- Improved resiliency allowing telecom networks to operate for extended periods in the absence of utility power.
- Geographic coverage to include less populated areas where utility infrastructure is usually located.
- Demanding availability, latency, jitter, and synchronization requirements.
- Elevated levels of security, to avoid malicious interruptions of public service operations.
- Long term profile for solutions and products in recognition of longer investment cycle adopted by companies (and regulators) in their business segments.

The harmonization of spectrum destined for utilities in Brazil and Latin America will bring medium and long-term benefits to the utilities segments, such as reduced interference and lower costs of solutions that will certainly benefit end consumers.

In conjunction with these developments and the underlying public and private investments, essential empowerment professionals' activities must also be undertaken. Chief among them is the development of effective strategies to protect the privacy of data related to the smart grid and to protect the computing and communication networks that will be critical to the performance and availability of this electrical energy infrastructure.

While the integration of information technologies is essential to building the smart grid and realizing its benefits, the same network technologies add complexity and introduce new interdependencies and vulnerabilities. Approaches to securing these technologies and protecting privacy must be designed and implemented early in the transition to the smart grid.

2. For what do utilities use telecommunications?

Electricity segment: Electric utilities require telecom solutions to add intelligence to their networks in a variety of mission-critical applications, including:

- Teleprotection systems to isolate parts of the electricity grid when a fault is detected, preventing the propagation of this fault to other consumers connected to the interconnected electrical system. These systems trigger the protection circuit breakers in an extremely quick way, before fault currents reach levels above the maximum capacities supported by the electrical devices, minimizing the risk of damage to the infrastructure in operation.
- Supervision Control and Data Acquisition (SCADA) systems aimed to supervise and obtain data to enable the visualization of a given process, with the objective of controlling it, providing an elevated level of interface to the system operator, informing in real time about all major events that occur in intelligent electronic devices (IEDs) distributed among industrial plants or geographically dispersed assets.

  For automated substations based on IEC 61850 standards, IEDs deployed in substations replace traditional relays, bus controllers and other measuring and switching devices (ex: circuit breakers). In this case, each IED is capable of direct communication with the SCADA Master Controller and direct communication is used for periodic calls from SCADA Master to obtain measurement responses, device status, event reports and control signals.
- Remote smart metering solutions are being implemented at consumer sites, substations and electrical network edge. Smart meters provide electrical measurements (energy consumed, voltage, power, etc.) at frequent intervals to monitor consumption, the quality of electricity supply and demand management.
- Distribution automation is implemented to remotely control electrical network equipment, through the built-in monitoring and control functions, and reconfigure the network automatically without operator intervention, reporting automation system actions to the control room.

- Dynamic asset management to continuously monitor the condition and loading of assets dynamically, optimizing capacities and avoiding the need to reinforce networks. Real-time measurements can also proactively help prevent failures and interruptions in supply to customers.
- Mobile voice communications to enable communications between the control room and field staff for routine operations, security, and emergency system restoration.
- Video monitoring to oversee the security of remote locations and asset monitoring. It is being used in substations, Operations Centers, and other strategic locations to assist in the operation of the physical and operational security of the system. The video feeds generated by the cameras are normally stored in local digital video recorders (DVR) and can be automatically transmitted to the Operations Center in the event of electrical incidents in substations or to the property security sector, in the event of detection of vandalism.

Gas transmission and distribution segment: Gas transmission and distribution companies make extensive use of SCADA to monitor and control their networks. Losses from the gas network are proportional to pressure; the lower the pressure maintained throughout the network, maintaining adequate output supply, the greater the efficiency. Mobile voice and data networks are also used to maximize management of field staff response to leak reports.

Water transmission and distribution segment: Water and sanitation companies use extensive SCADA systems to manage clean water supply, wastewater/sewage removal, and flood water defense. SCADA systems direct the network to reduce pressure while maintaining a fixed minimum, thus reducing energy usage and leakage along the supply network; they also monitor water quality to ensure the safety of their consumers and the general population.

Remote Smart Metering is also being increasingly deployed in water supply networks and smart meters require two-way communication to manage consumption.

New technologies and requirements are emerging, requiring additional telecommunications resources. In the electric power segment, devices called "synchrophasors" can increase grid stability as more distributed renewable generation is incorporated into electrical grids, reducing the likelihood and severity of catastrophic cascading failures. In the gas segment, future networks will encompass a wider range of gases from diverse sources that will require more complex control to maintain the calorific value and quality of the flames. In the water sector, increasingly stringent environmental regulations and climate change challenges to water management will require more extensive SCADA.

3. Why do utilities need to use radio solutions?

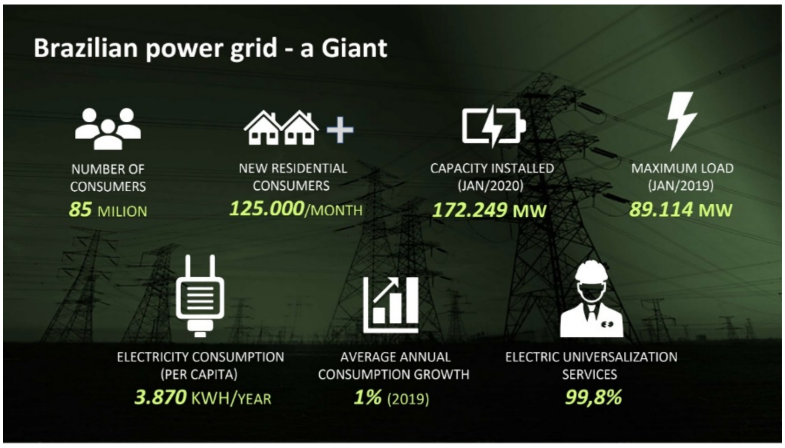
Electric utilities make extensive use of telecommunications solutions using their industrial facilities such as telecommunications stations and their own copper cables (Power Line Carrier - PLC) and optical fiber for data transmission.
However, given the coverage difficulties, the radio solution is also widely used and considered essential for the interconnection of its facilities in the control and supervision applications of an interconnected electrical system. With radio it is possible to:

- Reach numerous geographically dispersed (decentralized) assets easily, quickly, and reliably.

- As it is a more robust solution, it can be quickly deployed in response to changing requirements (climate, environment, catastrophes, etc.).
- Maintain communication with field teams, enabling greater mobility, agility and security in network maintenance and repair activities.

In general, the deadlines for achieving energy and environmental policy goals do not allow for the addition of significant wired telecommunications infrastructure, requiring the implementation of radio solutions so that the agreed goals are achieved.

In Brazil, due to the current size of the electrical system, it is possible to assess the impacts caused to stakeholders involved by failures in processes and applications resulting from an inadequate telecommunications system to support mission-critical applications demanded in the generation, transmission and distribution segments.



4. What are the special characteristics of the telecommunications requirements to meet the needs of utilities?

Although recent developments facilitate the transport of data from mission-critical companies, such as utilities in the electricity, water and gas segments, over the networks of operators of telecommunications, utilities need to meet a series of extremely stringent requirements to:

- The growth in telecommunications demand by mission-critical companies results from the increasing need for geographic coverage of their monitoring networks and reduction of response time, instead of increasing data transmission speed.
- The demand requirements that drive operators' businesses telecommunications, in corporate and residential markets, are moving towards capacities of no less than 300 Mbps and possibly, in the medium term, 1,000 Mbps, while for utilities, there is still talk of 2.4 Kbps per site, potentially growing to 10 Mbps.

- Geographic coverage includes less populated areas and low commercial interest, especially where power lines energy or water pipelines or oil pipelines cross remote regions and with very low commercial importance for commercial telecommunications operators.

- Renewable energy and water resources are also often in remote locations.
- Enhanced resiliency is necessary for networks to continue to operate, even in the absence of power mains (from the utility's supply network) for long periods.
- The latency and asymmetry requirements of telecommunications systems in the electrical segment are linked to power parameters, requiring latencies of 6ms, with associated asymmetry of less than 300 µs, for protection systems to function properly. These requirements emerge from the need to compare values "on cycle" in a real-time electrical network, where the duration of a half cycle is 8ms (10ms in networks at 50Hz) to maintain stability and identify faults.
- Commercial telecommunications networks are inherently download-centric, while utility telecommunications networks are upload-focused, with a small number of Operation Centers and control rooms remotely monitoring large geographic areas.
- As they are “mission-critical”, the applications adopted by utilities present requirements that demand high levels of security for telecommunications networks, not only in terms of integrity, to avoid malicious interruptions of operations, but also for guaranteed access.
- While the cycles of consumer telecommunications products are decreasing and the products become obsolete in an increasingly shorter period, the infrastructure adopted by utilities has a longer typical lifespan (> 20 years). The telecom equipment of an electrical company operates continuously and replacing obsolete equipment is a big exercise, unlike the ease of a telecom operator in replacing a Wi-Fi router.

5. Do all utilities have the same requirements?

In addition to the obvious differences between gas, water and electricity infrastructure, utilities operate in different physical environments with different types of legacy assets. In dense urban areas, for example, the utility will have access to the infrastructure of several commercial telecommunications providers, while in rural areas it will not have many infrastructure options and possibly only one commercial telecommunications option.

Financial considerations also play an important role in the decision-making process as some utilities have substantial investments in fiber optic cables, while others may have significant investments in radio towers.

6. How much bandwidth is needed?

The European Utility Telecom Council (EUTC) has identified a typical spectrum "portfolio" required by a utility, comprising a total 16 MHz band of dedicated spectrum below 3 GHz.

A 16 MHz band for utility operational requirements represents only 1.3% of the 1200 MHz of spectrum identified in the European Radio Spectrum Policy Program and is sufficient to meet the growing demand for wireless data traffic, in addition to allowing the development of commercial and public services – a small price to pay for the reliability requirements demanded by the mission-critical services of utilities around the world.

Around the world, utilities in different countries are focusing on similar requirements, with the global involvement of the Utilities Telecom Council (UTC, EUTC, UTCAL, AUTC). Although they have been participating for a long time in the world of radio spectrum regulation, utilities are seeking greater interaction with national telecommunications regulators, in addition to the Inter-American Telecommunication Commission (CITEL) and the International Telecommunication Union (ITU). These activities have already enabled, in Brazil, the creation of the Anatel-Utilities WG that discusses the spectrum needs of utilities. Internationally, UTC USA is the representative at CITEL and UTCAL is associated with ITU-R SG5. In addition, AUTC, the emerging African UTC, is seeking to establish ties with the African Telecommunications Union. In Europe, the identification of small and multiple frequency bands for use by utilities is being conducted within a process of regional spectrum harmonization, according to the data below:

- VHF – (50-200 MHz) – for voice and distribution automation in remote and rural areas [2x1MHz]
- UHF – (400 MHz) – for SCADA, automation, smart grids, and smart meters [2x3 MHz]
- UHF – (870 – 876 MHz) – for smart meters and mesh networks
- UHF – (1490 MHz) – for more data intensive smart grid, security, and point-to-point applications [10 MHz]
- SHF – for backbone and backhaul on strategic routes and availability improvement
- Satellite – complementary to terrestrial services in special applications.

In Brazil, the telecommunications regulator (Anatel) has already allocated the following bands to fixed and mobile services that can be used by utilities in their own private networks, on a non-exclusive basis. The spectrum assignment process requires that utility companies first obtain a telecommunications license for provision of a Private Limited Service – SLP, prior to obtaining an authorization for the use of radiofrequencies associated to the SLP.

Bands already allocated:

- VHF - 250 MHz: it is possible to use 2 bands of 5 + 5 MHz, Resolution nº 555/2010. Despite not being a 3GPP band, there is LTE equipment approved in Brazil.
- UHF - 1,5 GHz (L-Band): 3GPP bands 50 and 51, the upper 30 MHz is for preferential use of SLP; provides wide bandwidth with coverage characteristic; point-to-point applications.
- UHF - 2,3 GHz: 10 MHz bandwidth. Band 40 of 3GPP, has high scale of LTE equipment available - Resolution 710/2019.

- UHF - 2485–2495 MHz 3GPP Band 53: 10 MHz TDD (low power); the band is already allocated to all telecommunications services.

In addition, the allocation of the following bands is being studied by the agency:

- UHF - 410/420 MHz: 3GPP band 87, the availability of a 5 + 5 MHz band is being considered.
- SHF - 27,5 a 27,9 GHz: IMT2020 3GPP band n261, 400 MHz for preferred use by SLP.

Additionally, the use of the 700 MHz band and other sub-3GHz bands is being reassessed by ANATEL. The following possibilities are being considered:

- 450 MHz: The existing band plan comprises two 7+7 MHz segments aimed to enable the deployment of IMT based networks. ANATEL is currently revising it with a view to enabling the adoption of a 100 KHz channeling arrangement, aligned with international standards already adopted in the world. This revised channeling arrangement will enable the aggregation of offer 200 KHz carriers for NB-IoT applications, 1.4 MHz for LTE-M networks and up to 5 MHz for LTE (4G) carriers.
- 700 MHz: Currently Block 1 (5 + 5 MHz in 703 MHz and 758 MHz) is reserved for use by public security, national defense and infrastructure sectors. Anatel is considering the relocation of such users to the 850 MHz band (10+10 MHz) releasing 700 MHz Block 1 for other users, such as SLP license holders, which include the utilities segment.
- 900 MHz: 10 + 10 MHz duplex arrangement with 905-915 MHz (uplink) and 950-960 MHz (downlink).
- 2,5 GHz: 5 + 5 MHz duplex arrangement under study.

7. Can this spectrum be shared with other users?

Utilities, in general, have no objections to the sharing of spectrum or telecommunications networks with other users, however it is essential that the sharing fully supports the quality, availability and security requirements demanded by mission-critical applications, established by regulatory agencies and bodies responsible for the operation of the electrical interconnected system. However, for systems such as teleprotection and SCADA that have remarkably high availability and strict security requirements, sharing could make the operation of the electrical system unfeasible, for example.

8. Emerging threats

Security is a new area that expands telecommunications requirements. This applies to preventing malicious network disruption and customer data privacy, whether individual consumers who do not want third parties snooping into their lifestyles or business users who are vulnerable to rogue traders distorting the energy market.
Recent attacks on utility networks (specifically, the disruption of Ukrainian power grids by an unknown attacker in December 2015 left 225,000 people without power) demonstrate the potential vulnerability of utility provision to malicious intrusion. The answer lies in the ever-expanding security measures that increase data traffic on mission-critical networks, along with air gaps between utility control networks and public networks to create secure barriers against denial-of-service attacks.

On May 7, 2021, the Colonial Pipeline company, which transports 45% of the fuel consumed on the east coast of the United States, was the victim of a ransomware attack that forced Colonial to suspend all its operations.

A ransom of 75 bitcoins, the equivalent of $4.4 million, was paid to hackers after the May attack. Interesting fact is that investigators were able to trace the financial transfers and identified 63.7 of these bitcoins, which were confiscated according to a statement from the Department of Justice.

9. What is the timescale for this requirement?

The deployment of "smart" grids is driven by energy and environmental policy goals rather than commercial requirements such as:

a. Cutting greenhouse gas emissions.

b. Increase in the share of renewables in the energy mix.

To achieve these goals, the spectrum access process by utilities must be made quickly feasible.

10. What happens if this requirement is not met?

Unless access to adequate spectrum is granted quickly, it is difficult to see how the quality of supply can be maintained. In the case of electrical networks, the risk is accentuated with increasing instability in the network, raising the prospect of surprising cascading failures, as seen in the US in August 2003 and in Europe in November 2007. It is also reported that in July in 2012, an incident in India resulted in the failure of electricity supply to 650 million people.

Preventing the next major outage depends on accessing reliable, secure, and resilient communications for utility networks.

Or are we just going to say, "I told you so?"

This document was prepared by:

Dymitr Wajsman – UTCAL
Ronaldo Santarem – UTCAL
Adrian Grilli – EUTC
Mario Torraca – UTCAL
Wanderley Maia Filho – UTCAL
Brett Kilbourne – UTC