ST8500 – Power Line Communication

Package for PLC non-metering applications

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Agenda

- ST and PLC
- ST8500 platform description
- ST8500 package for non-metering applications
- Deliverables & reference designs
- Hybrid PLC & RF Connectivity

The ST leadership in smart grid

ST technology solutions covering all smart grid applications building blocks

30 Years Experience in Smart Grid with key Utilities, Manufacturers, Industrial Alliances and Standardization Bodies

meters and more OPEN TECHNOLOGIES

PRIME ALLIANCE

G3-PLC Alliance

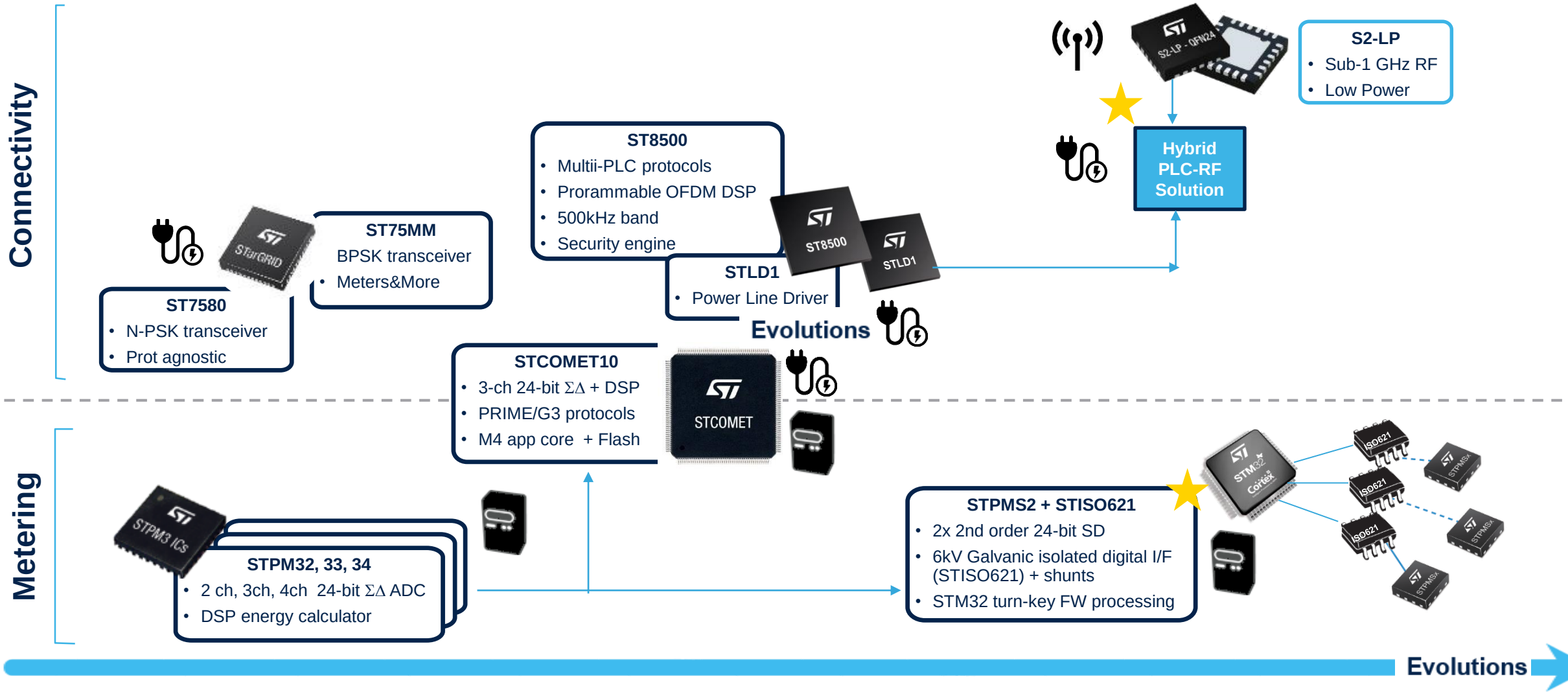
ITU

IEEE

+130 million smart meters with ST inside

Field-proven, integrated, performing flexible and future-proof

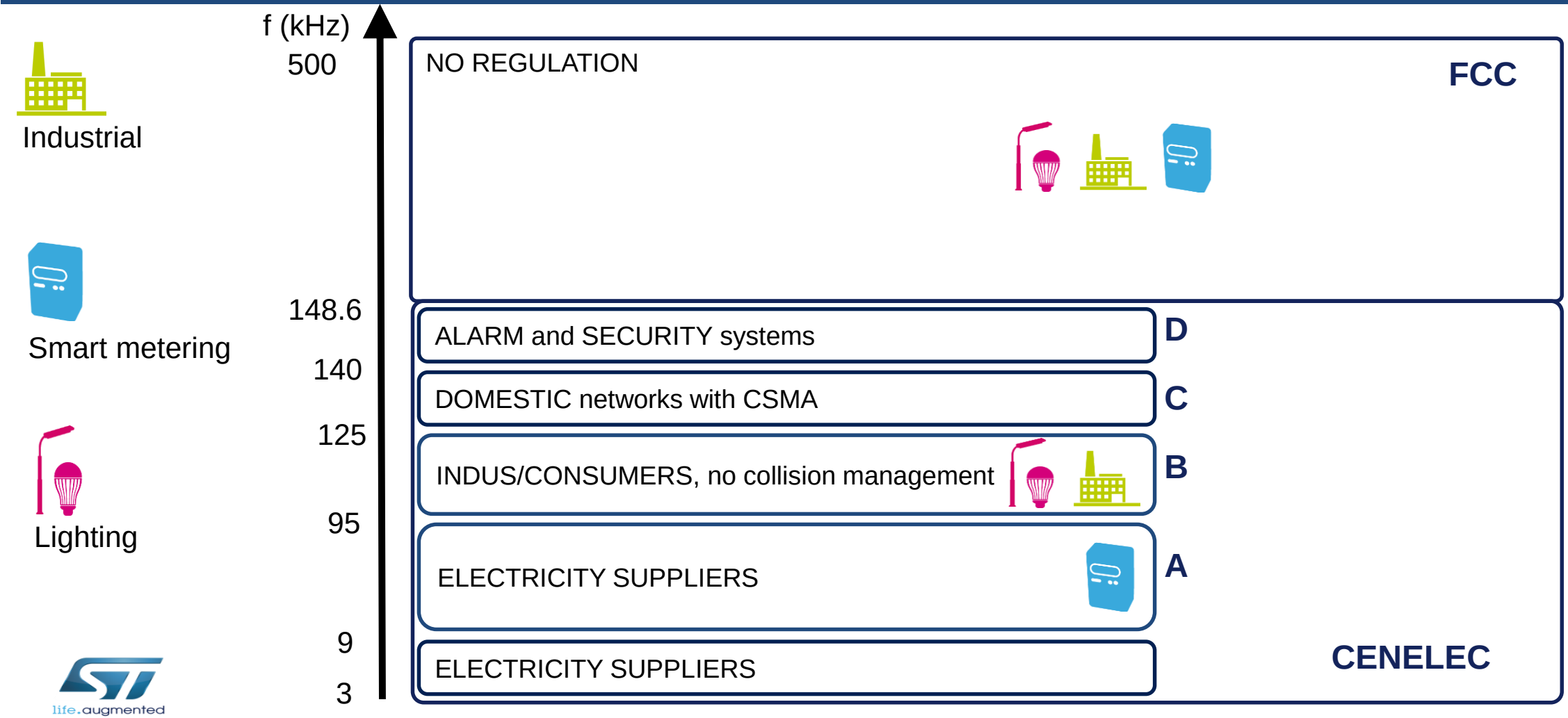
Smart Grid – Product Roadmap



PLC RF Metering New, proto availables

PLC Frequency Bands Regulation

EUROPEAN REGULATION CENELEC EN 50065-1



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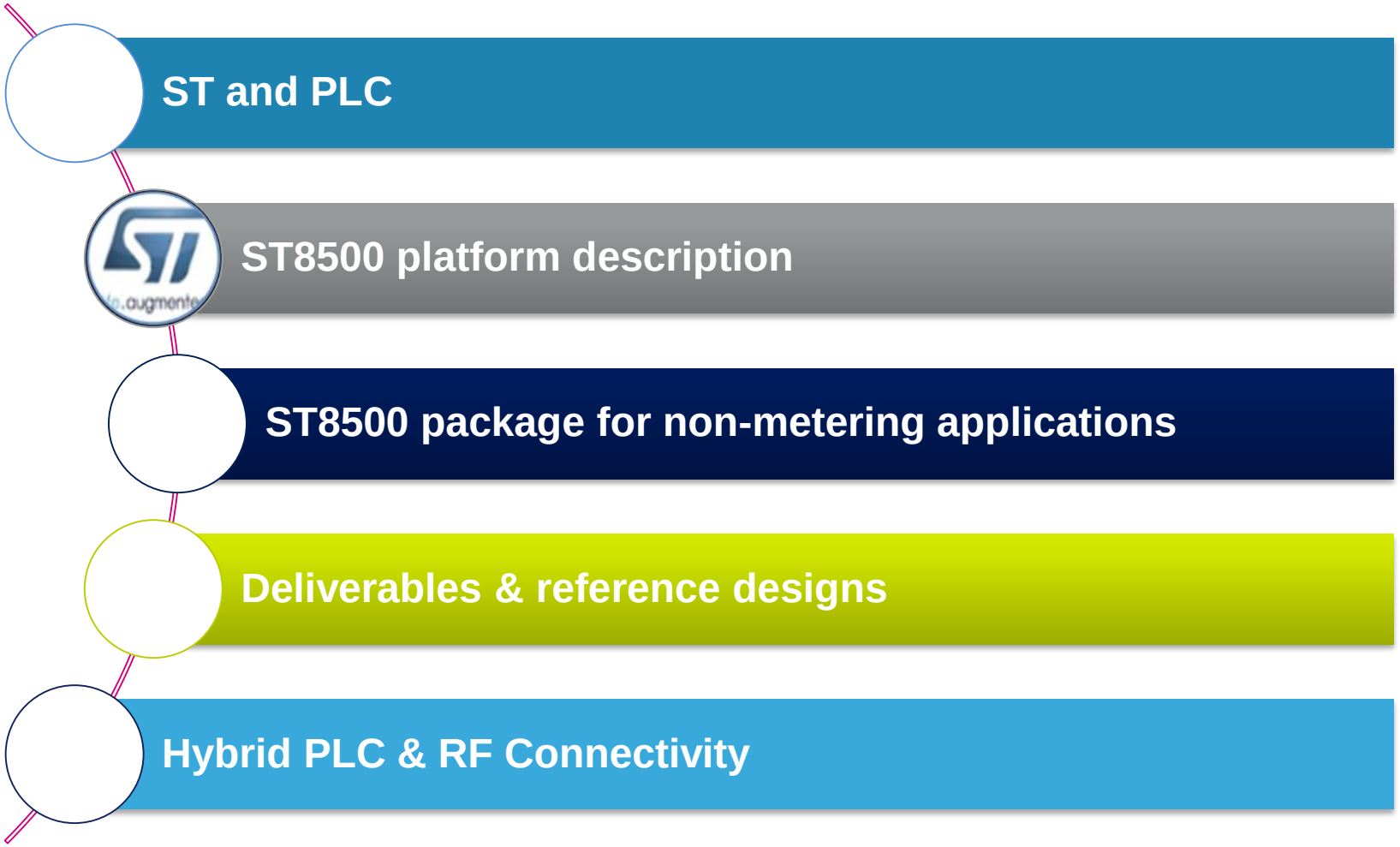
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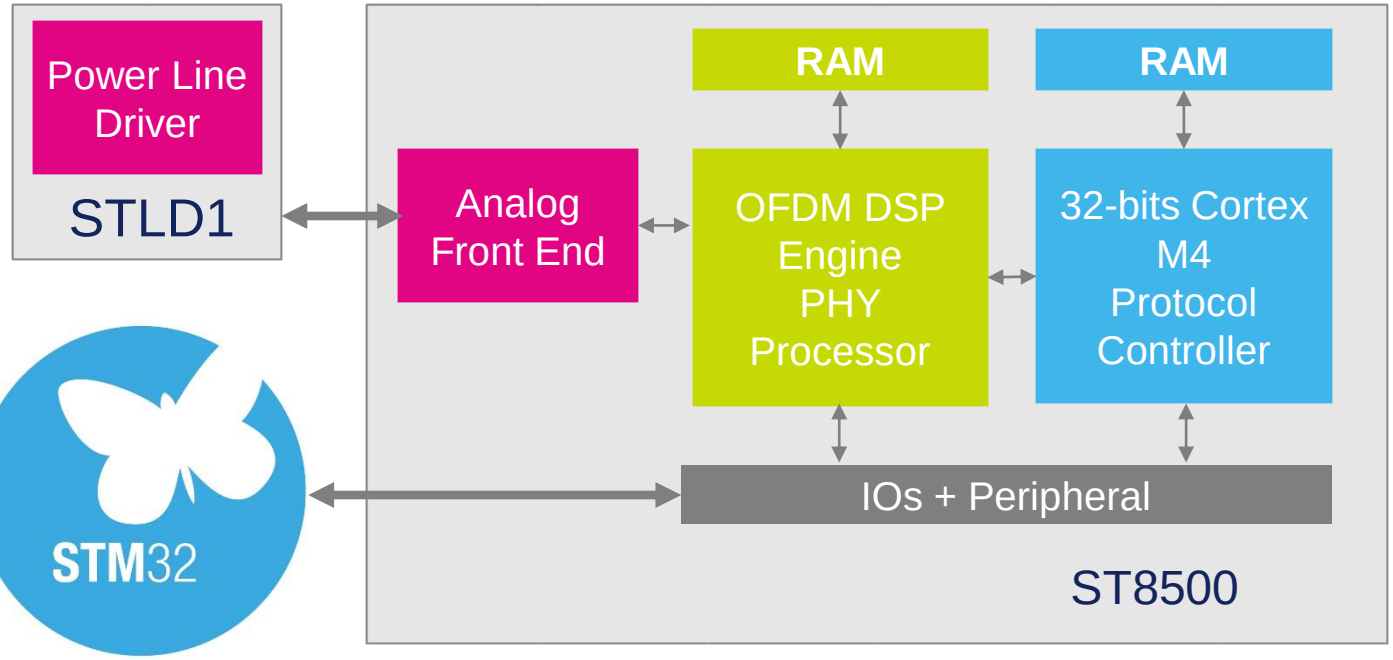
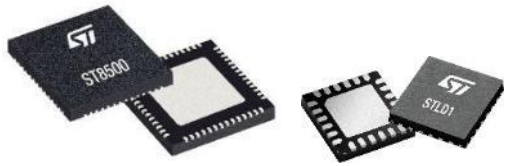
ST8500 / STLD1

Programmable, ultra-low power and compact PLC solution



- **Fully programmable, high performance**
  400 MHz DSP and 200 MHz ARM® 32-bit Cortex®-M4F core, 360kB RAM
- **Ultra-low power consumption**
  <100 mW in Receive mode
- **Embedded AES cryptography engine**
  up to 256-bit key and multi-security modes
- **Multi-standards, full 500 kHz bandwidth**
  support any band: CENELEC, and FCC
- **Extended temperature range**
  -40°C to 105°C
- **Small footprint package**
  QFN56 7mmxmm



ST8500 Application Block Diagram

ST8500

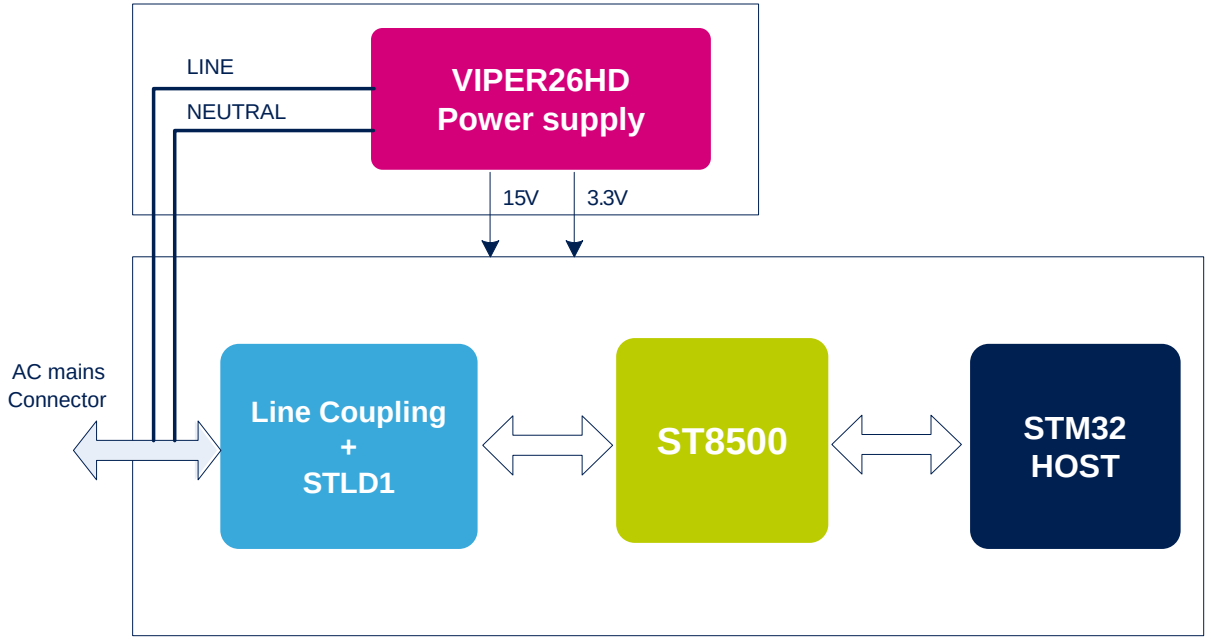
- **Reprogrammable** Power Line Modem
- Integrated Analog Front-End (0 – 500 kHz)
- Full duplex interface via UART
- Security: OTP**,** AES 128 -256 with (GCM; CCM; ECB…)

STM32 Host MCU

- Store FW images in eFlash or external SPI Flash
- Download image to ST8500 & drive modem
- Manage customer FW application

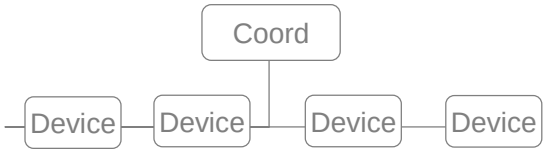
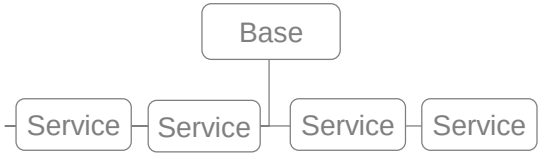
STLD1 – Line Driver

- Dual line driver 18 V p-p single ended, 36 V p-p differential output range
- Up to 1.5 A RMS driving capability
- Thermal and Current feedback



ST8500 PLC Stacks

Multi Standard Power Line platform

Protocols	CENELEC A	CENELEC B	FCC
G3-PLC Alliance	Unique HW/FW for **Device node & PAN Coordinator** **G3 certification** in Cenelec A, B and FCC band		
PRIME ALLIANCE	1 FW for Service Node / 1 FW for Base Node Certifications: PRIME 1.3.6 (CenA) PRIME 1.4 : channel 1 (CenA) / ch 2 (Cen BCD) / ch 3 to 8 (FCC)		

ST PLC FW Partitioning

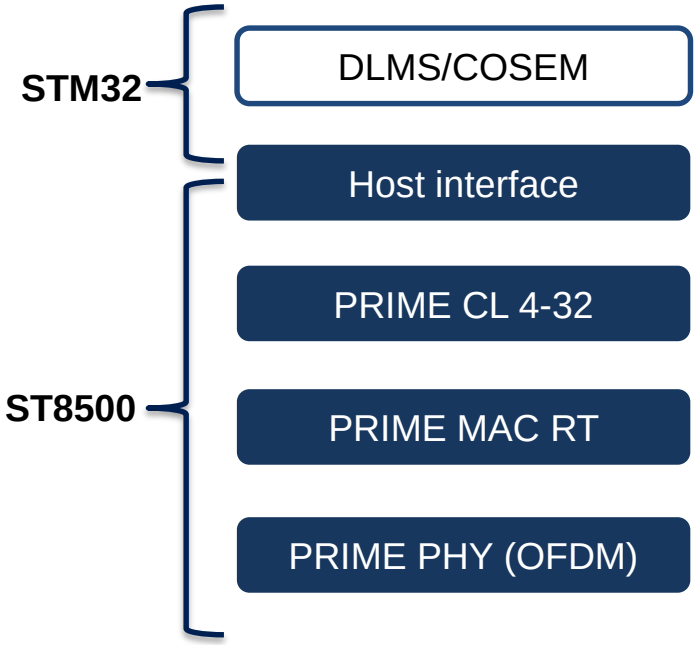
ST8500 based solutions

NOT ST

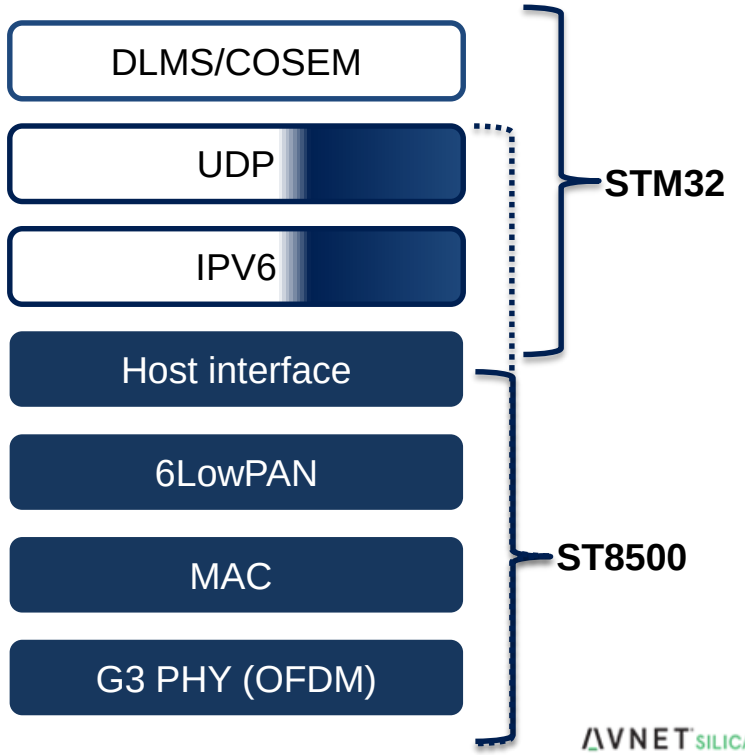
ST

PRIME ALLIANCE

(Service node)



G3-PLC Alliance



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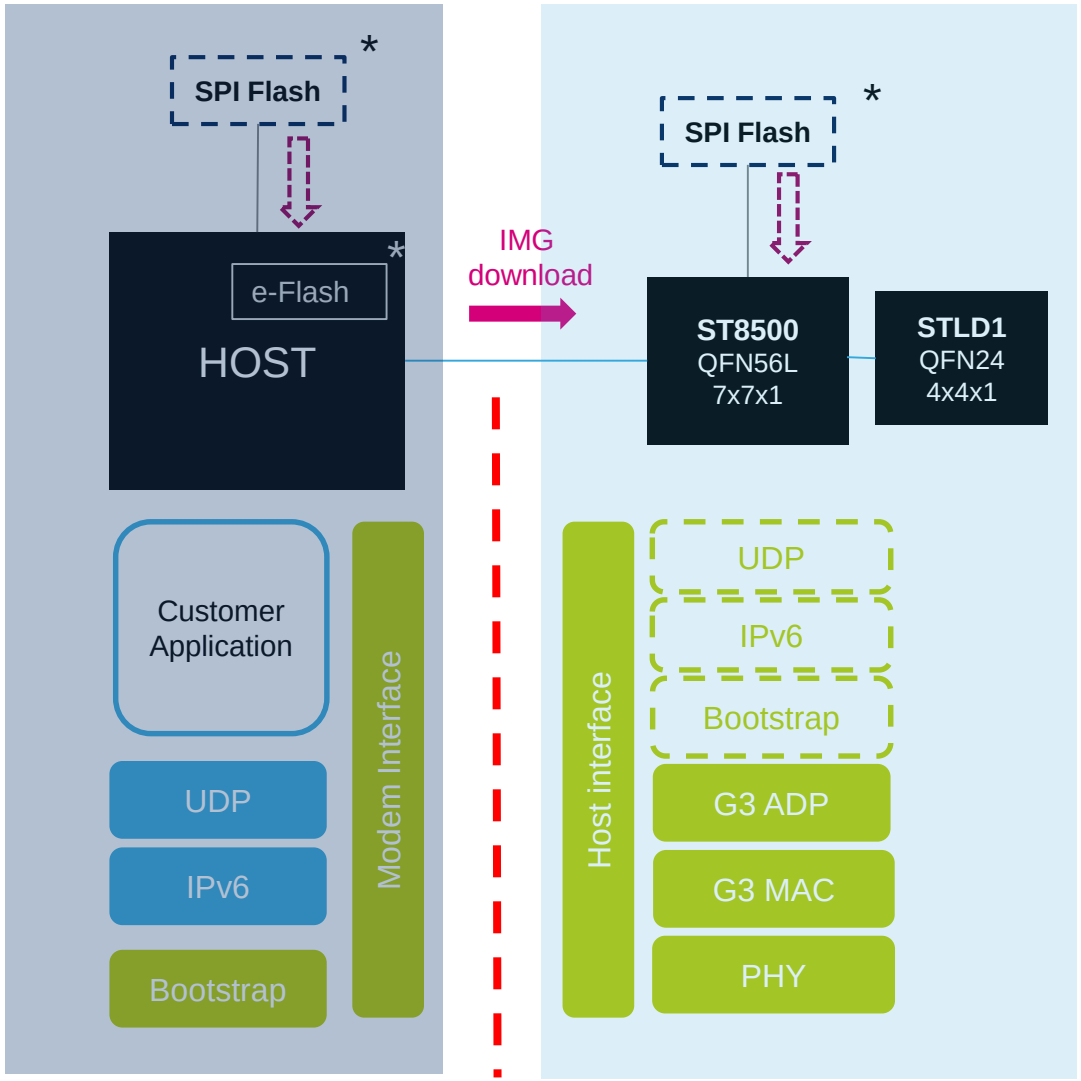
ST8500 : Host / modem G3-PLC FW partitioning



- Cortex and RTE Images (350kB) can be stored in *
  - SPI Flash connected to ST8500
  - SPI Flash connected to STM32
  - directly in HOST eFlash
- Image download from STM32 UART to ST8500
  - Download using USART @ 920kbps
    - ✓5sec for typical application
- ST8500 starts in ADP (6LoWPAN) mode
  - configured by the Host (UART msg)
- Flexible UDP/IP and bootstrap:
  - on STM32 side
  - on ST8500 side

ST Development

CTM development

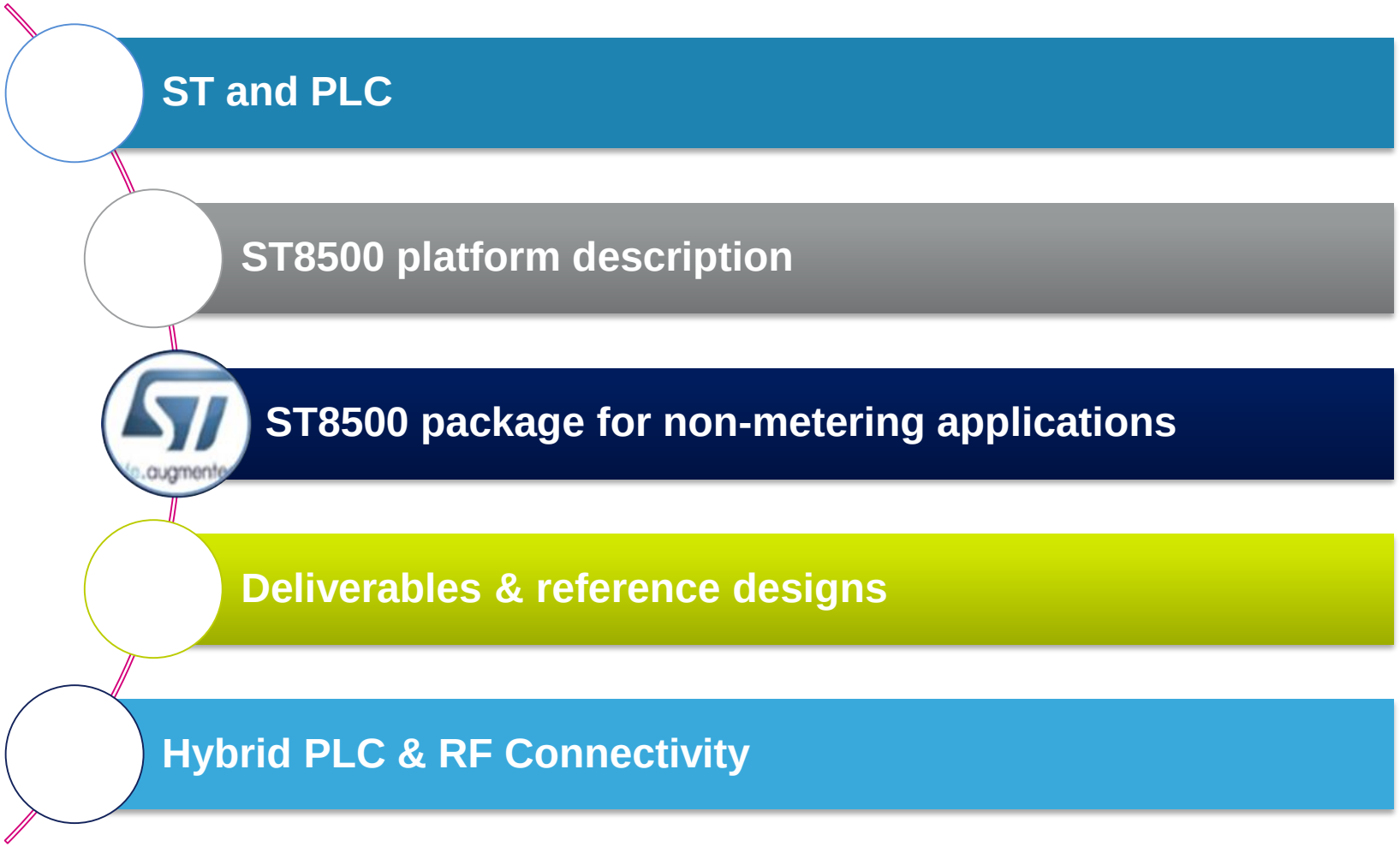
ST8500 standard G3 package Pros & Uses

Narrow band power-line communication platform

Advantages
Benefit from intensive G3/Linky validation
Turn-key communication stack (G3 based) included
Fully programmable platform
HW AES up to 256 bit encryption service

Typical Uses
Typical user DR in range of 10-20Kbits/s 200kb/s max data rate (PHY level)
Mesh Network topology
All protocol and network features embedded (code to be stored on external Flash or MCU)
Typical up to 1000 nodes

Agenda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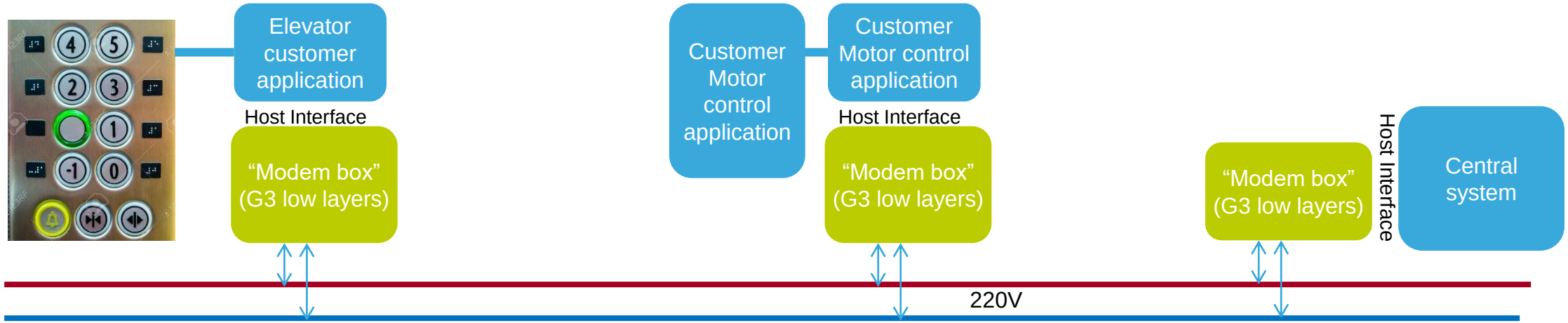
Industrial example

PLC used for elevator system control

- The customer application is dedicated for elevator functions (call button, floor selection, alarm,..)
- The modem will transmit the commands through the mains
- The commands will be received by the “motor control” application
- The modem can also receive broadcast information from the central system (remote monitoring, alarm, …)

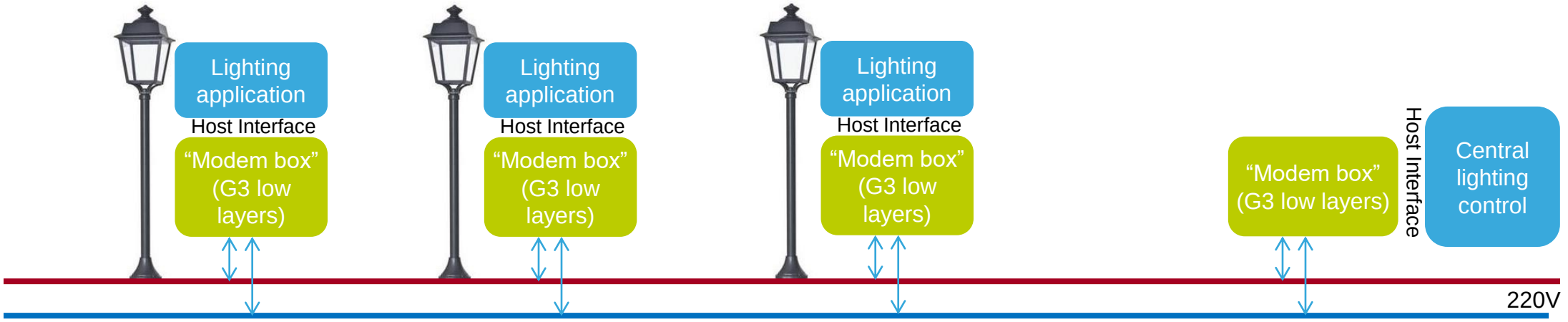


The **bootstrap protocol** (discovery, individual adressing, etc..) is autonomously proceeded by Modem boxes

Lighting example

MESH networks, PLC used for a cities lighting control

- A very simple application runs on each street lamp
- The central lighting control will command each lamp independently
- Each lamp can also inform the central for remote maintenance

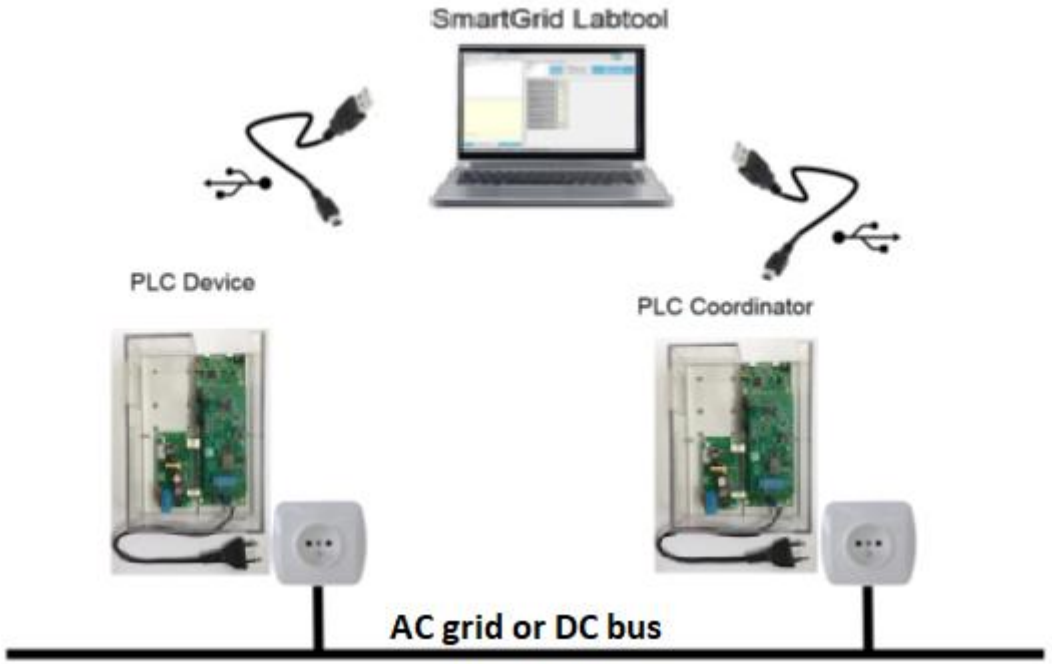


G3 communication has been validated **over several kms distance and in noisy conditions**
A similar system can be used to connect stations for air quality, security and traffic

«Open Market» setup presentation

Demo setup

- The partitioning of demo as follow:
  - 2 evalkits ST8500 (minimum) connected to the AC grids (or a DC bus 20V to 60V) and to the laptop
  - The user's laptop running the SmartGrid Labtool GUI (1 instance for each node)



ST8500 “open market”: FW package overview

ST8500 for industrial applications

STM32

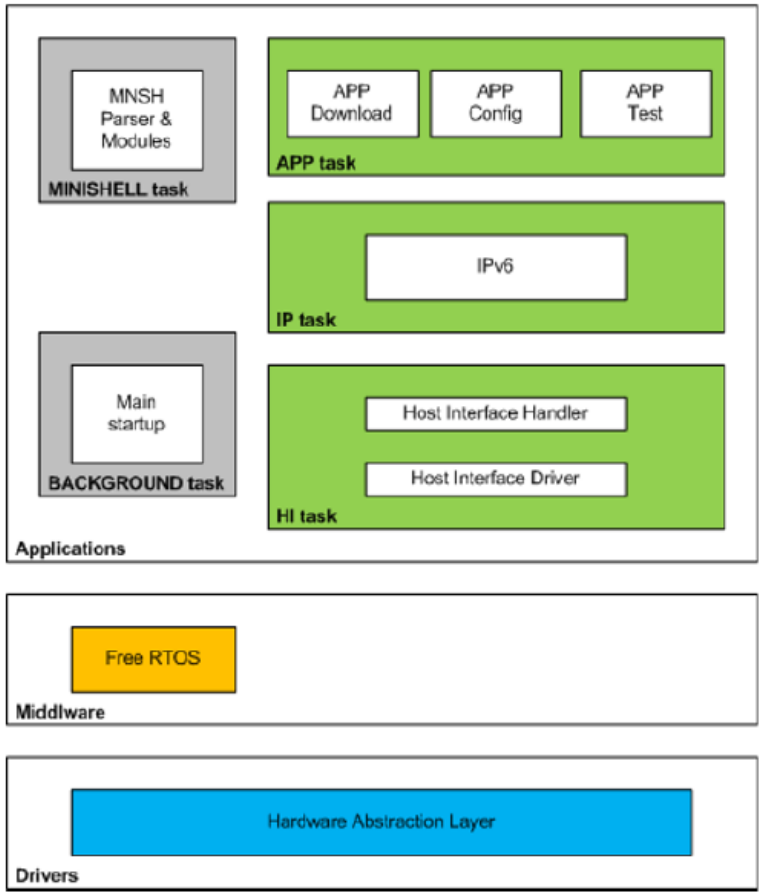
- Customer application
- UDP
- IPV6
- Host interface
- 6LowPAN
- MAC
- G3 PHY (OFDM)

ST8500

NOT ST

ST

Figure 1. **Static architecture view**



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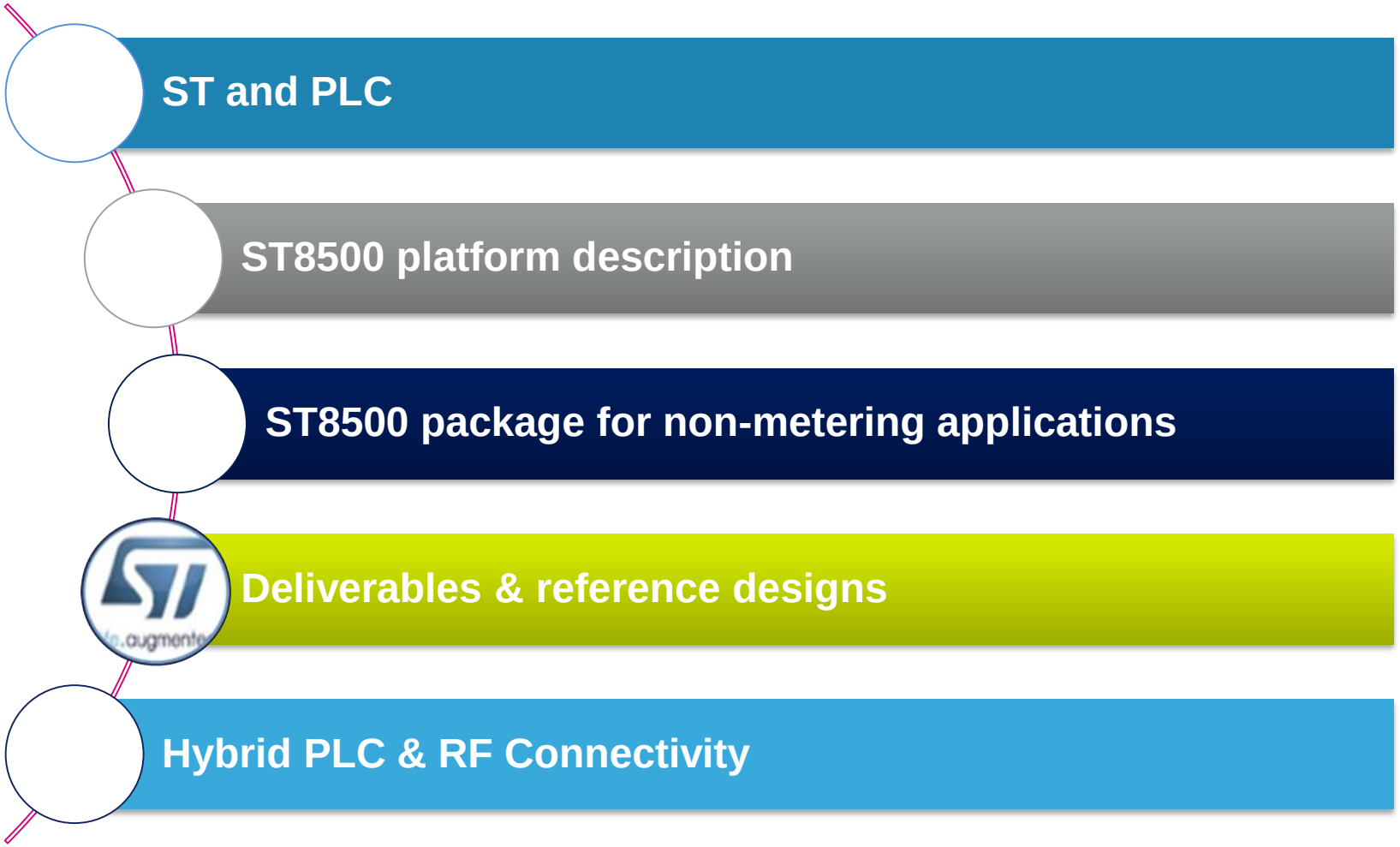
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«Open Market» package presentation

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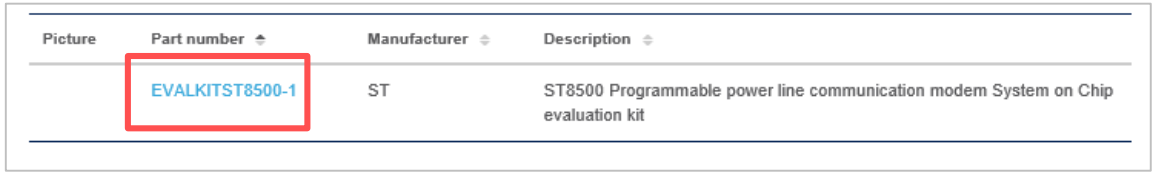
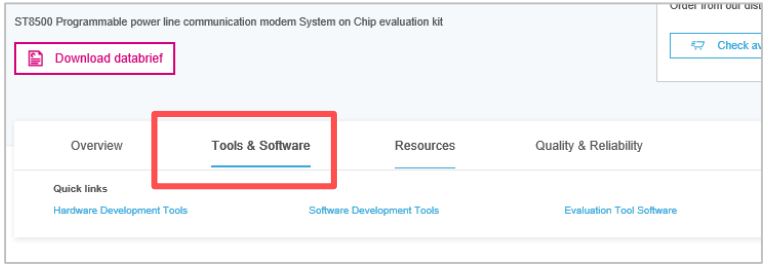
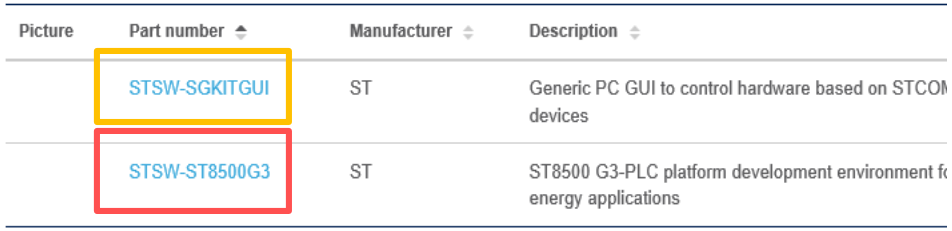
- It can be downloaded from ST web site:
  - └ Tools & Software
    - └ Embedded Software





- *"STSW-SGKITGUI"* : GUI for PC (=SmartGrid_LabTool)



- *"STSW-ST8500G3"* is composed of :
  - G3 PLC images for ST8500 (binaries)
  - STM32 FW: .dfu and source code, including IAR project

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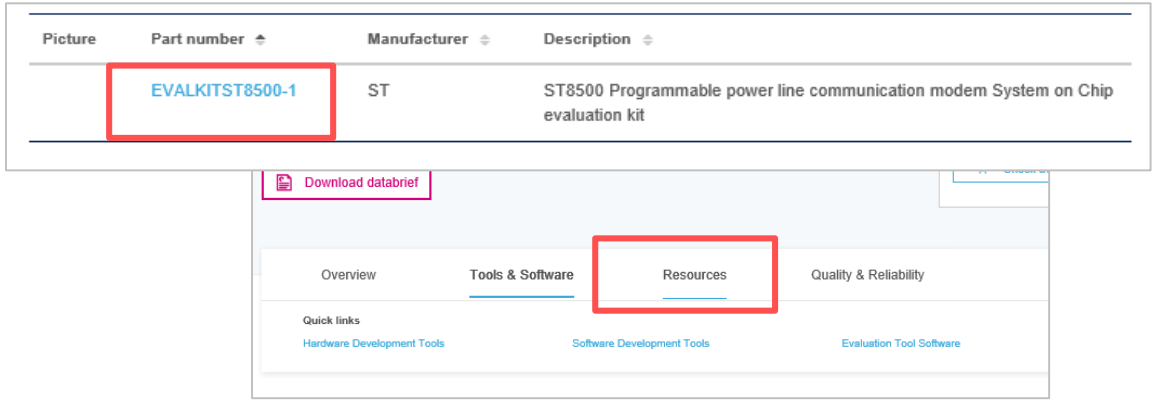
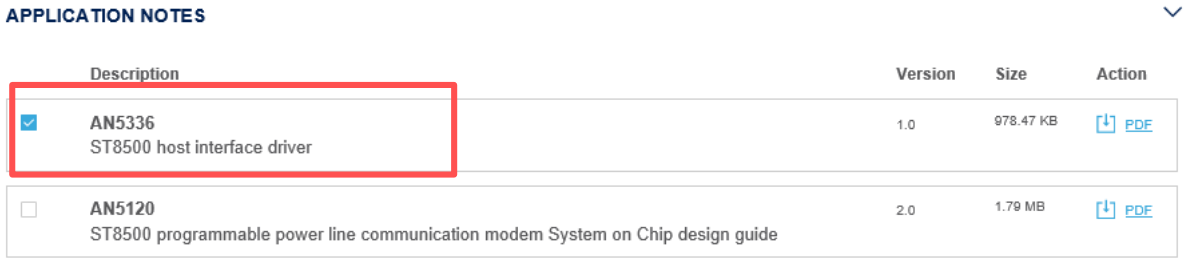
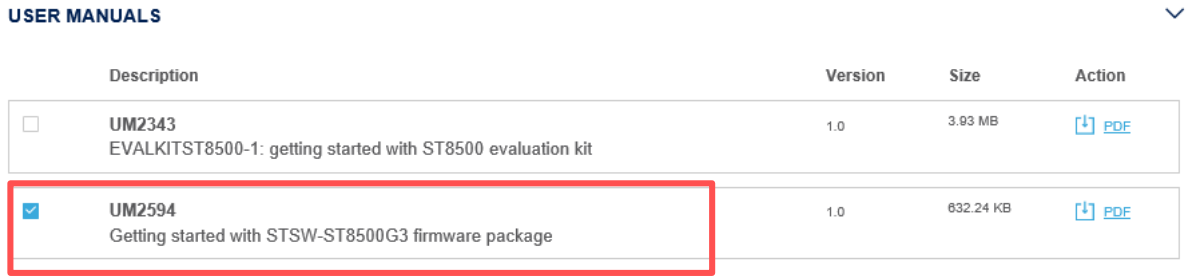
- Some documents are also proposed
  - └ Ressources



- *AN5336*: ST8500 host interface driver
  - Overview of Host Interface for FW download and for G3 protocol interaction



- UM2594: STM32 FW User Manual
  - FW architecture overview
  - Description of STM32 application FW example



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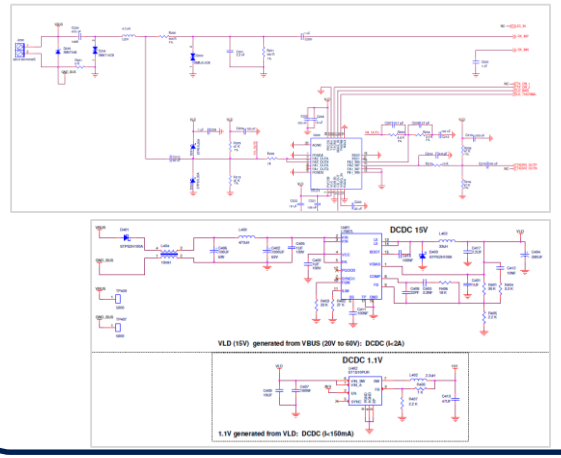
ST8500 Evaluation Board

EVALKITST8500-1

- The original kit is made of three boards:
  1. The ST8500 PLC module including the companion STLD1 line driver
     Designed for AC grid – Compatible with DC bus
  2. The STM32 mother board
     Connectors for FW upgrade, GUI connection and FW debug
  3. The AC/DC power supply board based on the VIPER26H
     This board should be replaced by DCDC board for DC application



- **Reference designs** for AC and DC application are proposed:
  1. Differential and single ended design (no Transformer)
  2. DCDC power supply design adapted to different network characteristics (voltage, wire length, impedance)
  3. More to come… (example application, BOM optimized design, …)

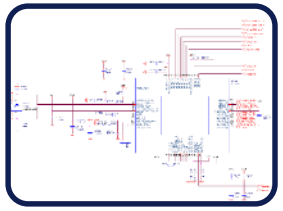
ST8500 Ecosystem

PC Tools

- Graphical User Interface
- FW download
- Small network installation

Evaluation Kit

- Order on st.com
- Schematics, gerbers, user manual
- Testing facilities for debug



HW resources

- Datasheet
- Reference design for AC and DC configuration
- Application notes, tips, guidelines

SW packages

G3-PLC Alliance

- Open market package
- G3 Firmware deliveries
- Host API driver for STM32 and Linux
- Documentation

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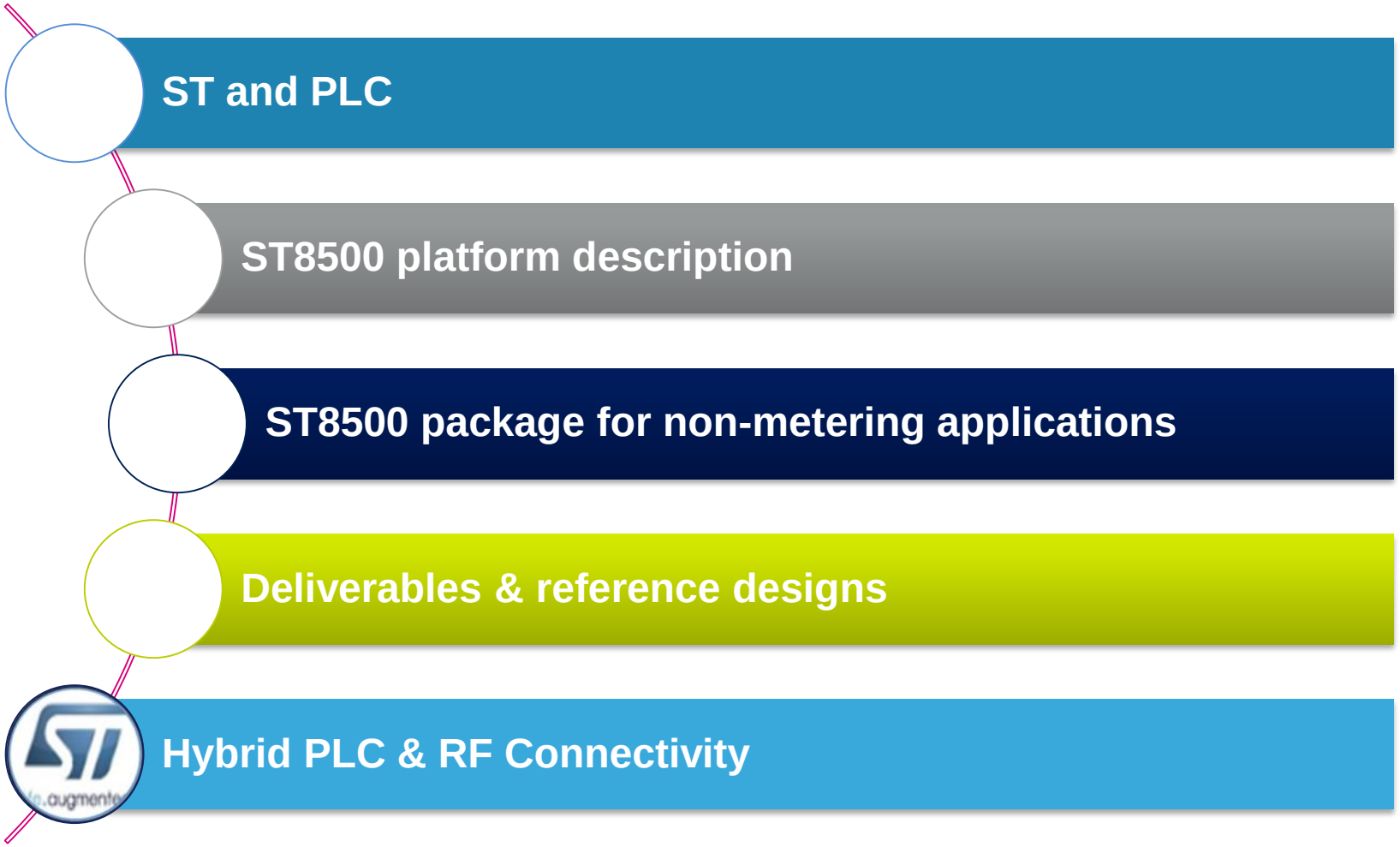
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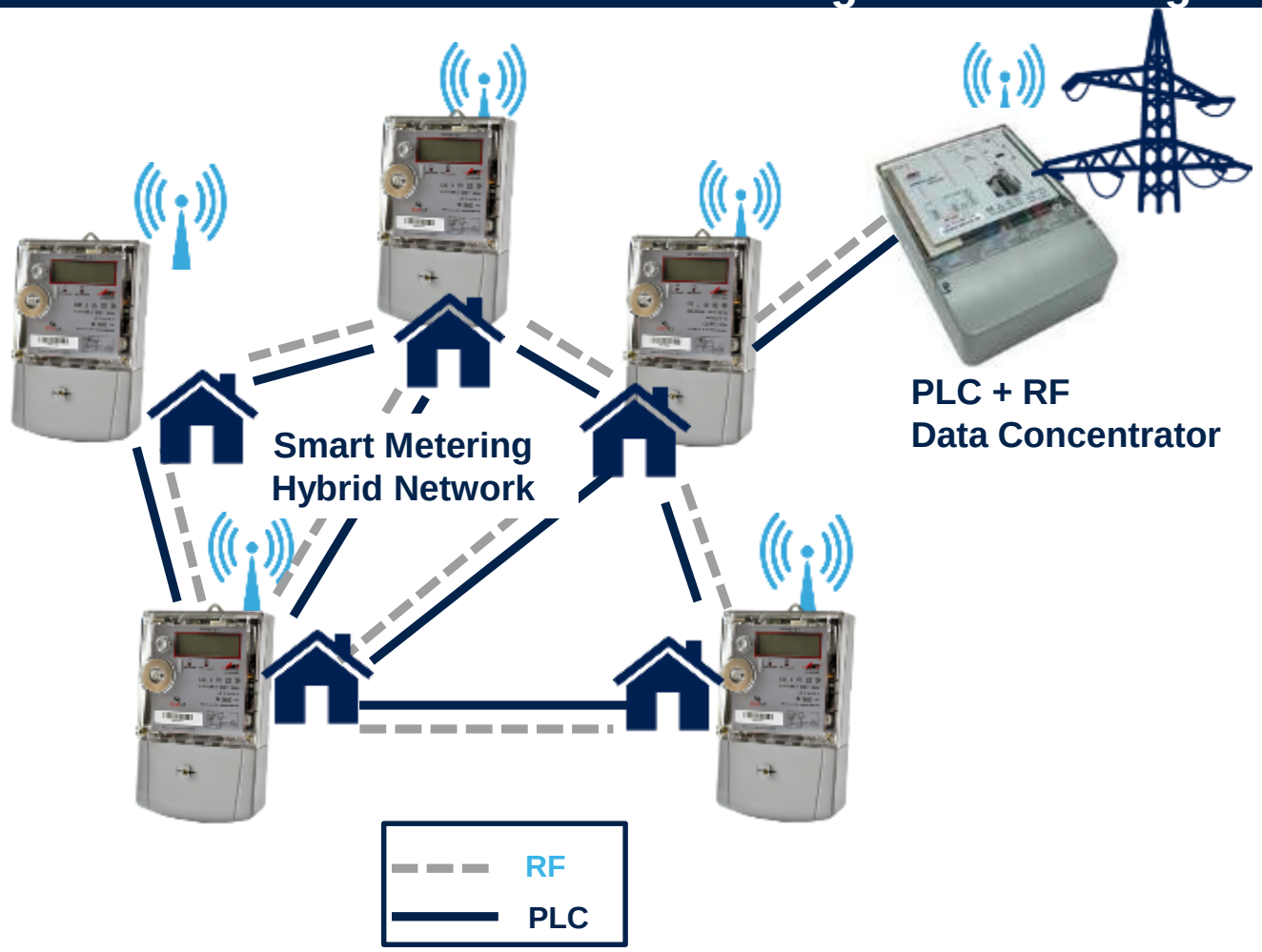
Hybrid PLC & RF Connectivity

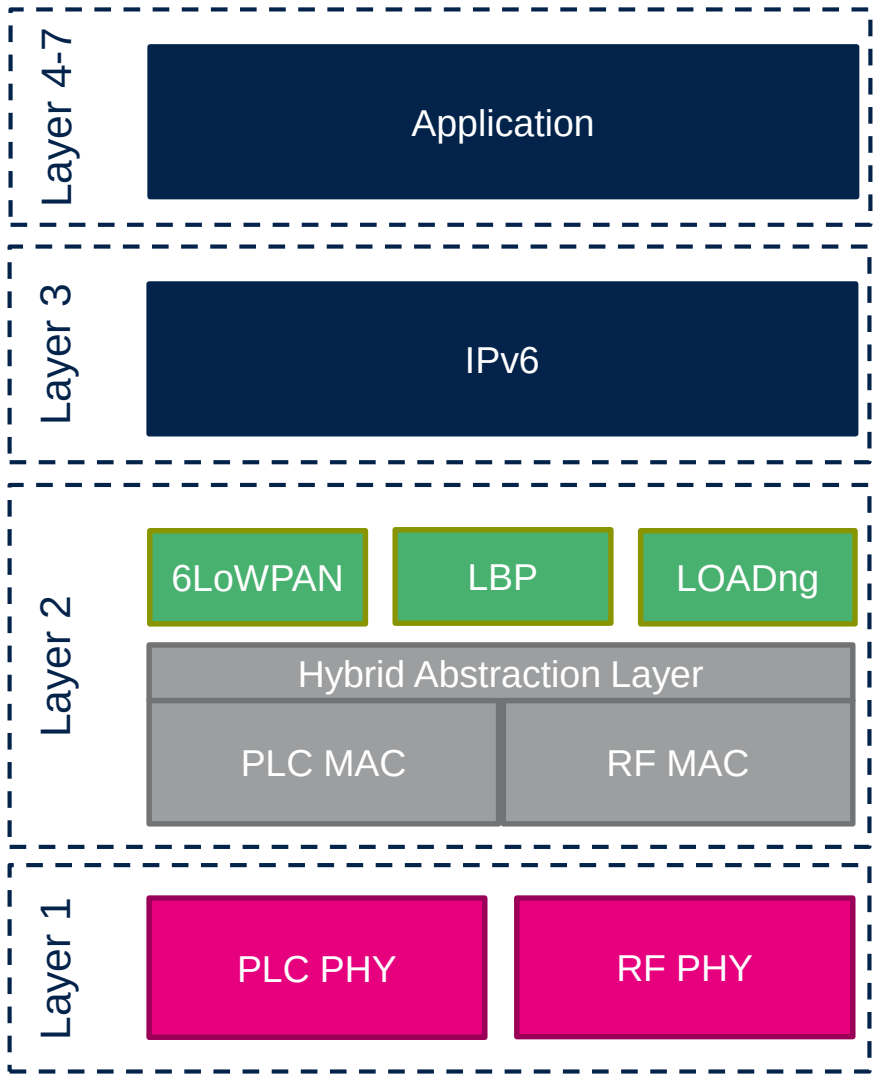
Hybrid PLC+RF technology: beyond typical Smart Grid connectivity

Overcoming limits of a single communication technology



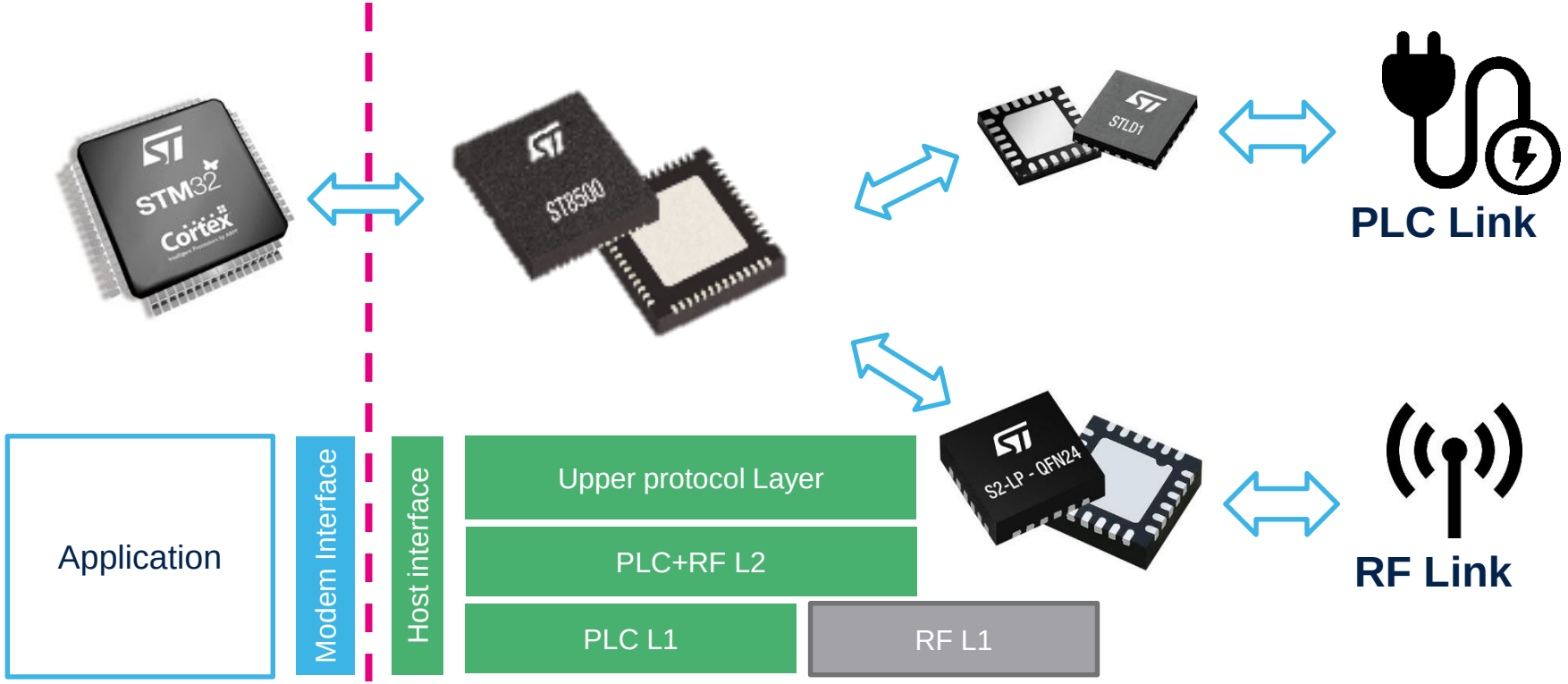
- Higher KPI requirements, challenging network topologies
  - Dual non-integrated technology may not give the best performance
  - The best integration should be done in the lower layers of the communication protocol stack
- Possibility to expand to other Smart Grid services
- Solution: fully hybrid PLC + RF Network
  - Each node has PLC or PLC+RF connectivity to others
    - PLC as preferred channel
    - RF-only can be one option for “leaf” nodes
  - The route is built with a hop-to-hop automatic selection of the “best” between PLC and RF media
  - The media selection is dynamically adjusted based on the media status

Hybrid PLC + RF technology: optimal integration choice



- First approach on G3-PLC technology
  - Already based on IEEE 802.15.4-2007 standard
- Layer 1 extension: added FSK RF PHY from 802.15.4-2015/17
- Layer 2 integration:
  - 2 separate MAC Layers (CSMA, ACK, …)
  - Hybrid Abstraction Layer to deal with common lower layer procedures
  - Hop-by-hop PLC or RF media selection
- The same approach is suitable for other PLC standards
  - PRIME Alliance is working on a similar integration, based on the same FSK RF PHY

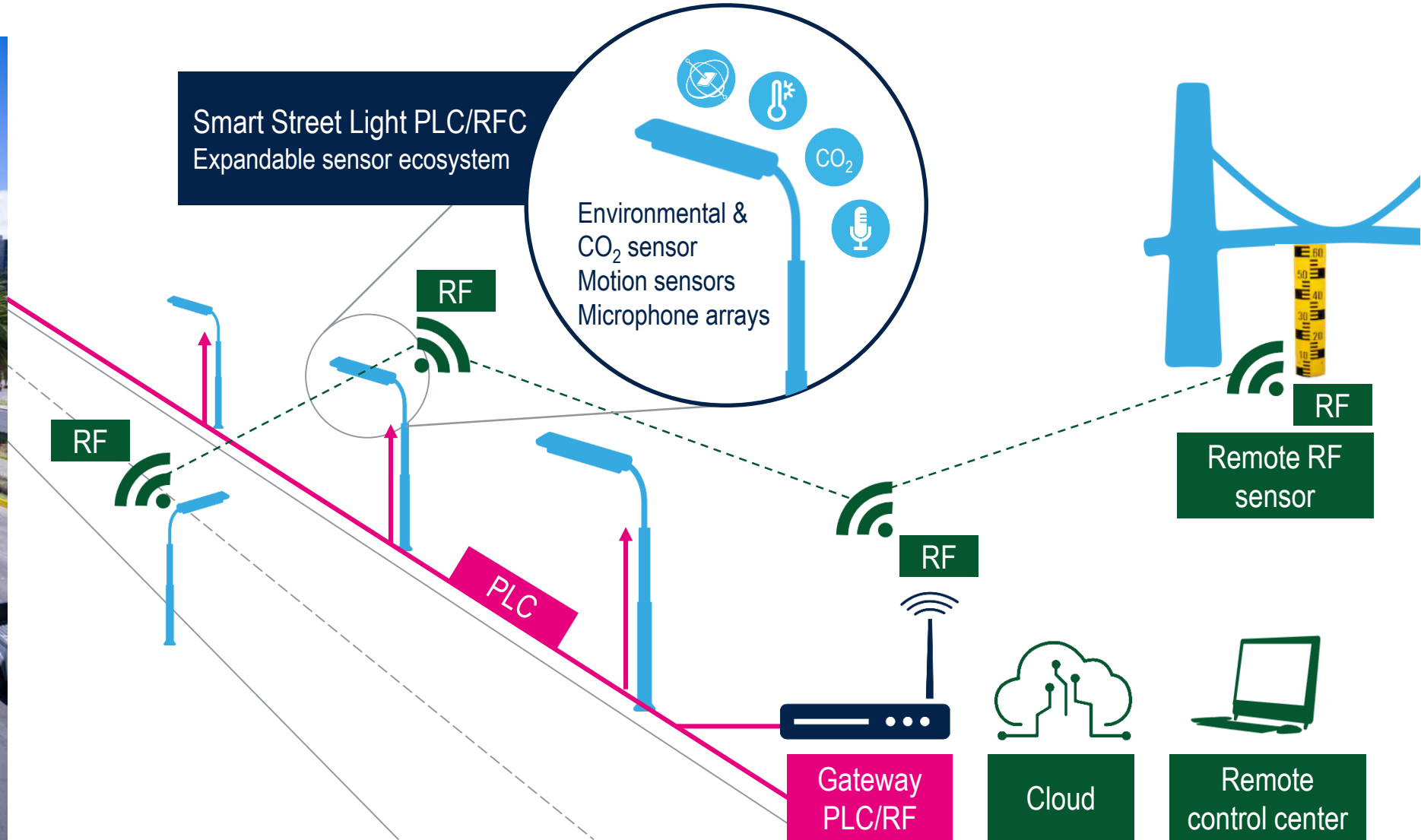
Hybrid PLC + RF technology: ST turn-key solution

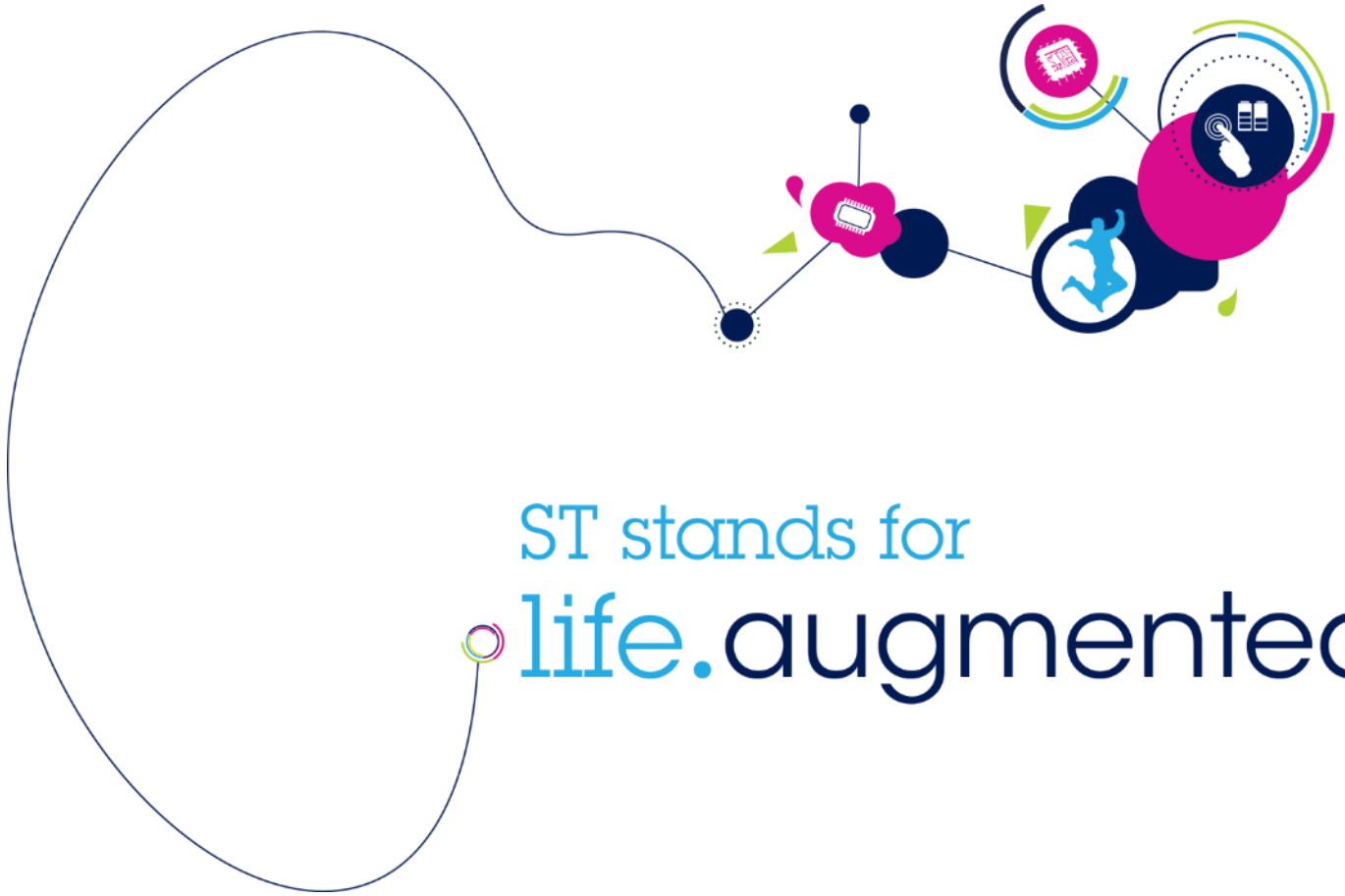


- Fully modular solution:
  - Scalable choice of STM32 application host
  - ST8500 as PLC modem and PLC + RF protocol processor
  - S2-LP (RF L1) can be removed for PLC only nodes
  - STLD1 (PLC Line Driver) can be removed for RF only nodes (options for leaf nodes)

Hybrid connectivity for smart infrastructure

IPv6 PLC & RF connectivity for cities, buildings, utilities, industrial & commercial areas





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