Key Requirements for HAN Communication in Smart Metering

Executive Summary

- Many required functions of HAN communication within the customer's premise in the context of Smart Metering are so challenging that most currently available Radio Frequency standards cannot meet them.
- There are different options to support interoperability of the Smart Meter infrastructure. However compatibility with devices outside the currently considered 'narrow' Smart Meter infrastructure should also be ensured.
- The recently developed SipCos protocol presents an attractive opportunity towards HAN communication in Smart Metering meeting the expectations.

Home Area Network communication usage in Smart Metering goes far beyond the upload of readout data

Smart Meter Use Cases	Focused HAN Scope	Extended HAN Scope	Future HAN Scope
	> Inhome communication between SmartMeter and WAN module to enable **reliable data readout** also in difficult RF environments	> Transmission of consumption data from SmartMeter to inhome display stimulate behavioral change by **visualising energy consumption over time**	> Distribution of tariff events to devices for **demand side management**
	> Transmission of consumption data from SmartMeter to inhome display to allow **verification of invoice** / control of consumption	> Transmission of **time/load based tariffs** over WAN to display for invoice forecast	> Two-way communication with **microgenerator** to integrate as virtual powerplant
		> **Remote disablement of users** to prevent energy theft and enable **prepaid/credit services**	

HAN should support all required Smart Meter functions

Specified Smart Meter functions implies various requirements on Metering HAN communication

	Smart Meter Function	Functional Requirements to HAN
Focused HAN Scope	Data Readout	> Transmission between Meter and WAN, if WAN module is seperated > Sufficient range even for difficult environments needed > Data privacy, integrity and authenticity
	Control of Consumption	> Standardised data structures by time/consumption > Data privacy
Extended HAN Scope	Visualisation of Consumption	> Data privacy
	Time/Load based tariffs	> Import of tariffs over WAN, data transfer over HAN to meter/display > Standardised data structures > Data privacy, integrity and authenticity
	Remote disablement of users	> Import of customer admission over WAN, connection to meter switch > Data privacy, integrity and authenticity > Reliability – meter should react to commands without lag
	Prepaid/credit services	> Import of customer admission over WAN, connection to meter switch > Data privacy, integrity and authenticity > Reliability – meter should react to commands without lag
Future HAN Scope	Demand Side Mgmt (DMS)	> Import of tariffs over WAN > Standardised data structures > Interface to PC/display, electrical devices and gas boiler > Data privacy, integrity and authenticity needed
	Communication with Micro generator	> Import of tariffs over WAN, HAN receives available generator capacity > Data privacy, integrity and authenticity > Reliability – near real time communication for tariff events needed

Derived functional requirements impose some serious challenges on existing HAN technology

	Extensive functional requirements for HAN..	..cannot be achieved by most prevailing standards
Data privacy	> Privacy needs with consumption data > Burglars shall not be able to monitor occupants' behaviour	  > Data communication should be encrypted with secure keys > Key exchange during setup needs to be secure
Data integrity	> Meter - WAN communication may not be influenced by attackers from outside > Without integrity any device forming part of DSM infrastructure could be controlled by attacker	
Data authenticity	> Data originator needs to be authenticated if customer can be disconnected > Secures that nobody else than utility is originator of access activation / deactivation is utility	
Reliability	> Unreliable communication dilutes utility of Meter > Microgeneration and DSM require close to real time control signals	 > Should run on frequency band without competition of WiFi, blue-tooth etc.
Range	> Sufficient range needed to operate reliably in most household > If communication does not work in the intended environment all standardisation efforts are diluted	 > Sufficient transmission power needed plus ability to operate battery powered

Interoperability can be ensured by standardized gateway or restrictions to allowed architecture

Interoperability by standardized gateway

> Interoperability is secured by a **standardized gateway** integrated in the Inhome Display, WAN communication module or standalone

(+) Supplier change or integration of new device does not require changes to Meter infrastructure as interoperability is secured by the gateway connecting to systems operating on other standards

(–) Question of **responsibility for the remaining infrastructure** (e.g., in home display) if customer changes to supplier operating on other standard

Interoperability by one single standard

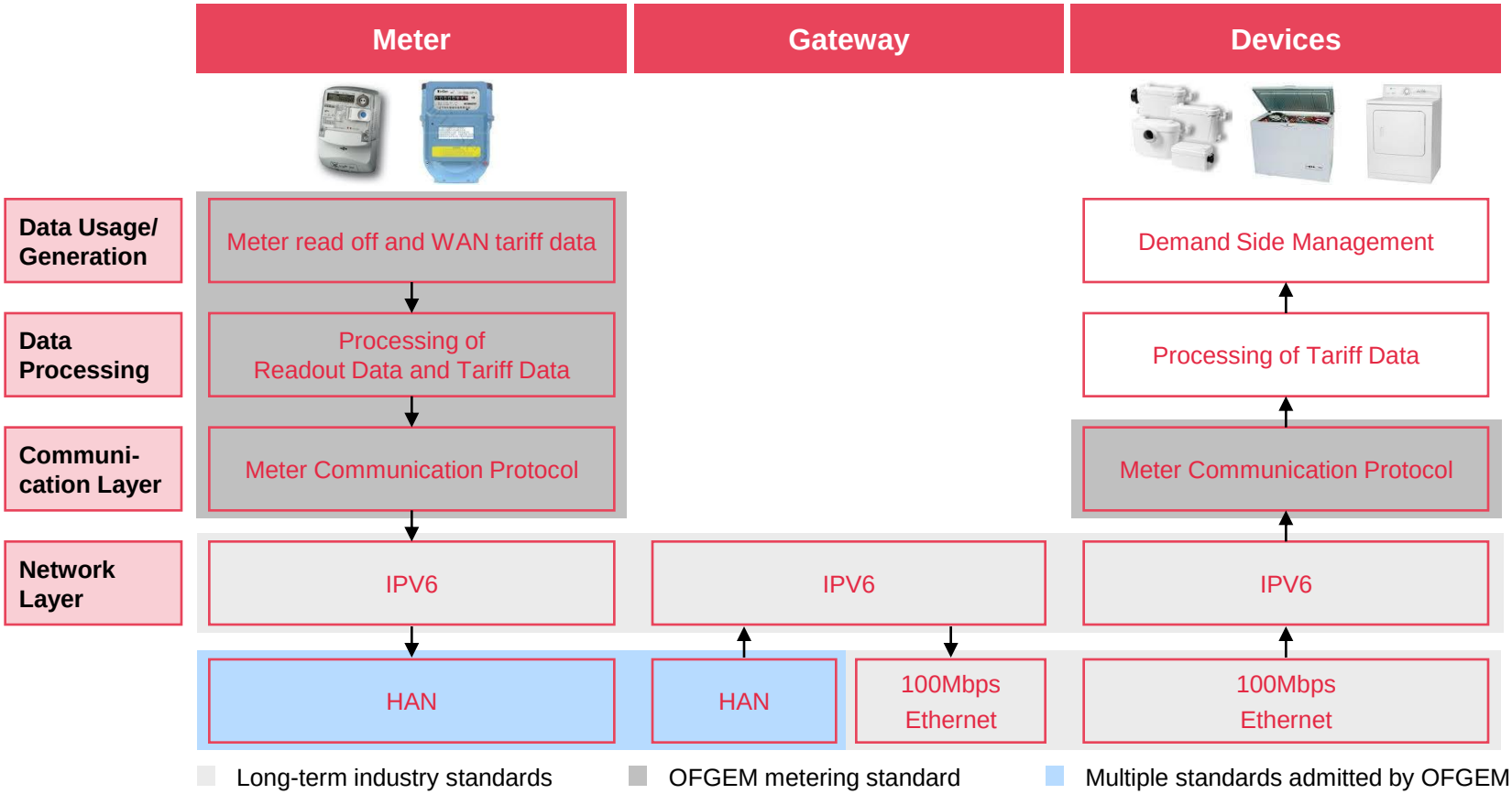
> Solution is **only acceptable** from an interoperability viewpoint if HAN port has **modular design** or only **one standard** with IPv6 compatibility is admitted

(–) Admission of one **standard** without flexible HAN module implies decoupling from technological progress in RF technology — at least **IPv6 compatibility needed** to be future-proof

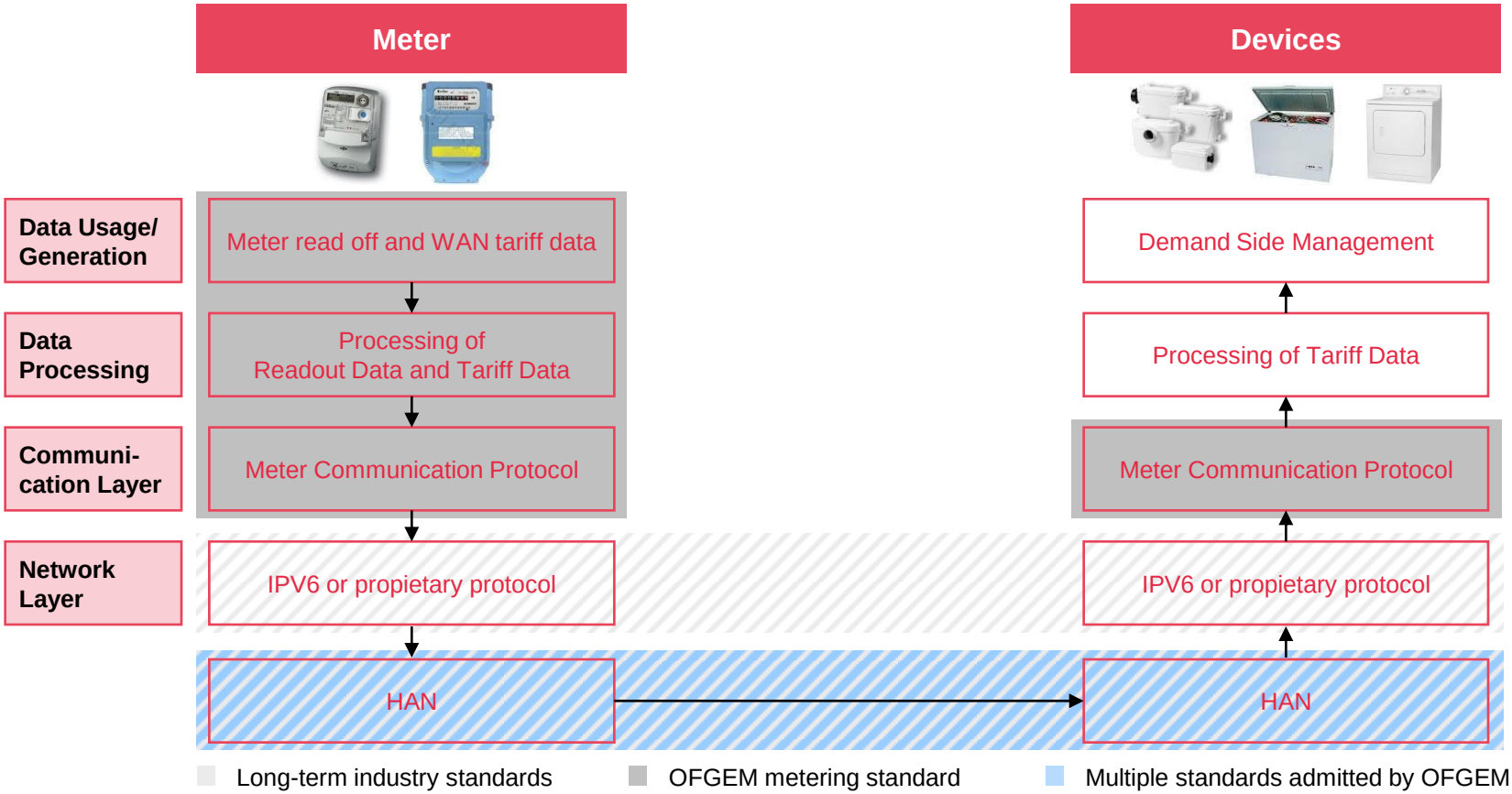
(+) **Modular design** of the HAN port mitigates these problems as there is no need to exchange the meter when a new HAN standard is required

Gateway or modular solution preferred as opportunities to profit from developments in RF protocols remains

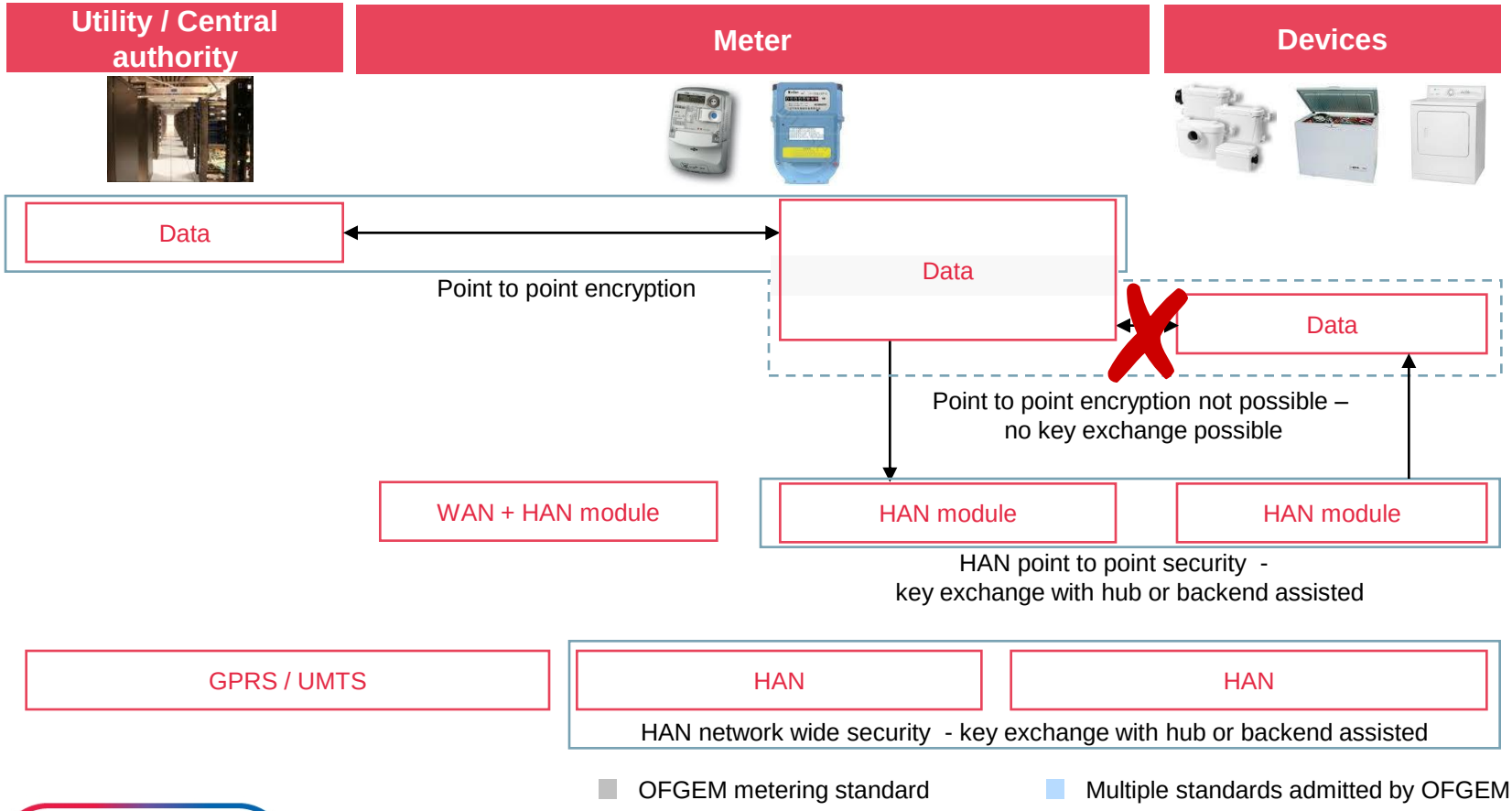
Gateway enables parallel usage of multiple HAN standards making architecture future-proof



Integration over one standard is possible, but linked with limitations as technology will evolve



Meter / device communication cannot be encrypted "over the fly" but needs locally secures connection



SIPCos protocol can copre with wide range of technical requirements for Smart Metering HANs

Standard meets requirements..

- **Two-way communication** acknowledging protocol
- **Sound reliability** able to cover multi-party and detached houses by operating on 868 MHz band with fieldproven and robust 10kbps, 10mW, FSK modulation
- **No interference** with WiFi and bluetooth (2.4GHz), important with rapidly growing usage of Video on Demand and audiostreaming over WiFi
- **No need for mesh networking** allowing for operations with very few devices (Smart Meter— WAN module)
- **Data privacy, authenticity and integrity** secured by strong encryption and secure key exchange

...not sacrificing global interoperability

- Widely available and exchangeable RF **components**
- **Native IPv6** ensures compatibility independent from option selected for HAN plus available address space with all flexibility for all possible future applications
- **Clean standard** without legacy boundaries
- **One communication stack** for all applications— no different stacks for smart metering, demand side management and home energy management

Implications for standard setting process

- Many required functions of HAN communication within the customer's premise in the context of Smart Metering are so challenging that most currently available RF standards cannot meet them.
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Backup

What is a Home Area Network (HAN)?

- A Home Area Network (HAN) is a residential communication network. The most typical example of a HAN nowadays being that which connects PC/Laptop with wireless router

- In Smart Metering the HAN provides the two way communications between
  - the meters (electricity and gas)
  - the communications hub which connects to the Wide Area Network (WAN) for communication to the energy provider and
  - the In Home Display (IHD)

- Taken in a broader context, this Smart Meter HAN could be used and linked to further devices. For example it could enable a link between smart meter and household appliances which in turn could help provide detailed real time energy usage information and even allow the control of those appliances remotely

How does a HAN work?

- In the metering context, a HAN operates wirelessly over radio waves, as installations which involve wiring are expensive and inappropriate for connection to gas meters and the In Home Display

- More common examples already in the home such as WiFi or Bluetooth operate at the ranges 2.4GHz or 5 GHz, however other bands are allowed, thus avoiding confusion between different networks

- Using radio waves, packets of data can then be distributed between the central hub (in most cases one single unit with the Electricity Meter) to the various peripheral devices, for example a display or home appliances

What is a Protocol and what is standardisation?

- A protocol describes the format and rules used for communication between the different devices involved in the HAN over the chosen band frequency
- The openness of a protocol trades off adoption speed and compatibility
  - A „closed" protocol is developed by only one standard-setting party
  - An „open“ protocol allows parties other than the original developer to use the protocol in new compatible devices or applications
  - Whilst allowing the freedom to adapt the protocol to specific appliances can be positive, opening a protocol too early can mean too many "enhancements" by too many parties – creating incompatibility issues which dilute the standard character
  - Hence, requirements concerning ownership should take the protocol lifecycle into account and favour standards w/o incompatibility issues
- There is no direct link between openness and the question whether a protocol is proprietary or not, most HAN protocols are proprietary

What is Encryption?

- Encryption makes data unreadable until it is unlocked. In the case of a HAN, the encryption would take place as the data is being sent
- The encryption of the data uses an algorithm to make it unreadable to anyone without the allocated “key”. The use of the key then decrypts the data at its end point, so that the content can be accessed once again. This practice is common with data transfers, from banking to bluetooth
- When referring to data exchange between flexible groups’ devices, the initial key exchange is the basis for secure encrypted communication
- The combination of secure key exchange and encryption help ensure security, as well being useful where several HANs are working in close proximity, as they can help pair up the right devices, ensuring reliability
- Encryption also helps ensure Data Authentication i.e. that the right data packets reach the correct recipient

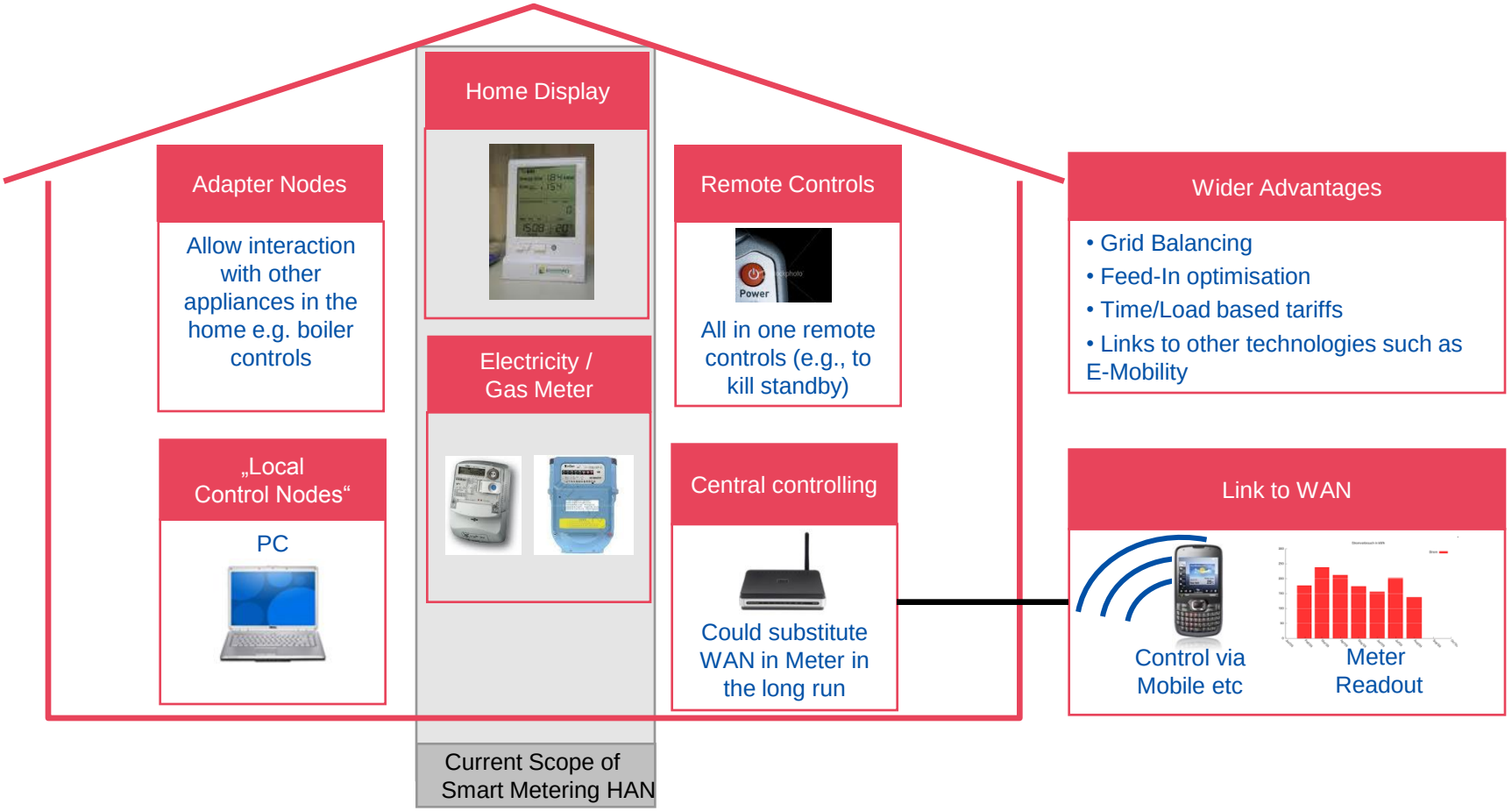
Further terms

IPv6 – short for Internet Protocol version 6. IPv6 will be the future of the internet. The version used most to date is IPv4. Its purpose is to allow all points in the internet to be individually addressed. IPv6 has been brought out due to a shortage in these addresses and has the capacity to give, for example, every plug socket in the world an individual address. Useful futureproofing, considering what demand for home automation may lie ahead in the world of energy efficiency.

Mesh Networking – a system set up, where each individual point in a network can add as a mini-router and pass on data packets that otherwise would not be able to bridge the gap between the original transmitter and the final recipient. This allows weaker signals to transmit further, but does have disadvantages in terms of greater power consumption

WAN – the abbreviation for Wide Area Network. A common WAN would be that allowing employees to access the same file directory from different offices around the country. In the case of today‘s discussion, the WAN is what will link each Smart Meter to a central database and vice versa.

How could the HAN‘s activities be expanded in the future?



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