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Enabling the Virtual Digital Substation through Edge Computing

Challenges

The usual technology that is deployed in **Power Grid substations** to run and control critical service operations is frequently based on single-purpose appliances built and installed by vendors. This scheme implies some form of subjugation, and the following issues are on many occasions generated:

01

VENDOR LOCK-IN

This **equipment's IP** is hold by each vendor and **cannot be interconnected**, resulting in low efficiency and *"vendor lock-in"* situations.

02

VENDOR LOCK-IN

Expensive equipment that can't be repurposed for deployment of **other services resulting in low efficiency.** This results in the customer **being tied up and dependent on the provider.**

03

REDUCED VISIBILITY

Although certified, **substation equipment are used as black boxes**, and they **do not expose** operational and error metrics.

04

LOW FLEXIBILITY

Expensive equipment that **cannot be used to deploy other services** resulting in **low efficiency.**

05

RIGID

High capex and **high innovation access.**

Edge Computing overcomes all the above limitations. **By decoupling the SW from the HW**, all services and functions become a virtual yet fully performant asset. These SW elements can be instantly deployed on top of small edge computing general-purpose HW platforms located at every substation and connected to a central automation platform.

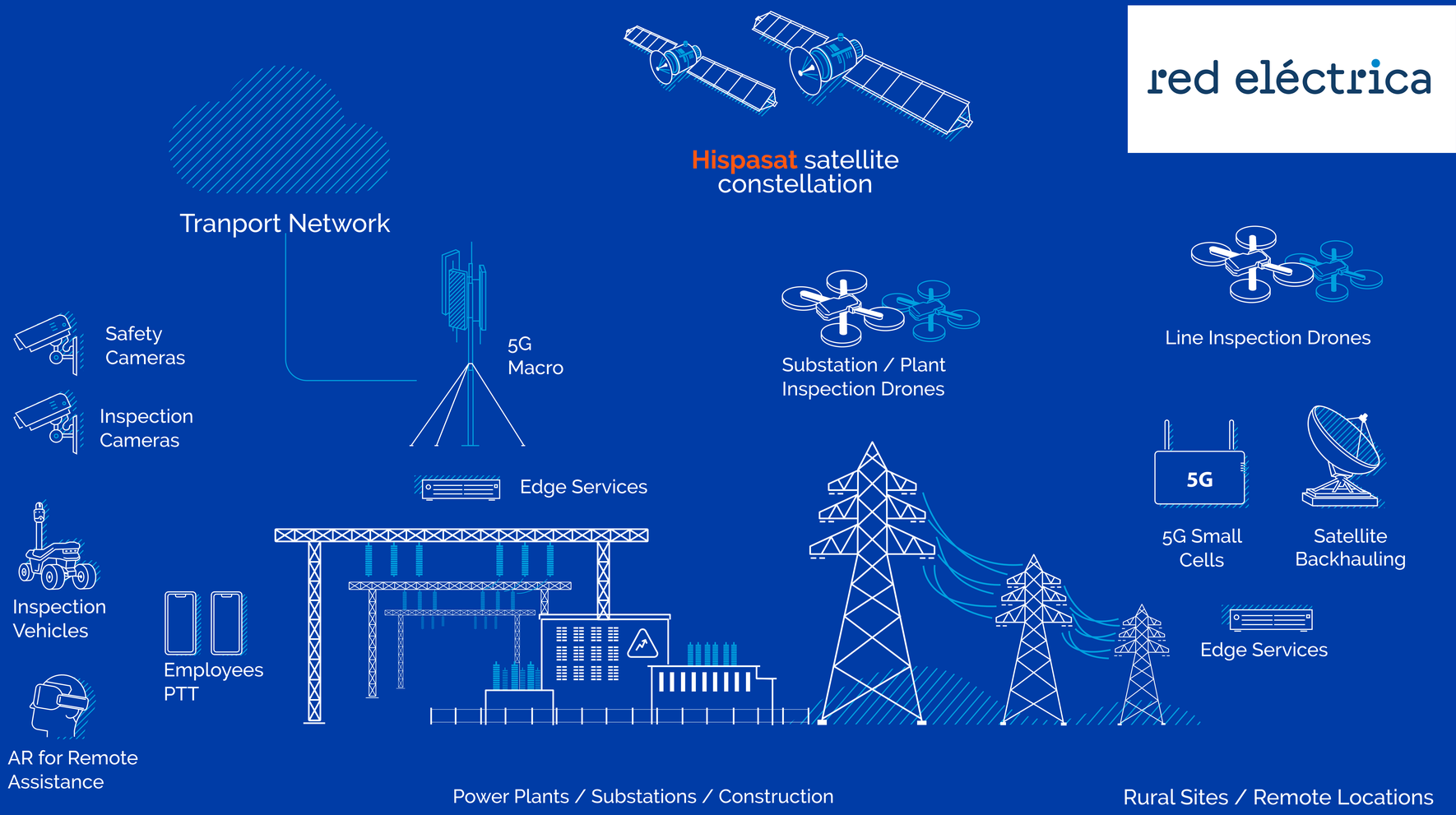
Solution architecture

Assets

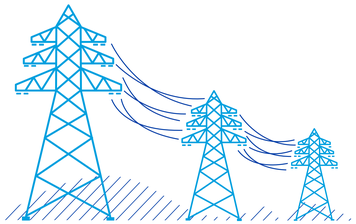
- 5G Spectrum* (n40)
- Satelite Constellation
- Transport Network (Fiber)
- Inspection Devices
- Employees hand devices
- ARVR Goggles

Edge & Orchestration

- Massively distributed infrastructure
- Ad-hoc communications
- Macro and Micro – orchestration
- Multi-tenancy
- Use-case enablement – edge computing



Use cases implemented



1

POWER GRID

+ **Automatic power grid fault detection:** monitor the power grid remotely and detect failure locations along lines reducing operation costs.
+ **Monitor and secure substations through** high resolution 3D sensors combined with AI support workers during maintenance, avoiding to reach live parts of the power grid.

2

CENTRALIZED MANAGEMENT

+ Edge Computing brings the possibility to virtualize the **"Protection and Control function"** and make it a SW that is installed on top of regular servers, instead of being delivered through an appliance. Edge Computing systems can have a centralized management from a central location.

3

VIRTUALIZING THE PROTECTION AND CONTROL FUNCTION

+ A SW app has been developed to read data from powerline sensors, apply a decision algorithm and produce a signal to execute a physical circuit break if needed. **Orchestration is responsible for securing that low-level compute resources (CPU threads, cache memory, NIC bandwitdth)** will always be available to secure the response takes place in less than 2ms.
+ That is the critical automated response to anomalies in a power line: **the system detects the anomaly and induces a circuit break to avoid a potential extension of the issue to the whole power grid.** The maximum amount of time to ingest data, decide and potentially produce a response is 2ms (ultra-low latency).

4

LIFECYCLE MANAGEMENT

+ Orchestration is also **responsible for the deployment and lifecycle management of the SW solution** across the hundreds of substations in the country.
+ This example paves the way for **the extension to other services that are currently executed through function-specific appliances**, to implement the "virtual substation".

REMOTE ASSISTANCE

+ Edge Computing brings the possibility to virtualize the "Protection and Control function" and make it a SW that is installed on top of regular servers, instead of being delivered through an appliance. **Edge Computing systems can have a centralized management from a central location.**
+ Real-time wide area monitoring: **Aggregate and control data of 1000s of Medium and High Voltage decentralized Renewable Energy Sources** and their inverters.
+ **Regional Security Coordination:** From Distributed Energy Resources at Medium Voltage level operated by DSOs, to High Voltage level operated by TSOs.

REMOTE INSPECTION

+ Edge-To-Cloud AI analytics
+ Mission-Critical Comms

VALUE-ADDED SOLUTION

Solution **outcomes**

Edge Computing **can overcome these limitations and create a disruption by decoupling the SW from the HW** and making all the different services and functions that are used in the daily operations, **a virtual asset that can be instantly deployed on top of a normalized edge computing** platform located at every substation. Intel calls it "the virtual substation".

Avoids vendor lock-in

Increase flexibility and reliability through a Multi-vendor open solution that **avoids vendor lock-in** targeting different HW and SW vendors to lower costs.

Inherent Observability

The Edge Platform provides telemetry on a normalized format to be **directly injected into the maintenance system**.

Breaking down data silos

The utility will have **one common network model** that all departments work from to ensure reliable planning, operation, and protection of the power grid.

Lower CAPEX, Lower OPEX

Lower costs using **traditional and modular server** and edge computing solutions.

Reliable low latency

Reliable low latency performance even in shared compute environments thanks to Custom Provisioning Profiles that Create provisioning profiles tailored for each specific use case.

Full innovation cycle

Unlocking and accelerating the full innovation cycle.