IP/Ethernet Drivers and Landscape: Smart Grid in Iberdrola

NETWORK BUSINESS SPAIN
Control Systems and Telecommunications

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Alberto Sendín

July 2013
• Iberdrola

• Communication Network and Architecture in Iberdrola

• Evolution towards Ethernet

• MPLS as Extended LAN basis
Iberdrola
**A Great Company**

<table>
<thead>
<tr>
<th>OTHER OPERATING DATA</th>
<th>Q1 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENERGY POWER DISTRIBUTED (GWh)</td>
<td>55,871</td>
</tr>
<tr>
<td>USERS ELECTRICITY-SUPPLY POINTS UNDER MANAGEMENT (MILLIONS)</td>
<td>28.11</td>
</tr>
<tr>
<td>USERS GAS-SUPPLY POINTS UNDER MANAGEMENT (MILLIONS)</td>
<td>3.59</td>
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<tr>
<td>GAS SUPPLIES (GWh)</td>
<td>36,639</td>
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<tr>
<td>GAS STORAGE (bcm)</td>
<td>2.44</td>
</tr>
<tr>
<td>IBERDROLA EMPLOYEES (NUMBER)</td>
<td>30,764</td>
</tr>
</tbody>
</table>
Coordinated strategies and architectures across Iberdrola Group
Communication Network and Architecture in Iberdrola
Utilities rely on assets that make them different from many other companies when facing Telecommunication challenges.

- Poles and ducts for fiber optic cables
- Poles for Base Stations
- Substations as nodal premises
- Radio station sites

*Carriers’ carrier model in place*
• Telecommunication Services are fundamental for the Operational activities of the company. However, not all “telecommunications” are well suited for Operational activities.

√ Operational activities have more demanding requirements than Corporate ones:
  − A network that is prepared for operational services is ready for corporate use (but not necessarily the other way around!)

• Not all operational communication services have the same criticality:
  − Data is not the same as voice.
  − Cost of the solution is biased by initial investment.

• Not all data related communications in operational areas have the same relevance and requirements:
  − Remote control is critical to improve electricity grid availability.
  − Remote metering of certain points of supply is not time critical.
### Communications in Iberdrola. Network Perspective

<table>
<thead>
<tr>
<th>Type</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substations (Primary – ST&amp;STR)</td>
<td>Thousands</td>
</tr>
<tr>
<td></td>
<td>(1,100, IBD, Spain)</td>
</tr>
<tr>
<td>Distribution Substations (Surface&amp;Pole mounted)</td>
<td>Tens of Thousands</td>
</tr>
<tr>
<td></td>
<td>(36,000 + 26,000, IBD, Spain)</td>
</tr>
<tr>
<td>Distribution Substations (Underground)</td>
<td>Tens of Thousands</td>
</tr>
<tr>
<td></td>
<td>(26,000, IBD, Spain)</td>
</tr>
<tr>
<td>Points of Supply</td>
<td>Millions</td>
</tr>
<tr>
<td></td>
<td>(10,800,000, IBD, Spain)</td>
</tr>
</tbody>
</table>
Telecommunications Network

**BACKBONE**
- Hundreds
- Ethernet

**ACCESS NETWORK**
- Thousands
- Ethernet/IP

**PRIME**
- Millions
- Not IP (narrowband)

The Smart Grid...
And how does the Smart Grid affect us in terms of telecoms?

- **Pervasive reach**: due to the distributed nature of electricity assets.
- **Bandwidth**: depending on the services needed (i.e. Smart Grids), bandwidth will be different.
- **Two way comms. and interactivity**: the communications have to be from the system to the devices, and vice versa.
- **Scalability and flexibility**: subject to changing demands and concepts, solutions must be flexible.
- **Reliability, Security and Safety**: the critical nature of the assets need such an approach.

Electricity utilities own assets that configure a privileged situation for the provision of telecommunication services

However ...
Which elements condition telecom technologies planning and programming:

- Who is going to pay for the Remote Management?
- Who is going to pay for the Smart Grid?
- Which regulatory changes will affect the evolution of Smart Grid?
- Technologies almost fine-tuned. Integration is the biggest concern.
- Large amounts of devices from manufacturers.
- Changes are going to take place in all parts of the network, and day-to-day activities will be modified. Changes in processes.
- Deployment works will be taking place in a non-greenfield environment. Economic deviations must be closely controlled.
Efficiency (€) is the key when selecting the proper solution.
• IP (Internet Protocol) plays a fundamental role in Communications Systems, due to its wide adoption.

• However, there are some communication environments (narrowband PLC channels, narrowband VHF&UHF radio channels) where IP might not be the best solution:
  ✓ Because channels are usually narrowband: IP was born in a broadband world.
  ✓ Because its overhead both in terms of payload, and in terms of message exchange, cannot be supported and at the same time provide the best performance.
  ✓ Because IP protocol might not be providing any added value (just cost).

• In these cases, end to end IP solutions are not probably the most cost efficient solutions. Communication Systems can provide gateways and/or adaptation layers to external networks using IP:
  ✓ There is no need to use IP internally in some systems as adaptation layers can get interoperability.
  ✓ Narrowband systems can avoid the unnecessary burden of the broadband-engineered IP protocol message exchange.
Telecommunications Network

Communications in Iberdrola. Access Technologies

ETH / IP Based
Communications in a Utility. Technology Comparison

- **BPL vs. GPRS comparison:**

<table>
<thead>
<tr>
<th></th>
<th>GPRS</th>
<th>BPL (x 10, x 100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Throughput</td>
<td>10 kbps – 20 kbps</td>
<td>100 kbps – 2 000 kbps</td>
</tr>
<tr>
<td>Latency</td>
<td>400 – 700 ms</td>
<td>80 – 150 ms</td>
</tr>
</tbody>
</table>

- **Performance example:**
  - **Firmware Update (FW). Data Concentrator:**
    - *FW image = 1,5 MB;* Minimum throughput ➔ GPRS = 20 min.; BPL = 2 min.
    - Maximum throughput ➔ GPRS = 10 min.; BPL = 6 s.
  - **Data Concentrator web page:**
    - *Web page = 0,05 MB;* Minimum throughput ➔ GPRS = 40 s.; BPL = 4 s.
  - **Telecontrol status update (with data):**
    - Minimum throughput / Maximum Latency ➔ GPRS = 4,88 s.; BPL = 0,81 s.
    - Maximum throughput / Minimum Latency ➔ GPRS = 2,64 s.; BPL = 0,33 s.
Communications in Iberdrola. Increasing Data Volumes

Data exchange

Points of Supply
Retailers
TSO

Telecommunication Network

Telecomm.
RTU
Camara
IP
Sensors
Actuators
Concentrador AMR

Secondary Substation

Mbps
Gbpsi
kbps

Home Area Network Detail

Network

METERING & DSM

IT & APPLICATIONS

Retailers
Evolution towards Ethernet
• **Backbone technology evolution: Transport**

- **PDH**: 34 Mbps
- **SDH**:
  - STM 16 (2.5 Gbps)
  - STM 64 (10 Gbps)
- **DWDM**: 40 λ (1.6 Tbps)
  - λ = 40, **10**, 2.5, 1 Gbps
Evolution towards Ethernet. Transport Circuit Evolution

A huge investment to take into consideration: Ethernet transport

### TYPES OF SERVICES

- TELECONTROL
- TELEPHONE
- TELEPROTECTION
- OTHERS, non critical services
Protocol towers

Evolution towards Ethernet. Protocols
Evolution towards Ethernet. Switching

- Backbone technology evolution: Switching

- Point to point: 34 Mbps
- Frame Relay/ATM: 155 Mbps
- MPLS: 622 Mbps, 1/2/10 Gbps
VPLS Services
• MPLS Network Management: Transport-like system
- Layer 2 based MPLS core.
- Types of service offered:
  - VPLS (Virtual Private LAN Service) Ethernet Multipoint Wide Area Network.
  - VLL (Virtual Leased Line): Ethernet point to point circuit using MPLS network.
MPLS as Extended LANs basis
MPLS and Extended LANs

IBERDROLA MPLS NETWORK
• Direct Ethernet connectivity: Fiber Optics and Ethernet over SDH or DWDM.
• Ethernet extension from the core to the border: EthoSDH, and optical switches.
• Iberdrola matches VLANs with VPLS (administrative purposes): each VLAN is a service (VPLS). Simplification
• MPLS allows QoS. Iberdrola supports QoS:
  – Quality to specific Services.
  – Mapping with DSCP (IP field) and Quality (internal customers).
• Single device type: spares, training, ...
• Just Ethernet services (no PDH, RS232 over Eth encapsulation, ...).
• L2 MPLS provides the provision simplicity we need.
Main and Backup Systems

- Criteria: Infrastructure for Redundancy
Corporate Systems

– Data Center Connectivity

Substation Connectivity

Generation Control Centers Connectivity

Renewable Premises Connectivity

...
Switching and IP network:

- **Switches**: (LANs are straight-forward to provision)
- **Routers**: (Smart Grid derived concentrations: scalability reasons)

### Switches and Routers

<table>
<thead>
<tr>
<th>Number of devices</th>
<th>Switches</th>
<th>Routers</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>500</td>
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<tr>
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<td>3500</td>
<td></td>
<td></td>
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<tr>
<td>4000</td>
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</tbody>
</table>

### Switch Providers

- **NSN**: 24%
- **ZIV**: 40%
- **Ruggedcom**: 36%

### Router Providers

- **ZIV**: 40%
- **Teldat**: 60%
Summary of Implementing & Operating IP/Ethernet to Support the Smart Grid Survey

Carried out by Phoenix Forums
March 2013
Based on responses from 42 Smart Grid professionals

9) What do you consider to be the single most important benefit of migrating from SDH to IP/Ethernet in the electric utility environment?

Top 3 answers:
   a) Flexibility
   b) Cost savings
   c) Ease of maintenance

   EthoSDH,oTDM & L2MPLS
   Transport & Reuse & Simple Oper
   Network Evolution

10) What do you consider to be the single biggest challenge in migrating from SDH to IP/Ethernet in the electric utility environment?

Top 3 answers:
   a) Security
   b) Ability to meet teleprotection and differential protection service requirements
   c) Converging of systems and seamless integration

   Transport & L2
   Transport & Fiber Optic
   Network Evolution
Conclusions

• Iberdrola takes profit from carriers’ carrier model activities: (1) see “outside the box” & (2) develop private infrastructure.

• **MPLS** has been the technology that, together with transport capabilities, has allowed Iberdrola to provide a simple implementation of Ethernet service provision anywhere:
  – Iberdrola soon realized that PDH platforms, even if appropriate for low speed services, would not allow to take benefit from **mass market prices**. This fact drove us to install SDH, and soon **NGN-SDH (Eth)**.
  – Iberdrola soon realized that Switching platforms would allow to **simplify** operational models and service provision: low number of premises, but widely spread.

• There is a **big question mark** on the evolution of MPLS networks together with the evolution of Transport Systems.

• **Smart Grids** are changing the status quo with tens of thousands of premises, and millions of smart meters.

• **Cost** is a critical concern when we need to change the scope from hundreds, to thousands of premises.