FUNDAMENTALS OF THE SMART GRID

Utility Telecom Networks

Sérgio Pinto, EDP Distribuição S.A.

28th August 2019

Agenda

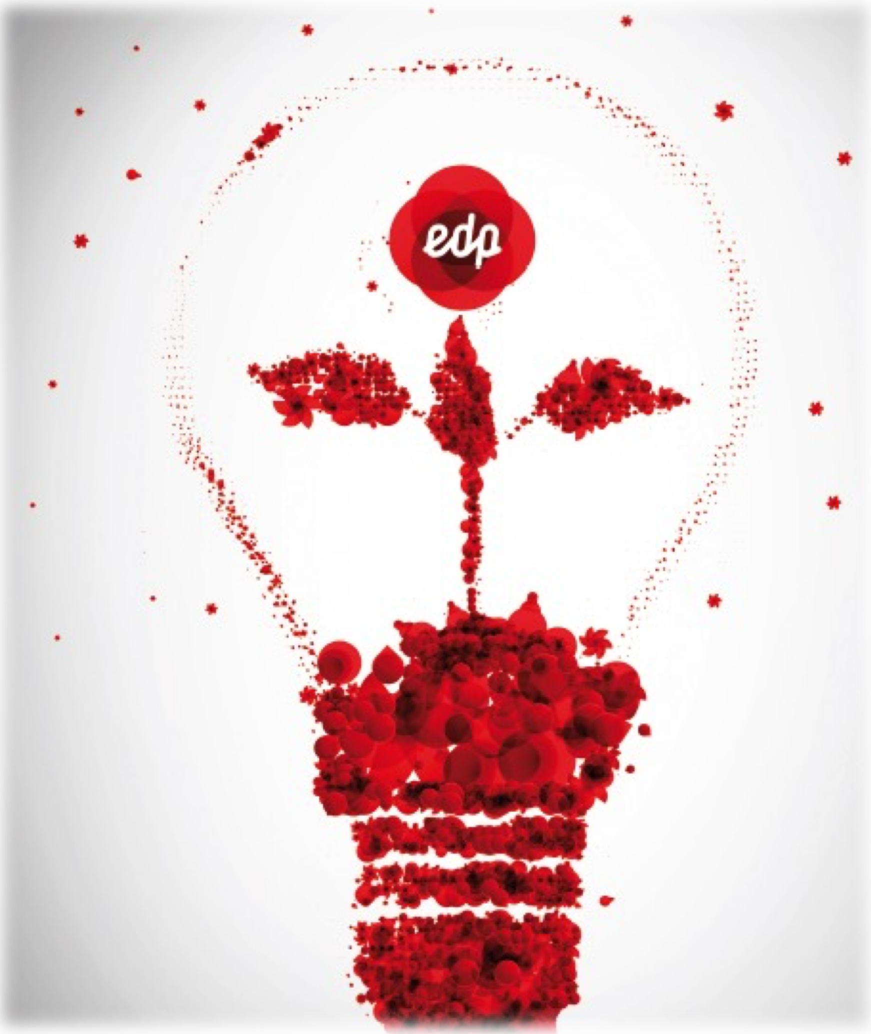
Fundamentals of The Smart Grid 2019 - Utility Telecom Networks

1. **EDP in brief**
2. Electricity, challenges and Smart Grids
3. Communications in Utilities
    - Technologies and medium
    - TDM technologies
    - Packet networks
    - Transition to IP and special services

5. Mobile Networks and Services

4. Assurance and Security
    - PVNO - Multi sourcing
    - Private Networks & Spectrum

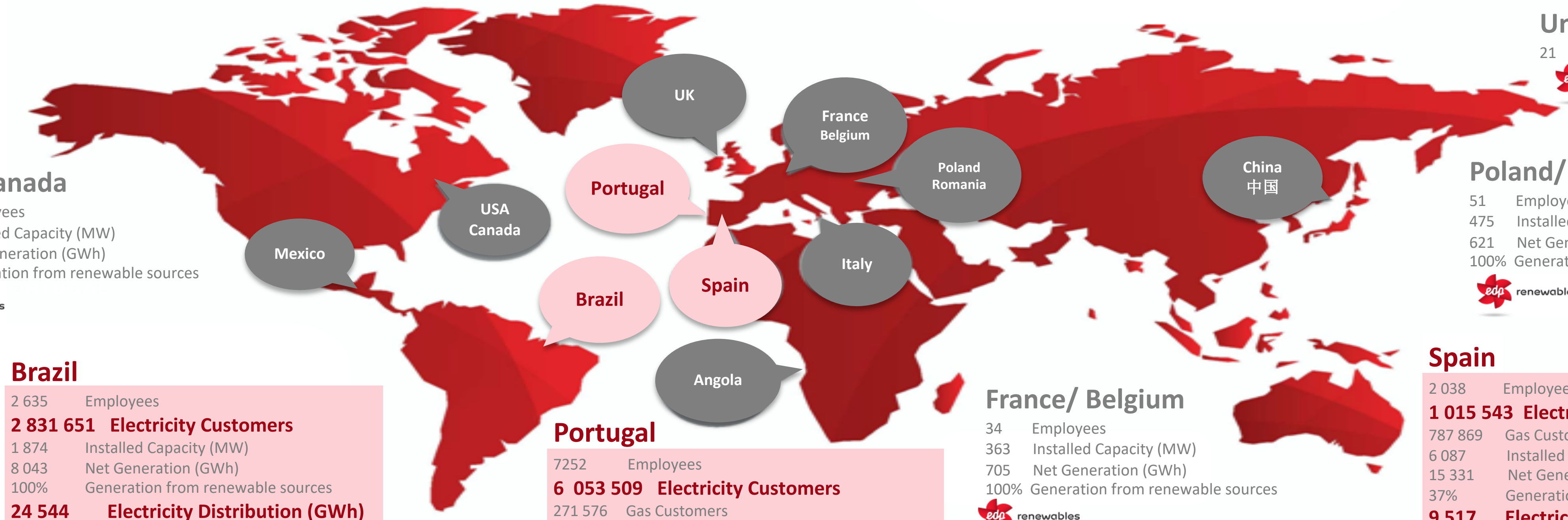
5. Final remarks



From a local electricity incumbent, EDP has grown into a global energy player with strong presence in Europe, Brazil and considerable investments in the USA

EDP Group – overview

Top position in Electric Sector in Dow Jones Sustainability Indexes	#3 World wind energy company	#1 Europe hydro project (+3,5 GW under development)	#1 Portugal industrial group



United Kingdom
21 Employees

edp renewables

USA/ Canada
260 Employees
3 422 Installed Capacity (MW)
9 330 Net Generation (GWh)
100% Generation from renewable sources

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Poland/ Romania
51 Employees
475 Installed Capacity (MW)
621 Net Generation (GWh)
100% Generation from renewable sources

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Brazil
2 635 Employees
2 831 651 Electricity Customers
1 874 Installed Capacity (MW)
8 043 Net Generation (GWh)
100% Generation from renewable sources
24 544 Electricity Distribution (GWh)

edp, edp renewables

Portugal
7252 Employees
6 053 509 Electricity Customers
271 576 Gas Customers
10 992 Installed Capacity (MW)
34 364 Net Generation (GWh)
51% Generation from renewable sources
46 508 Electricity Distribution (GWh)
7 138 Gas Distribution (GWh)

edp, edp renewables, edp gás distribuição, edp distribuição

France/ Belgium
34 Employees
363 Installed Capacity (MW)
705 Net Generation (GWh)
100% Generation from renewable sources

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Italy
14 Employees

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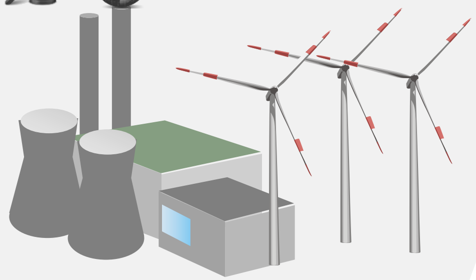
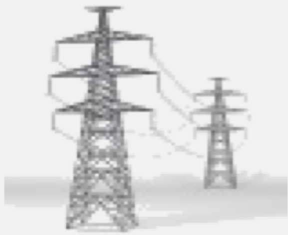
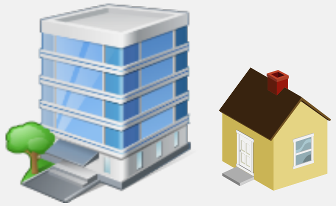
Spain
2 038 Employees
1 015 543 Electricity Customers
787 869 Gas Customers
6 087 Installed Capacity (MW)
15 331 Net Generation (GWh)
37% Generation from renewable s.
9 517 Electricity Distribution (GWh)
48 447 Gas Distribution (GWh)

edp hc energia, edp naturgas energia, edp renewables

... Countries in which EDP has Distribution activities

The Portuguese National Electricity System includes EDP Distribuição (EDPD) as the main electricity distribution company

	Production	Transportation	Distribution	Retail Market
Value chain				
Agents	edp produção edp renewables endesa IBERDROLA Production market integrated at an Iberian level	REN	edp distribuição[1]	edp FORTIA endesa galp energia gasNatural fenosa IBERDROLA

EDP D drivers

Assets management

- **Grid concessions** from HV till LV and meters
- Agreed network investments **remunerated at the IRR of Portuguese bonds**

Operations management

- **Efficient network operations** & guarantee of service continuity and energy quality
- **Controllable costs baseline** recovered until a certain price cap (pressure for costs decrease)

Information management

- **Information broker and settlement** between market players and consumers
- **Monitor energy balance and minimize energy losses** (technical and commercial)

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Regulated activity

Liberalized activity

1. & small cooperatives (<1%)

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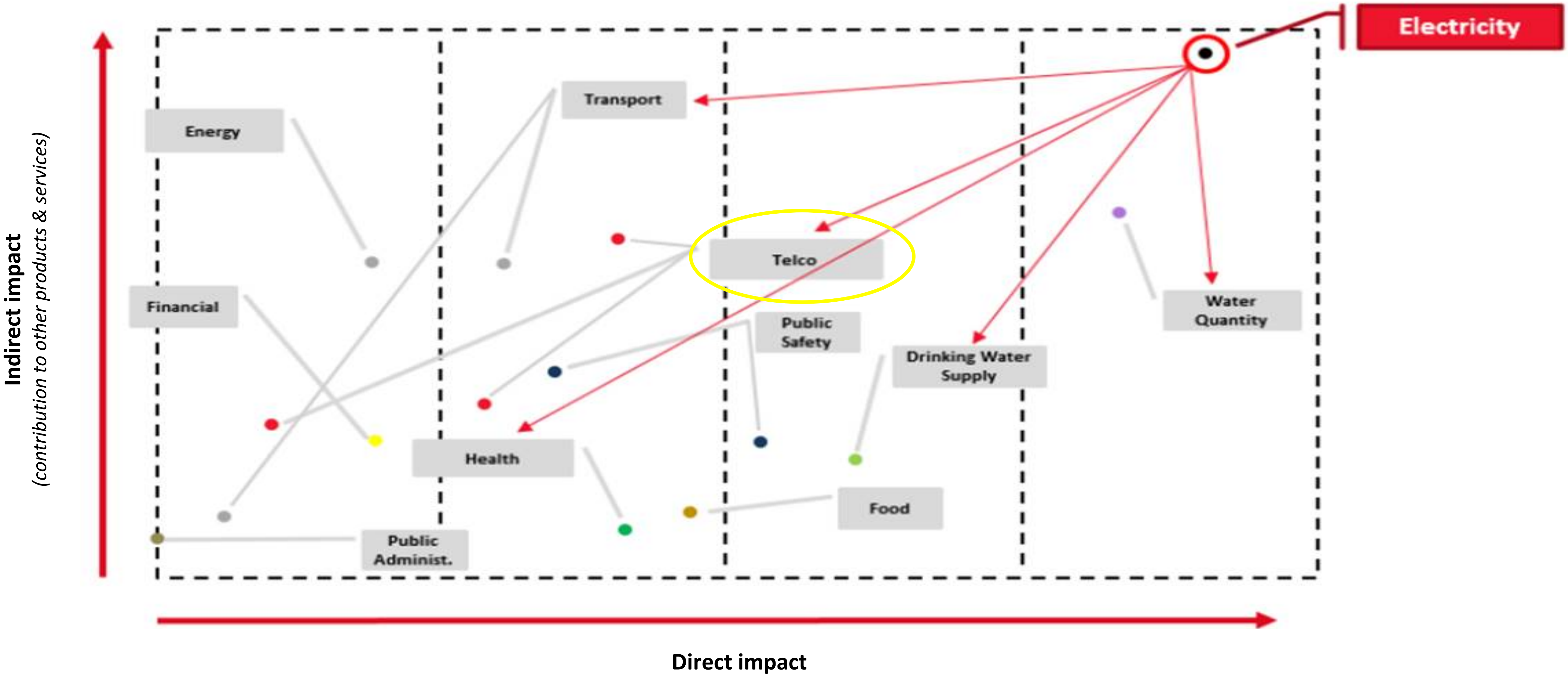
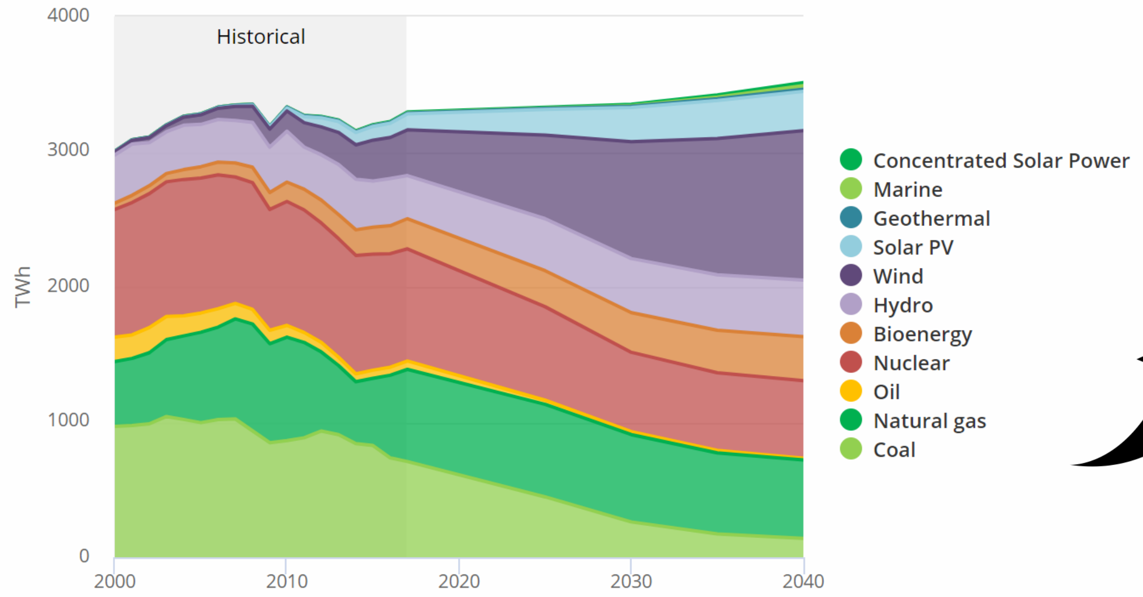
Our society dependence on Electricity is increasing significantly, with several critical sectors depending almost exclusively on it (Telecommunications, being one of them)



Accomplishing Affordable, Secure and Sustainable Energy by transforming the Electric System, orchestrating new sources and dynamic demand side by deep digitalization



Iea.org / European Union /Electricity generation by technology

Economic growth is still correlated with energy consumption, does requiring structural transformations to increase energy efficiency, to electrify the economy, and source energy from renewable sources

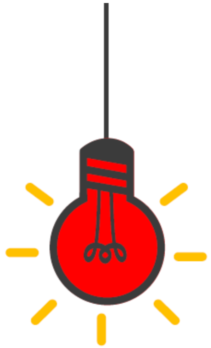
EU’s energy strategy is made up of five dimensions: security, integrated energy market, efficiency, decarbonising, R&I and competitiveness.

Main goal

- EU transition to become a low carbon economy

Package aims

- Energy Efficiency
- Lead in renewable energy
- Involve consumers

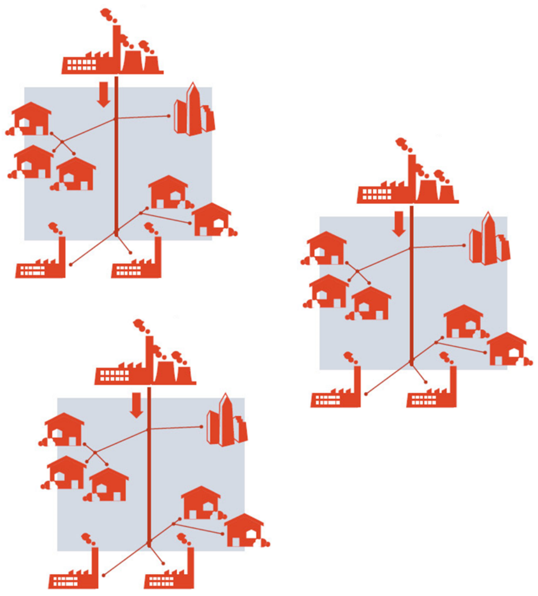


Domains

- Energy market design
- Security of supply
- Governance
- Renewable energy
- Efficiency

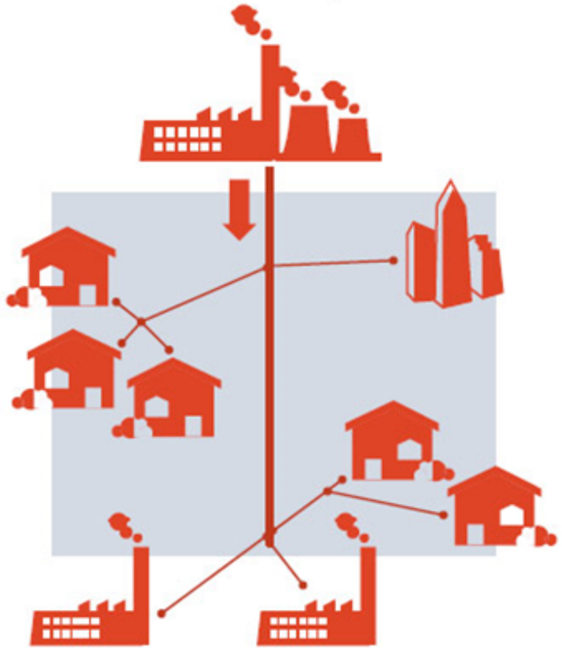
Grid transformation needs to accelerate to meet the requirements of an All-Electric Society, sustainable, secure and decarbonized, a journey from One-Way to Grid of Things

1850s.. 1950s



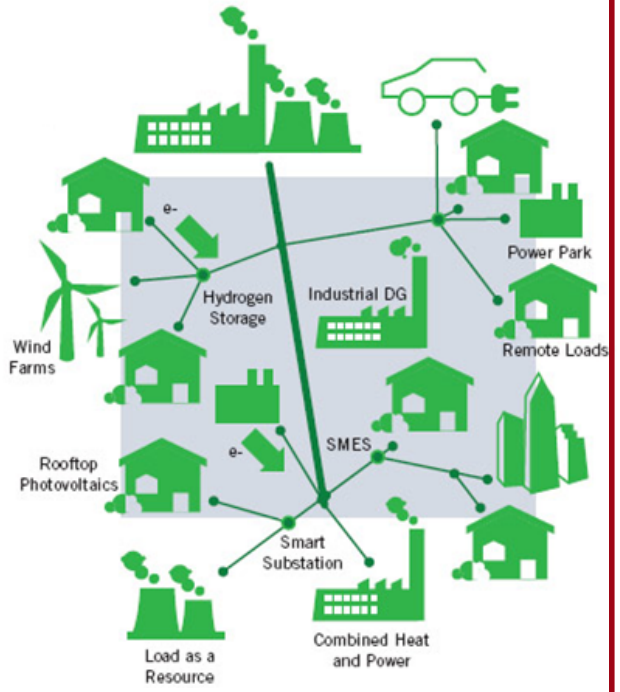
- Localized Generation and Consumption
- Unidirectional Flow
- Small Scale
- Generation follows demand

1950 to 2010



- Centralized Generation
- Unidirectional Flow
- National Wide Grids
- Generation follows demand

From 2010 …



- Distributed Generation
- Bidirectional Flows
- Demand mobility
- Demand follows generation

Fonte: IEEE

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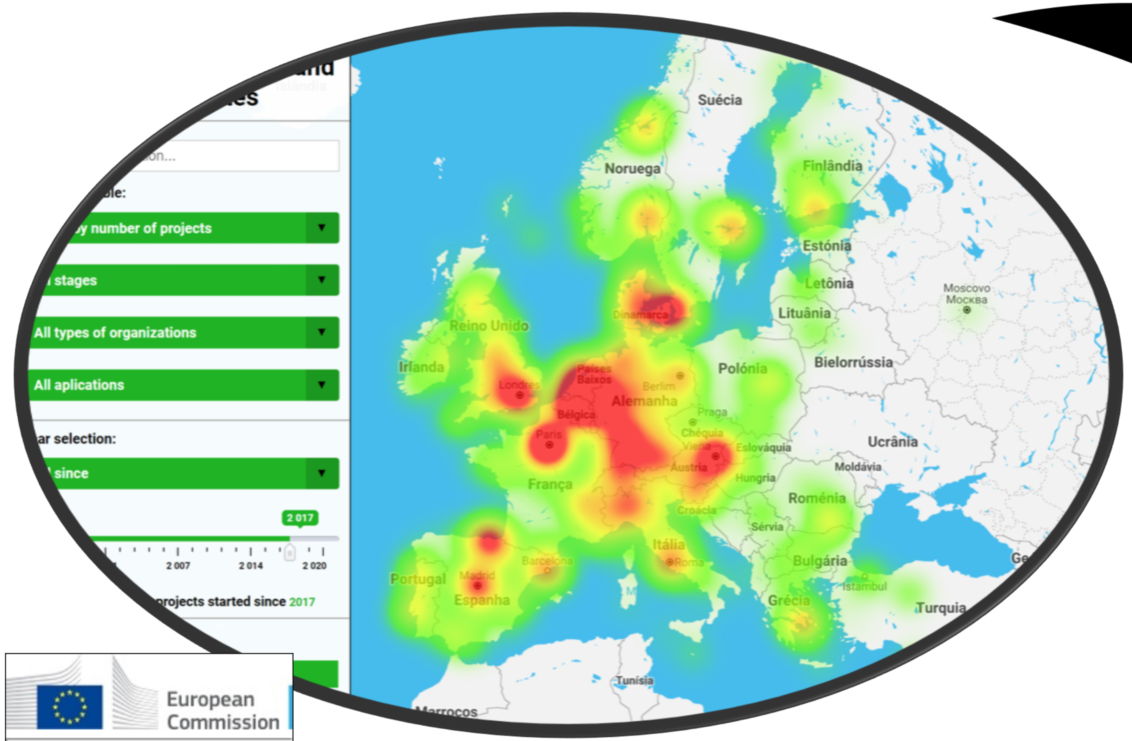
In support of transformation, EU Smart Grid projects portray the dependency on performant, reliable and pervasive connectivity services



European Commission

Map maintained and updated by
Joint Research Centre,
Smart Electricity Systems
and Interoperability group

ses.jrc.ec.europa.eu

- Total Coverage of System Actors and Assets
- Adequate performance profiles
- Need for Contracts and governance
- Standard Interfaces
- “quality and performance of communication as a big technical barrier”

Application	Communication Delay (msec)	Data Rates
State Estimation	100	136.8 Kbps
Generator Synchronization	50	91.2 Kbps
Intelligent Scheduling	50	300 Kbps
Islanding	50	10 Kbps
Oscillation control	200	27.4 Kbps

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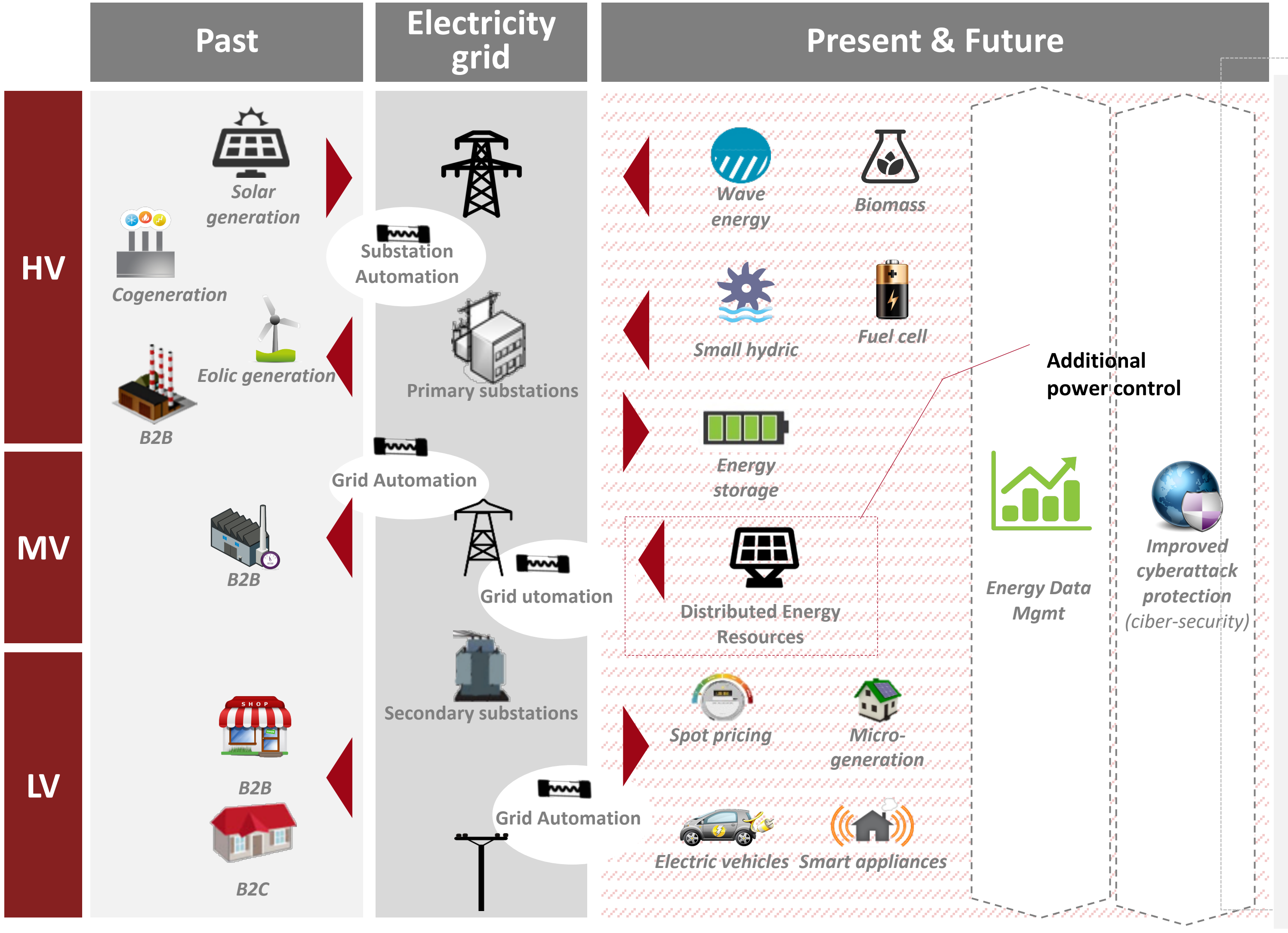
The number and variety of information transactions will increase, demanding pervasive and permanent information flows



New *stakeholders* & underlying services (e.g. DER, prosumers) …

… additional wide area control systems & data collection mechanisms …

… higher capillarity of enabling infrastructure …

… higher costs of permanent fixed systems

INCREASING OF CONNECTED ACTORS AND ASSETS AND DATA INTENSITY

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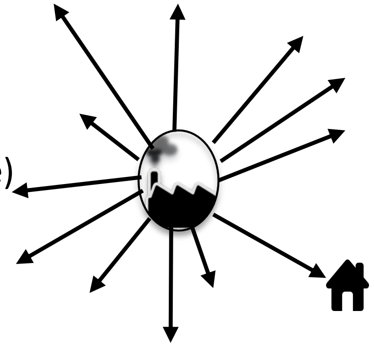
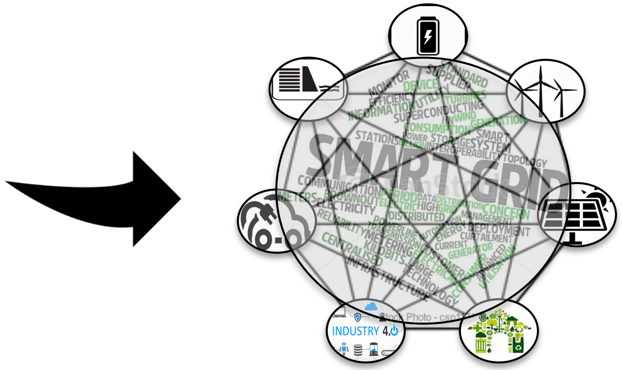
The inclusive Smart Grid ecosystem, with dynamic Supply/Demand adjustments and efficiencies is supported by a new Market Design requiring real time information

From Centralized, nuclear & fossil fuel

- Supply follows demand
- One way flow (Bulk Gen-transport – Distrib – consume)
- Transport/Distrib capacity for peak
- Predictability of consumption
- Demand Curtailment

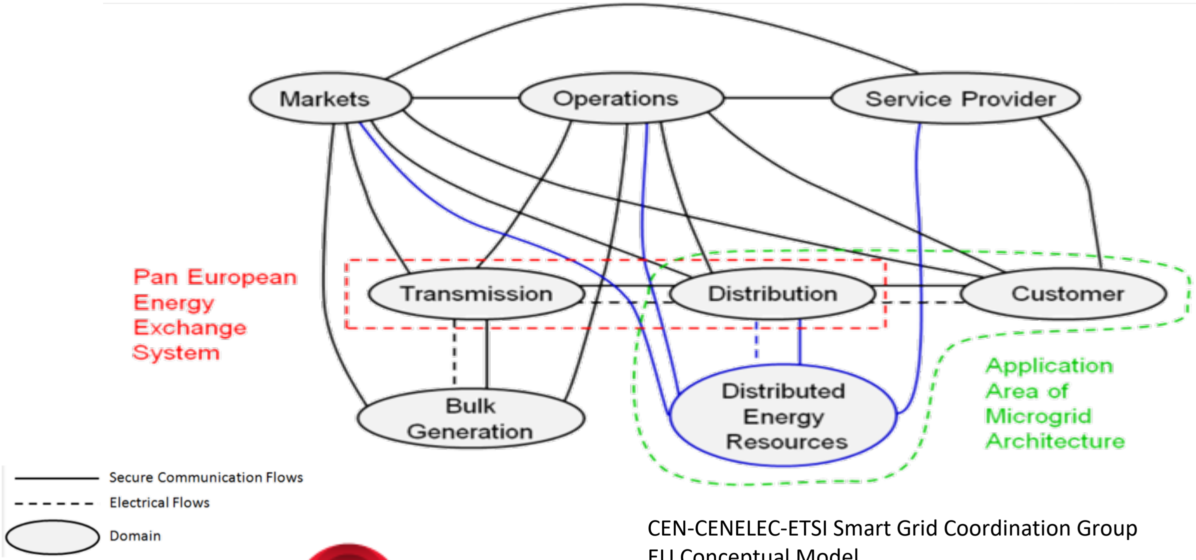




- Demand follows supply
- Further electrification society and economy
- Two way flows (prosumers)
- Virtual Power Plants aggregates multiple micro generations
- Storage and flexibility
- Micro Grids

To a sustainable system, with a new market design and the emergence of 3D Utilities

Operations: Stable and safe operation of the power system (Grid, Meters, Systems, …)
Customers: generation, consumption, storage, flexibility
Markets: Flexibility, Capacity, Energy
Service: Trading



CEN-CENELEC-ETSI Smart Grid Coordination Group
EU Conceptual Model

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This always-on Grid ecosystem demands for an Operation and Assurance framework that integrates and manages a complementary and diverse technology and services portfolio

BUSINESS SERVICES

- Grid Operation
- Energy Quality
- SmartGrid
- Advanced Asset Management
- Predictive Maintenance
- Renevue Assurance
- Work Force Management

DIGITAL PLATFORM

Connectivity

Core Network
- Optical Fiber
- VHF/UHF Links
- Satellite

Access Network
- PVNO (2G/3G/4G/5G,IoT)
- LTE Network 450MHz
- Satellite (LEO/ GEO)

Local Network
- PRIME PLC
- GPRS / NB IoT / LTE M
- FTTH / 5G

Applications and Infrastructure

OSS · IoT Platform · Artificial Intelligence · Disaster Recovery

OT Data Lake · Advanced Analytics · OT Cloud · SDN/NFV

Cybersecurity

Data Protection · Identity and Access management · Control system security · Integrated SOC

Service Operation and Management

Digital Platform Supervision Center
- E2E Monitoring
- QoS

DIGITAL ASSETS

URTAs OCR/SPCC · IED · Transformers · Sensors · Smart Meters · DTCs · Routers · Public Lighting · Digital Field Worker · Robotics · Vehicles · Storage

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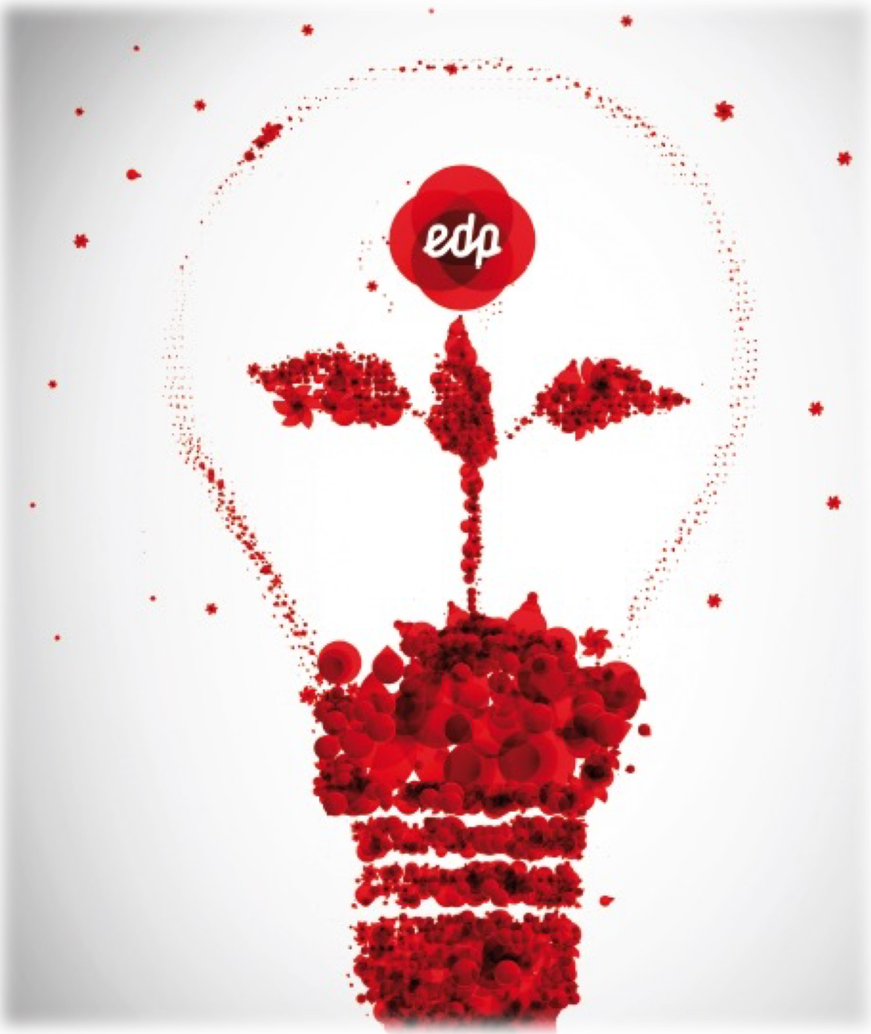
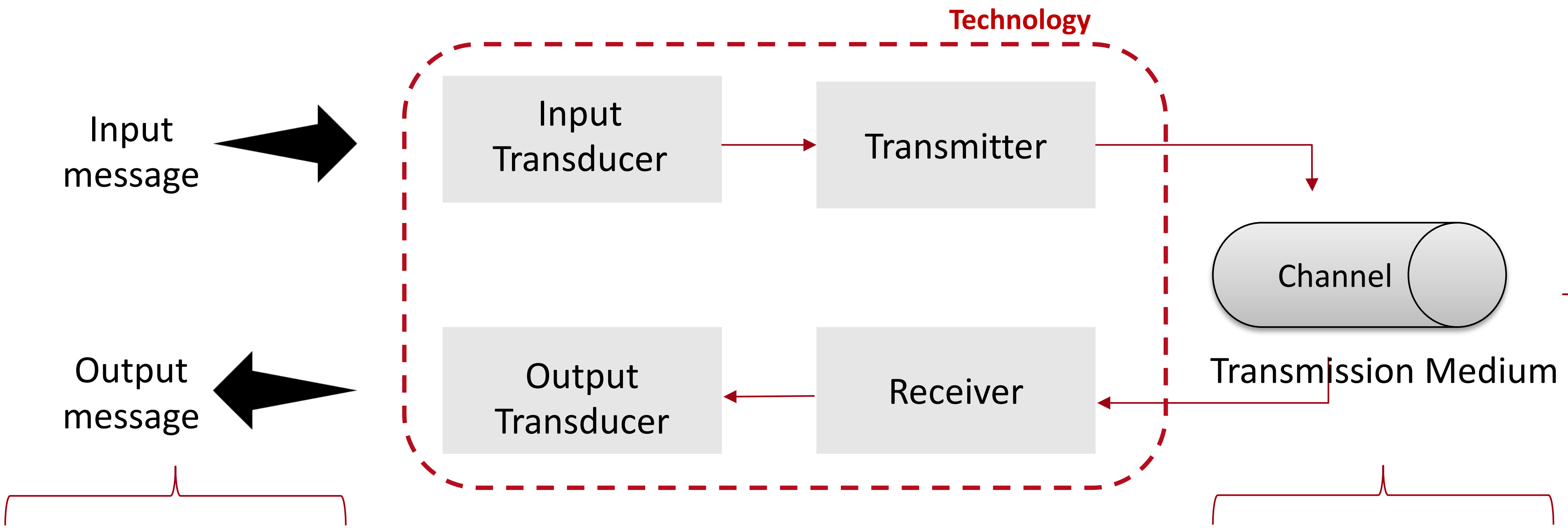


The choice of Communication Technology/media takes into account the fundamental characteristics of systems and existing transmission medium



Examples

- Space / Atmosphere
- Copper pair
- Coax cable
- Energy line
- Fiber Optic

Service characteristics

- Simplex, Half-Duplex, Full Duplex
- Information Rate / Bandwidth
- Error rate
- E2E delay

Medium characteristics

- Attenuation
- Bandwidth
- Propagation speed
- Distortion
- Noise

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Connectivity requirements and geographic ubiquitous led Utilities to leverage energy related assets in coordination with the offers from service providers

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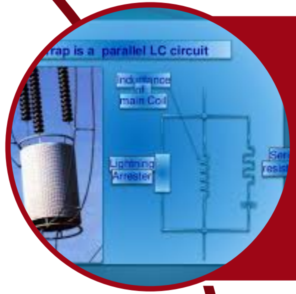
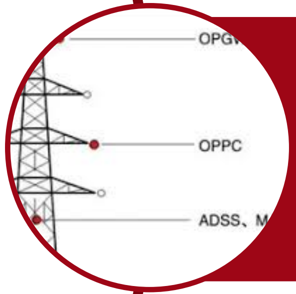


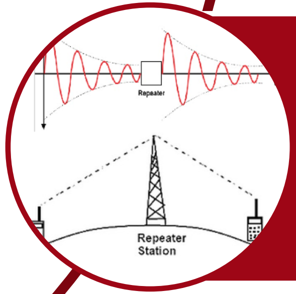
Powerline Systems

> Coupling to energy cable
> Higher frequencies (> 50 Hz, < 300 kHz)
> Analogue and Digital Systems



Fiber Cables

> Support fiber cable along the power lines
> Take advantage of corridors and low incremental investment
> Higher bandwidth systems and possible fiber rent



Radio Systems

Own site and private repeater sites

Licensing spectrum for private Radio Systems

Point-to-point higher bandwidth / Lower bandwidth for multipoint geographical coverage

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Available bandwidth needs to be “Shared” between services, supporting the growth of services per site and usage profiles that portray Grid’s digitalization

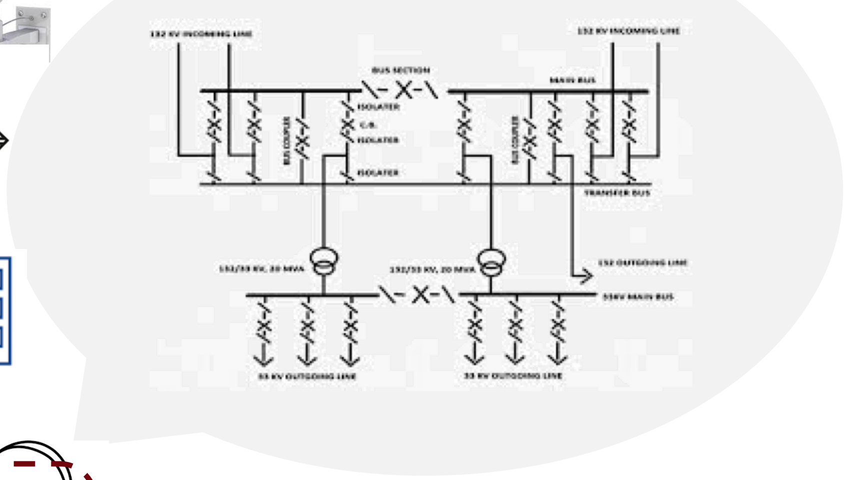
Centralized Supervision & Control

Video Surveillance

Access Control

RTU

Non exhaustive

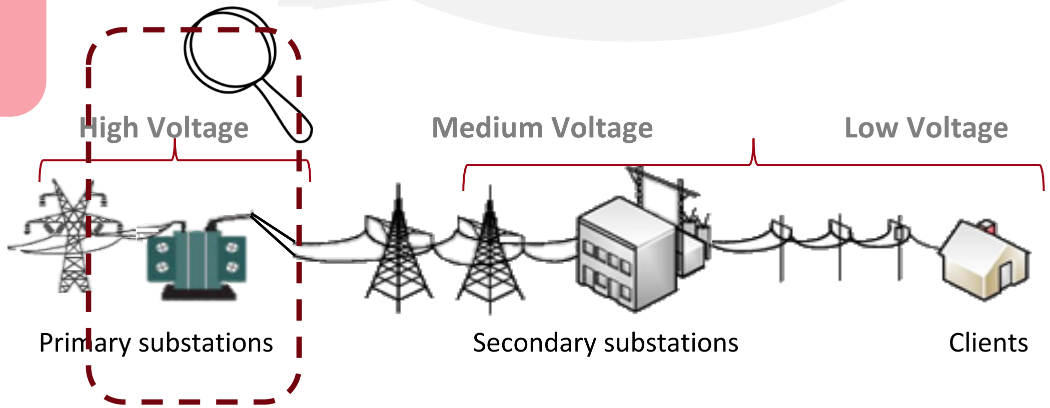


Service 1

Service 2

Service n

Increase Capacity
Share Systems

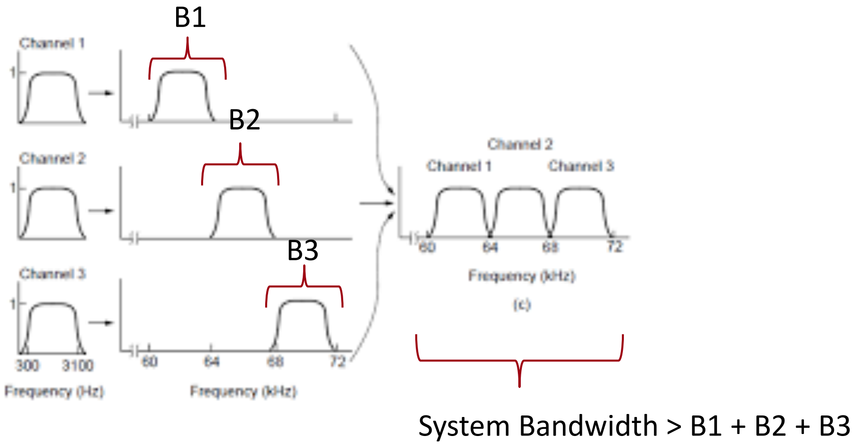


Security Control

Remote device engineering and maintenance

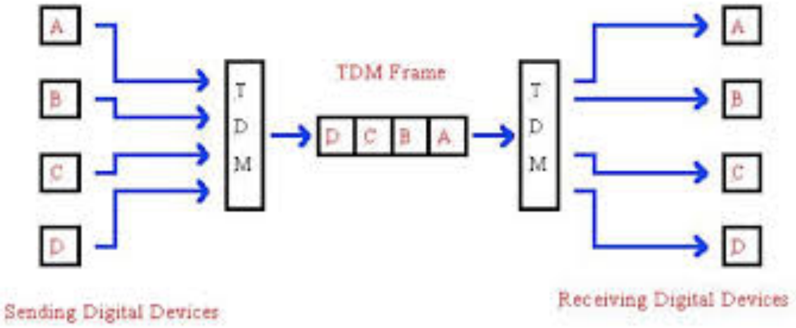
Sharing capacity or bandwidth in a multi-service platform resulted as the only viable technical and economic solution, leading to multiplexing technics

Frequency Multiplex (FDM)



- Each service is coded into a basic frequency band (Channel)
- Channels are tuned into non overlapping frequency slots
- Channels are combined up to the system carrier capacity

Time Divison Multiplex (TDM)



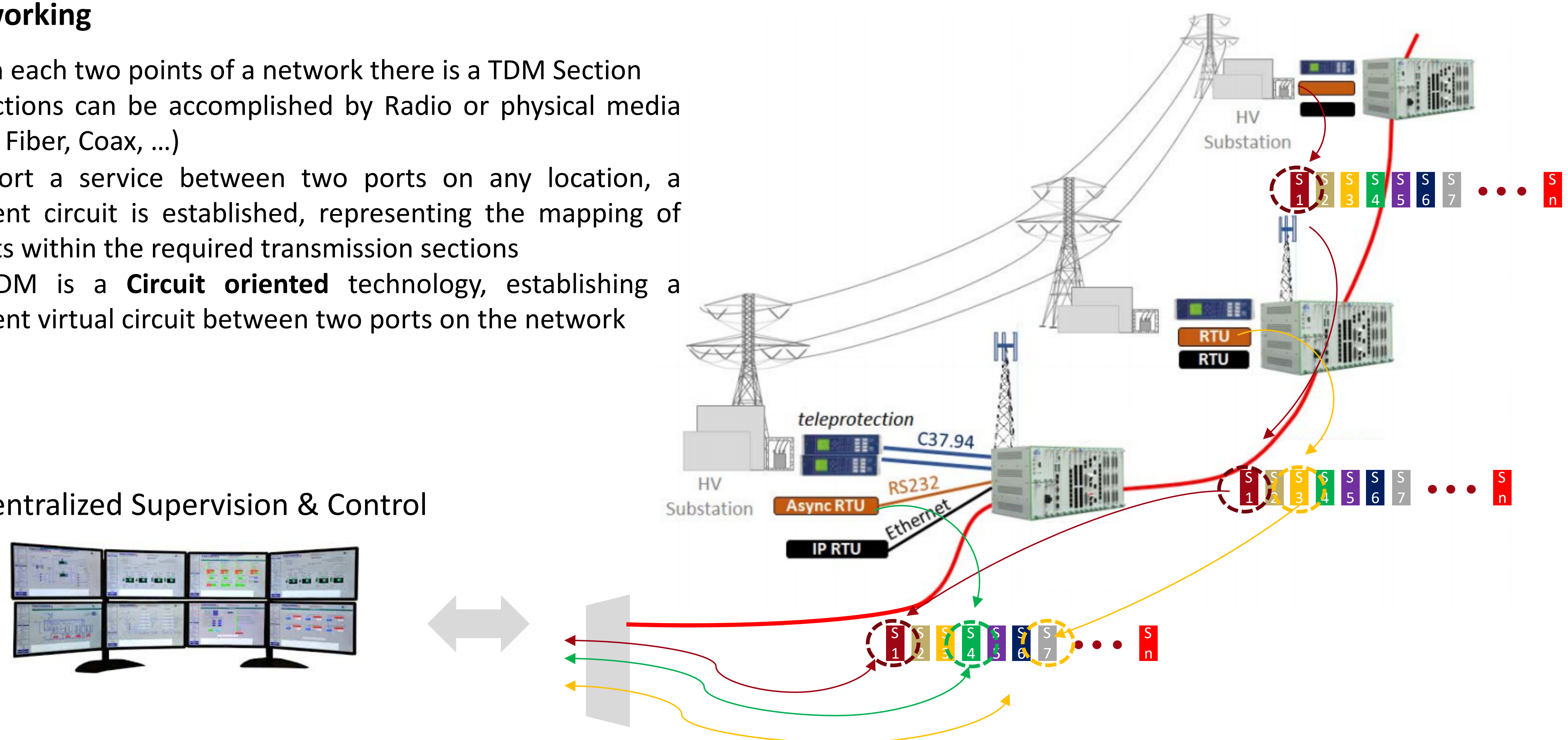
- Each service is coded into a basic Time-slot (Channel)
- Time-slots are serialized and mapped into a higher speed time-slot frame (TDM Frame)
- Service time-slots are added up to TDM Frame capacity
- TDM Frame corresponds to the rate transmitted

Due to lesser complexity and cost, higher capacity systems (Radio or Fiber) adopted TDM multiplexing, giving rise to TDM networks

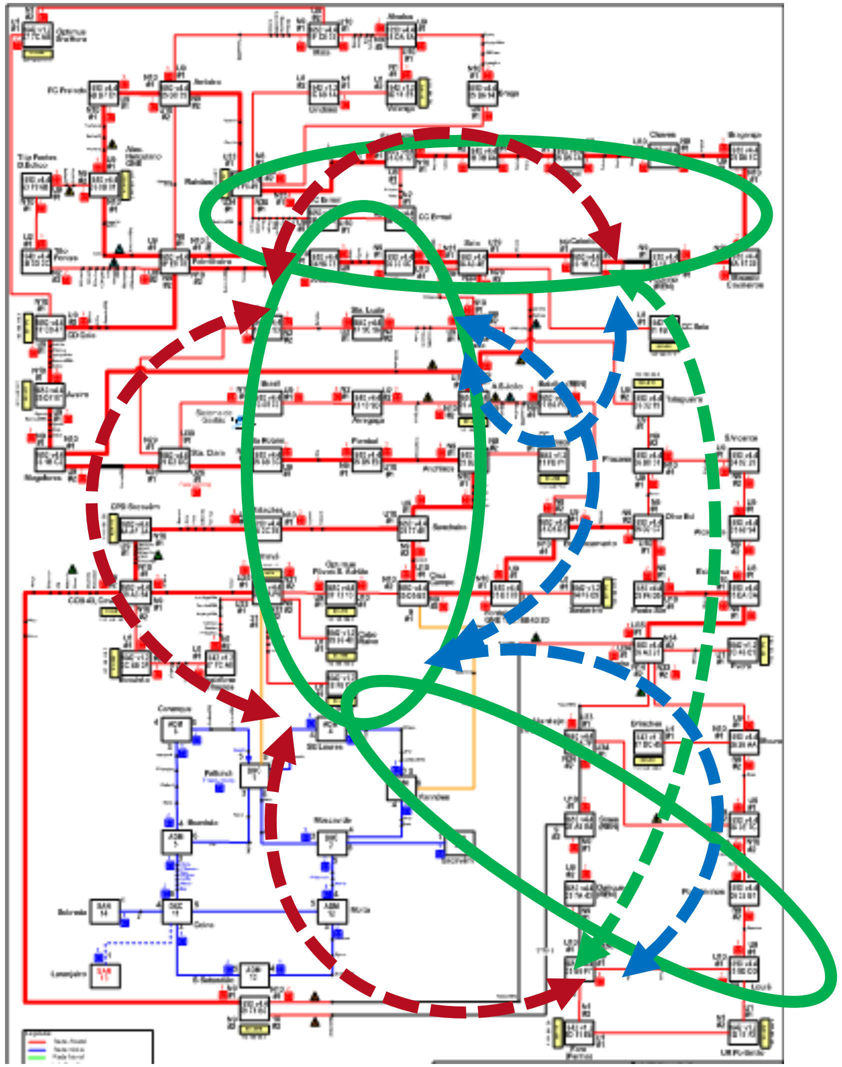
TDM Networking

- Between each two points of a network there is a TDM Section
- TDM sections can be accomplished by Radio or physical media (Copper, Fiber, Coax, …)
- To support a service between two ports on any location, a permanent circuit is established, representing the mapping of time slots within the required transmission sections
- Thus, TDM is a **Circuit oriented** technology, establishing a permanent virtual circuit between two ports on the network

Centralized Supervision & Control



TDM networks scaling is operational and economically challenging, namely resulting from dedicated bandwidth, further amplified by static additional resources for protection paths



For each port-to-port connectivity service:

- Map service through the TDM ring sections
- Allocate bandwidth (static and permanent)
- Sections can be accomplished by Radio or physical media (Copper, Fiber, Coax, …), some are low bandwidth
- Protective path implies additional permanent resources
- High peak bandwidth services with a low average requirement, starve existing infrastructure all along circuit paths (Worker & Protection)

Ring strcuctures

Direct path

Protection path

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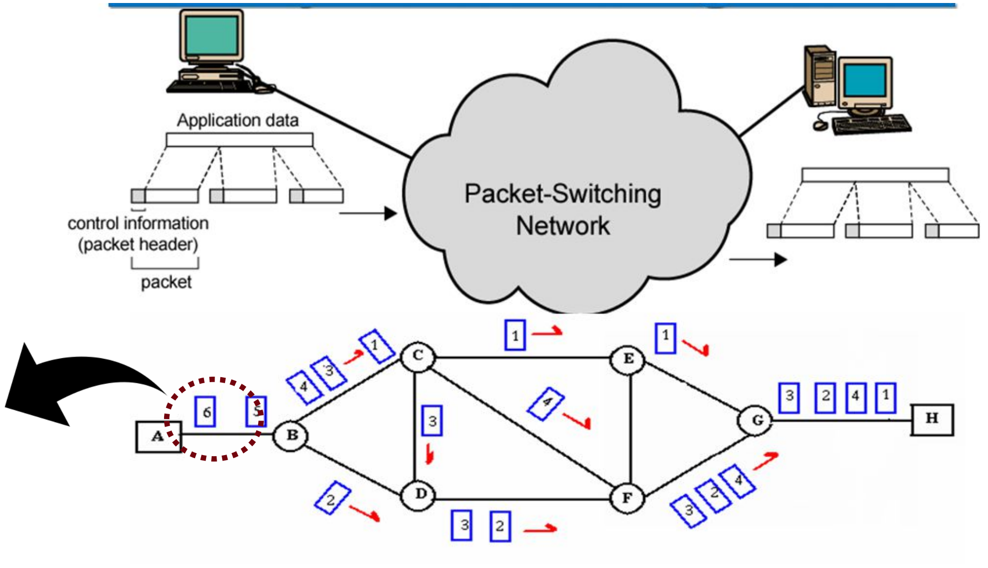
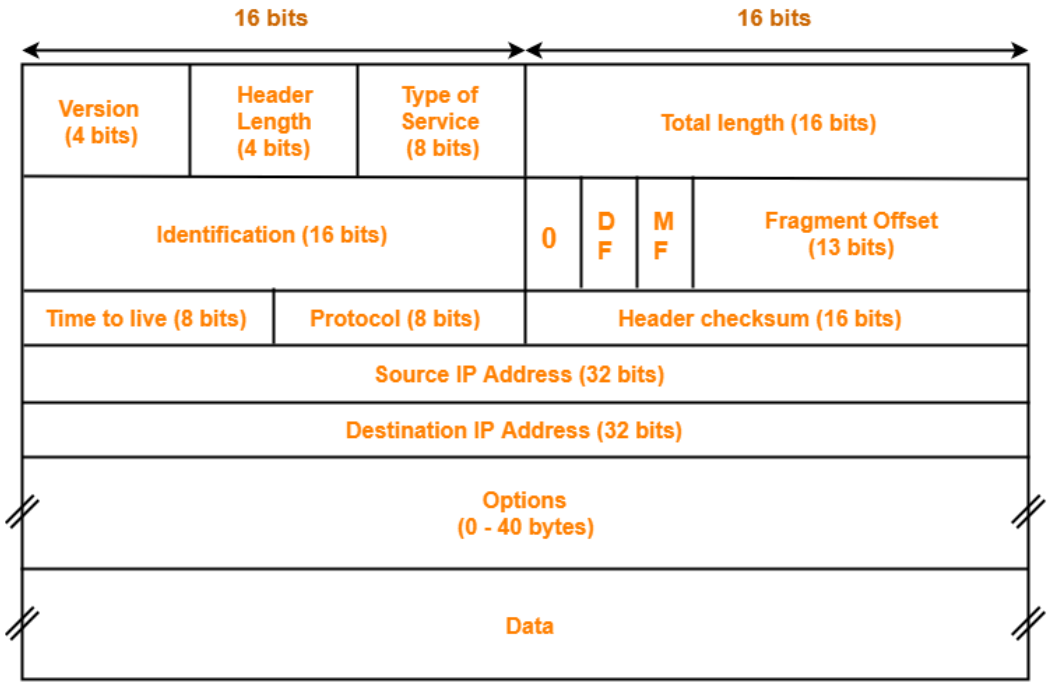
Packet Networks transformed the TDM paradigm, packetizing data and working at packet granularity, trading time predictability for maximum traffic flexibility

Information to be transmitted is packetized:

- Packets can vary in size
- Original data is fragmented
- Packet is transparent to payload
- Many paths may be used in a single communication, routing each packet on a best available path at the time

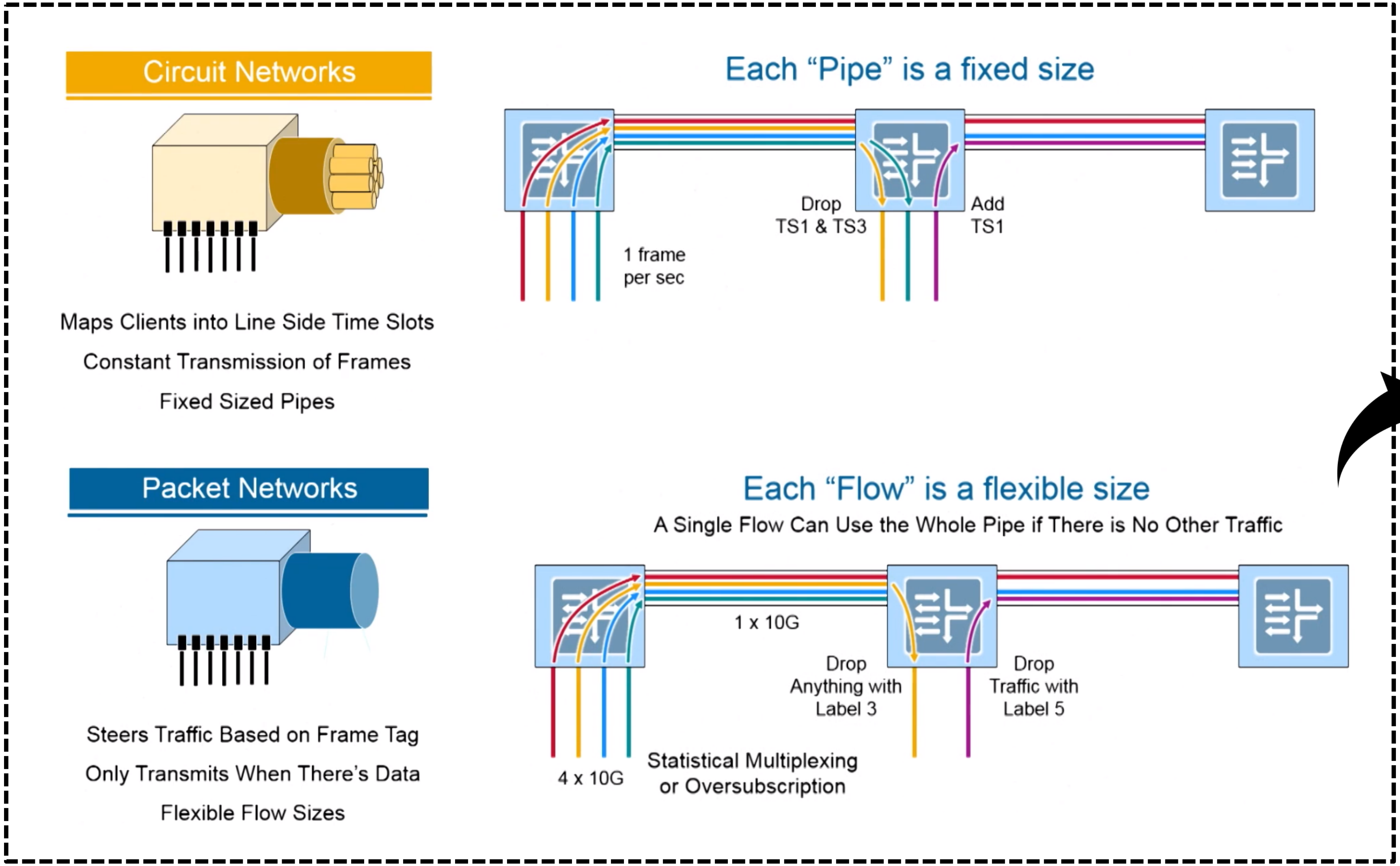




IPv4 Header

- Datagram upto 65.535 bytes (IPv4)
- TOS bits used for priority and QoS
- CRC for packet error detection
- Time to live, avoids packet to “wander” in case of malfunction
- Each packet includes addressing, control and security information
- During peaks, packets may be delayed

Packet Networks can overbook bandwidth based on it's statistical BW usage profile, managing effective resource allocation and optimizing when possible packet overhead



From Coriant: Understanding Circuit Switched Networks vs Packet Switched Networks

Data flows can be optimized based on link quality, MTU and overhead.

Example:

A High quality link (low error) should Support higher MTU (Ethernet Max transmit unit is 1500 Bytes)

An IPv4 Packet, requiring TCP and GRE Tunnel could use a PDU of:

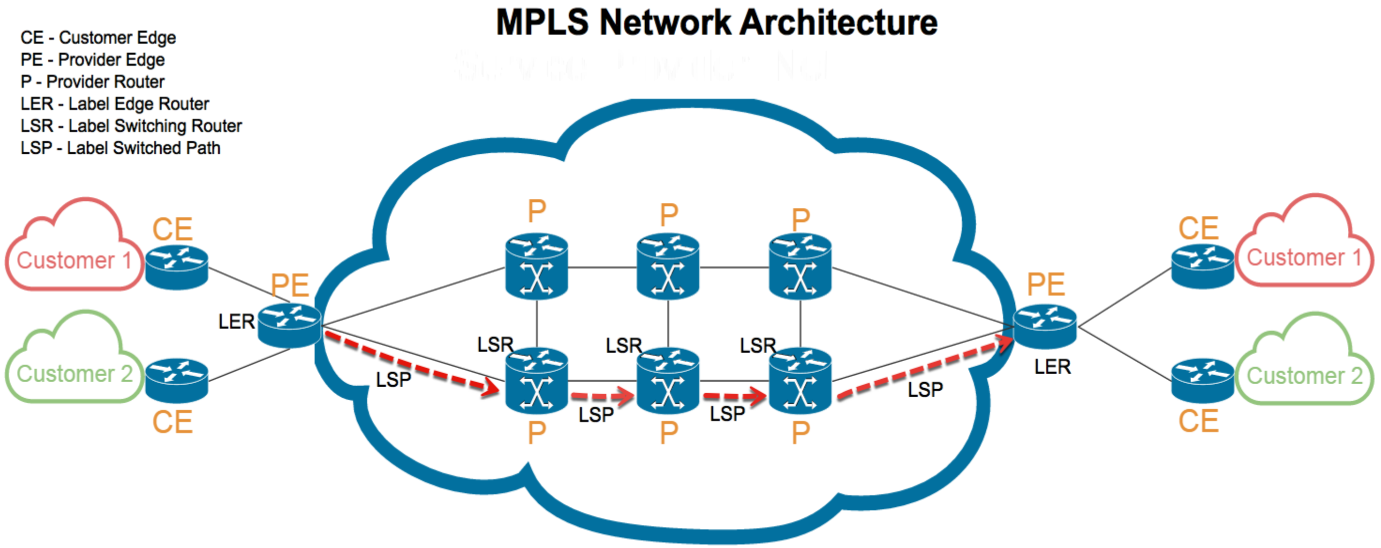
1500B
- 20B IPv4
- 4B GRE
- 20B TCP

= 1456B

With IP mass adoption, IP-MPLS technology established Wide Area Network scalability with multi-service and adequate traffic control capabilities in multitenant environments

IP-MPLS network basics:

- IP-MPLS encapsulates any protocol packet and assigns a Label according to destination port
- Network switchs packets based on labels at the HW level with much faster throughput (no routing lookups per hop)
- Label Switch paths are determined by more efficient label routing protocols
- Packets with same origin and destination follow the same Label Switch path
- Label switch paths can be defined to be symmetrical for both directions
- Paths can manage traffic requirements and protection paths can be predetermined

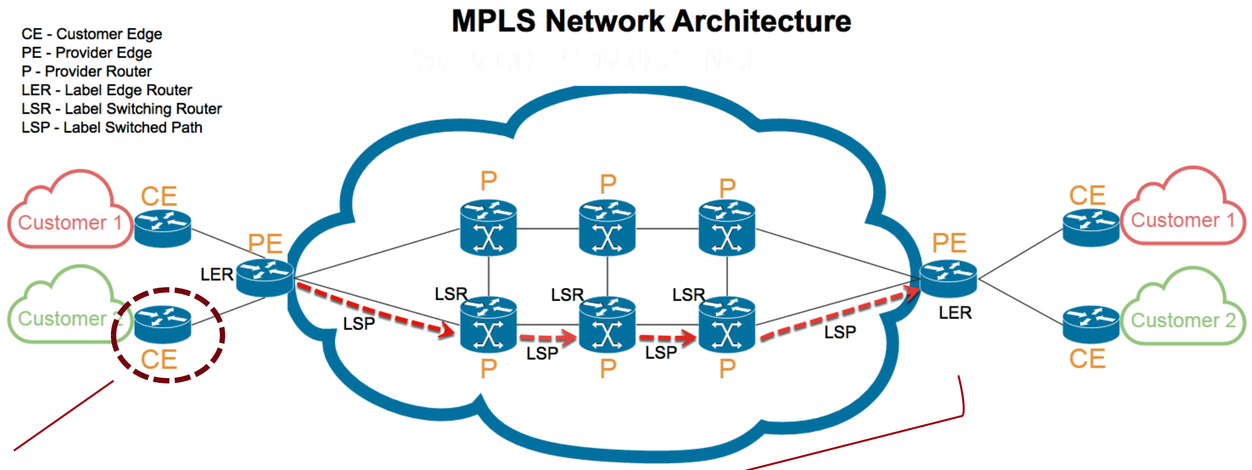


Services

- L3 VPN, private IP networking, user edge routers apply IP routing and private IP addressing as if in a completely segregated environment
- L2 ELAN, for ethernet services
- Circuit emulation and pseudowires, transparent transport and TDM emulation

distribuição

IP-MPLS further develops traffic engineering capabilities that combined with QoS provisions can ensure reliable and predictive traffic behavior between ports



Ingress

- Traffic classification and mapping to transport services
- Traffic shaping / Rate enforcement
- Minimum rate

- Quality class Label Paths
- Pseudowires
- Predetermine protection paths for fast reroute (< 50ms)

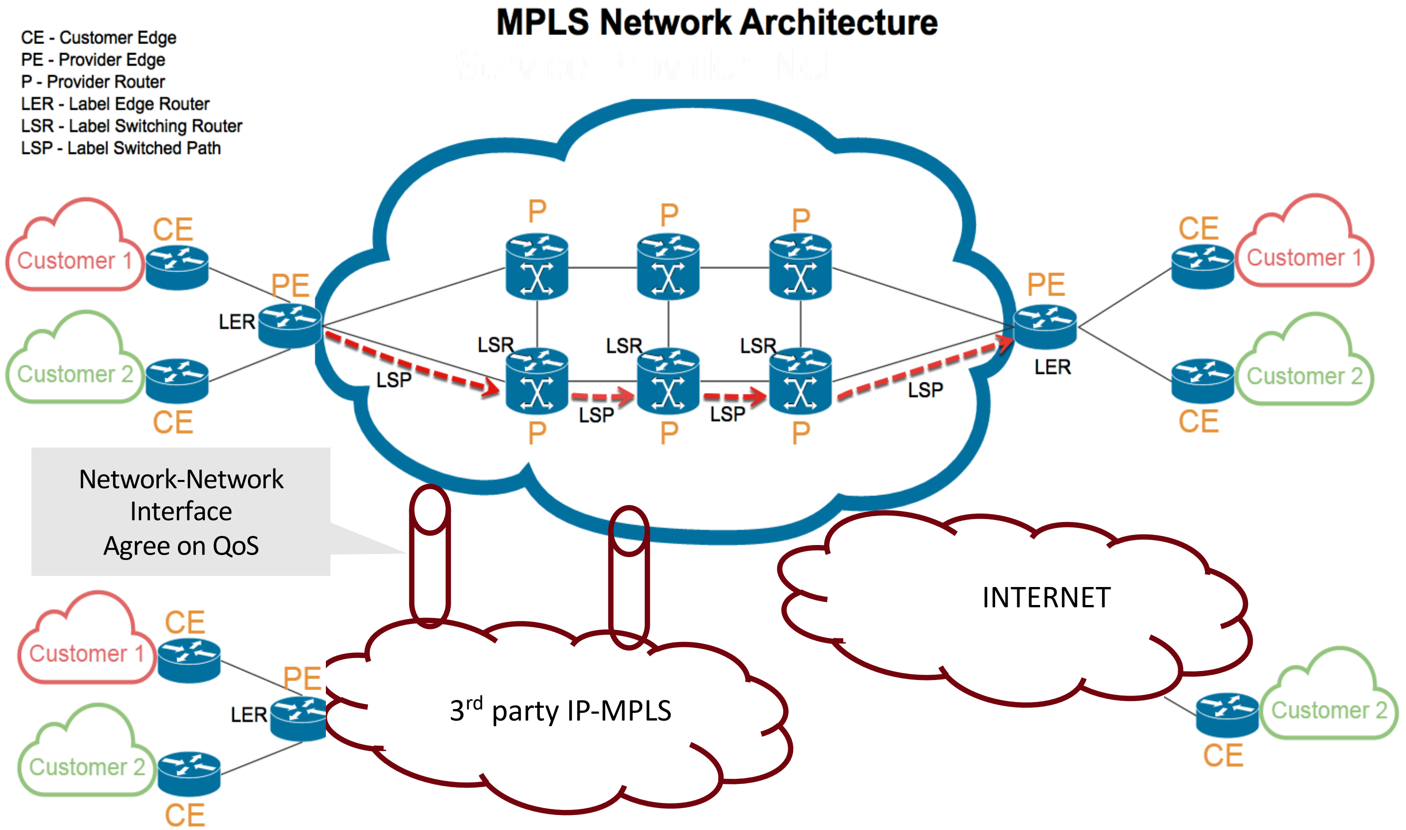
Traffic Engineering

- Label routing with QoS constrains …
- Reserve resources for specific LSP (RSVP-TE)
- The ability to control where and how traffic is routed on your network, to manage capacity, prioritize different services, and prevent congestion

Private IP-MPLS network can extend its reach by contracting external MPLS services or by using the Internet for lower cost and guarantee of QoS extensions

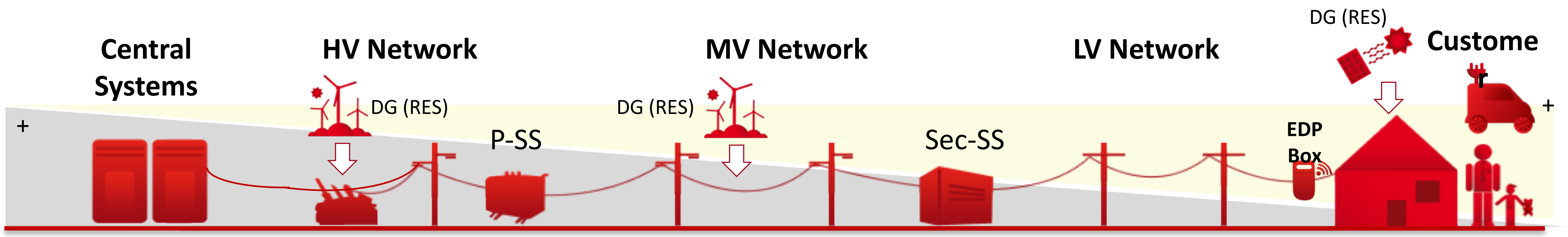
Standardization, wide adoption by service providers, and IP capabilities enable global connectivity and networking:

- By establishing proper Network-to-Network interfaces, reflecting agreed QoS requirements, services can transverse multi IP-MPLS Clouds
- MPLS transport capabilities are transparent to end services
- Traffic can be tunnelled for additional security within external MPLS networks
- Internet and security tunnels can further extend the reach of IP services, not assuring QoS parameters



Utilities have prioritized fiber and high bandwidth systems has their communication core, and wireless communications, for their wide geographic reach networks (Access)

EDPD MAP



Tech	BW	Core Network (Dispatch – P-SS)	FAN (P-SS – Sec-SS)	NAN (Sec-SS - Customer)
Power Line	Low	HV Coupling (< 90's)		LV Coupling
Fiber Cable	High	HV Lines (> 90's)		
Radio ≥ UHF	Med	Pt-2-Pt	Cellular Tech.	Cellular Tech.
Radio - VHF	Low		Multipoint	
Copper Cable	Med	Pt-2-Pt (< 80's)	Pt-2-Pt	

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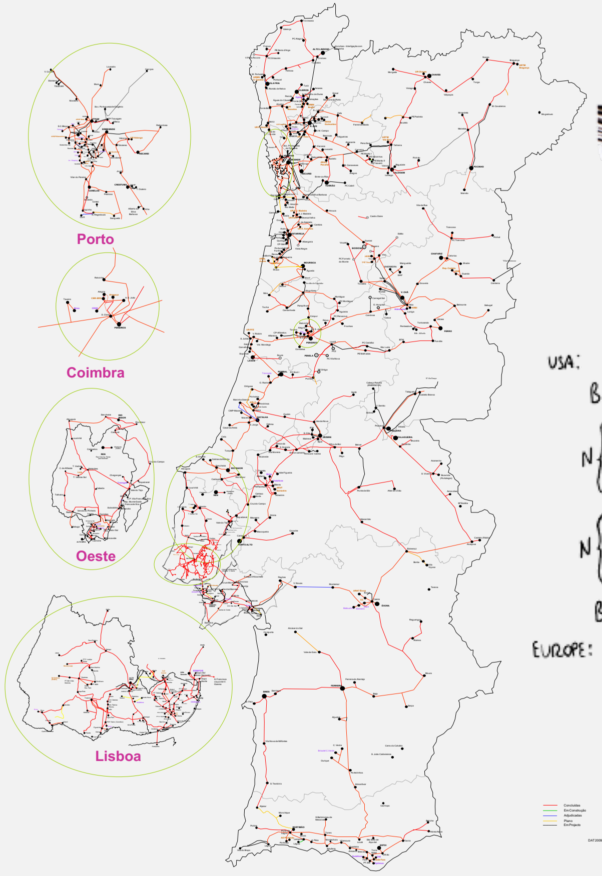
Fiber and TDM technology came to constitute the early foundation of utility digital backbones, supporting connectivity for Primary Substations and main control nodes

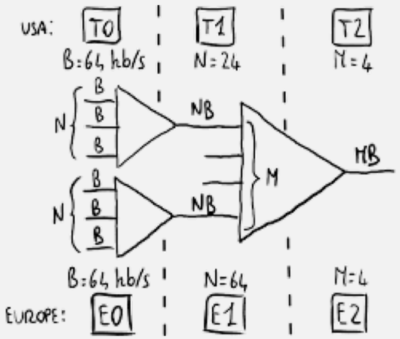
90's - 00's Vision...

- **Digitalization will increase beyond analog and NB current systems** (Analog radio UHF/VHF; Powerline HV)
- **More control and management capabilities will be necessary**
- **QoS metrics will be more demanding**

...led to Fiber and PDH/SDH investments...



>7.500 km



PDH / SDH

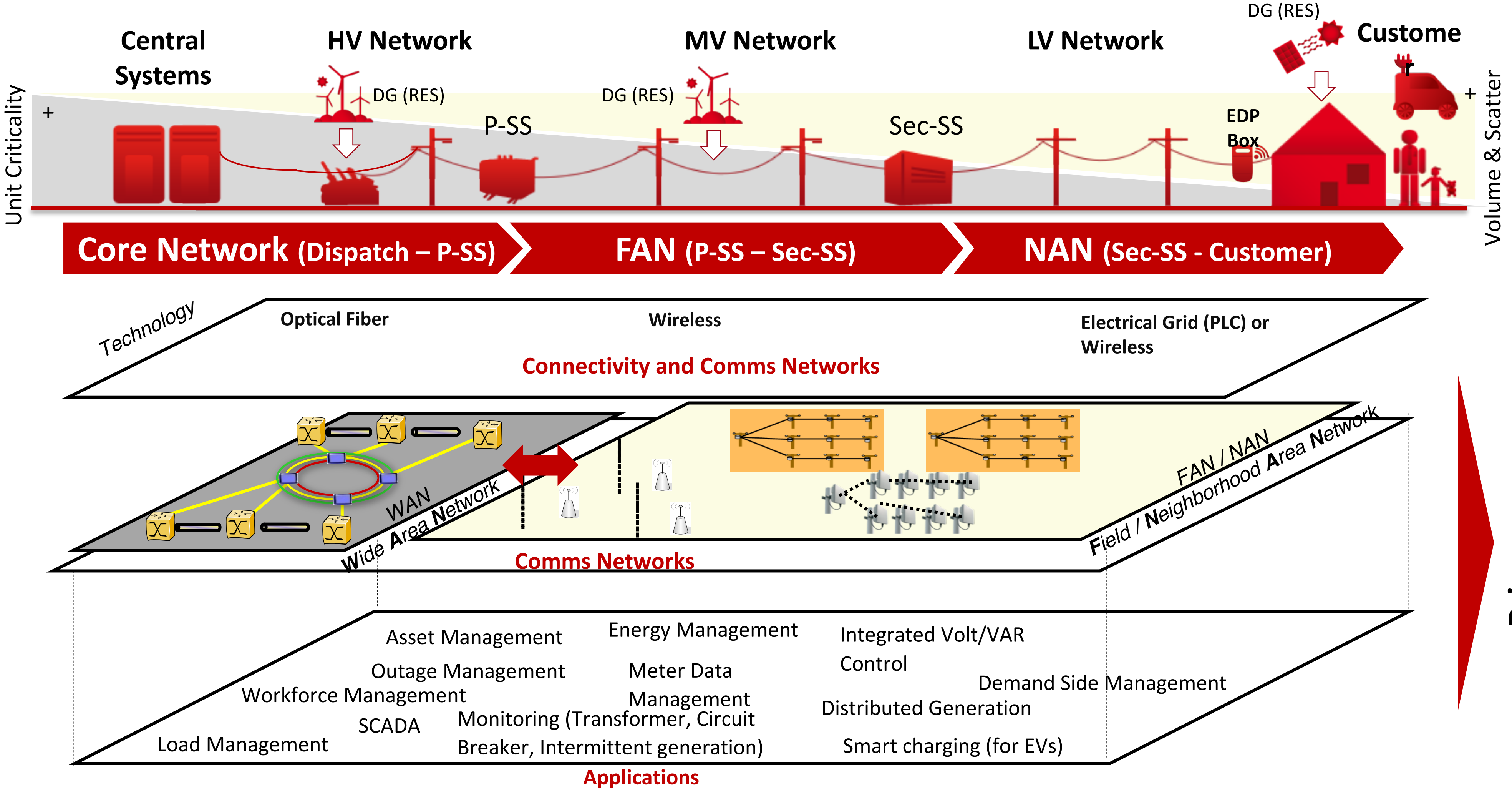
...with several limitations

- **EoL technology**
- **Several TDM legacy Islands**
- **Static and dedicated bandwidth allocation**
- **Service BW ≤ 2Mbps**
- **Point-to-Point**
- **Limited/Complex Multi point setup**
- **Not all traffic protected**

EDPD case

distribuição

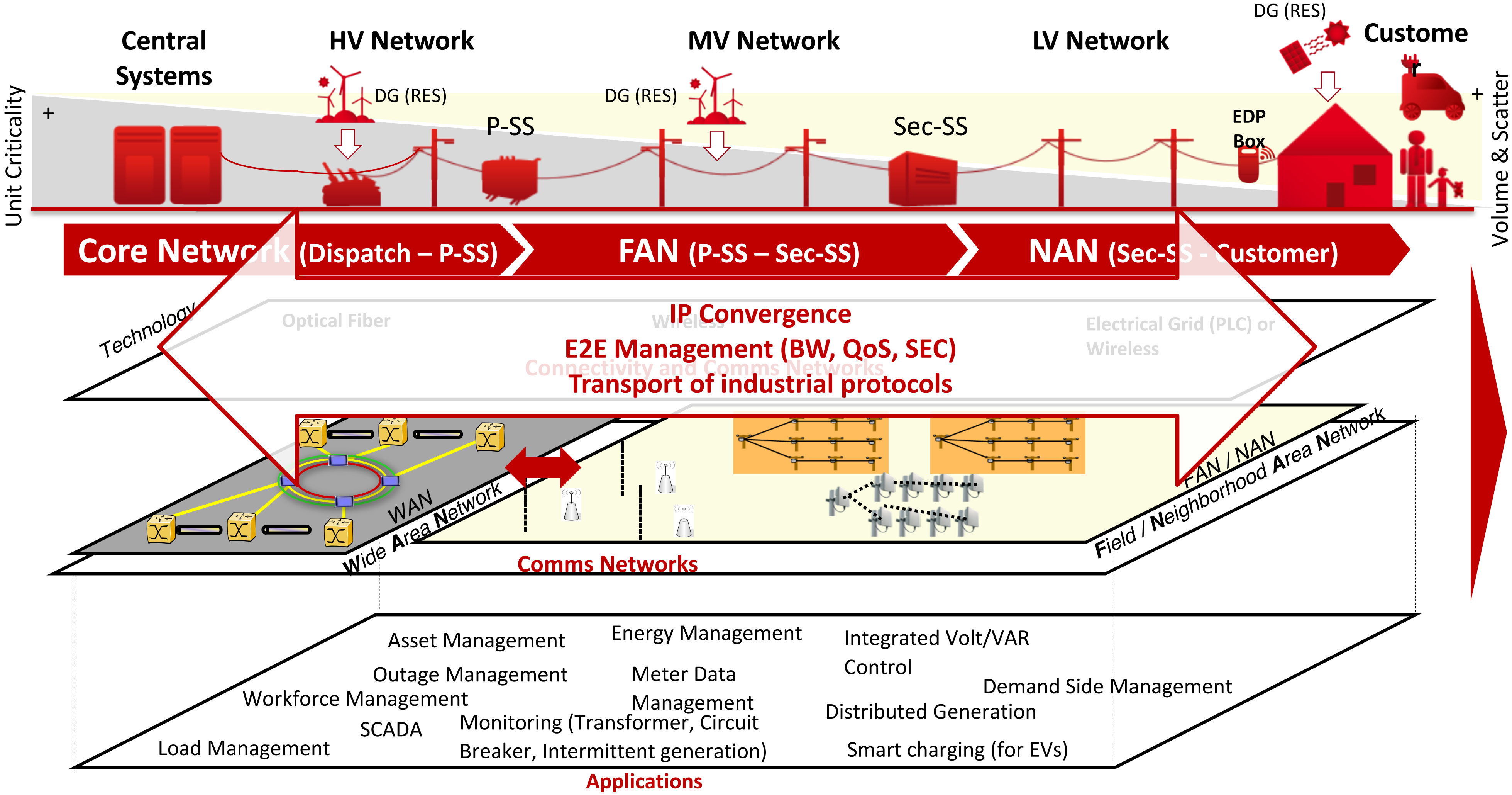
An advanced transversal and integrated telecommunications infrastructure, ie a Connectivity Platform, is a main pillar of the Smart/Digital Grid



Technology Match

- Service requirement
- Information volume
- Geographical distribution
- Cost per Byte
- Existing Assets

Packet networks and IP protocols enable the connectivity convergence of an heterogeneous industrial and all-connected environment

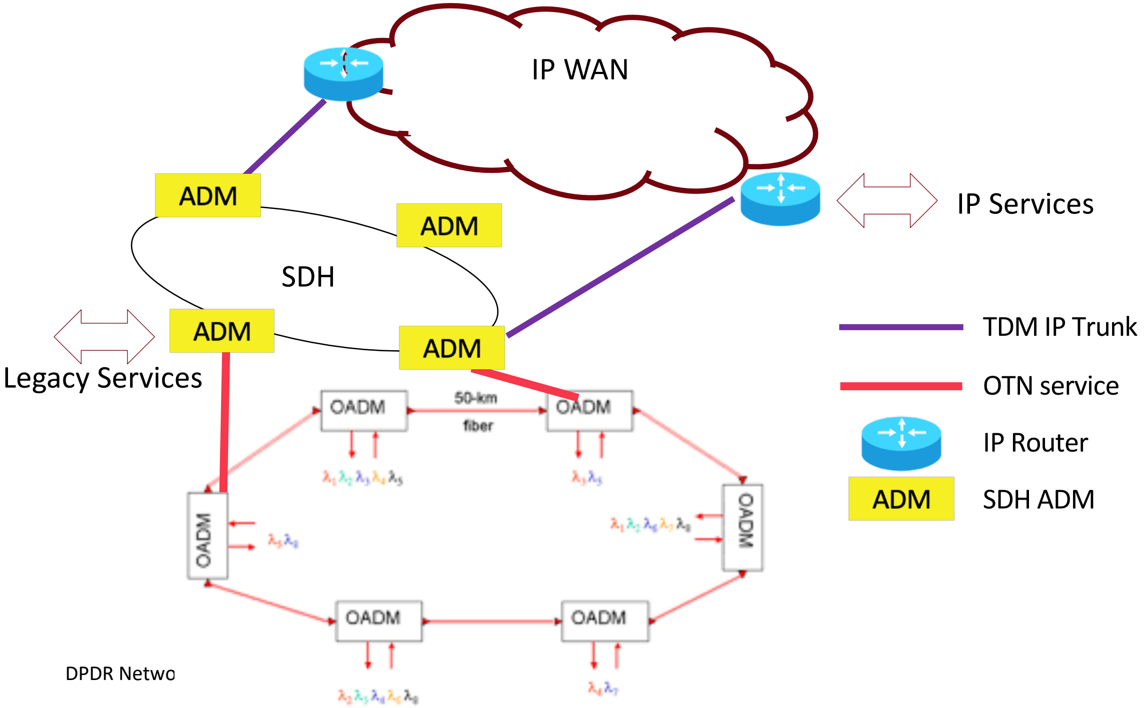


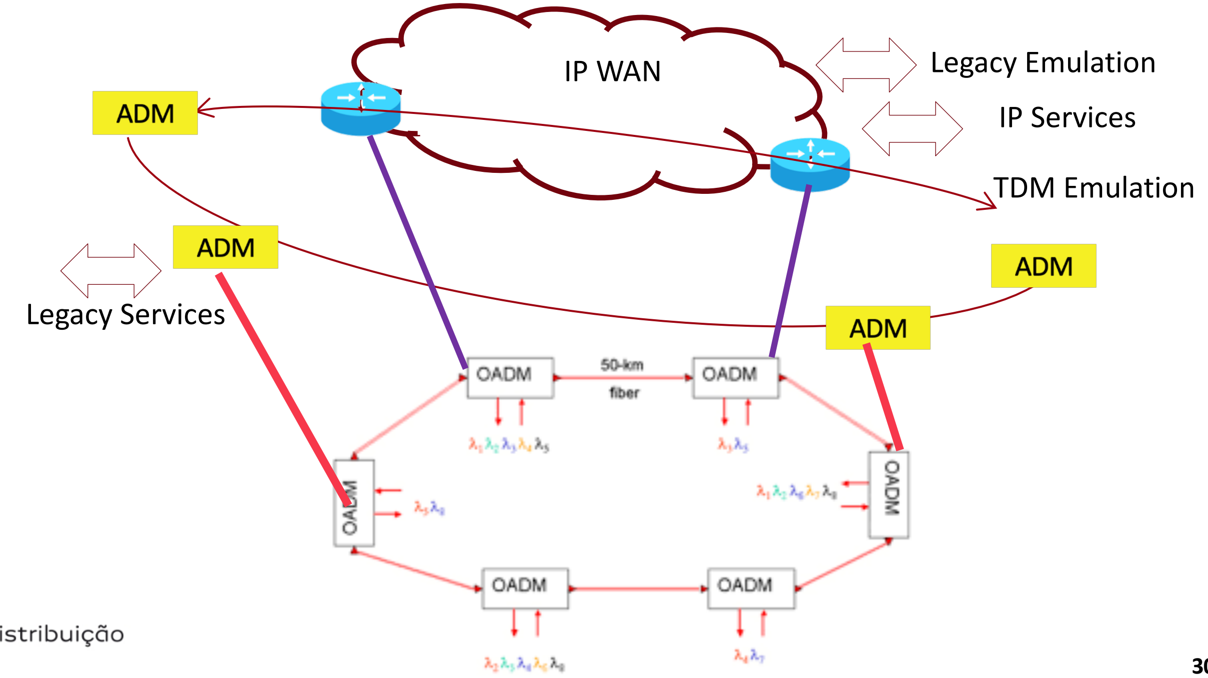
Ethernet & IP are todays networking defaults:

- Focus on segregation and security
- VPN/eLAN for private domains
- Unified management

Transition from TDM to Packet can be phased, evolving from IP overlays to IP Core supporting TDM emulation for legacy services and TDM network sections

IP Overlay	IP Core
• Create IP Highlands to address specific nodes requiring IP connectivity • When applicable, consider IP trunks supplied by TDM systems, extending the IP reach • SDH can support L2 PtP, facilitating the transition	• Emulate PtP TDM services over IP • Consider a suitable optical core, for high bandwidth IP trunks and legacy TDM • Start islanding TDM aligned with legacy TDM clients and respective life cycle





distribuição

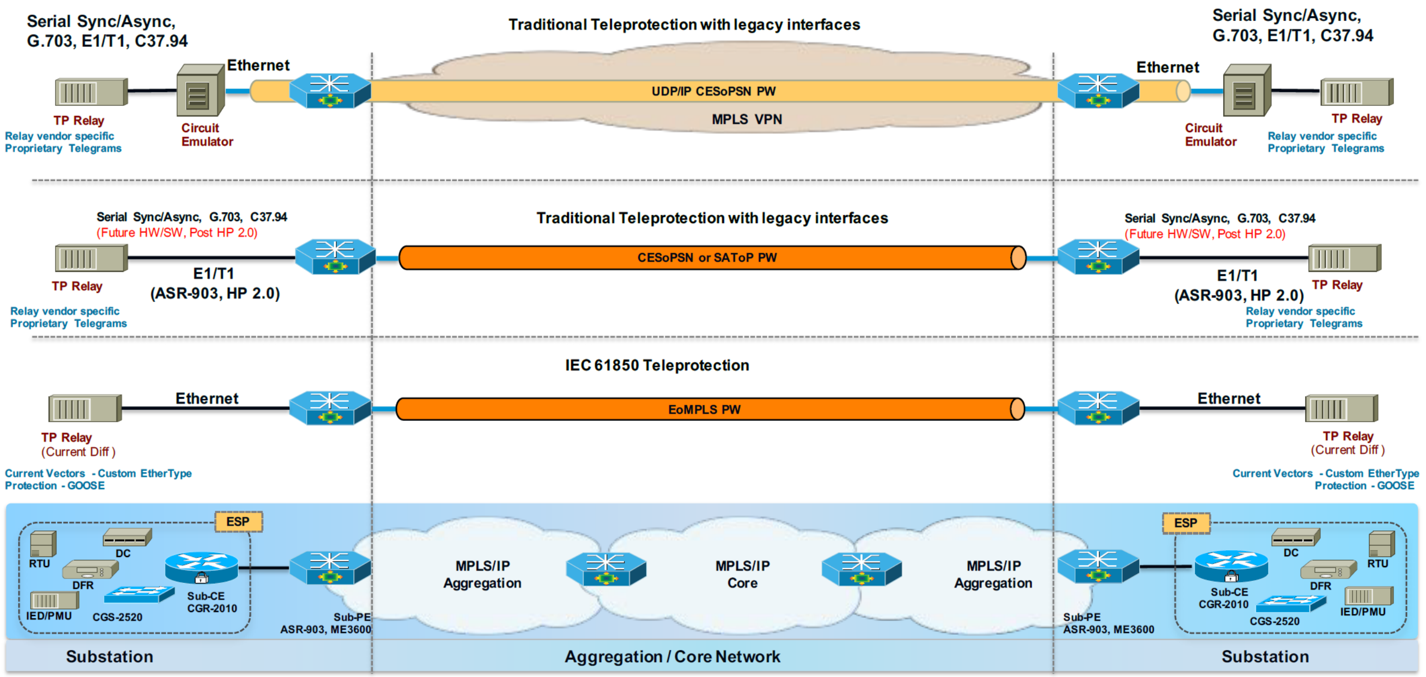
Supporting critical and QoS sensitive services often demands for a detailed revision of the underlying functional and technical capabilities, testing and migration planning

Teleprotection Use case

- Point-to-point connection
- Functional requirements demand for very low latency and jitter
- Legacy systems using direct dark fiber or 2Mbps TDM links

To investigate & consider

- Detailed specs of teleprotection equipment
- How teleprotection detects and signals link impairments
- Detection and consequences of connectivity QoS breach
- Product evolution and options



- Get teleprotection and IP vendors involved / Setup Labs and stress tests
- Plan teleprotection evolution to L2 compatible models
- Setup high quality label paths, with resource reservation
- Priority to teleprotection vendor options for digittering modules
- Use GPS high resolution time source tags to reinforce time marking

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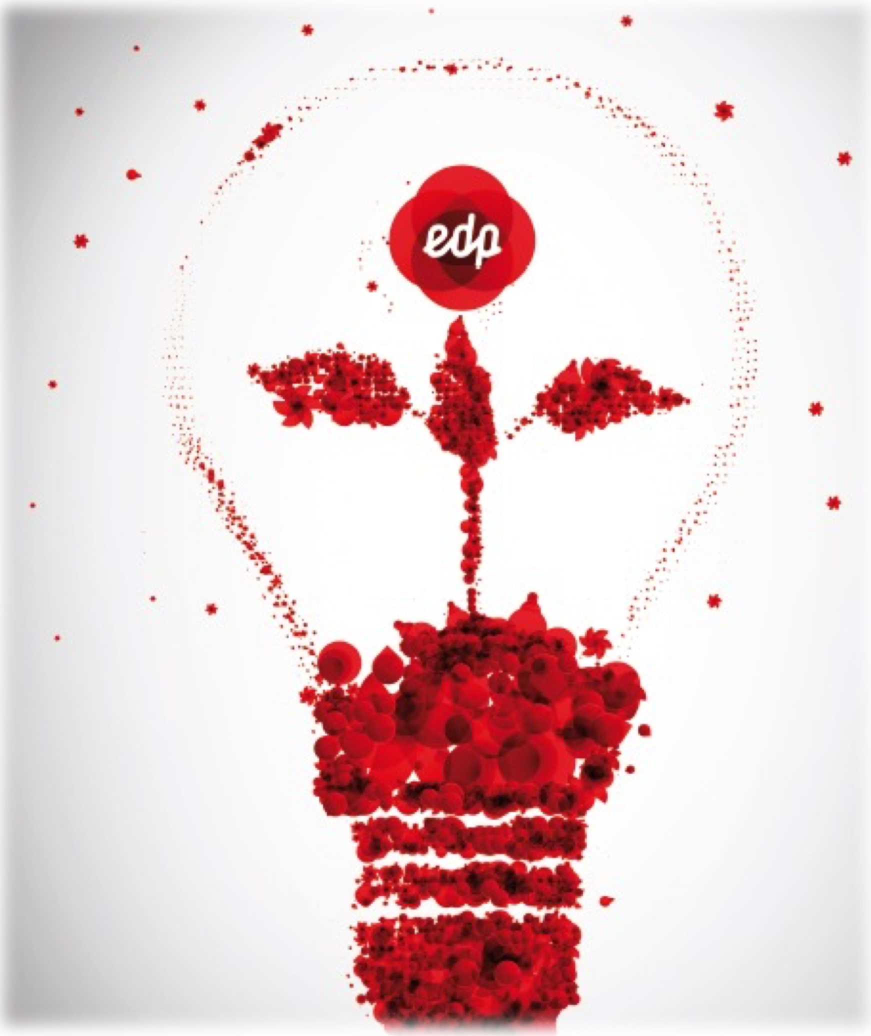
5. Mobile Networks and Services

4. Assurance and Security
   - PVNO - Multi sourcing
   - Private Networks & Spectrum
5. Final remarks



Mobile networks will play an increasing role in an all connected environment, reinforcing IP and Service management orientation by Utilities

SERVICES

- SCADA, TCMT
- Qualidade de energia
- WFM
- Iluminação pública
- Smart metering
- Voz operacional
- MicroGrid / Self-Healing
- Manutenção Preditiva
- Gestão Avançada de Ativos
- Controlo de Perímetro

CONTROL & ORQUESTRATION

PVNO(1)

CONNECTIVITY INFRASTRUCTURES

PUBLIC NETWORKS

(todos os operadores com redes nacionais)

2G/ 3G/ 4G / (5G) Networks

IoT (NB-IoT, LTE-M, MMTC), WiFi

Satélite services (LEO/ GEO)

PRIVATE NETWORK

LTE 450 MHz

Tactical component

IoT (NB-IoT, WIFI)

EDPD ASSETS

Network

Routers

OCRs

DTCs

Smart IP

Sensors

Operational Teams

Field force

Operational Vehicles

ASSURANCE

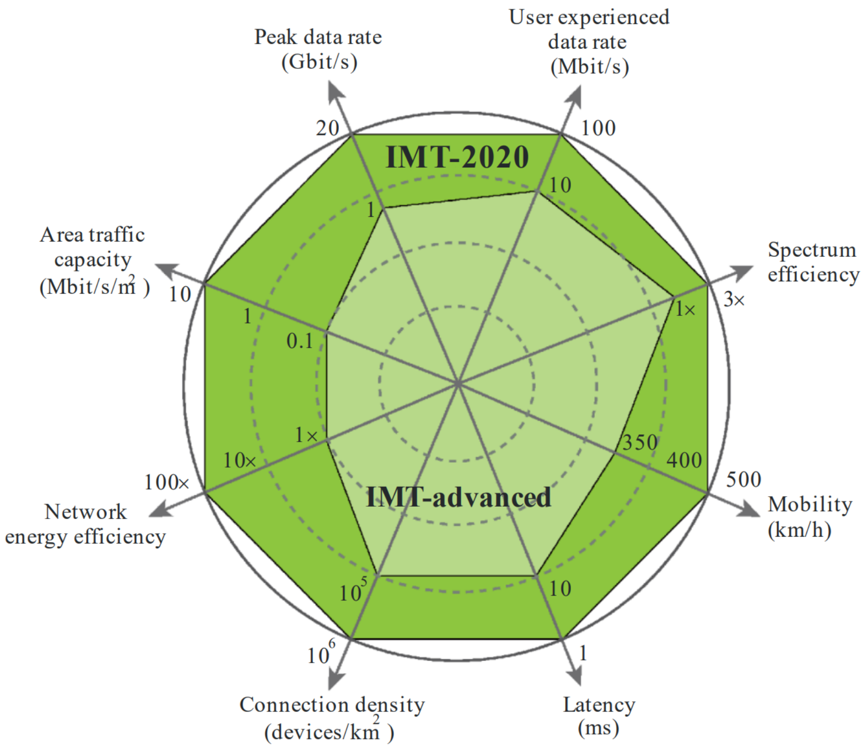
- Service Control
- Maximize availability & resilience
- Asset coverage
- Emergency Support
- Flexibility for tech adoption
- Foster competition

Legend: Existing Future

(1) Private Virtual Network Operator

5G addresses the implicit and pervasive connectivity of a digital society, matching human centric and machine type communications requirements

5G VERTICAL SUPPORT



Rec. ITU-R M.2083-0

Enhanced of key capabilities from IMT-Advanced to IMT-2020

Besides the enhanced Mobile Broadband capabilities 5G shall support next level of human connectivity in an all-connected world of humans and objects:

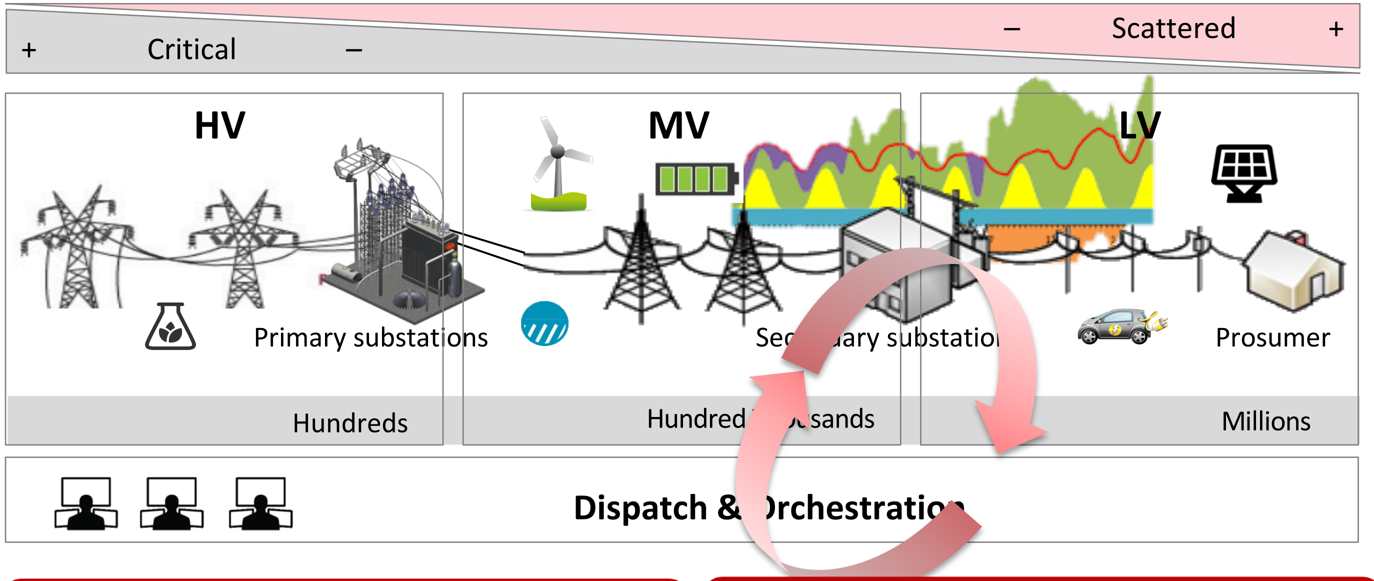
- Foster the 4th industrial revolution, enabling reliability and latency-critical communication between machines, or among machines and humans, in industrial environments;
- Enable the transformation of the automotive sector and transportation in general, allowing for advanced forms of collaborative driving and increased efficiency in railroad transportation;
- Revolutionize health services;
- Supporting **Smart Grids and Smart Cities**, improving the quality of life through better energy, environment and waste management;

distribuição

As so, 5G capabilities resonate with Smart Grids requirements, raging from massive machine type connectivity to Ultra reliable Low latency for Energy orchestration processes

EDP Distribuição infrastructure ecosystem

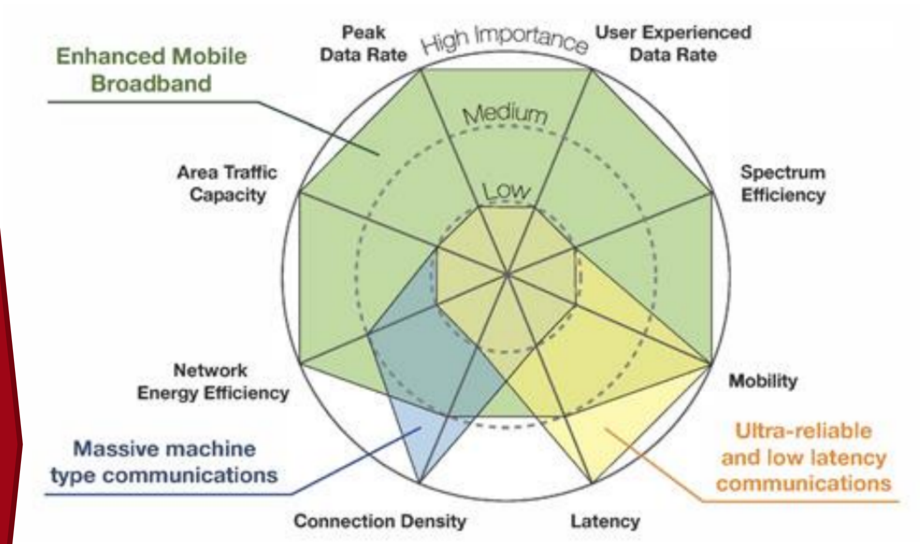
Electric Grid



Market Enabler

Enabling Local Energy Grids	Enabling Flexibility Management
Device to Device Comms	Orchestration of Supply/Demand
Loads & Producers Local Self-Balancing	Real Time Flexibility Market
Decentralized Grid Control	Smart Contracts
BlackStart from Islanded LEN	Balance & Settlement Improvement

5G VERTICAL SUPPORT



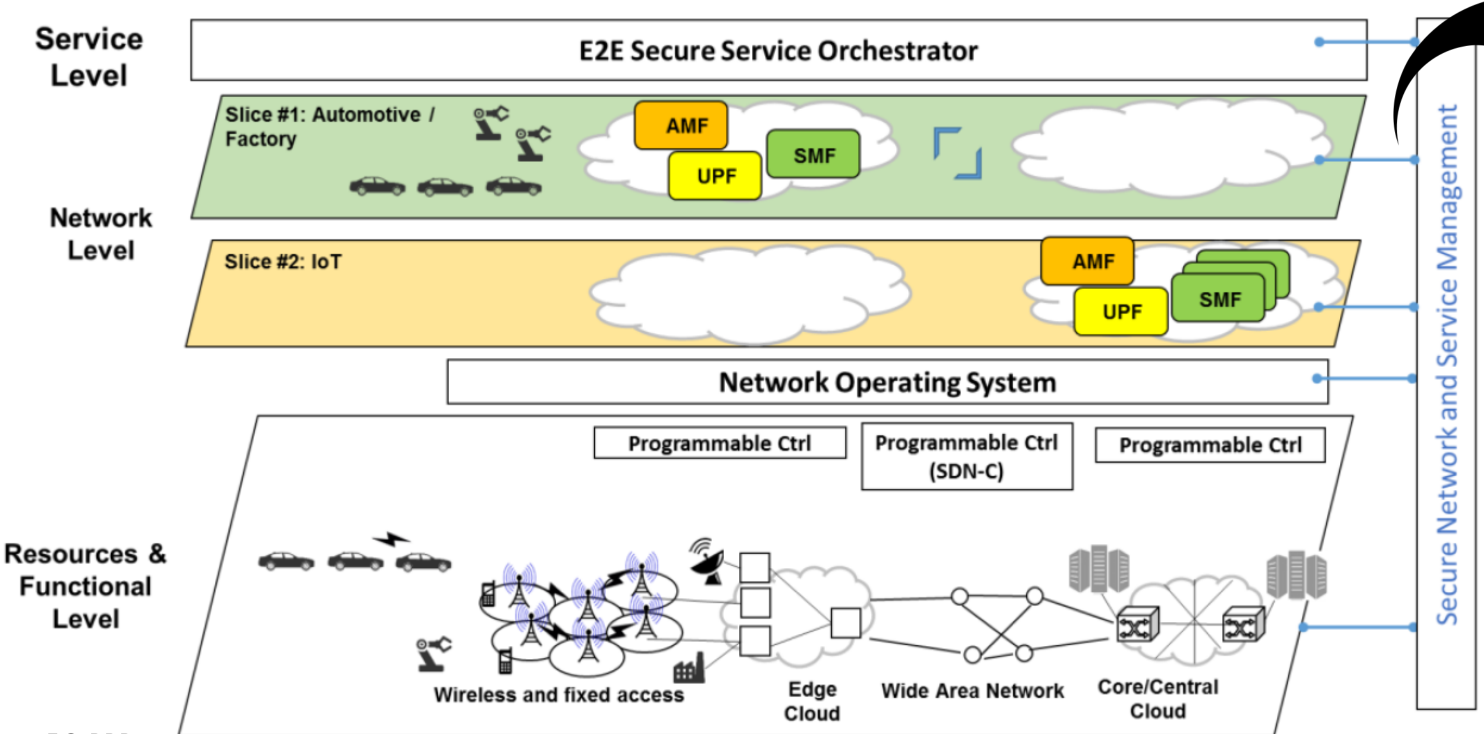
Rec. ITU-R M.2083-0

Enhanced of key capabilities from IMT-Advanced to IMT-2020

5GPP- 5G Empowering Vertical Industries

distribuição

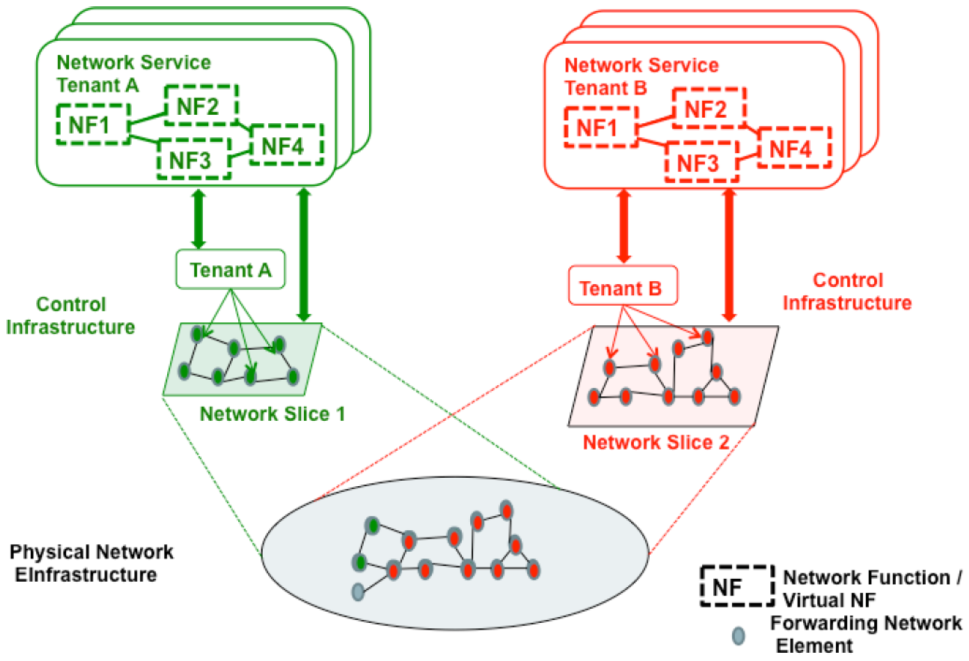
As seen in TDM to IP transition, 5G "Slicing" brings dynamic system multiplexing to Mobile Networks, tailoring network and services to Vertical's requirements



5G-PPP

5G Architecture

Slices can be presented as Networks instances without changes to underlining infrastructures



5G-PPP

5G Architecture

E2E concept covering all network segments including radio networks, wire access, core, transport and edge networks, composing network functions, network applications, and the underlying cloud infrastructure (physical, virtual or even emulated resources, RAN resources etc.), to meet the requirements of a specific use case

edp distribuição

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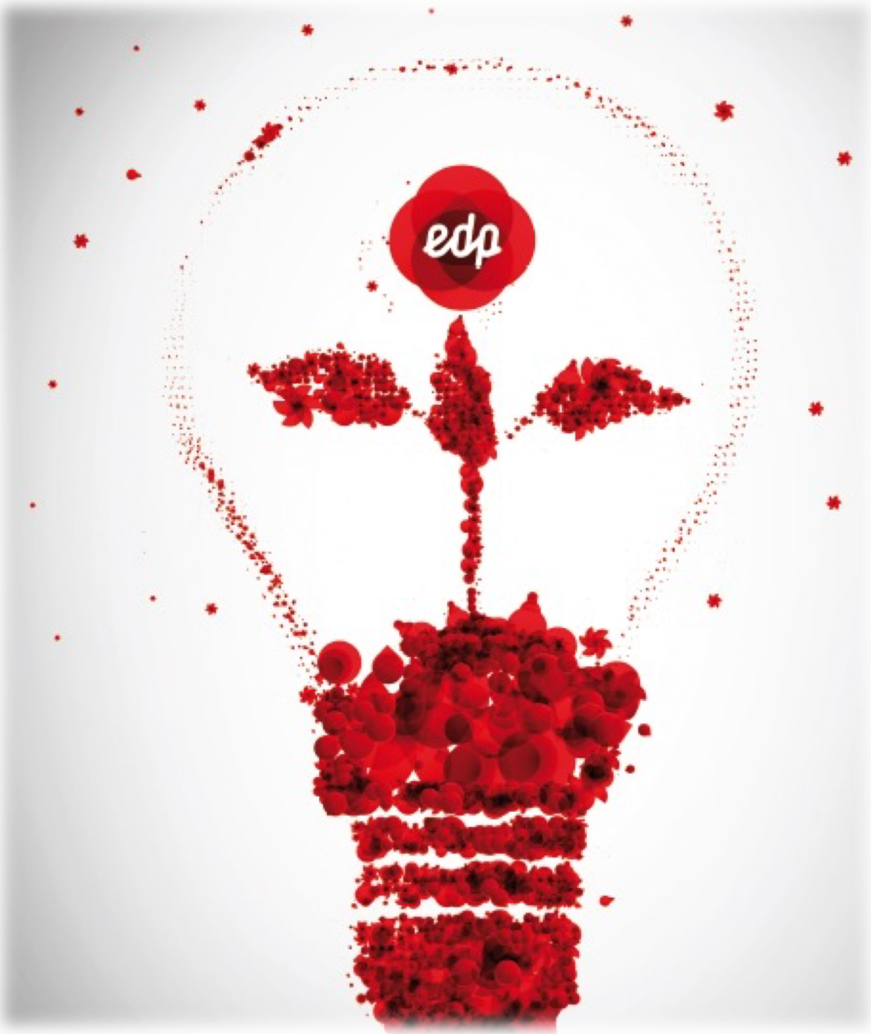
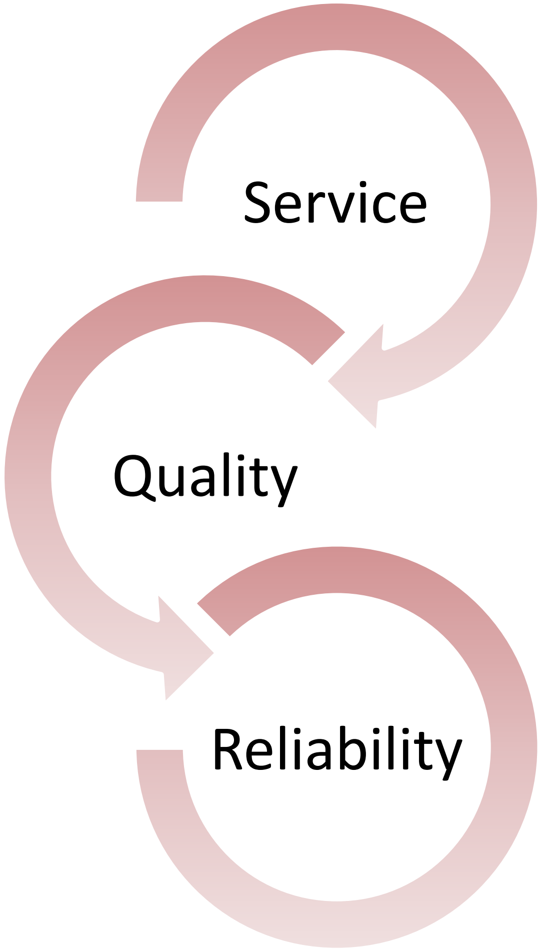


Besides technology and connectivity capabilities, Utilities need to foster a service oriented organization, promoting E2E service assurance and competitiveness



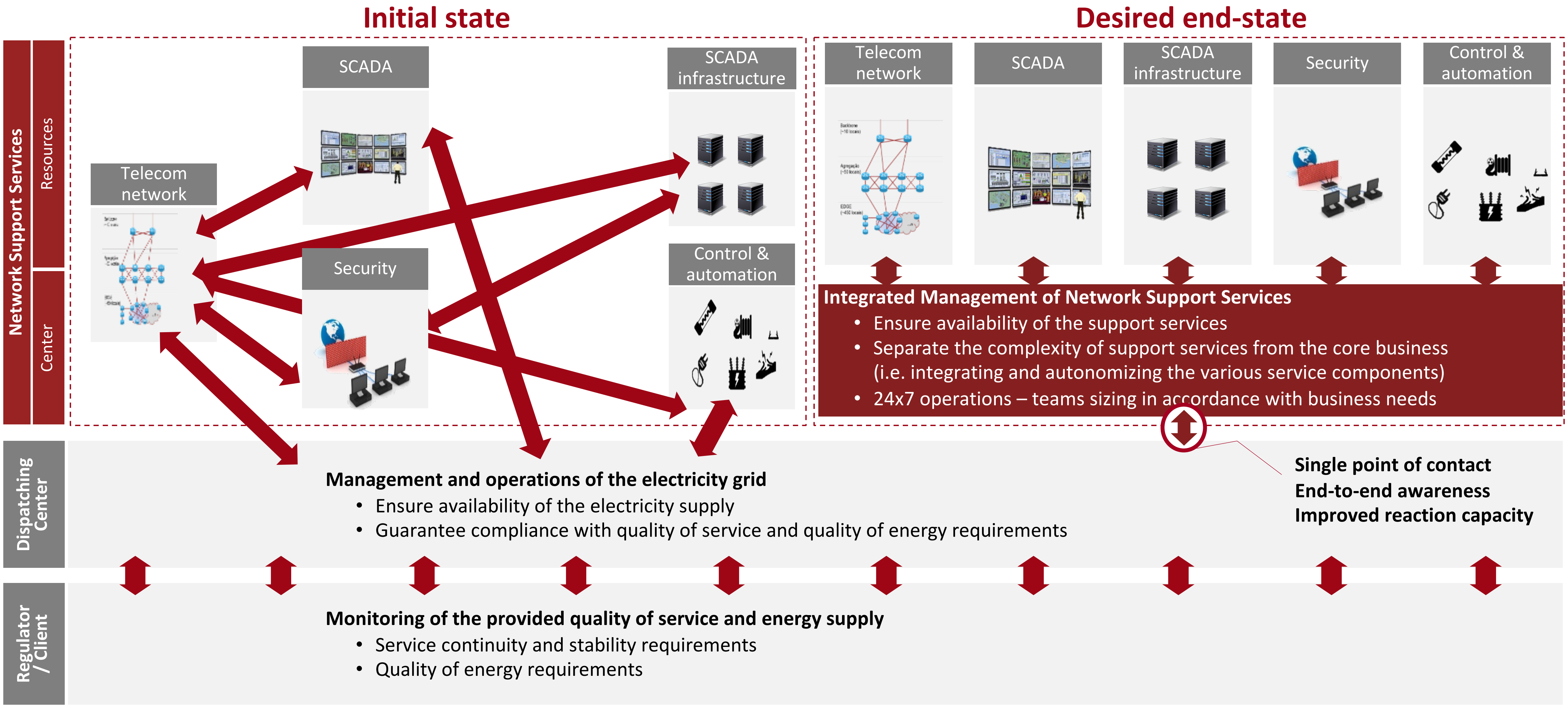
- Service management framework
- Staff and core competencies
- Develop OSS platform
- Define operational procedures
- Proactivity and continuous improvement

Service excel / Benchmark

- Availability
- Time to provision
- Number of service impact
- Track and benchmark Totex

edp distribuição

Service Assurance and Cybersecurity Capabilities need an integrated operational and security management practice, with improved global awareness



EDPD realized the need to address E2E service assurance, developing an operational framework for it’s NOC/SOC, responsible for service continuity and quality improvement

Contact and monitoring layer

Technical Operations’ layer (troubleshooting)

Analytics & Performance management

Operating model & best practices for the Smart Center

Service & Contact Management

Service Integration & Monitoring

Technical operations

- ***Telecom network***
  - Core network
  - *Wireless* public & private network
- ***Infrastructure (servers)*** / ***Applications***
  - SCADA
  - BI, *Front ends*
  - Active Directory Integration
- ***Automation & Control***
  - OCR
  - RTUs
  - Sensors
- ***DTC e meters***
  - DTC
  - EB
  - Meters

Operational Security Management (SIEM)

Functions/ responsibilities

- Professionalized relationship with the clients with a **single point of contact**
- Services’ **predictive & integrated monitoring**
- **Trouble-shooting** & management of **incidents & service requests**

- ***End-to-end*** service & priority management
- **Integrated vision** of multiple technologies
- Services’ **performance analysis, catalogue mgmt. & predictive analysis & reporting**

- **Back-office support** for technical operations execution
- **Monitoring** with event and replenishment mgmt., **and swift incident resolution** (or avoidance preventive action)
- **Capabilities for incident and root cause analysis** identifying and executing corrective actions
- Contact and **coordination of suppliers’** operational involvement
- **Availability and capacity** mgmt.

- Technical **security mgmt.,** implementation & supervision of **security processes, policies and rules**
- **Access mgmt. (IAM & PAM)**
- **Intrusion tests**

The threats within the Digital Grid are real. The root causes for blackouts are no longer exclusively physical or normal operative failures

- 3 DSOs compromised
- 250.000 people affected
- 1 to 6 hours to recover

… and it could have been worse!

CNET › Security › Ukraine blackout is a cyberattack milestone

Ukraine blackout is a cyberattack milestone

Hundreds of thousands of homes were left in the dark in what security experts say was a first for hackers with ill intent.

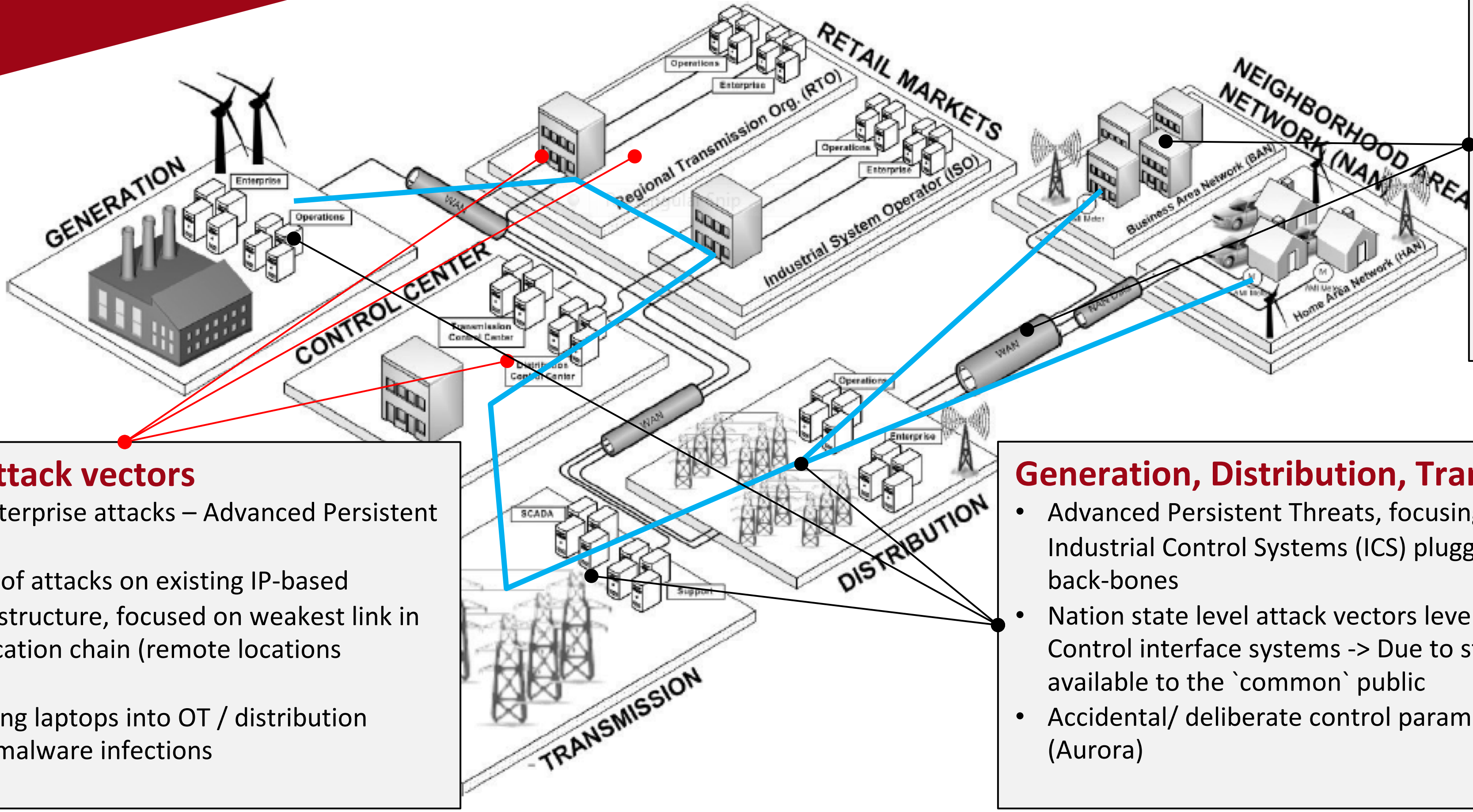
The Age of Hacker-Caused Blackouts Is Upon Us

A malware attack left thousands of homes without power in Ukraine and this is only the beginning.

Internal and external threat actors may impact all components from generation to distribution, with attack vectors changing on a regular basis

Growing cybersecurity significance in energy

Main energy ecosystem attack vectors, needing close monitoring



Advanced Meter Infrastructure

- Meter tampering, meter data fraud
- IP-based threat vectors, partially combined with mobile attacks
- Gateway-level attacks

SMARTGRID connectivity to internet through smart thermostats!

Enterprise attack vectors

- Traditional enterprise attacks – Advanced Persistent Threats
- Full spectrum of attacks on existing IP-based (control) infrastructure, focused on weakest link in the communication chain (remote locations preferred)
- Engineers taking laptops into OT / distribution stations with malware infections

Generation, Distribution, Transmission

- Advanced Persistent Threats, focusing on SCADA and Industrial Control Systems (ICS) plugged into IP back-bones
- Nation state level attack vectors leveraging Process Control interface systems -> Due to stuxnet also available to the `common` public
- Accidental/ deliberate control parameter changes (Aurora)

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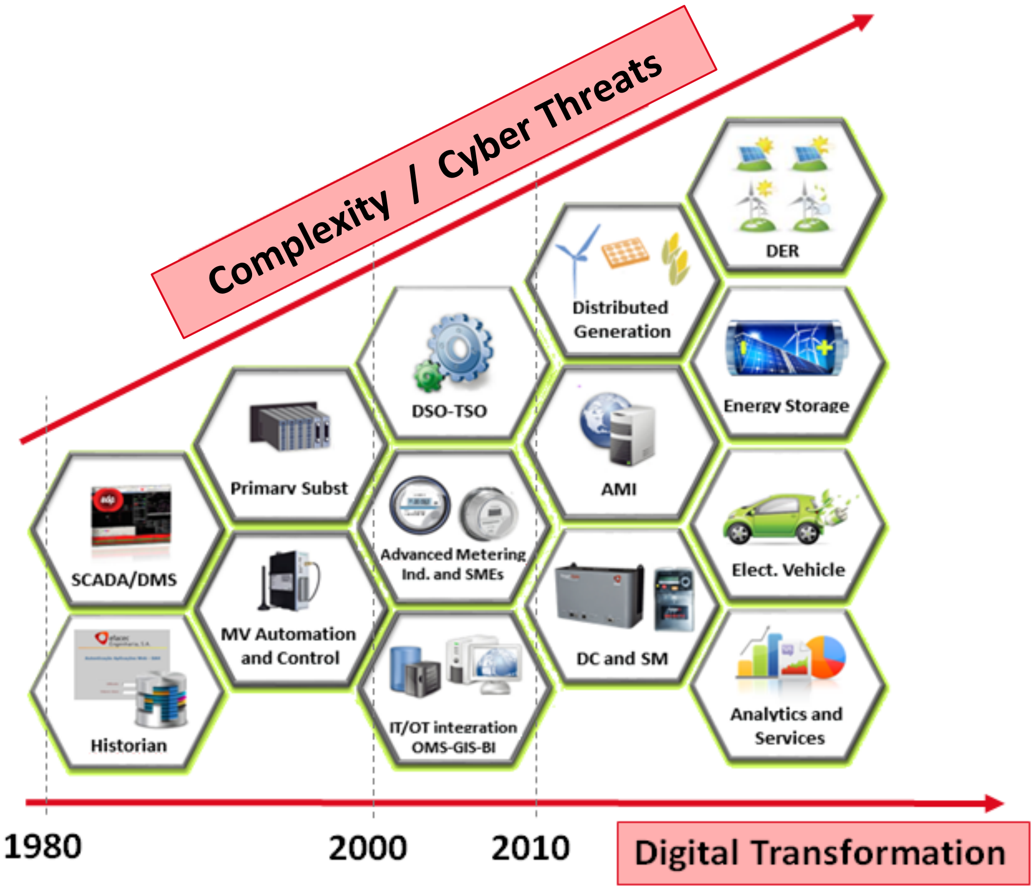
Digital Grids have no physical boundaries, they’re heterogeneous and decentralized, entirely changing the landscape of a Critical Information Infrastructure



Exposure	• Everywhere • Multiple connections • Millions of Nodes
Communications	• Multiple Standard protocols & networks
Systems	• Complex and highly Interconnected
Human Resources	• Hundreds in&out • Remote Access
Security Approach	• Perimeter Security • Defense in depth • Something different

Challenges of Future EC Regulation

- Network Information Security (NIS) Directive
- General Data Protection Regulation (GDPR)

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Taking operations as foundation for quality and compliance (configurations, SW, FW, …), 5 specialized security oriented domains provide a higher level of security.

Security Operations integrated in the Digital Platform of Supervision Center

Monitoring & Detection	Incident Response & Recovery	Continuous Sec. Operations

Technology & People & Processes

- Identify
- Protect
- Detect
- Respond
- Recover

Continuous Audit

KEEP IT SECURE 24

Identification of vulnerabilities and fast remediation

Implementation of ISO 27001 certification

Establishes the requirements to define, implement,
maintain and continuously improve Security

Yearly Cyber security Projects

Cyber Risk Assessment (Business focused investments)

Awareness and training at all levels of the organization are key in implementing robust and reliable cybersecurity strategies

Imperatives for cybersecurity at EDP Distribuição

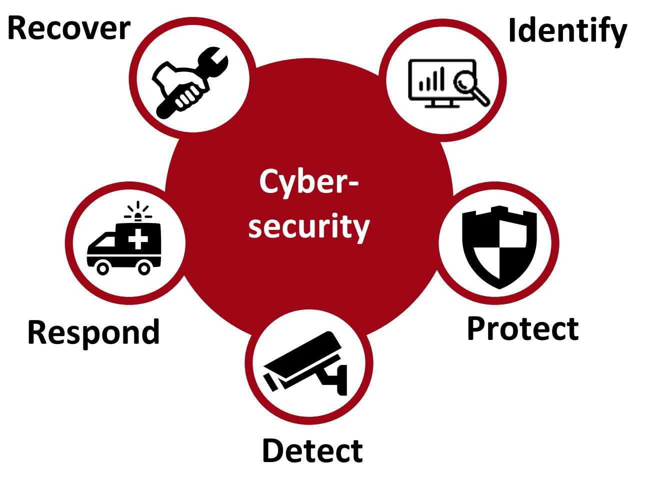
- Introduce security requirements on most future tenders – ICS and SG
- Maintain an active involvement and cooperation in European Initiatives and Groups

CNCS · CERT.PT · enisa · European Commission · EE-ISAC

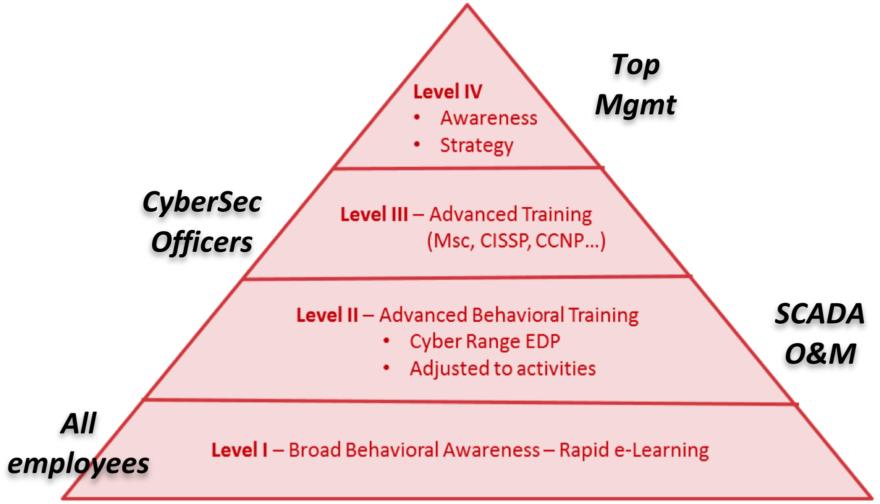
- Ensure the alignment of Cybersecurity Strategy with the NIS and GDPR
- Improve the SOC as a key factor for Cyber Security
- Keep investing in Cyber Security to prevent its uncertainty…

Training and awareness program on cybersecurity for Critical Information Infrastructure (CII)

Develop cybersecurity incident response capabilities …



… applied at all levels of the organization



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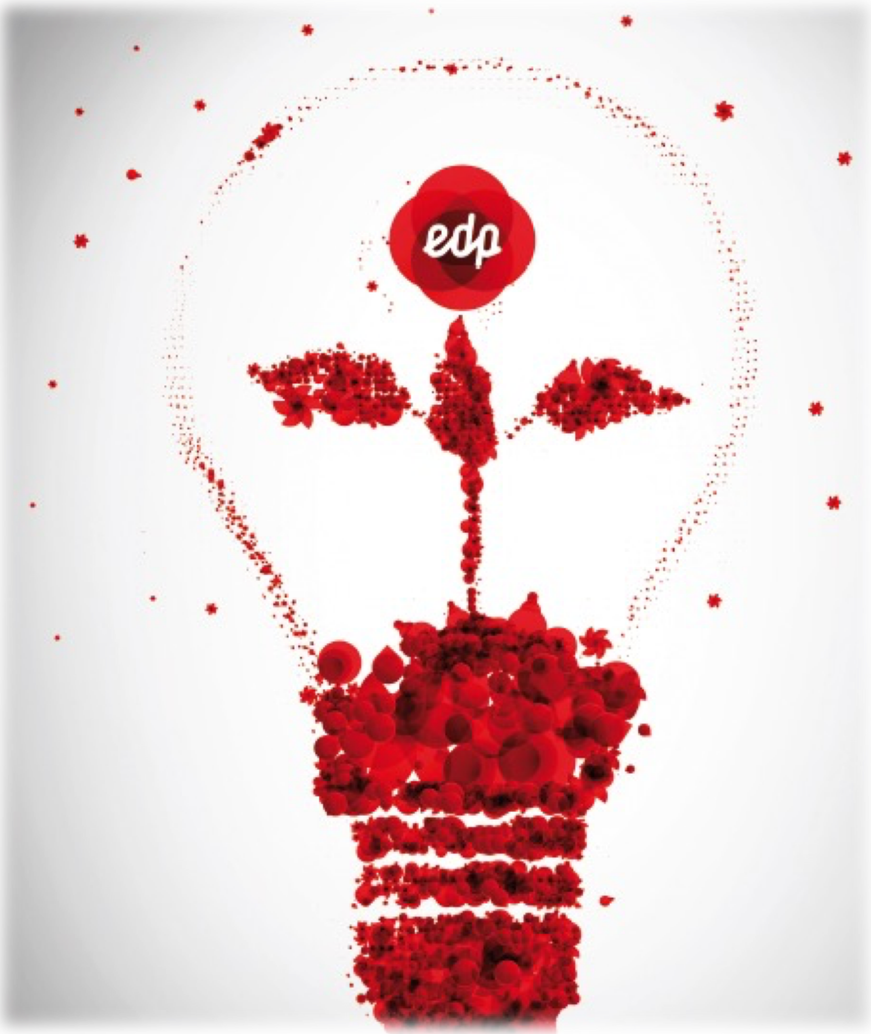
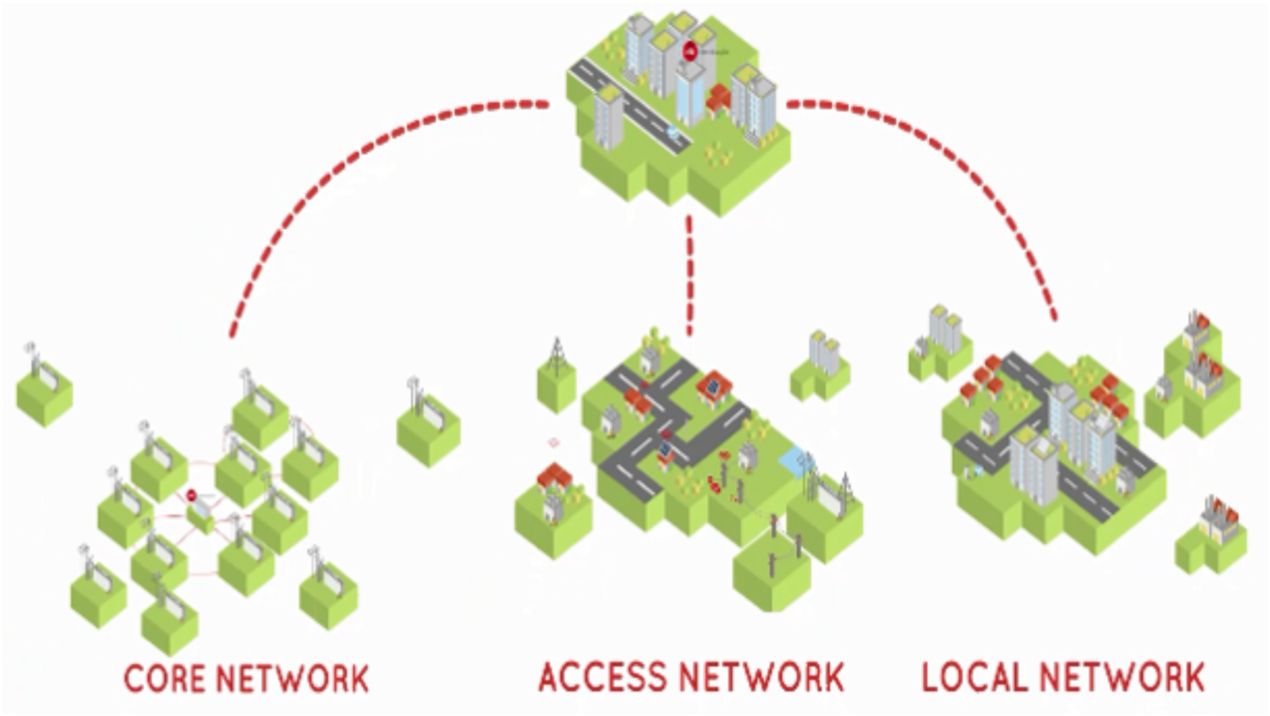


Its more than technology, being core to modern Grids, Utilities need robust frameworks for Service Assurance, Security and efficiency, in what led EDPD t it's "The Connect Program"



Final Remarks

Challenges and Concerns

- **I** Smart Grids entail an all connected environment with multiple permanent data transactions
- **II** IP and mobile wireless technologies play an increasing role in digitalization, facilitating the IoT of everything, and the applicability of authentication and security mechanisms in scale
- **III** Standardization is addressing special vertical requirements, promoting convergence of technologies used in Public and Private Networks
- **IV** Smart Grid connectivity services will involve a multitude of technologies and suppliers, requiring appropriate skills and staffing for utilities to drive their priorities and responsibilities
- **V** Regulator engagement and cross sector alignment is of utmost importance
- **VI** Private network components will maintain an essential role in assuring adequate business continuity and complementing market "holes"
- **VII** Connectivity/digital assurance are new Utility's Core assets, requiring adequate skills and staffing

Thank you for your attention

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