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# Developing New Solutions For Smart Grid

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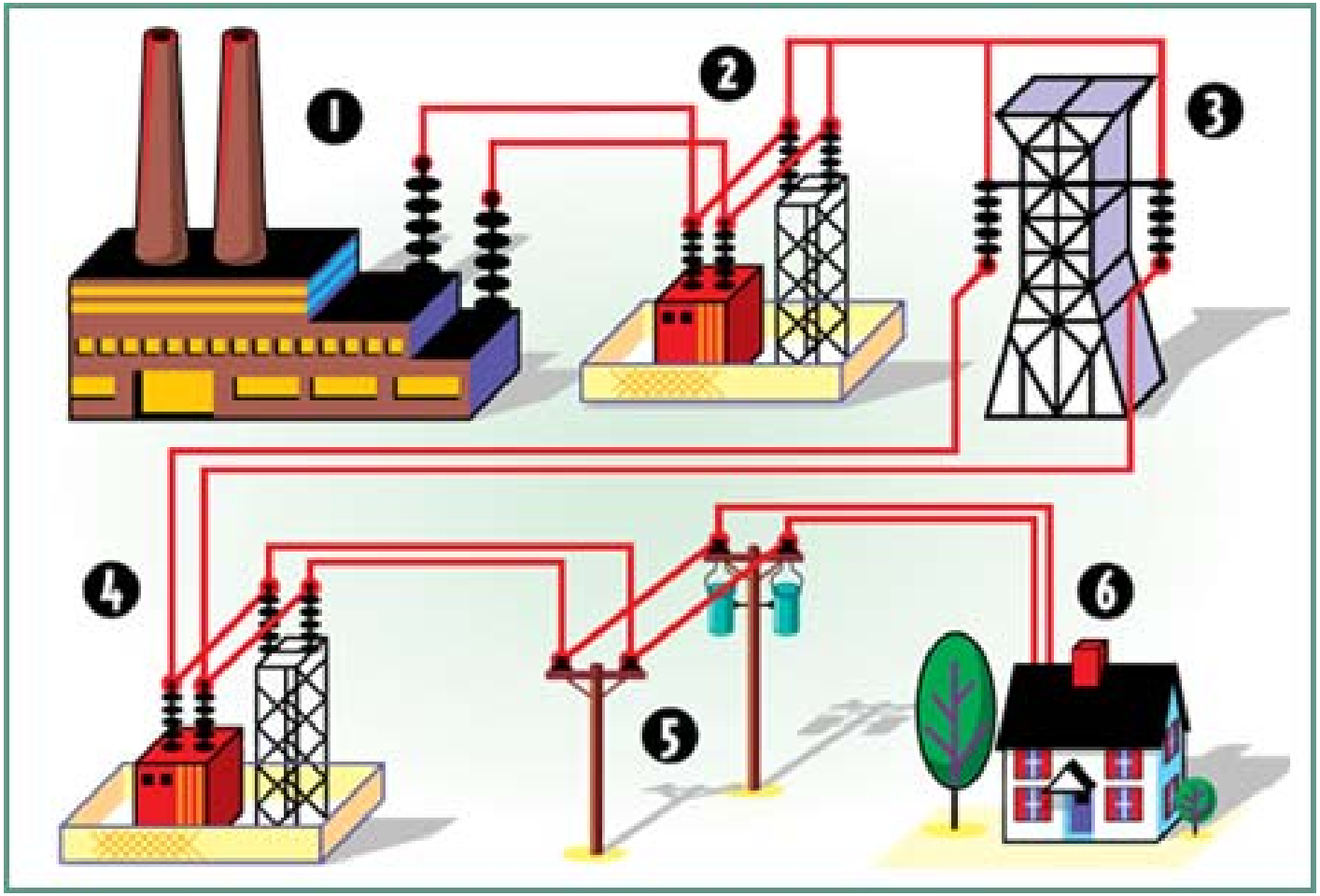
# Background: Power System




1: Power plant, 2: Step-up substation, 3 : Transmission. 4: Step Down Station,
5 Distribution. 6: Consumption

Figure Source: http://www.mnpower.com/about_electricity

# Traditional Enegy System

Main functions: controls supply and demand process (Updpwn Direction)

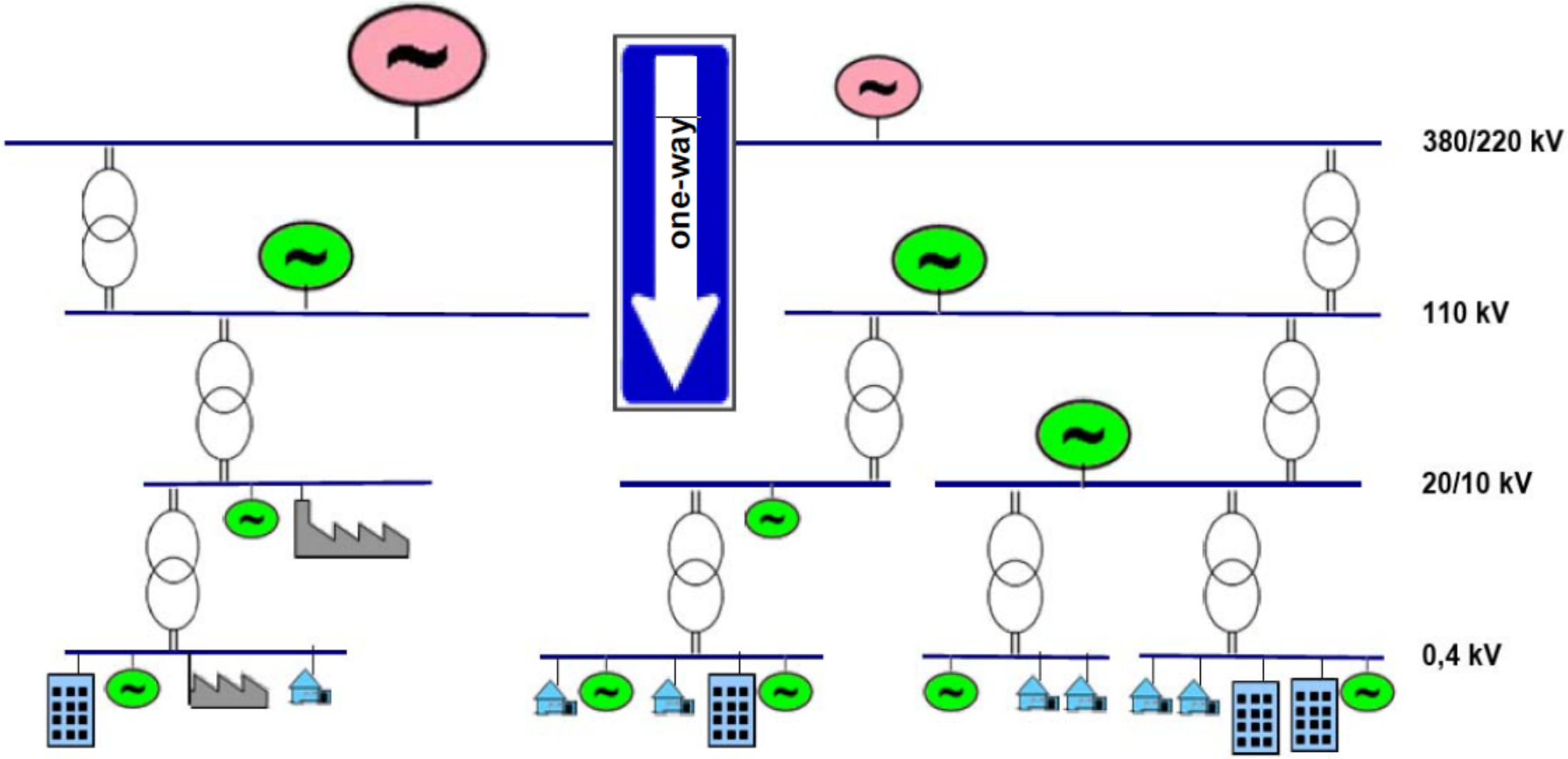



Figure source: Joachim Schyer, Remote Control for Smart Grid, 2010

# Energy System of the Future (Multi Direction)

## Multi-energy sources from both the suply and distribution side

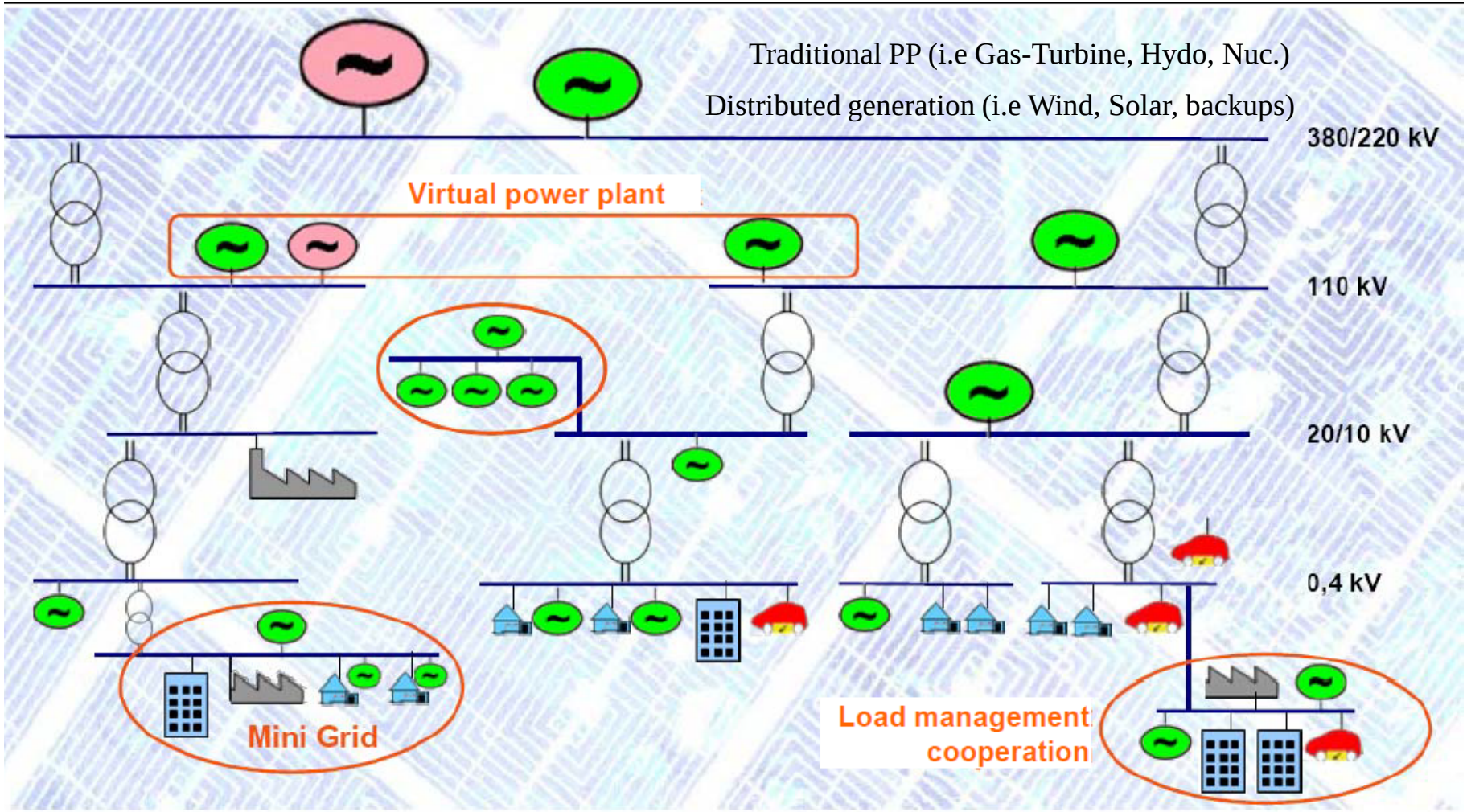



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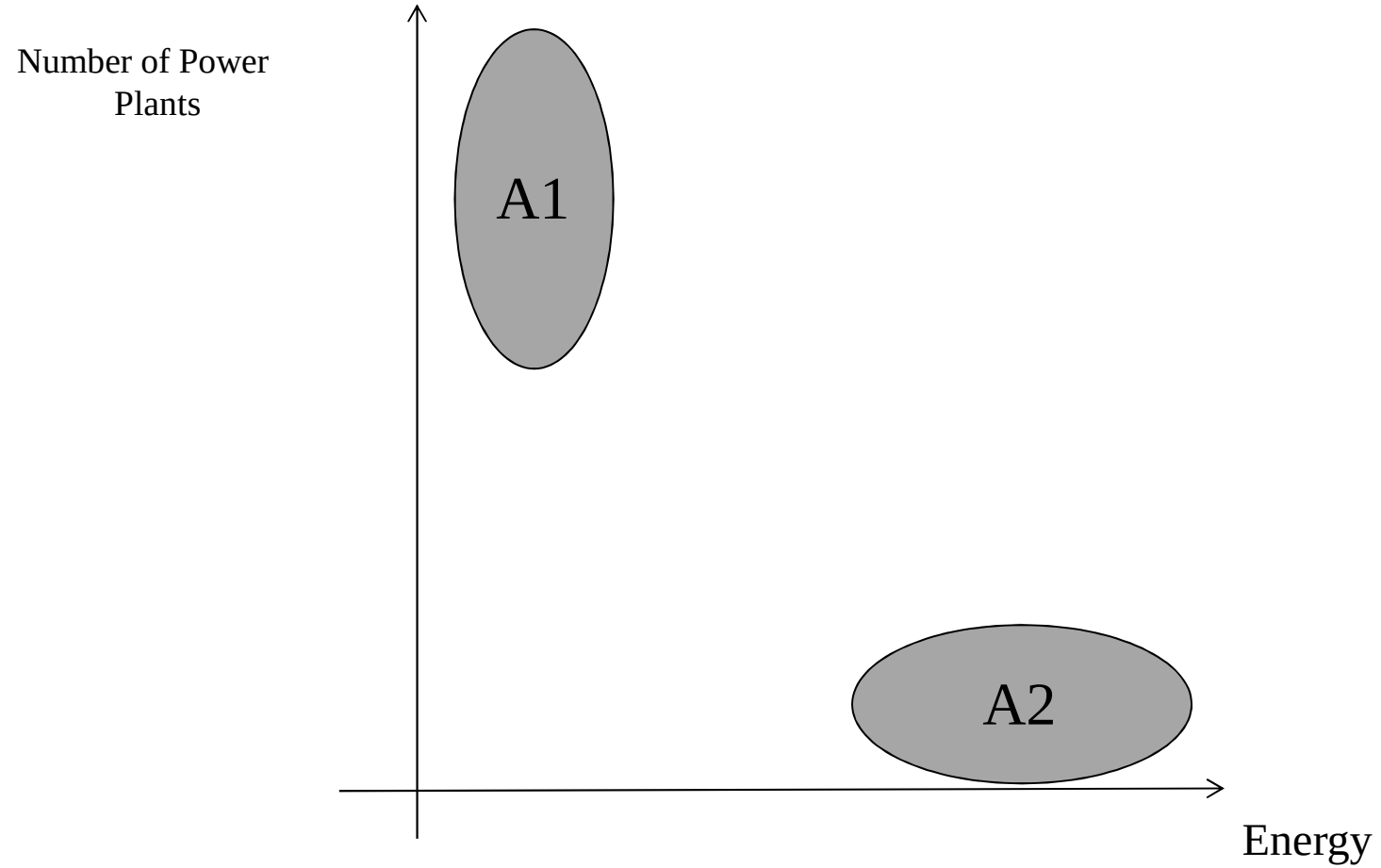
Figure source: Joachim Schyer, Remote Control for Smart Grid, 2010

# Distribution of energy supply (Challenges)



# Challenges of the Future Network

- Efficient Transmission
- Faster Fault location
- Faster Reaction to peaks
- Better Balance
- Protection for distributed grids with decentralised power generation
- Faster Load manipulation
- Managing net flow back into the network (backups)
- Interfacing (SA-DC/LV-MV) **è** Communication
- Managing Carbon emissions
- ..etc

# The needs and solutions

- Reliable Commication and IT systems
- Data acquisition and control:
  - MV source-Grid
  - MV Source-Load
  - MV to LV

**Intelligent Substation**

Ø **Monitoring low voltage stations**
Ø **Monitoring consumer appliances**
Ø **….**

**Intelligent Metering**

But must be implemented ino the existing electrical network

# Present Grid vs. Future

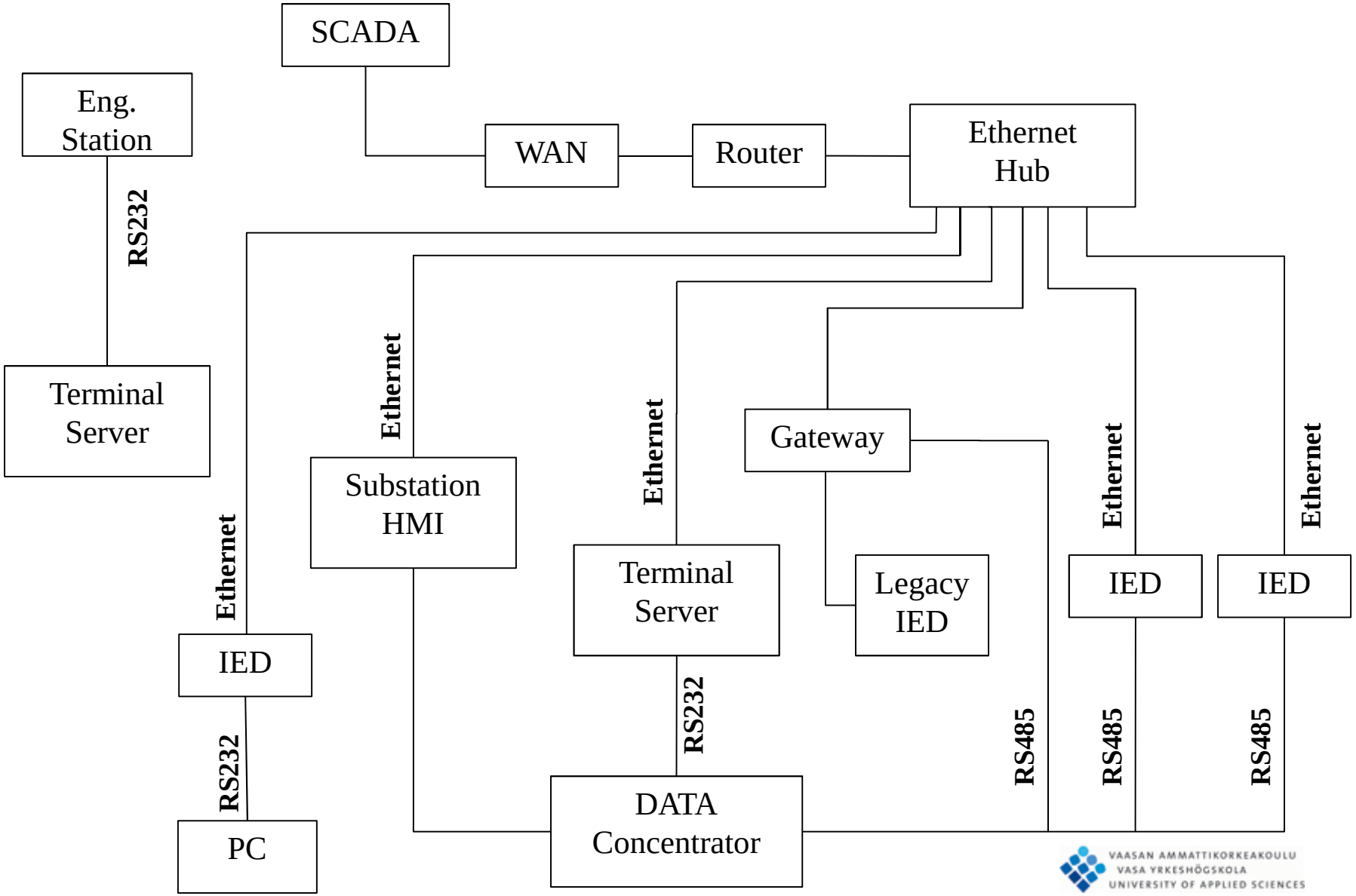
- Manual restoration of Customers
- One way Communication
- RTU
- Sensors for specific requirements
- System failure and outages
- Manual network components diagnostics
- Meter for billing

- Complete automated restoration
- Two way communication
- IDE
- Sensors installed at strategic network point
- Adaptive restoration
- Fully automated and remote interrogation
- Smart Meter for complete contol

These are more true at the Distribution Network. Since DN are relatively passive.
Transmission Networks already employs high levels of system monitoring and Intelligent Control

The key in DN to be intelligent is the Smart Meter

# Communication in Distribution SA



# Best possible solution for the SA is the IEC 61850

- SA specific data model evolves slowly
- Communication technology changes quickly
- Splitting of SA specific data model from communication technology

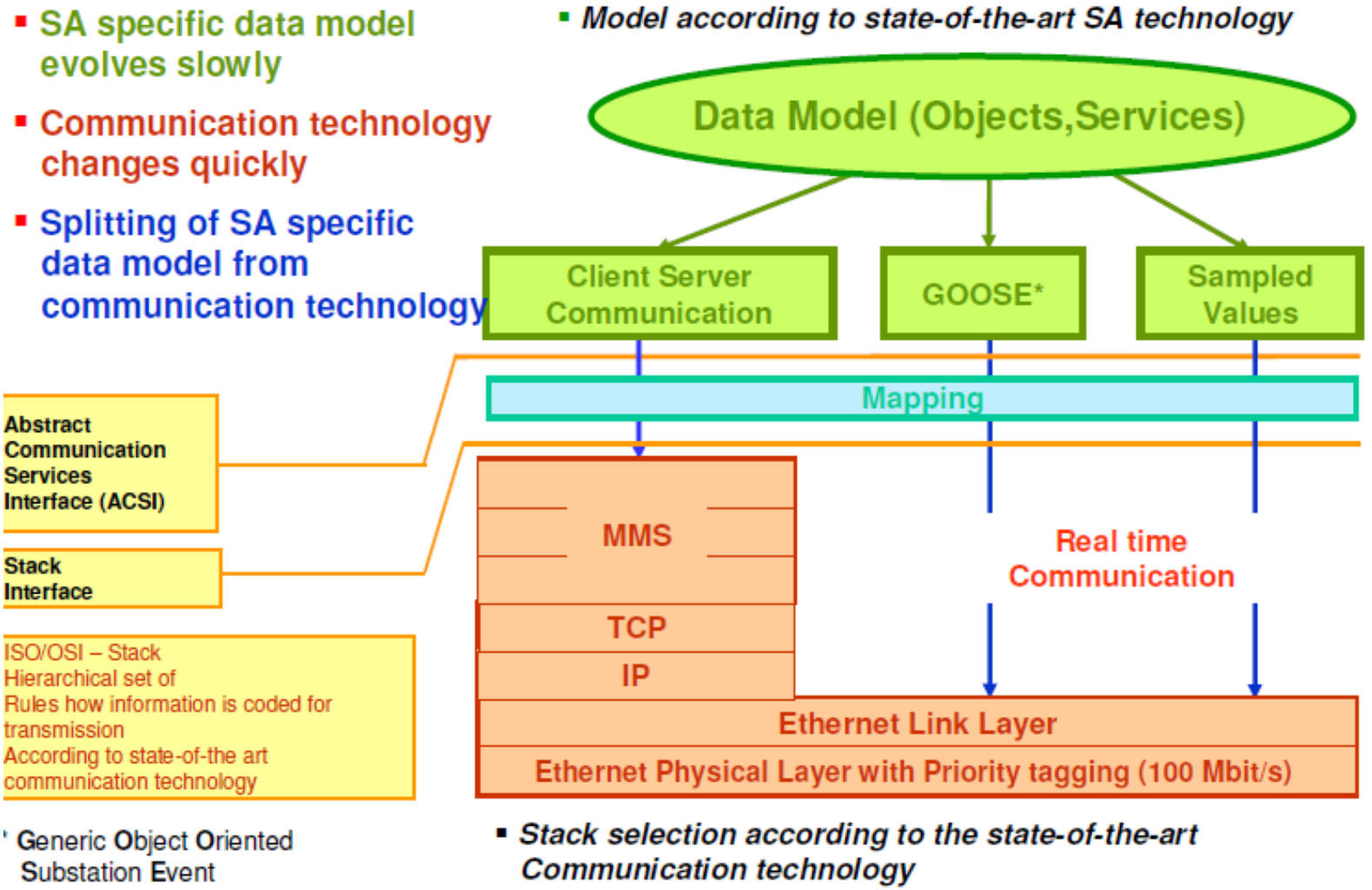
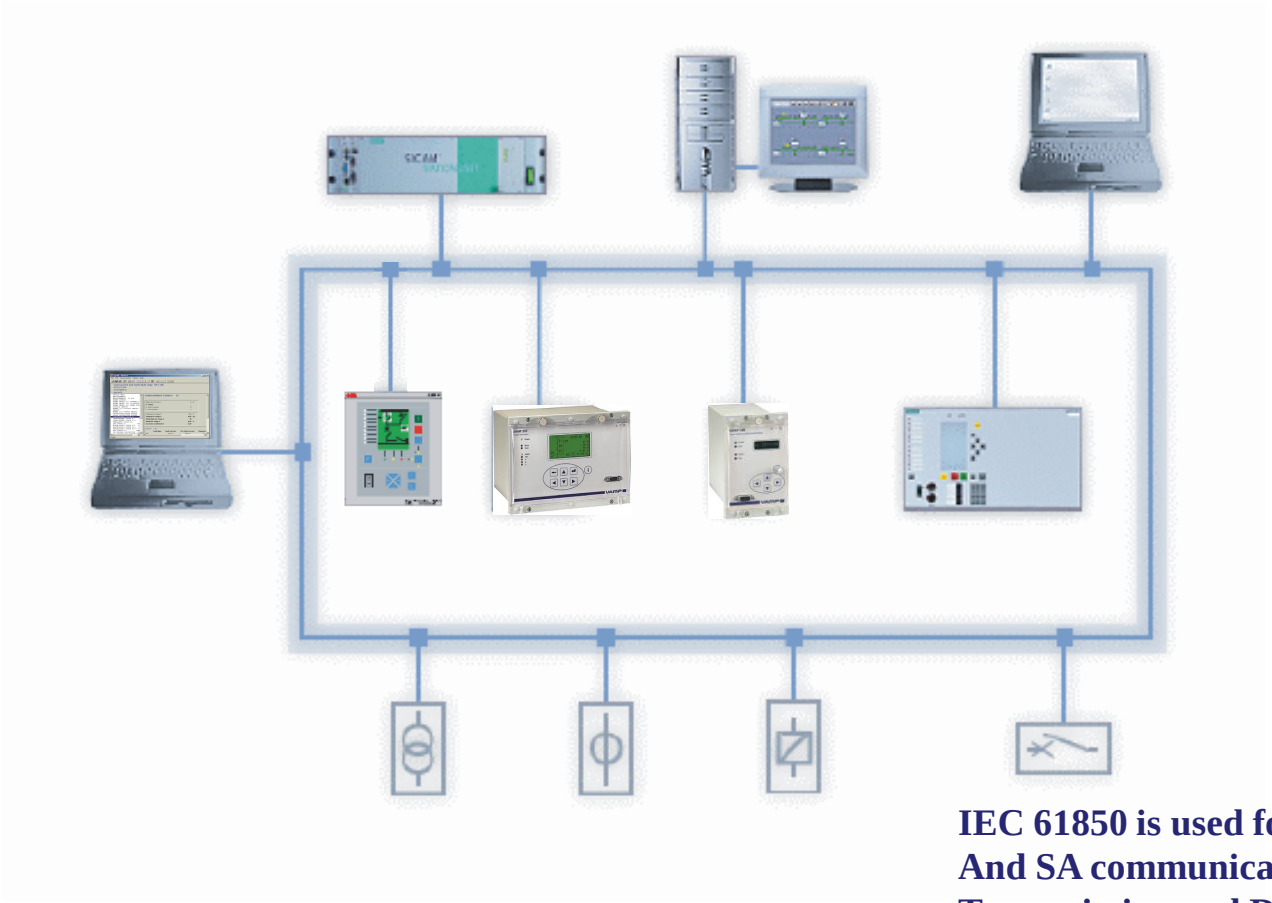



Figure source: Klaus Peter Brand , ABB Power Technologies AB

**MMS: Manufacturing Message Specification**

# IEC 61850 Interoperability

- Different SA elements can exchange data .



**IEC 61850 is used for grid integration And SA communication for all Transmission and Distribution**

Figure source: http://www.vamp.fi

# Smart Meter Overview

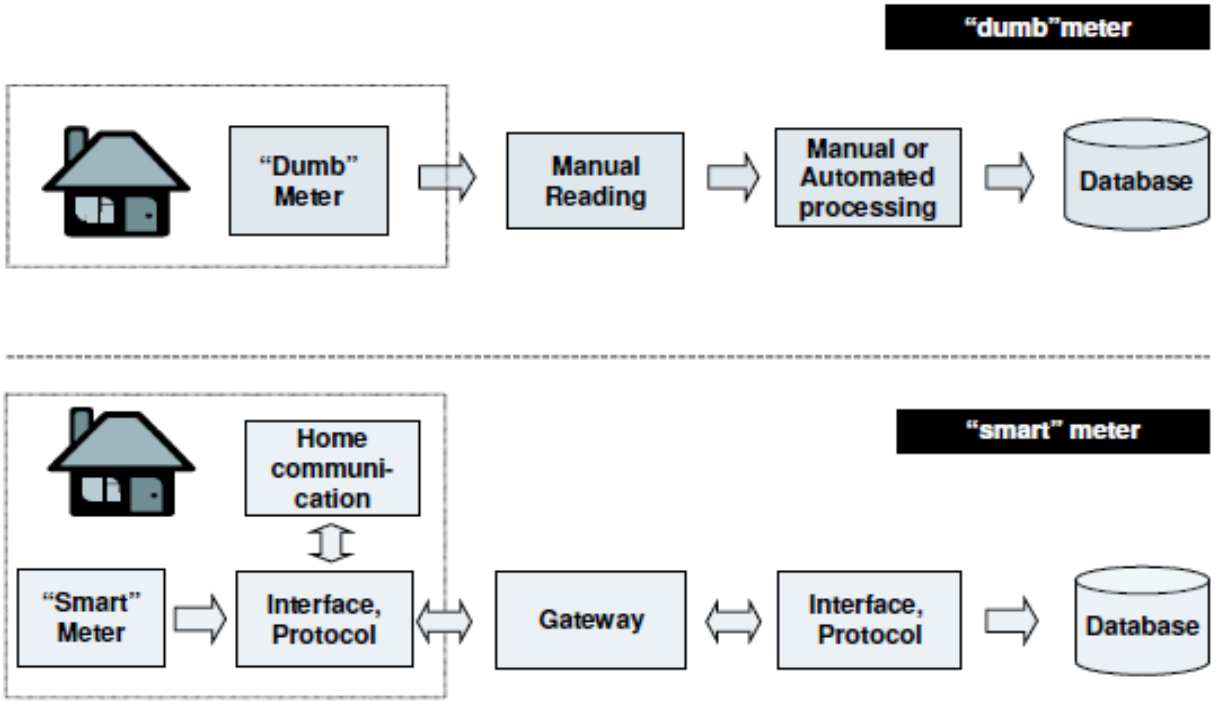



Figure source: Rob van Gerwen, Saskia Jaarsma and Rob Wilhite .Smart Metering by, KEMA, The Netherlands, July 2006

# Smart Meter Overview

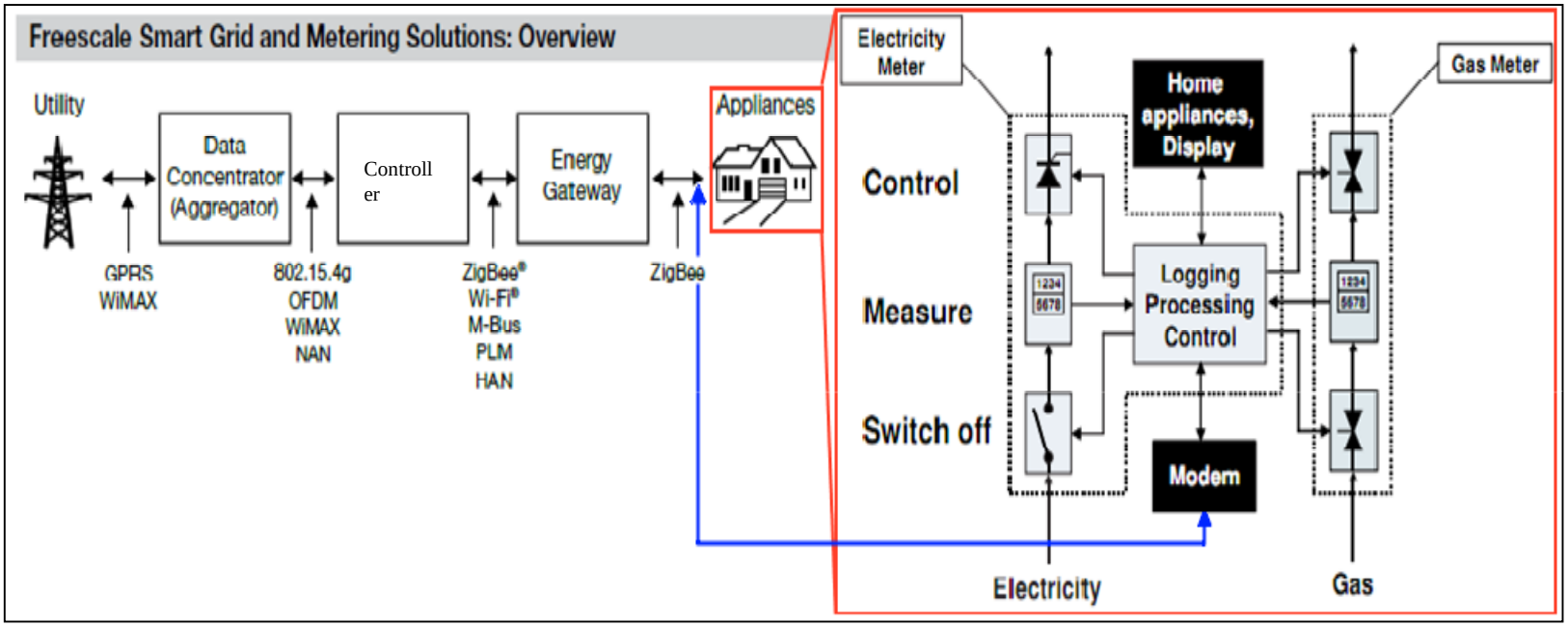
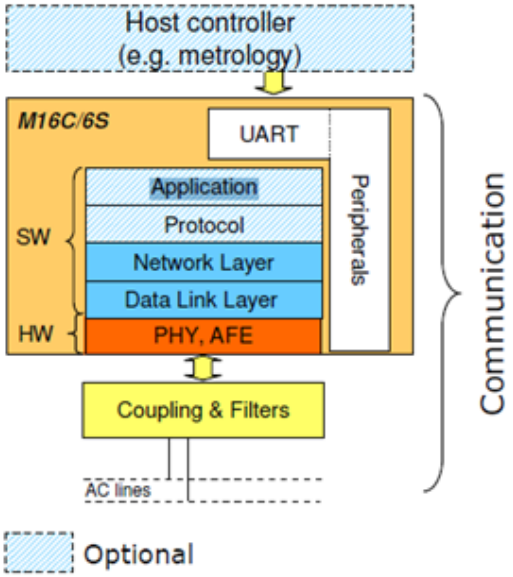
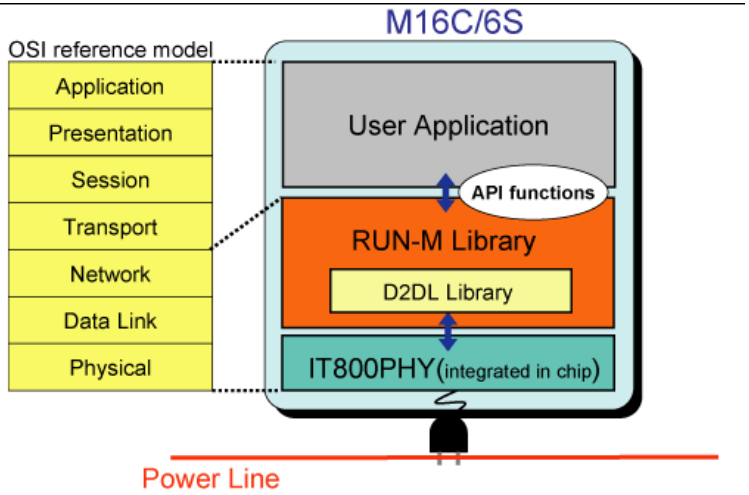


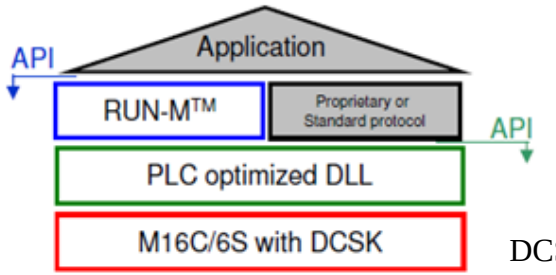

Figure source: Smart Metering by Rob van Gerwen et al, 2006

# PLC (Power Line Carrier)




Single chip MCU with integrated PLC modem




DCSK: Differential Code Shift Keying Modulastion (Robust against powerline noise)

***RUN-M:*** ***R****ENESAS* ***U****biquitous* ***N****etwork Layer for* ***M****etering Applications.*

- *Intelligent join procedure and self healing.*
- *Dynamic reconfiguration*
- *Intelligent Repeating mechanism*

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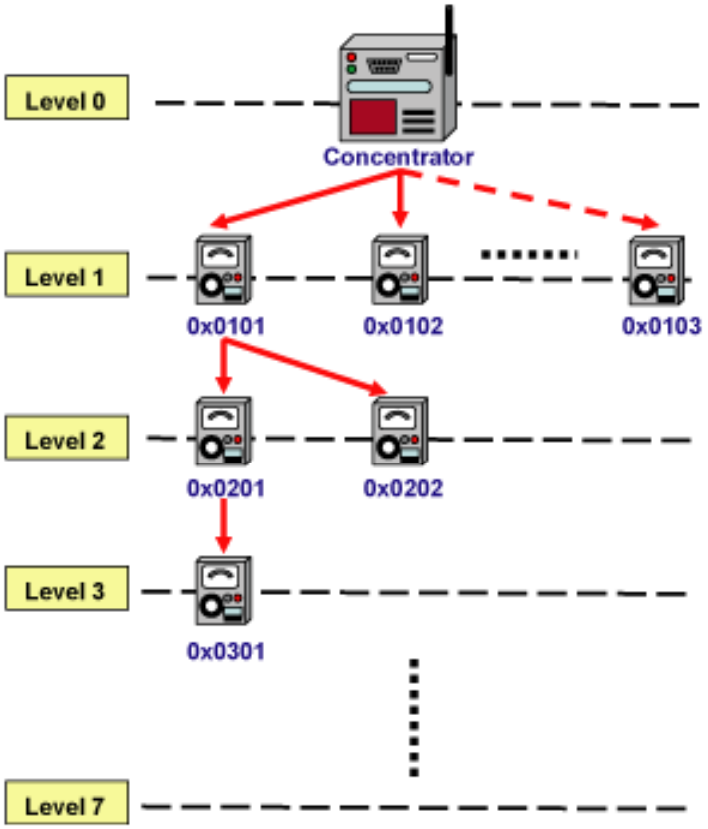
# RUN-M Network Structure




The features of the RUN-M network are described as follows:

- ü Tree network structure
- ü Up to 7 levels tree depth
- ü Up to 255 nodes in each level
- ü Allows 1785 network participants
- ü Network is controlled by a main device (Concentrator)
- ü Concentrator is the only device located on level 0

**Multiple Message Types**

- Unicast: Message to a particular node
- Levelcast: Message to all nodes on a particular level
- Multicast: Message to entire network

# RUN-M Network Structure

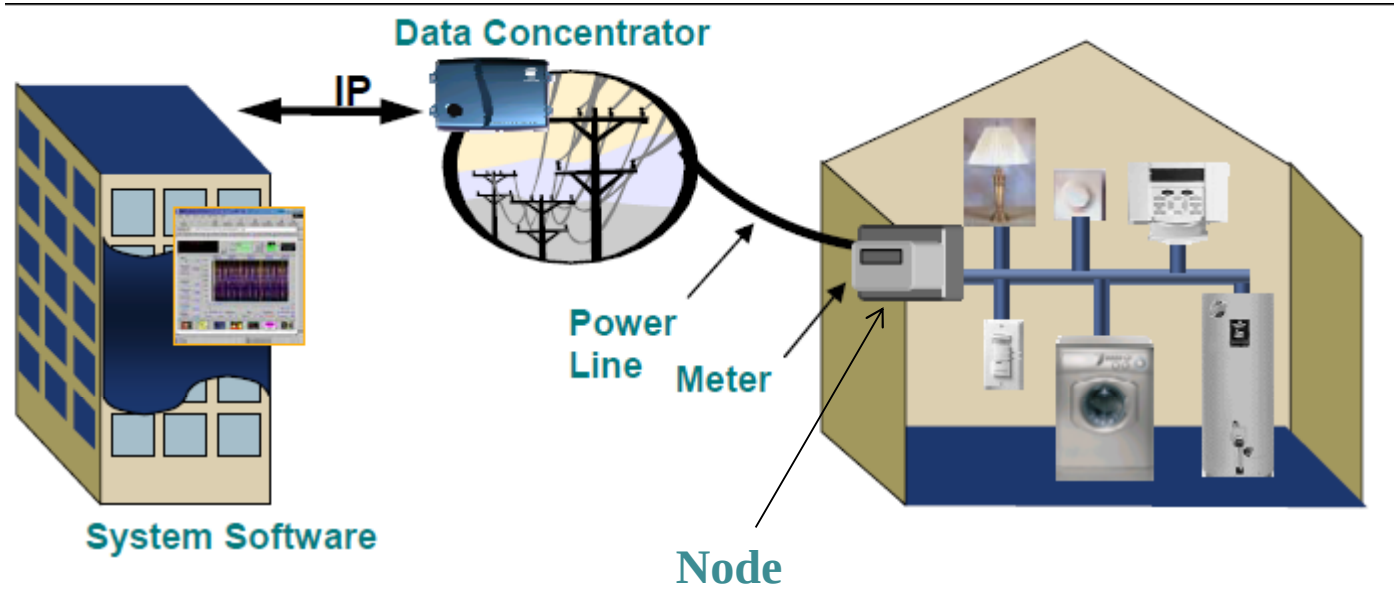
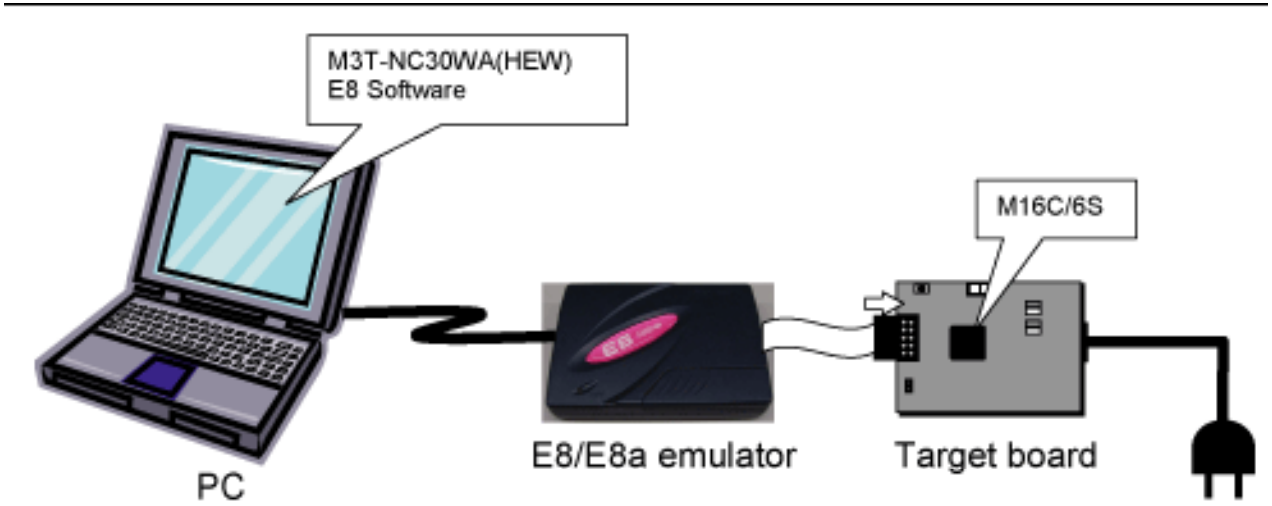
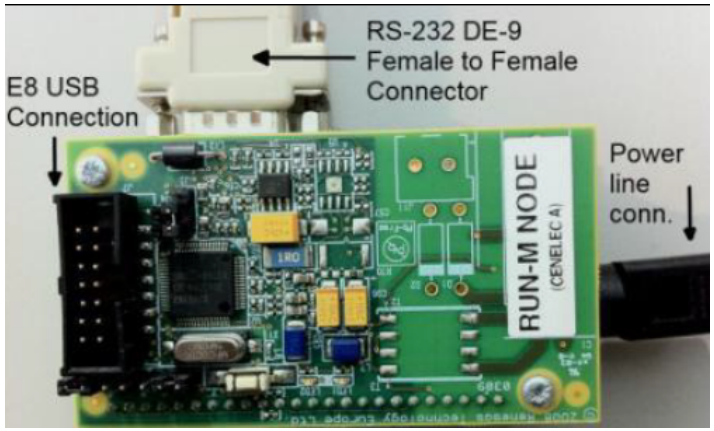



Figure source: Open PLC European Reseach  Aliances OPERA

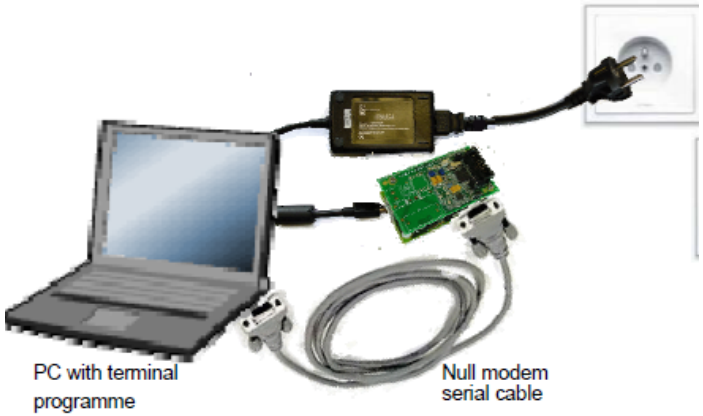
# Development Environment for SM



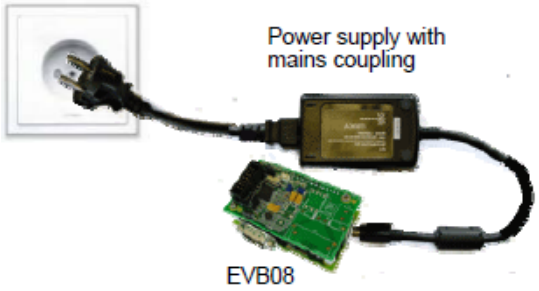




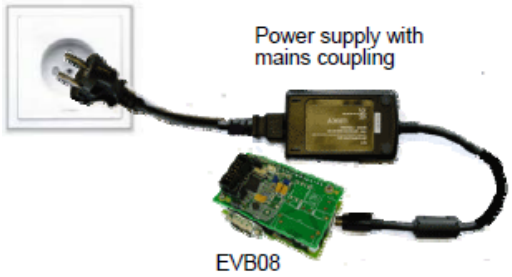
# Developement Environment for SM



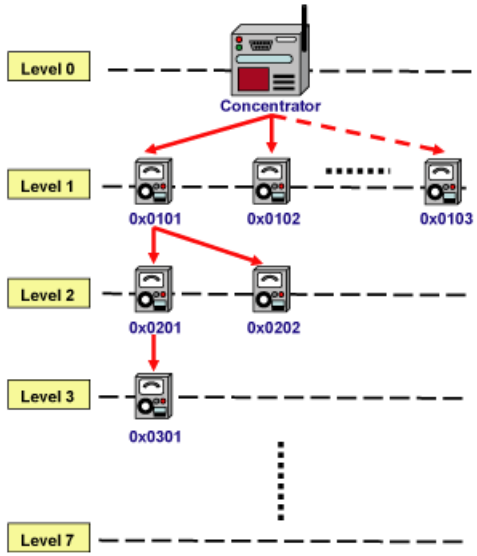

**Concentrator set up**




**Node setup**




**Node setup**

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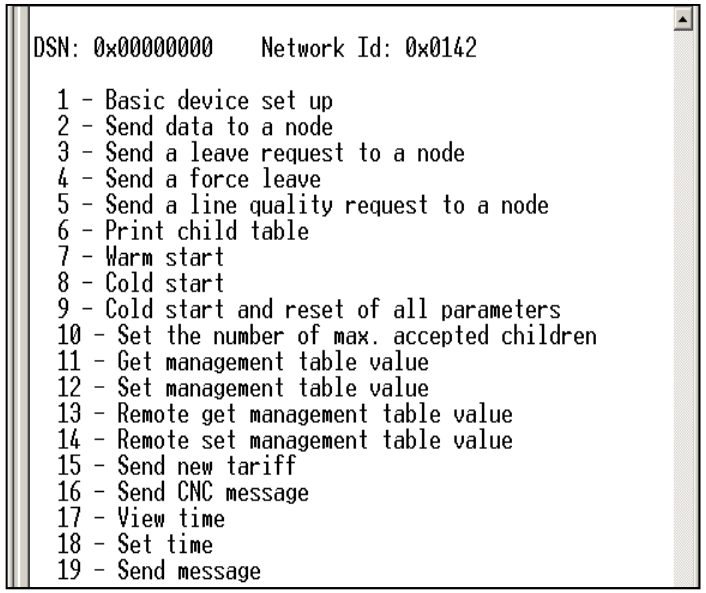
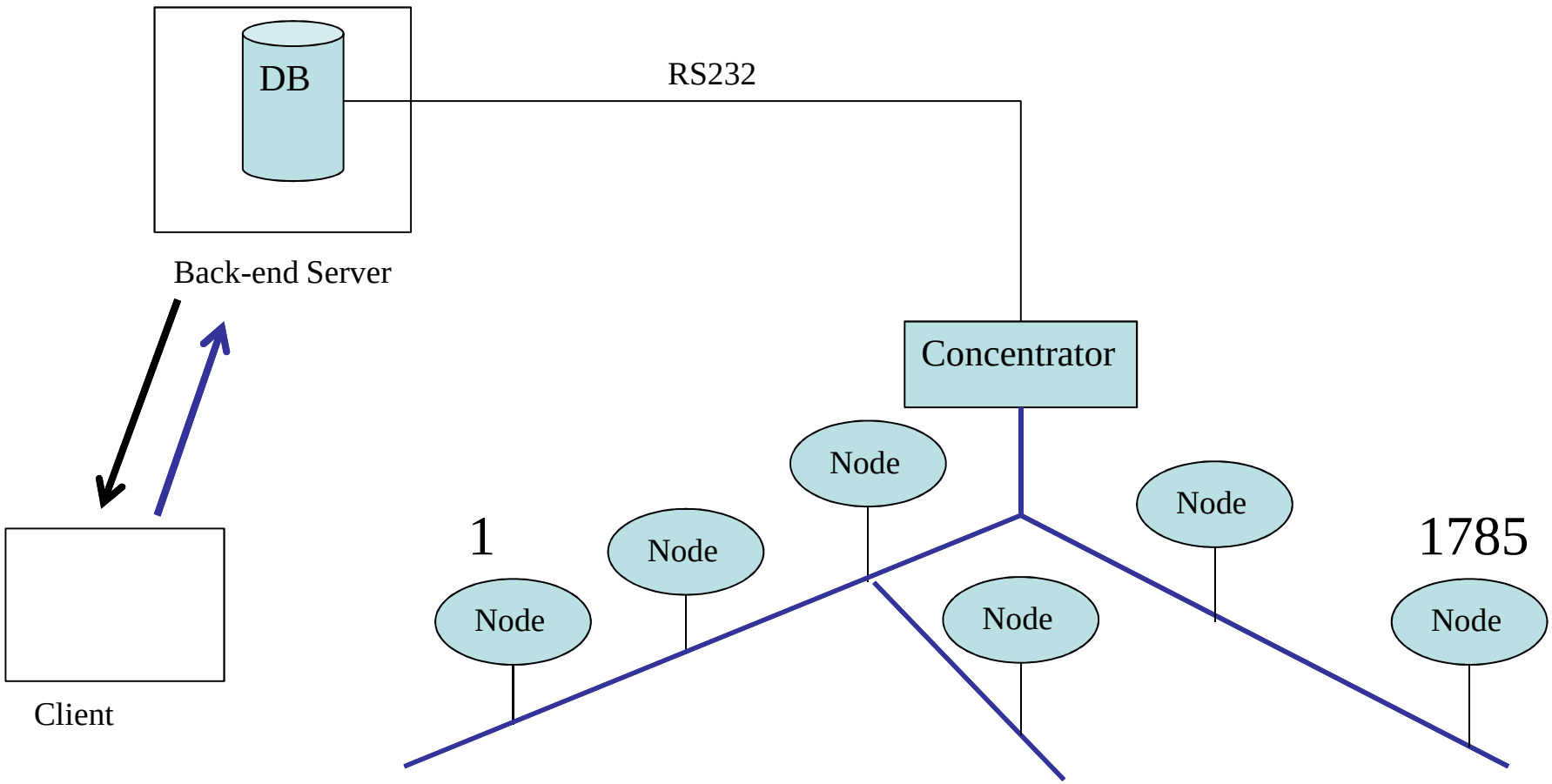
# New Functions added

- RTC (Real Time Clock): To be used in every application that require date
- Send auto-request: Use RTC to request data on from each node at regular period of the day/week/month/year
- Send auto-response: Similar to the request function, but with options to select which data will be sent.
- Tariff: Set the price per kWh
- Send messages: Send messages to selected node
- High usage Alarm: When customers uses more energy than predicted, the data concentrator sends a warning
- Store data of a node: The concentrator stores data temporary before sending to database
- Ping a node: To describes the status of the nodes

In Red: not implemented yet



# NES (Network Energy Service)



# Back-end applications

| Priority | Description | Dependencies |
|---|---|---|
| 1 | Data export & import. | Communications (TCP/IP, USB…) |
| 2 | Instant kWh view.<br>A live view of energy usage expressed in kWh. | Current power reading<br>Memory access (for storing readings) |
| 3 | Daily/Weekly/Monthly/Yearly view.<br>A historic view of average energy usage. | Memory access (retrieval of readings) |
| 4 | User input screen for settings regarding cost of energy (what prices at what times) and usage alarm threshold. | Input (buttons)<br>Memory access (saving/retrieval settings) |
| 5 | High use warning alarm | Current power reading<br>Access to settings<br>Communications (optional) |
| 6 | Instant Cents/hr. view | Instant kWh view<br>Input<br>Access to settings |
| 7 | Usage graph. | Daily/Weekly… view<br>Access to memory |
| 8 | Remote interfaces | TCP/IP Communications |

# Conclusion

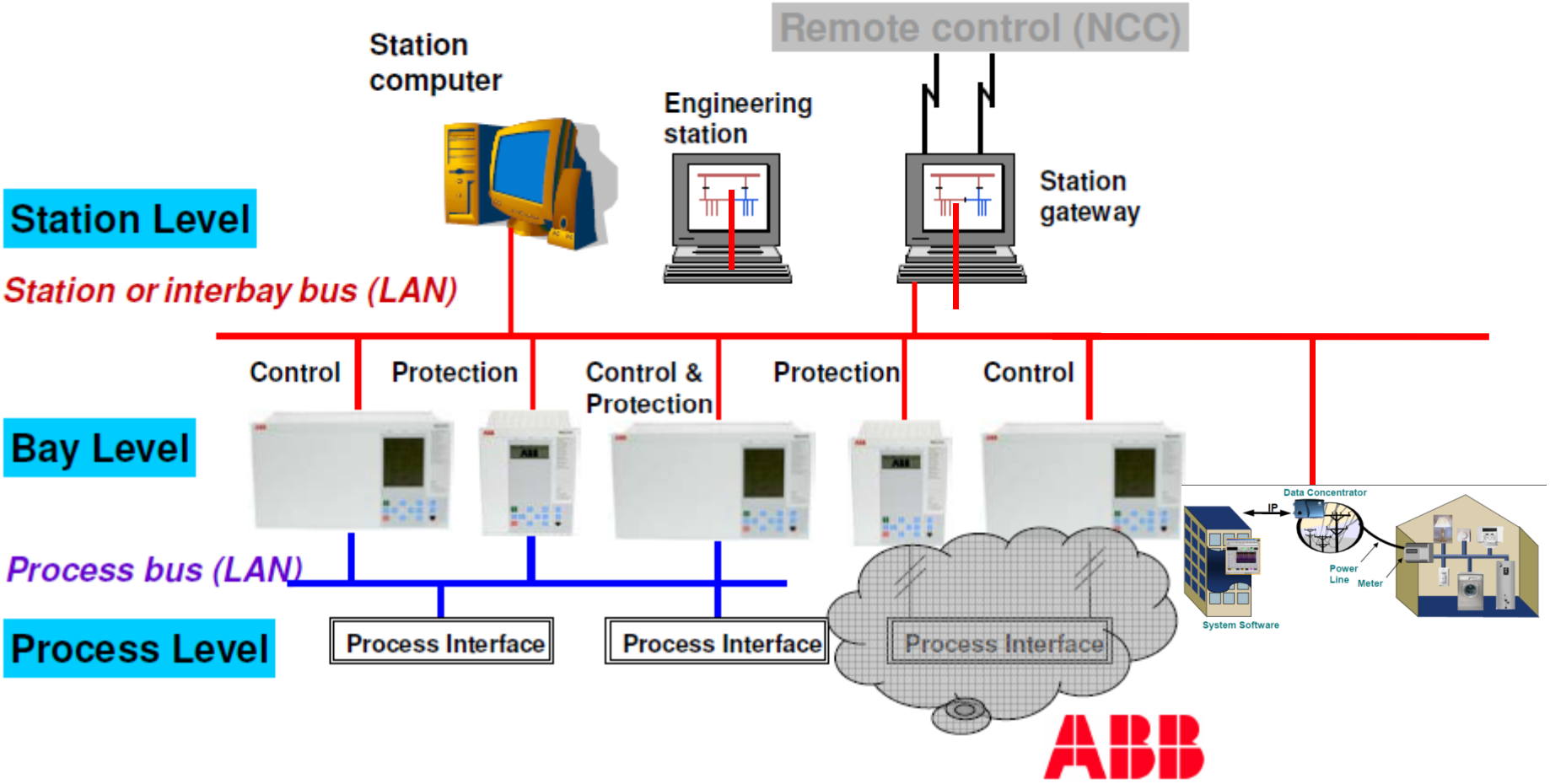



Figure source: Zoran Kajic, ABB Power Technologies AB