Broadband Powerline – A status

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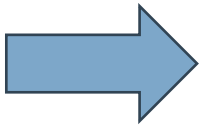
Agenda

- Broadband Powerline (BB PLC) introduction
  - Definition
  - Applications
- BB PLC in smart grid
  - 4 use cases
- BB PLC in residential
  - Residential
- BB PLC in other markets
  - Infrastructure
  - Industrial
  - Other

BB PLC introduction

What is BB PLC

- Many possible definitions:
  - From an application perspective:
    - Best definition "*Powerline technology that provides enough QoS performance to transport reliably broadband communication services*"
    - Performances needed are different depending on the application (normally > several tens of Mbit/s)
  - From a technology perspective
    - Technologies using frequencies above 2 MHz (up to 80 MHz)
- Definition evolves over time and application
- Several specifications & standards (ITU-T, IEEE) with different throughputs, and bandwidths
- Traditionally used in residential scenarios (connectivity), moving to many other scenarios as well



Adaptable technology that can provide Broadband without extra cables in difficult scenarios

BB PLC markets

- Main markets
  - **Residential broadband**:
    - Evolves from “Provides connectivity in the home” to “Provides backhauling infrastructure for Wi-Fi”
  - **Smart Grid**:
    - Provide “high” throughput infrastructure fully owned by the usitlity to transport control, monitoring and telemetry
  - **Infrastructure:**
    - Converting any infrastructure into “smart” by providing “high” throughput connectivity
  - **“Other”**:
    - PLC is basically a “reliable, adaptive transmission engine”. Technology can be reused in other applications where BB is also needed and that share similar characteristics but not the same medium:
      - LiFi
      - Access
      - Submarine
      - Etc…

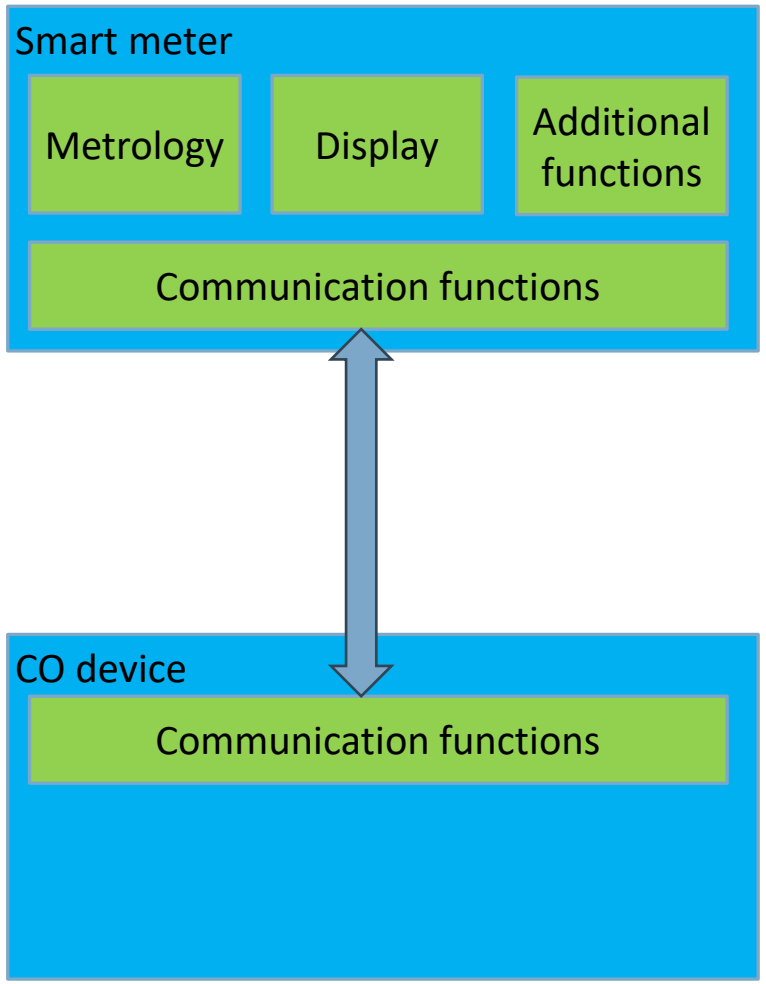
BB PLC in smart grid

BB PLC in Smart grid - Applications

Description

- 4 main applications:
  - Smart meter (SM)
  - Smart meter GW (SMGW)
  - Concentrator
  - MV Connectivity

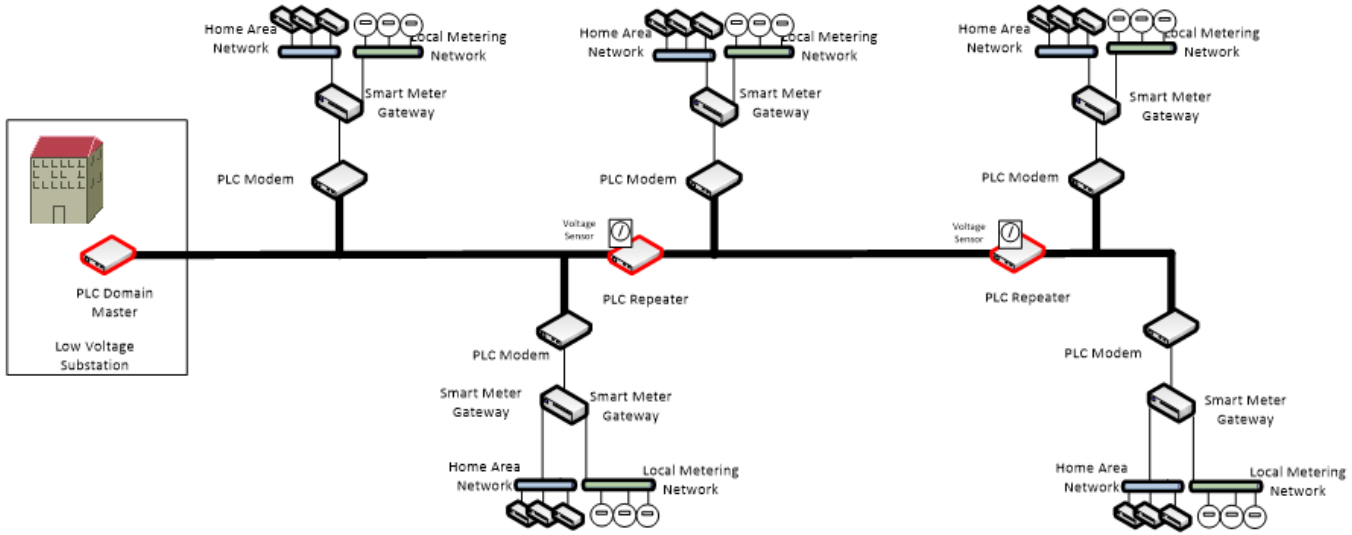
Use case 1: Smart meter



- **Description**
  - A communication module is directly integrated into a smart meter (SM) to provide connectivity and communications capabilities.
- **Main functions:**
  - Read metering data
  - Remote-control functions (e.g.) shutting down/limiting power supply
  - BPL network can also be used to provide meter reading information to the end-customer.
- **Reasons for using BPL:**
  - SW stack (security) needs more performance (> 1Mbps)
  - Reliability
  - Additional functions
  - Scalability
- **Challenges:**
  - Stability/Guarantee of throughput (as always)
  - Cost
  - Up to 250/500 nodes per network
  - “Competes” with NB-PLC

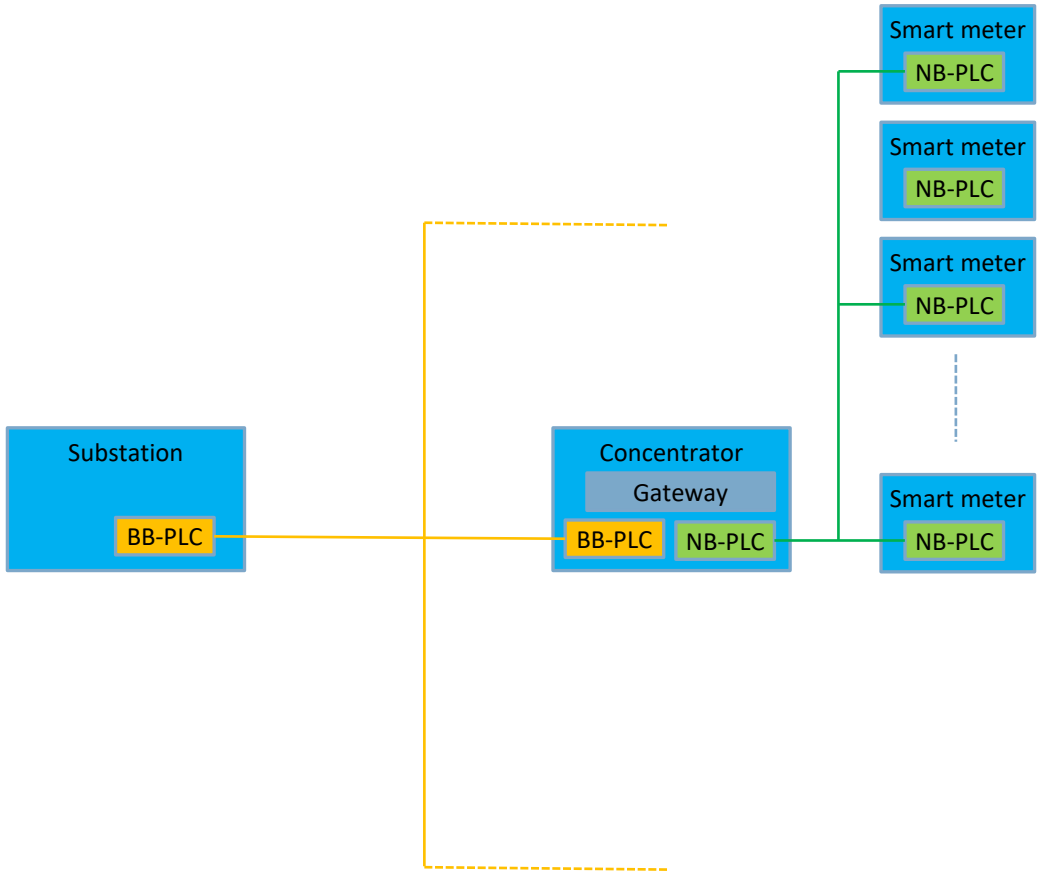
Use case 2: Smart meter gateway (SMGW)

- **Description:**
  - High-capacity network over power lines to provide a common communication infrastructure over which several services can be run
- **Main functions:**
  - Receives and stores data from meters and processes them for consumption by market players.
  - Administrative activities
  - Communicates with the controllable energy consumers or energy generators (e.g. intelligent household appliances, combined heat and power units or photovoltaic systems).
  - Supplies data for the final consumer and for service technicians working within the HAN



- **Reasons for using BPL:**
  - Complex GW needs more communication capabilities
  - Guarantees ownership of the infrastructure network
  - Seamless integration with other technologies (e.g, LTE, optics, etc.)
  - Scalability
- **Challenges:**
  - Stability/Guarantee of throughput (as always)
  - Cost
  - Up to 250/500 nodes per network
  - ~ 10 Mbps

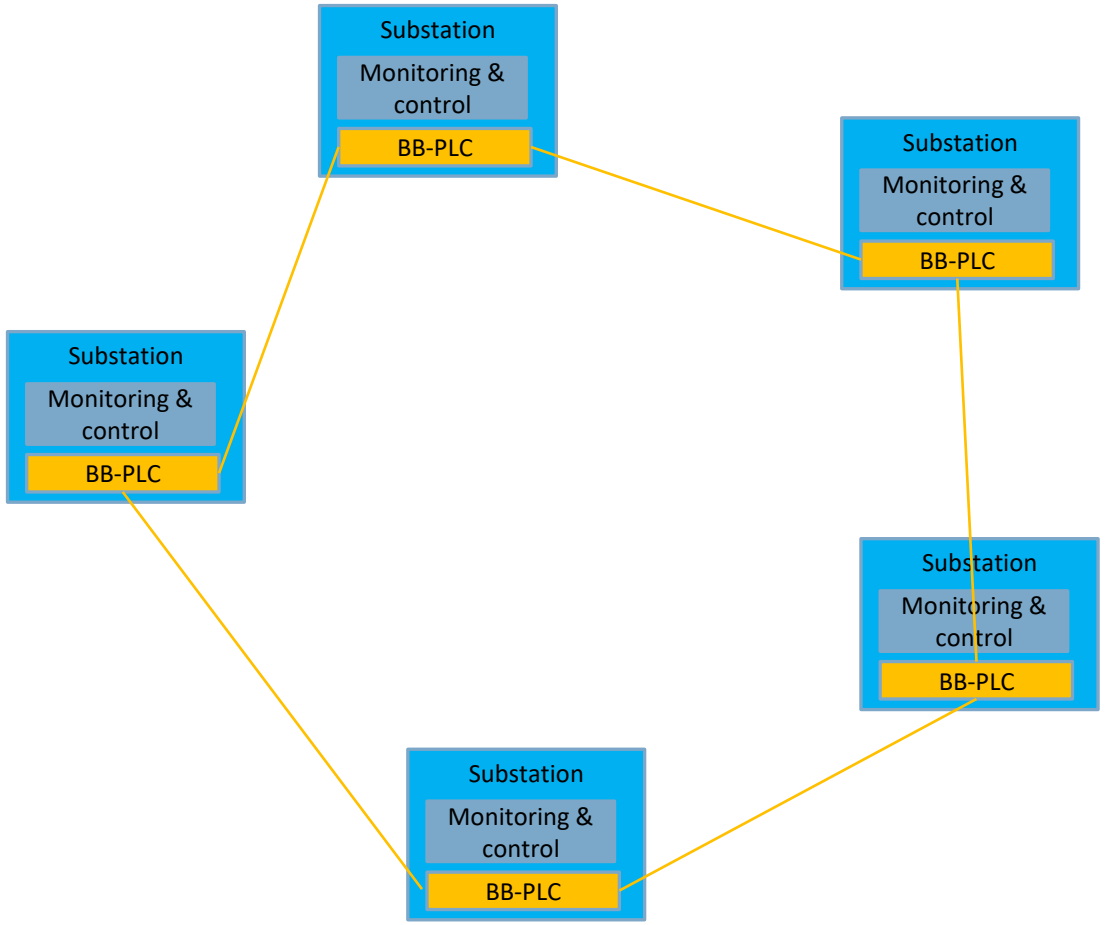
Use case 3: Narrow-band Smart meters concentrator



- **Description:**
  - Complements AMI deployments based on narrow-band powerline communications (NB-PLC) operating below 2 MHz.
  - Concentrates data from a building into a single flow
  - Allows parallelizing groups of meters, speeding up the process
- **Main functions:**
  - Meter reading by blocks of meters
  - Metering room monitoring
- **Reasons for using BPL**
  - Upgrades existing Narrowband networks with limited investment
  - Reuses existing infrastructure
- **Challenges**
  - Integration with metering architecture and protocols (security)
  - Performance >> 10 Mbps

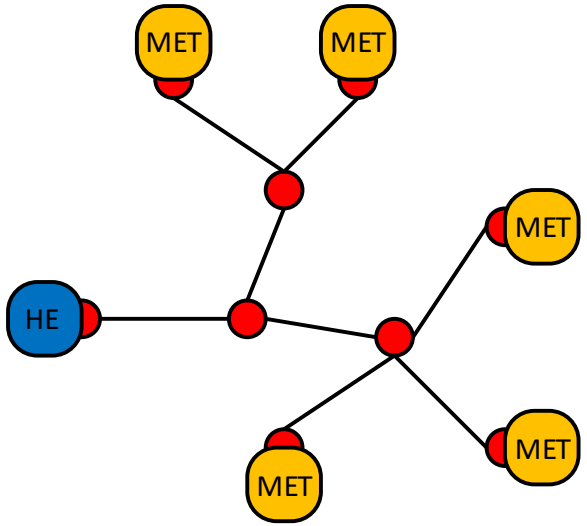
Use case 4: MV backbone

- **Description:**
  - Use of BPL technologies in MV grids as a complement of WAN access solutions at secondary substation level for smart grid services
  - Using medium-voltage power lines as a means of data transmission is a great advantage in itself.
- **Main functions:**
  - Control and monitoring of substations
  - Viseosurveillance
- **Reasons for using BPL:**
  - No dependence on external 3rd parties to provide connectivity
  - Fine tuning for the necessities
- **Challenges:**
  - Difficult and unknown channel
  - Low pass channel
  - Repetitions are needed / “Serial” topologies (spatial reuse)
  - Self-repair

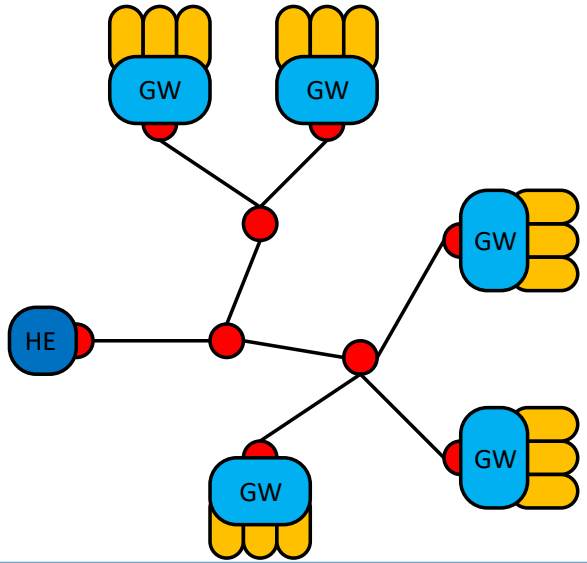


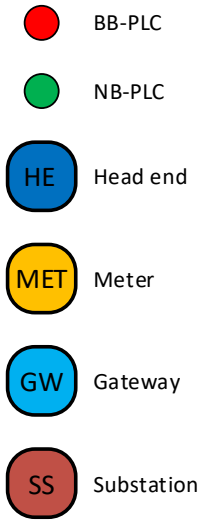
Smart grid use cases: Summary

BB-PLC metering

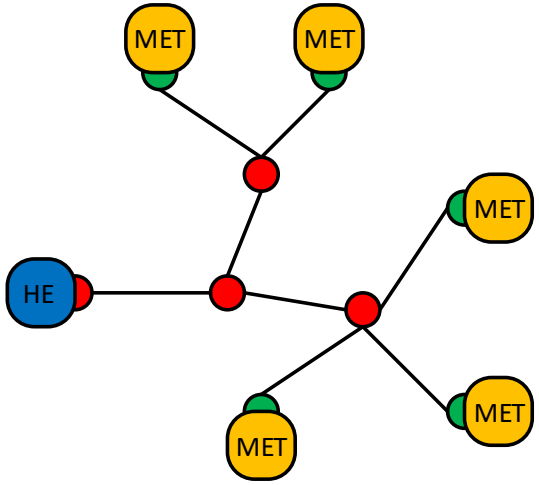


Smart Meter Gateway

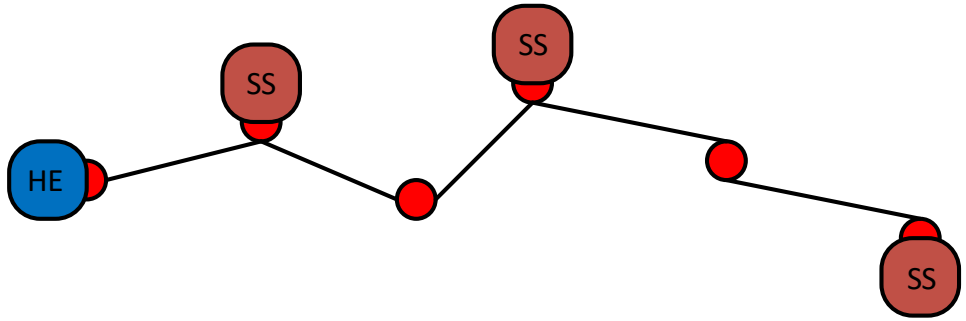




NB-PLC concentrator



MV Backbone



BB PLC – Residential

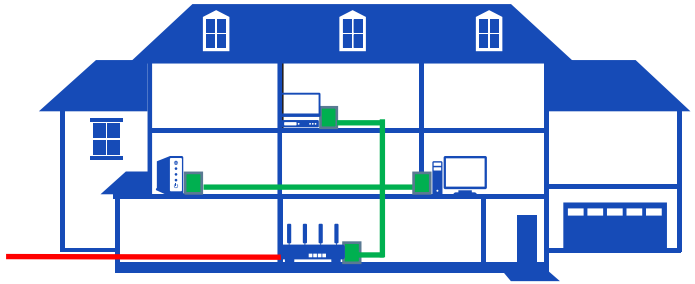
BPL for residential (1)

- Traditional use of BPL technology
- Is it over?... Not really. New opportunities to **complement** Wi-Fi
  - › PLC technology needs to focus on the Backhaul (Fronthaull will be Wi-Fi)
  - › Integration with Wi-Fi technology (e.g., Easymesh)

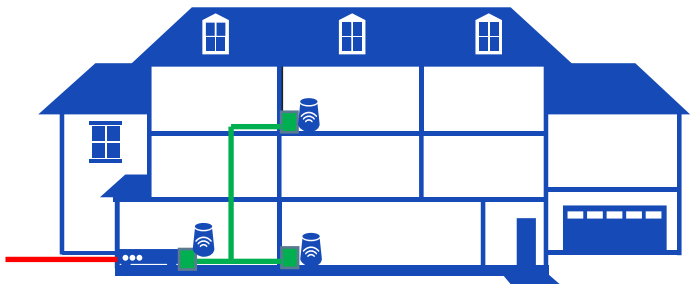
Change of paradigm on what has been done so far. From **"competing"** with Wi-Fi to **"complementing"** Wi-Fi

Change of paradigm on what has been done so far

Connectivity

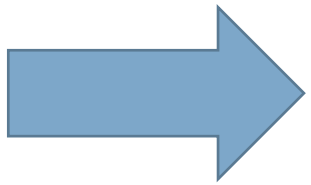


Wi-Fi backhauling



BPL for residential (2)

- Why keep using BPL in residential to complement Wi-Fi in a new “Wi-Fi 7 world”
  - “classical reasons”
    - Self install and flexible: It is still an “easy technology”
    - No new cables
    - 200 Mbps is enough for 90% of the users/Applications
  - “New reasons”
    - Low latency. End to end latency < 5 ms. Difficult to achieve in Wi-Fi consistently
    - Spectrum offloading. Scarce resource that have to be preserved for Fronthaul links. Whenever possible, use a wired backhaul and focus air resources in fronthaul
    - Reduced number of neighboring networks (Main issue in Wi-Fi)
    - The use of 5GHz/6GHz does not help in coverage
    - Allows reducing power in remote APs (facilitating spatial reuse)



Improve the weaknesses

- Instability
- Predictability
- Latency controllability
- Integration with Wi-Fi

BPL for residential (3)

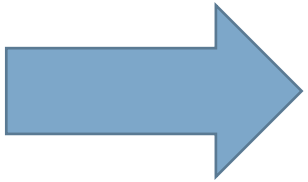
	Connectivity	Wi-Fi backhauling (wish)	Comments/Consequences
Socket coverage	Guaranteed 100 Mps in every socket	Guaranteed 250 Mbps in “selected” sockets	We can monitor socket quality and change it
Medium Access	“Pure” mesh	P2MP. GW-centric.	We can simplify MAC and reduce overheads Wi-Fi (and Easymesh) are P2MP Added value service need traffic to go through the router
Integration	Standalone technology	Cooperation with Wi-Fi	Authentication mechanisms, per-Flow traffic routing, bonding, etc…
Main focus	Peak throughput	Reliability, stability, predicatibility	It is better to have a reliable, stable 250 Mbps backhaul than a peak throughput of 1 Gbps in some sockets
PHY	100 Mbps per connected device	??	With Flow selection and bonding, trade off between Wi-Fi and BPL can be done. “*The more BPL is used, the better Wi-Fi will work*”

BB PLC – Other markets

Infrastructure/industrial/Other markets

- Provide infrastructures with connectivity through a reliable existing backbone (>10 Mbps)
- This allows:
  - Monitoring
  - Control
  - Deployment of advanced services

- **Examples**
  - Entrance guard systems
  - Smart Lighting
  - Smart Traffic lights
  - Navigation lightning aid at airports
  - Charging stations



- **BPL impact**
  - Higher number of nodes
  - Longer distances (multi-hop)
  - High level of repetitions
  - Low latency & jitter
  - Extremely noisy environments
  - Embedding specific protocols

- **The good side:** **Some of these requirements are similar to smart grid and we know how to handle them**
- **The bad side:** **HIGHLY FRAGMENTED MARKET** that requires specific adaptations ➔ Need SW development and more flexible APIs

Infrastructure (2)

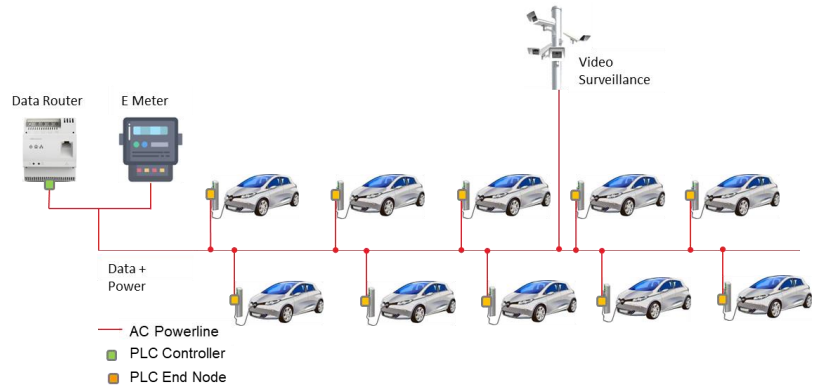
Smart Buildings

- **Benefits**
  - Use existing building wires
  - Simplify installation through data/power wire integration
  - Reverse power feed option
  - Extend ethernet distance

Smart cities

- **Benefits**
  - Simplify wiring architecture
  - Robust data through wired backbone
  - Lower operating cost than using LTE

Smart Charging stations



- **Benefits**
  - reliable and stable high-speed data backbone
  - No costly Ethernet/Fiber cable installation
  - Simplified installation through data/power wire integration

Conclusions

Main conclusions

- BPL is a mature technology with many applications
- Many applications and market opportunities
- Fragmented market. We need to aggregate technical solutions and provide adaptability through SW
- Work to do with a focus on reliability, predictability and low latency
- Integration in the overall “networking ecosystem” is a must (e.g. in residential). PLC SHALL not be a standalone technology.