Broadcasting Towers Operation

WEEK 10 – Power Elements interoperability

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Objectives

At the end of the topic students will be able to:

1. Review the concept of power requirement for BTS
2. Understand different architectures for power distribution for BTS
3. Explain the power requirements and AC for BTS
4. Explain the full cycle of broadcasting towers operated system.

Rationale

Interoperability among the grid, generators, UPS, AVR,ATS and AC systems is essential for the seamless operation of Base Transceiver Stations (BTS). Each component plays a crucial role in maintaining a stable and reliable power supply, which is vital for uninterrupted communication services.

The grid serves as the primary power source, while generators provide backup during outages, ensuring continuous operation. UPS systems offer immediate power during brief interruptions, protecting sensitive equipment from voltage fluctuations managed by AVRs. ATS facilitates automatic switching between power sources, minimizing downtime. Additionally, AC units are critical for maintaining optimal operating temperatures, preventing overheating of equipment ensuring that BTS to operate efficiently and reliably, even in the face of power disturbances or environmental challenges.

Turn and talk

- Today, we're diving into an exciting journey that connects technology, communication, and innovation. Imagine the forefront of telecommunications industry, where you can explore how Base Transceiver Stations (BTS) keep us all connected.
- You have a chance to understand the critical systems to power these towers, from energy sources to cutting-edge monitoring technology.
- Think about your role in shaping the future of communication. The hands-on experience and real-world challenges and solutions in power management, ensuring that BTS operate smoothly and efficiently.
- So, turn to your colleague and discuss why you think learning about power system for BTS is important, and how this knowledge could open doors to exciting career opportunities in telecommunications and beyond.

10.1 Review

The requirements for broadcasting towers operation involves:

- **Widespread coverage**: Broadcasting towers allow signals to reach a large geographic area, ensuring that information can be disseminated to as many people as possible, regardless of their location.
- **Diverse communication**: They enable the transmission of various forms of media, including television, radio, and internet, catering to diverse audiences and preferences.
- **Emergency communication**: In times of crisis or emergency, broadcasting to wers can quickly disseminate critical information to the public, helping to ensure safety and awareness.

Therefore, a tower should always be connected to make sure it doesn't to provide the intended services.

10.1 Review cont'd

- The purpose of broadcasting towers is to transmit audio and video signals over large distances. This allows content to reach a wide audience.
- The key components include the transmitter, antenna, power supply, and often a backup system to ensure reliability.
- Towers are typically placed at high elevations areas to maximize coverage. The location is crucial for minimizing interference and optimizing the broadcast range. This require a well set and always well function power system.
- Broadcasting towers are supplied by the main grid or utility grid which sometimes fail.
- When the main supply fails, the alternative ways to supply the towers include; generator and UPS with proper switching mechanism provided by the ATS and the well-regulated power to the towers' equipment provided by the AVR.

10.1 Review cont’d

Power system for broadcasting tower operations looks at several key factors:

- Power requirements: Determine the total power needed for the transmission equipment, including the transmitter, antennas, and any auxiliary systems.
- Power supply: Ensure a reliable power supply, often using a combination of the grid and backup systems (like generators or UPS) to prevent outage.
- Transmission line design: Design transmission lines to minimize losses and ensure efficient power delivery to the tower.
- Voltage levels: Use appropriate voltage levels for different components to optimize efficiency and reduce losses.
- Load management: Implement systems to manage loads and ensure the broadcasting equipment operates within safe limits.

10.1 Review cont’d

- Regulatory compliance: Adhere to local and national regulations regarding emissions, safety standards, and power usage.
- Backup systems: Often, broadcasting towers have backup power systems to ensure continuous operation during outages, adding to overall energy needs. To calculate full cycle power, you'll need to consider the average power consumption of each component, the duty cycle of operation, and any energy losses in the system.
- Generators supply the necessary electricity for transmitters, antennas, and other equipment at the tower site.
- Voltage regulation: They help maintain stable voltage levels, ensuring consist ent operation of broadcasting equipment.

10.1 Review cont'd

- Load management: Generators can manage varying loads, allowing multiple devices to operate simultaneously without overloading the system.
- A UPS for broadcasting towers is a backup power system designed to ensure that broadcasting equipment remains operational during power outages or fluctuations. Its primary functions include:
- UPS provides temporary power during outages, allowing broadcasting to continue without interruption.
- UPS stabilizes voltage levels, protecting sensitive broadcasting equipment from surges and sags that could cause damage, that is voltage regulation.
- UPS provide transient protection for shields equipment from electrical disturbances, such as spikes and noise, ensuring signal integrity.
- UPS provides extended runtime using external batteries, extending backup time during extended power outages.

10.1 Review cont’d

- Many UPS units come with monitoring capabilities, allowing operators to track performance and receive alerts about power issues.
- Through seamless transition, UPS ensures a smooth switch to backup power, minimizing downtime when the main power supply fails. In broadcasting, reliability is crucial, so having a robust UPS system is essential to maintain continuous operation and signal quality.
- AVR system maintains constant voltage level in electrical power systems.
- In the context of broadcasting towers, AVR is crucial for ensuring that the equipment operate efficiently and reliably, despite fluctuations in power supply.
- Broadcasting towers require stable power to operate transmitters, which can be sensitive to voltage changes.

10.1 Review cont’d

- An AVR helps to protect these systems by regulating the voltage, minimizing the risk of damage from power surges or dips. This ensures consistent broadcasting quality and reliability, which is vital for communication and entertainment services.
- ATS for broadcasting towers is a device that ensures continuous power supply to critical equipment. Its primary function is to automatically switch the power source from the main supply to a backup generator in the event of a power failure or interruption.
- ATS monitors continuously the main power supply for outages or voltage fluctuations.
- When a power failure is detected, it automatically switches to the backup generator, ensuring minimal downtime.
- It initiates the generator's start-up process when it detects a power loss.

10.1 Review cont’d

- ATS manages the load distribution between the main power supply and the generator, ensuring that critical broadcasting equipment remains operational.
- ATS provides status indication by providing real-time status updates and alerts regarding power sources and system health.
- ATS has a testing capability through features for periodic testing of the generator and switching mechanisms to ensure reliability.
- Reliability in operation of broadcasting services, which often require uninterrupted power.
- Safety protection for sensitive equipment from power surges or outages.
- Compliance for service providers to meet regulatory requirements for continuous operation. Thus, ATS is crucial for ensuring that broadcasting towers remain functional during power outages, contributing to the reliability of communication and transmission services.

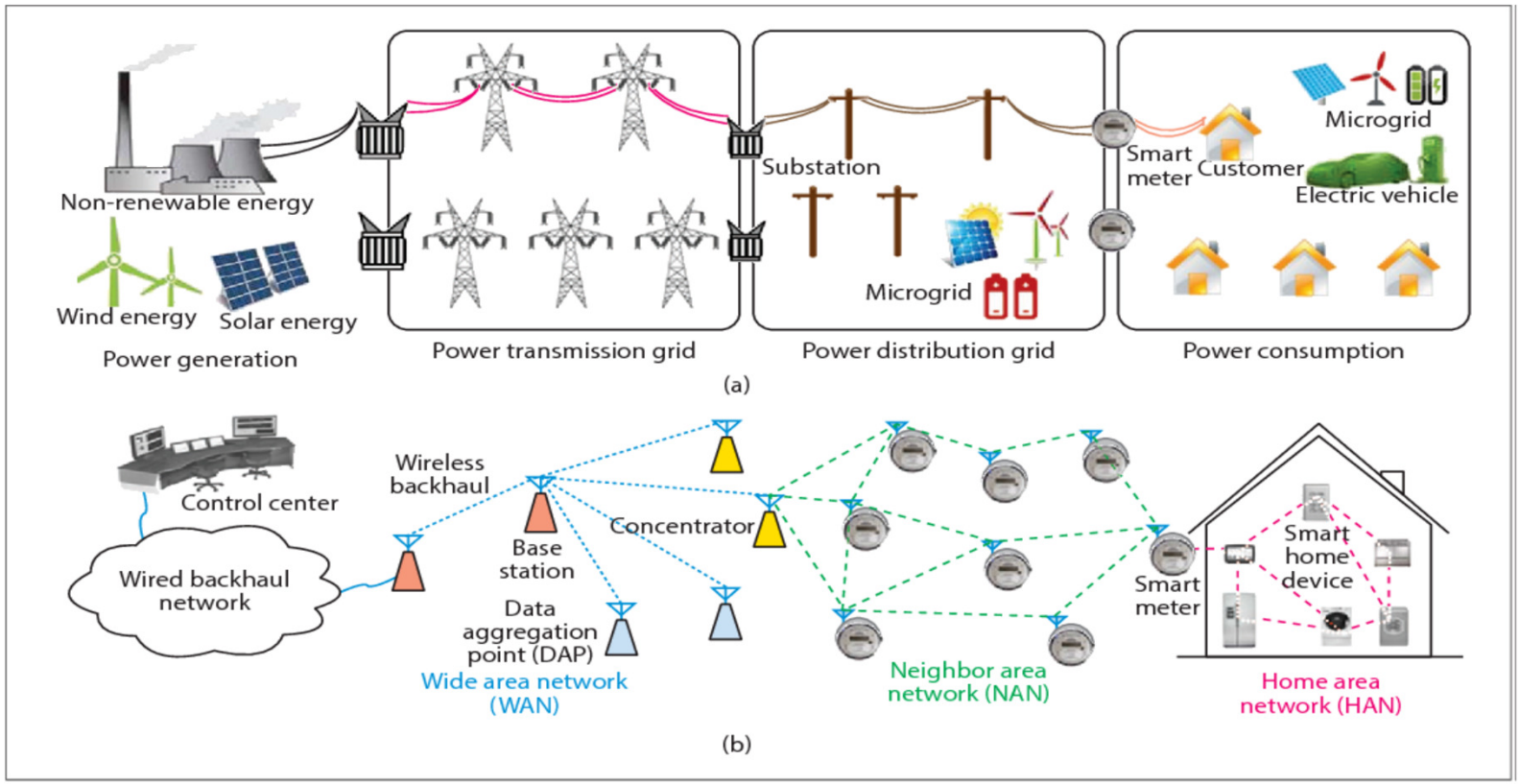
10.1 Review cont’d

- Full cycle power for broadcasting towers refers to the total energy consumption required for their operation, including all stages from generation to transmission.
- Energy generation: This can include traditional sources (like diesel generators or the grid) and renewable sources (like solar or wind).
- Equipment power requirements: Transmitters are the main power consumers; they can vary greatly based on the power output and type (AM, FM, TV, etc.), Antennas are passive components that require power for any active elements, support equipment like cooling systems, monitoring equipment, and backup power systems.

10.1 Review cont’d

- Operational efficiency considers efficiency of equipment and systems and their impact on overall power requirements. Upgrading to more efficient transmitters can reduce energy consumption.
- Powering the physical infrastructure like control rooms and maintenance facilities adds to the total energy requirement.
- Regulatory and environmental compliances necessitate the use of certain technologies that can influence energy use.
- Backup systems which ensure continuous operation during outages, add to overall energy needs.
- To calculate full cycle power, you'll need to consider the average power consumption of each component, the duty cycle of operation, and any energy losses in the system.

10.2 Power distribution for BTS



(Managing Power Outages in Communication Networks, Elisa Elmazaj, Michela Meo, Ph.D and Greta Vallero, Politecnico di Torino, 2021.)

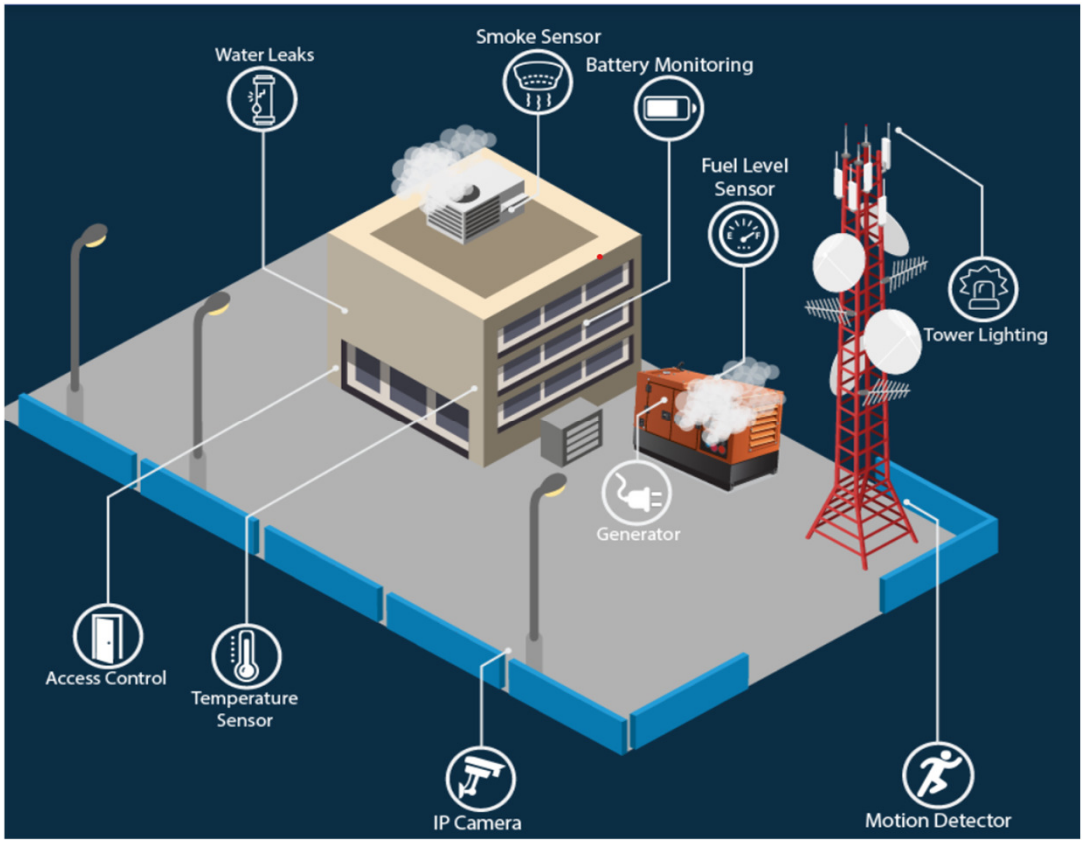
10.2 Power distribution for BTS cont'd

- Mobile network operators and carriers operate the nationwide infrastructure of Telecom Towers, (BTS) they form the major component of the GSM cellular network.
- They transmit and receive radio signals coming to and from mobile phones. The towers have BTS shelters which house the electronic communications equipment that is connected to the antennas on the BTS tower. Sensors are used to monitor environmental conditions in the shelters, as well as interface to third-party equipment for remote monitoring.
- Due to many BTS sites being in remote locations, power is one of the issues that are of major concern. Ensuring 100% uptime requires a robust approach to maintain power.

(https://www.flukeinfotech.com/base-station-transceiver-bts-monitoring/)

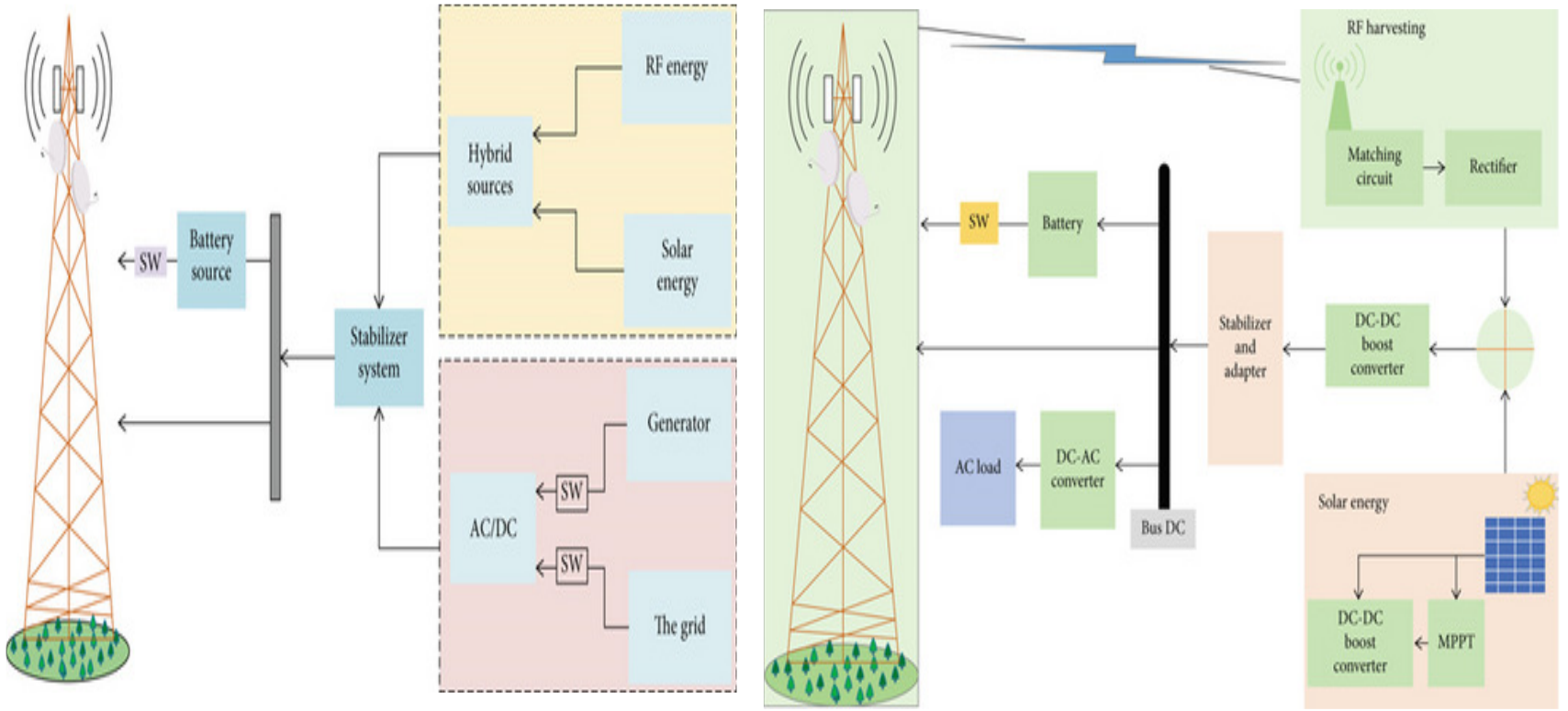
10.2 Power distribution for BTS cont'd

The operating environment is also of much importance. Temperature control through HVAC systems. AC units carry the risk of malfunction, and when temperatures rise rapidly putting equipment under stress and leading to failures. With AKCP temperature and Humidity sensors, it is sure that the operating environment within the BTS shelters is stable.



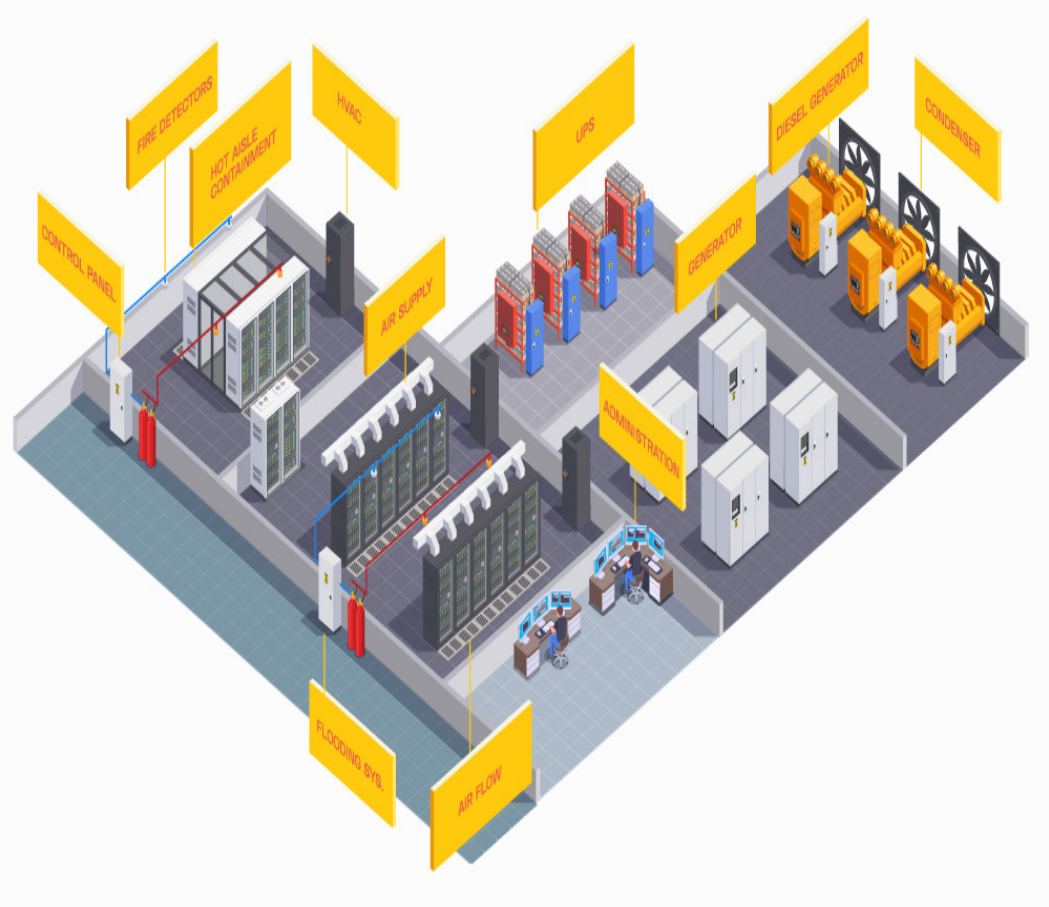
(https://www.flukeinfotech.com/base-station-transceiver-bts-monitoring/)

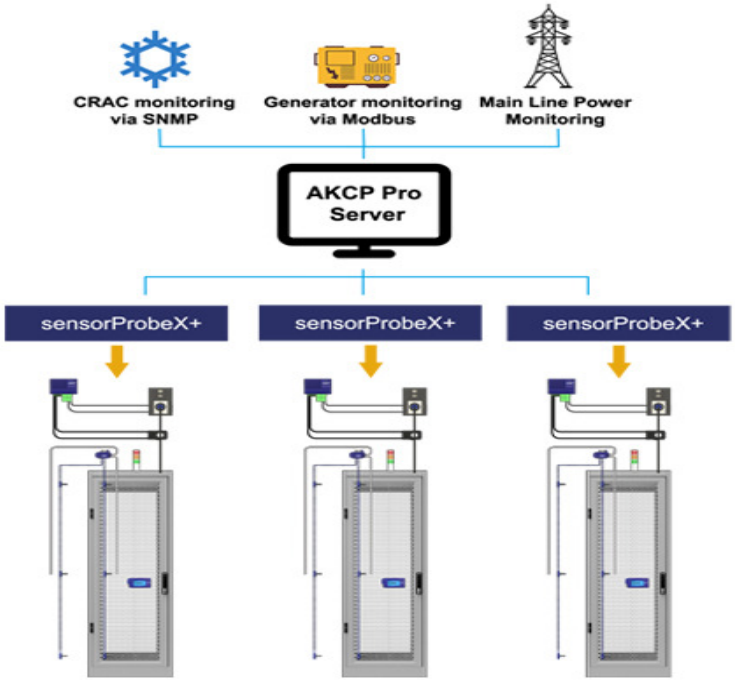
10.2 Power distribution for BTS cont'd



(Optimization of Power Supply for Base Transceiver Stations (BTS), A. M. S. Mahmoud, H. M. Hamdy, M. A. El-Shafie, Hindawi, 2020.)

10.2 Power distribution for BTS cont’d





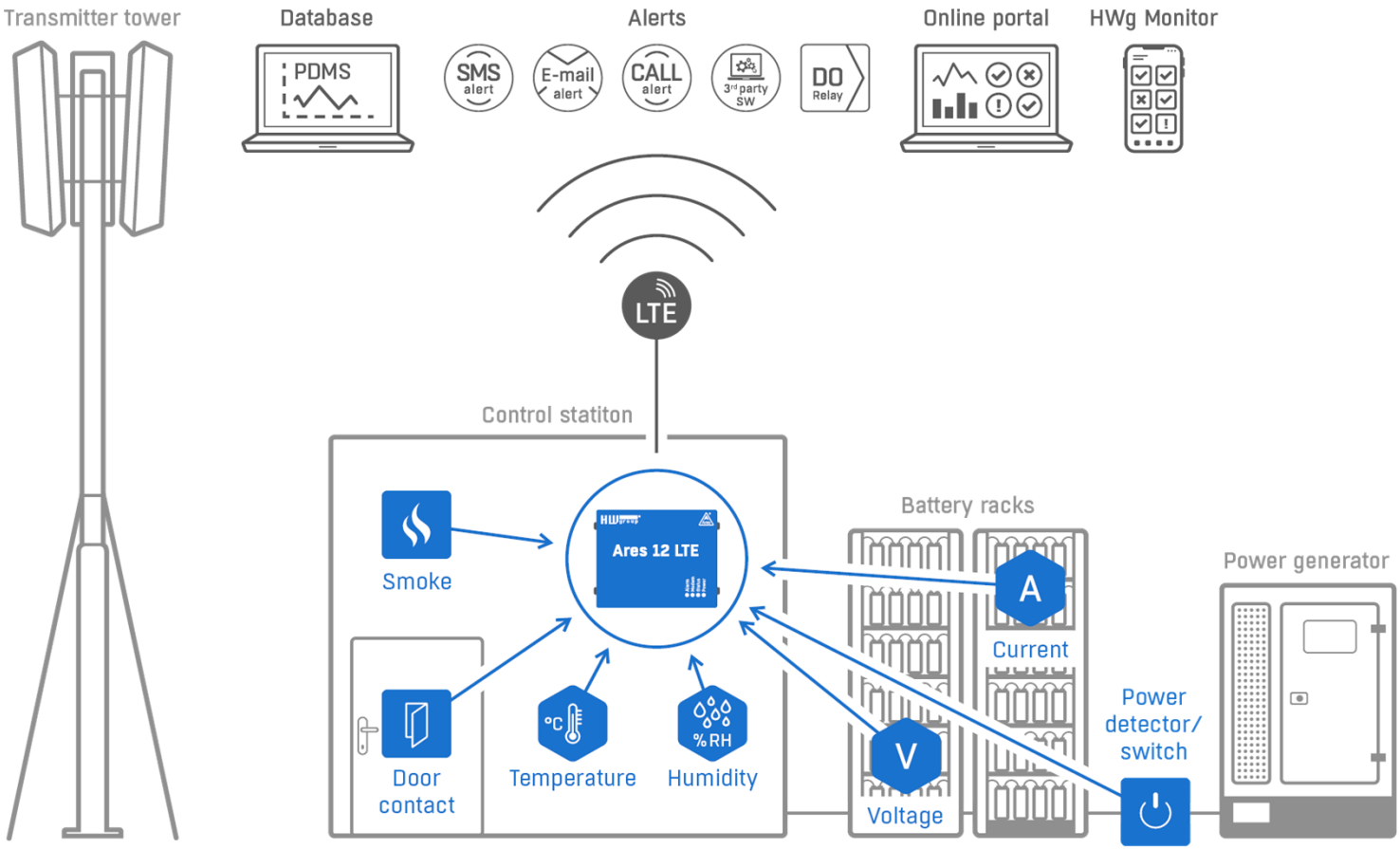
(https://www.akcp.com/blog/protect-your-data-center-during-power-outages-and-heatwaves/)

10.2 Power distribution for BTS cont’d

The most common power issues in the Data Center are:

- The main power line is physically damaged or overloaded.
- Instability of the main power frequency.
- Electrical noise is usually caused by nearby equipment.
- Voltage spikes, over-voltage.
- Momentary or sustained under-voltage.
- Distortion of the sine waveform on the power line.

10.3 Power and AC for BTS



(https://www.hw-group.com/solution/base-transceiver-station-bts-monitoring)

10.3 Power and AC for BTS cont’d

- To achieve high reliability, the operating temperature must be kept stable.
- This is achieved with an air-conditioning (A/C) unit, usually located in the top part of the technology cabinet.
- However, AC units are expensive and there is still a risk of malfunction. In add ition, a back-up power supply must be ready to overcome any power failures. The customer also wants to be alerted if there is someone near the BTS.
- Environmental, Power and Security sensors should be monitored.
- Remote monitoring anytime, anywhere to avoid frequent field visits.
- Realtime monitoring and alerts with wired and wireless sensors.

10.3 Power and AC for BTS cont’d

Photo taken from the tower that surround our College: Taken by Arcade.

10.3 Power and AC for BTS cont’d

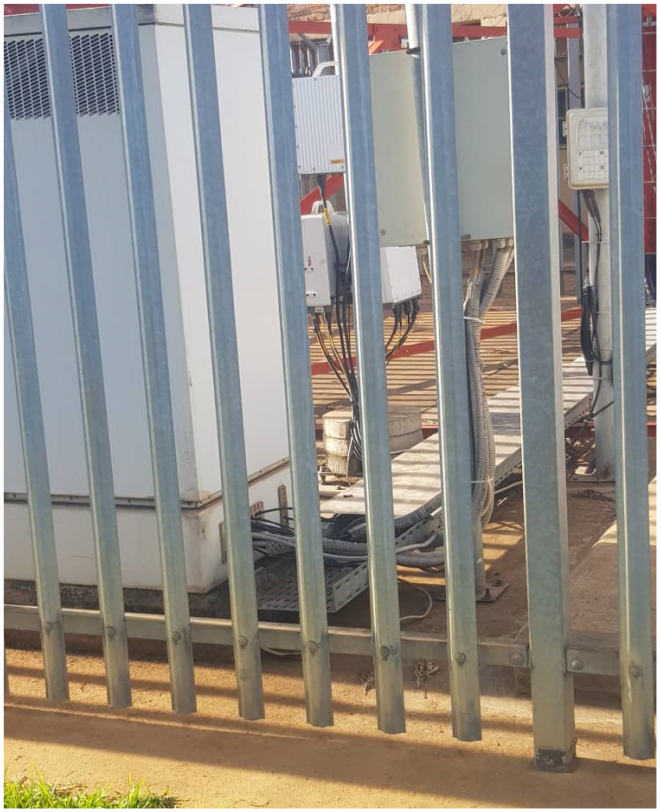


Photo taken from the tower that surround our College: Taken by Arcade.

10.4 Full power cycle

- Base Transceiver Stations (BTS) are essential components of mobile telecommunications, requiring a continuous power supply to maintain their operations.
- In regions with unreliable utility power, ensuring the functionality of BTS is critical for uninterrupted service.
- The integration of various power systems is vital to support these stations during outages, thus safeguarding communication networks.
- Utility grid with battery backup provide a reliable power source by utilizing the existing utility grid while allowing for energy storage in batteries.
- In power outages, the battery backup immediately supply energy, ensuring that the BTS remains operational. This configuration works better for areas with infrequent outages, as it balances reliability and cost-effectiveness.

10.4 Full power cycle cont’d

- Additional to utility grid and battery backup, diesel generator can provide power during prolonged outages beyond the battery’s capacity.
- This setup is particularly beneficial in regions facing frequent and extended blackouts, making it a robust solution for maintaining BTS functionality.
- In some areas when there is abundance of solar power, utility grid with battery backup and diesel generator can benefit to have the solar PV as a third alternative to reduce much dependence on fossil fuels and enhance eco-friendly power system for BTS.
- Thus, solar integration presents a sustainable option for powering BTS, aligning with broader goals of reducing carbon footprints.

10.4 Full power cycle cont’d

- The right mix of power sources can help mitigate risks associated with power outages, thereby maintaining critical communication infrastructure in diverse operating environments.
- Grid power supply contribution: The primary source of energy for broadcasting towers, providing consistent and reliable power under normal operating conditions. It ensures that broadcasting equipment runs smoothly, supporting high transmission quality.
- Diesel generator (DG) contribution: Acts as a backup power source during grid outages. Diesel generators provide high reliability and can sustain broadcasting operations for extended periods. They are crucial in regions with frequent power interruptions, ensuring uninterrupted transmission.

10.4 Full power cycle cont’d

- Uninterruptible Power Supply (UPS) contribution: Offers immediate power support during brief outages or fluctuations in grid power. UPS systems protect sensitive broadcasting equipment from damage and data loss by providing a short-term power supply, allowing time for generators to start up if needed.
- Automatic Voltage Regulator (AVR) contribution: Maintains a stable voltage level to broadcasting equipment, preventing damage from voltage fluctuations. AVRs ensure that all systems operate efficiently, which is essential for maintaining signal quality and reliability.

10.4 Full power cycle cont’d

- Automatic Transfer Switch (ATS) contribution: Facilitates the seamless transition between grid power and backup sources (like generators) without manual intervention. ATS ensures that broadcasting operations continue without interruption during power failures, enhancing operational reliability.
- Air Conditioning systems (AC): contribution: Essential for maintaining optimal operating temperatures for broadcasting equipment. Effective cooling prevents overheating, which can lead to equipment failure and signal degradation. Proper air conditioning is crucial in ensuring long-term reliability and performance of broadcasting towers.
- These components work together to create a robust power management system for broadcasting towers, ensuring consistent operation, minimizing downtime, and protecting valuable equipment.

Homework

- You will have to design an architecture that embeds together all the power sources for a broadcasting tower in one combined block.
- You will now draw the architecture of BTS components or parts which require the power and mention the supply voltage they required then interconnect that block with the block of power sources in accordance with their specific supply needed.
- To perform the above task, you will need to study and understand the GSM ar chitecture with emphasis on BTS.

Thank you for your good attention

Q&A

References

- Managing Power Outages in Communication Networks, Elisa Elmazaj, Michela Meo, Ph.D and Greta Vallero, Politecnico di Torino, 2021.
- Base Station Transceiver (BTS) Monitoring, Fluke Infotech.
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