

Smart Metering Communications Issues and Technologies

IET – Smart Metering 2009 – Making it Happen

We need Smart Meters to help address ...

- Climate Change
 - On average, UK citizens generate 30 kg of CO₂/day.
 - www.WithoutHotAir.com, Prof David MacKay, Cambridge University Physics Dept.
- Energy Security
 - On average, UK citizens consume 120 kWh/day (i.e 5 kW)
- Legal commitments
 - EU Triple-20 targets by 2020 (v 1990)
 - 20% reduction of energy consumption
 - 20% reduction of greenhouse gas emissions
 - 20% of energy from renewables
 - UK 2050 targets (v 1990)
 - 80% reduction of greenhouse gas emissions



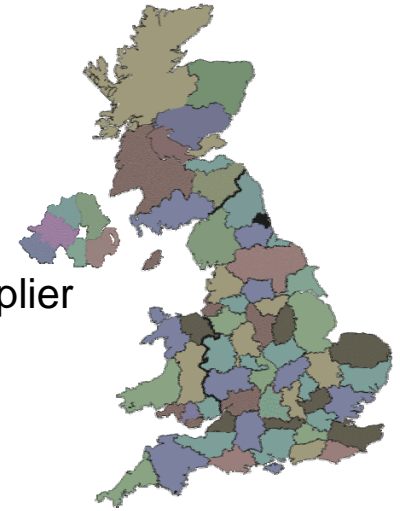
Smart meter activity so far ...

- Most meter manufacturers are international.
- Many energy suppliers are international.
- Existing smart meter installations are by single electricity suppliers for E-meters only, e.g:
 - Italy, Enel
 - Sweden
 - USA, California Southern Edison
- National standards are now being developed for Electricity and Gas meters (and Water and Heat meters in some cases) :
 - Netherlands, EnergieNed, NTA specifications, Dutch Smart Meter Requirements
 - Germany, OMS (Open Metering System)
 - UK, ERA (Energy Retail Association), SRSM (Supplier Requirements for Smart Meters), LAN and WAN committees. Govt Dept = DECC (was BERR).
- EU meters conform to MID (Measuring Instruments Directive) for metrology
 - MID is stable. Smart Meter requirements are fairly unstable (especially at higher comms layers).
 - Bill disputes must be resolvable under the glass of the meter itself.

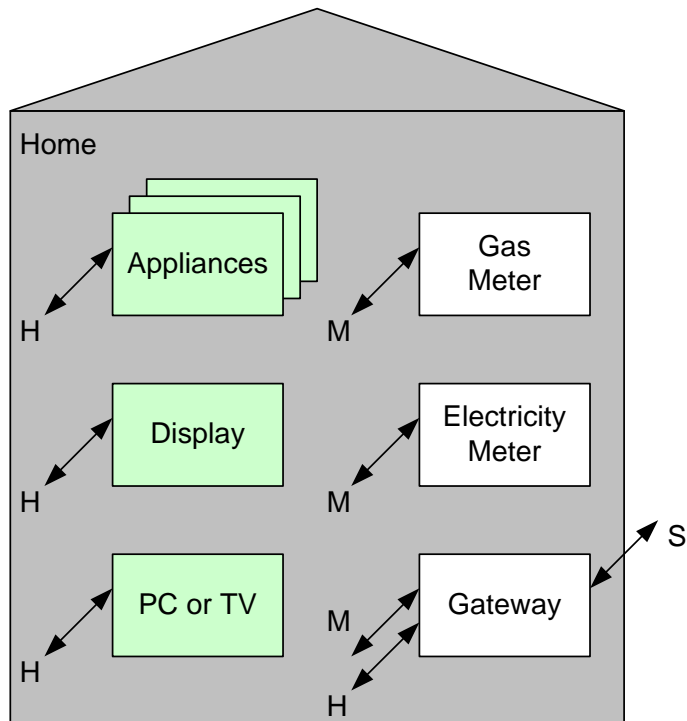


Special requirements for UK domestic Smart Meters

- We want to change all domestic meters to Smart Meters by 2020 :
 - 25M Electricity Meters (E-meters)
 - 22M Gas Meters (G-meters)
- User/Comms view of Gas and Electricity Meters should be the same.
- Interoperable standards – No meter change required when User changes Supplier
- All meters configurable as Credit or Pre-payment (Pay As You Go) meters :
 - By remote software configuration
 - E-meters contain a mains contact switch
 - G-meters contain a valve
 - Payment done without tokens (credit download from Head-End computer)
 - Must be able to download credit to E-meter even when E-supply is off (switch open)
 - Meters must handle money. Thick meters are much more complicated than Thin meters.
- Time-of-use tariffs on 30-minute steps (up to 48 different tariffs/day)
- 2-way Comms between meters and Head End Computer enables many functions :
 - Remote meter reading, credit downloads, software upgrades (security nightmare), etc ...
- Support electricity micro-generation
- Support demand-side management (directly by 'Big Brother control or indirectly by time-of-use price ?)



Smart Meters contain 2-way communications for ...



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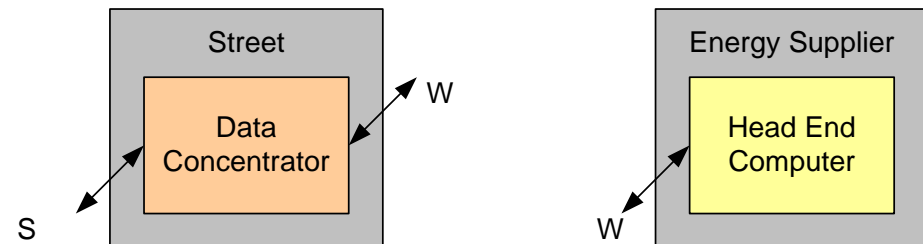
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- Metrology requirements tend to be stable through time.
- User and commercial requirements tend to be fast changing.

We should start with the Gas meter, not the Electricity meter ...

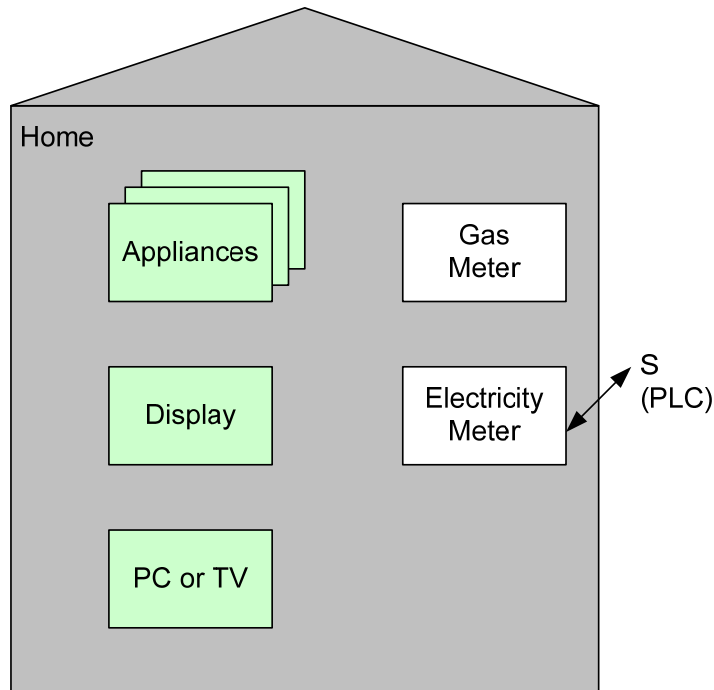
£pence/kWh	Gas	Electricity	E/G Ratio
Primary	6.5	26.4	3
Secondary	3.5	10.8	4



- Far more kWh energy goes through our Gas meters than through our Electricity meters.
 - Most gas domestic bills are higher than electricity, despite being about 4 times cheaper per kWh.
- Good design practice : Solve the hard cases first, then the easier ones
 - We want a common LAN communications standard for E and G meters.
 - Much less power available in battery-powered G-meter than mains-powered E-meter :
 - One AA battery (Lithium Thionyl Chloride) for 15 years = 15 uA average
 - Any LAN communications that works on a G-meter can be transferred to an E-meter.
 - Many LAN communications that work on an E-meter cannot be transferred to a G-meter.



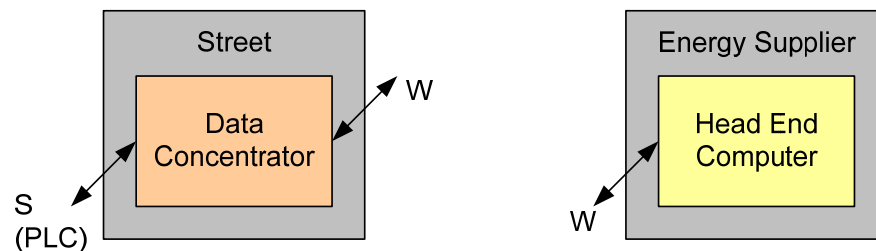
Comms Architecture – Italy (Enel installation)



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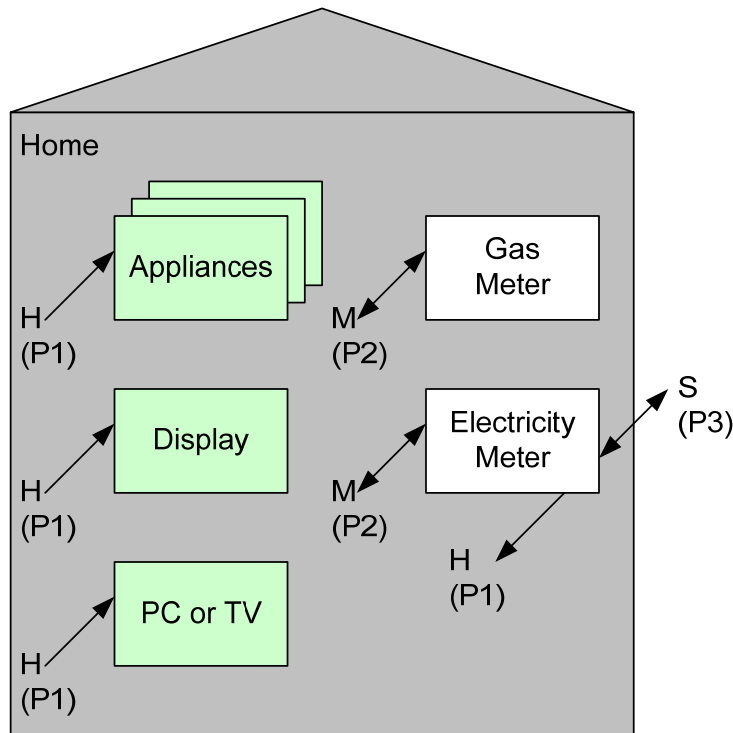
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- www.enel.it

Comms Architecture – Netherlands (NTA standard)



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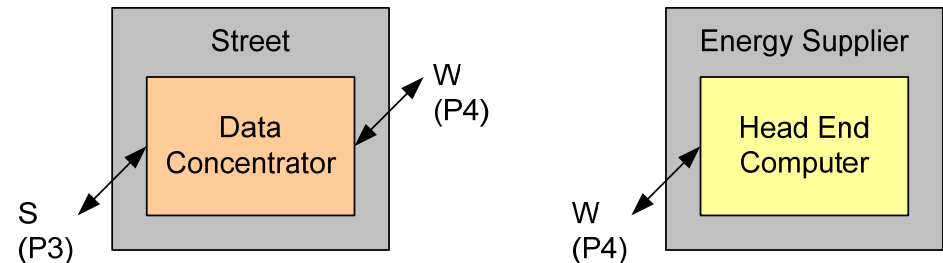
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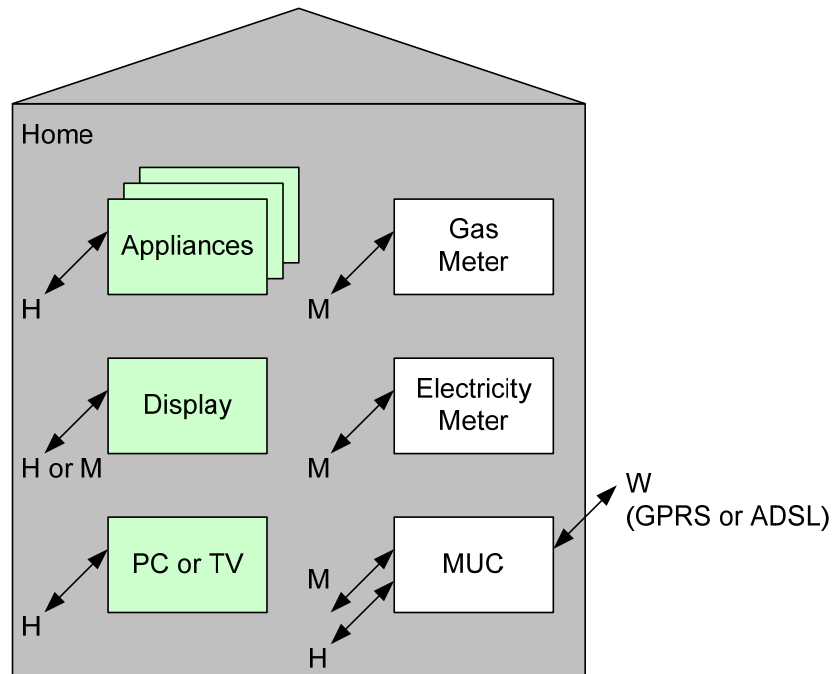
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- M = Wireless M-Bus T2 (EN13757-4)
- S = PLC

Comms Architecture – Germany (OMS standard)



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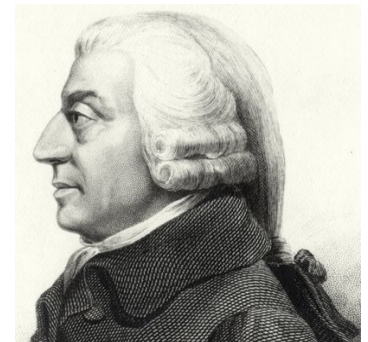
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MUC = Multi Utility Communications

- www.m-u-c.org
- M = Wireless M-Bus T2 or S2 (EN13757-4)
- SML (Smart Message Language), SyM² E-meter, www.t-l-z.org

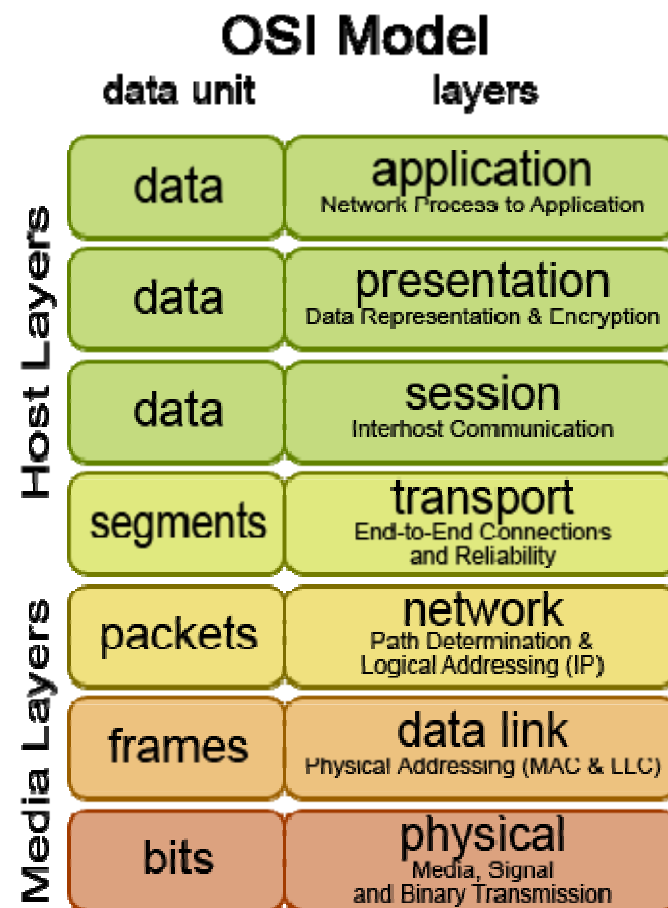
Trade-offs in choosing the Comms Architecture ...

- Engineers v Economists !
 - Engineers want standardisation and high volume
 - Economists want competition at every level in the commercial model
- Revolution (white box rollout) v Evolution (subsequent green box growth)
- Flexibility v Cost
 - Total UK system installation cost (ease of network configuration)
 - Total UK annual operating cost
 - How easily can it absorb new comms standards as they emerge (translation boxes) ?
 - Backward compatibility (3 meter installations is 45 years !)
- Total UK energy consumption (should use less than it saves !)
- Performance / functionality
 - Support all SRSM requirements
 - Integrate with Home Automation
 - Achieve the greatest UK reduction of :
 - Energy consumption
 - Greenhouse gas emission
- Security
 - Separate logical networks may share same physical layer, but must have clear separation of different security levels and permissions. Public and Private Licence keys. Encryption. Message Signatures.
 - Fraud (some people want their electricity and gas for free !)



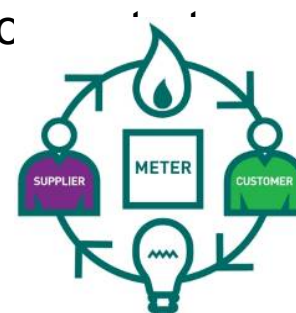
OSI 7-layer Communications Model ...

- Need to agree on Physical and Link layers now.
- For full inter-operability we will also need to agree on Application layer, including data objects and information representations :
 - Units
 - Time ...
- Some organisations are already trying to define such higher levels (protocols and data objects) :
 - DLMS
 - M-Bus
 - Zigbee Smart Energy profile
- Beware of 'Manufacturer-Specific' object codes!



Separate SRSM committees for WAN and LAN ...

- LAN or HAN (Local or Home Area Network)
 - Inside Home (for Meters and Home Automation)
 - Can address White and Green boxes
 - Not political, but who owns the HAN ?
 - Needs to be wireless (E and G meters stay in their nasty locations)
- WAN (Wide Area Network)
 - From Home to Head End Computer (HEC), possibly via Data Concentrator
 - Could be wired (PLC, POTS, ADSL) or wireless (GSM, WiMAX, ...)
 - Political. Who owns and runs the WAN infrastructure ?
 - Cost/wisdom of producing a third national communications network ?
- I am a member of the SRSM LAN committee (but not WAN), so will cc LAN issues.
- www.energy-retail.org.uk/smartmeters

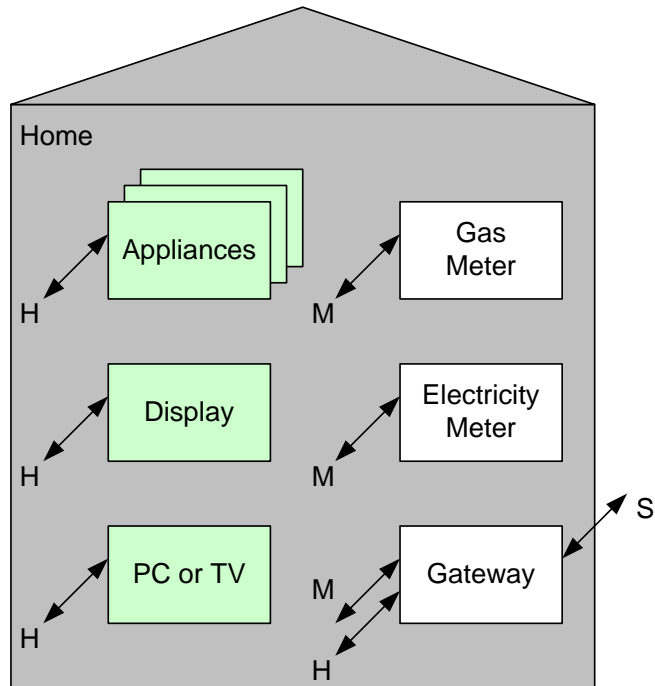


6 SRSM LAN/HAN Options

- Licenced Band
 - 184 MHz
- Unlicensed bands
 - 868 MHz
 - 2.4 GHz
- 6 standards still being considered :
 - Wireless M-Bus at 868 MHz
 - Wavenis at 868 MHz
 - Z-Wave at 868 MHz
 - ZigBee at 868 MHz
 - ZigBee at 2.4 GHz
 - Bluetooth Low Energy at 2.4 GHz
- WiFi not selected as power-consumption is too high



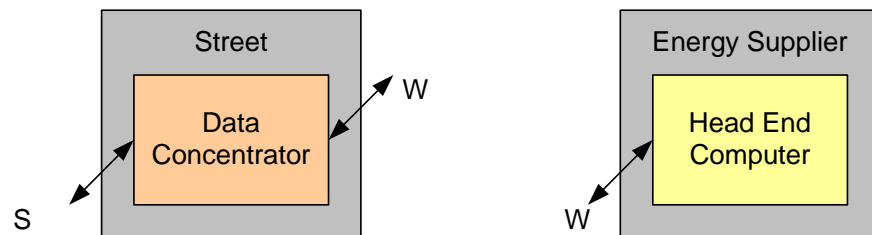
Comms Architecture 1



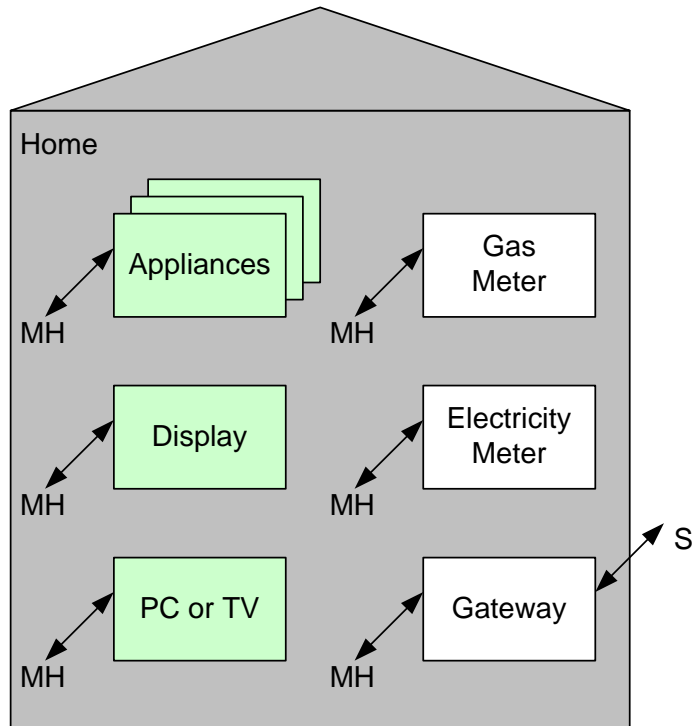
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Comms Architecture 2



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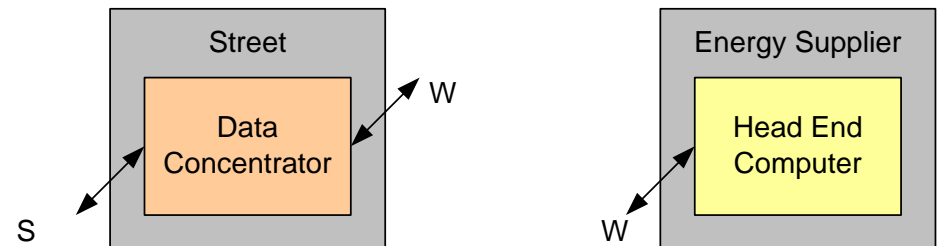
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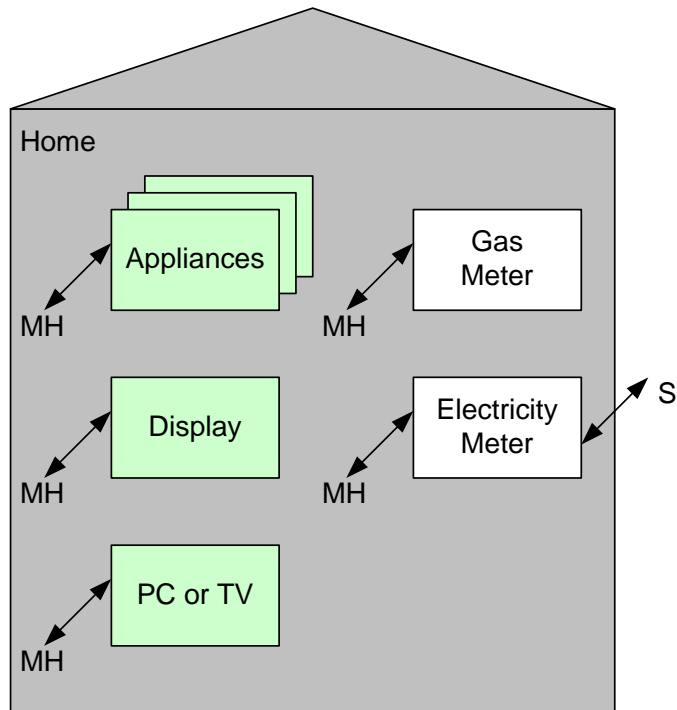
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- Merge M and H networks

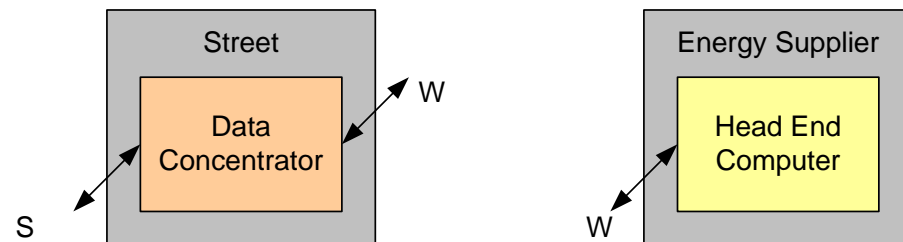
Comms Architecture 3



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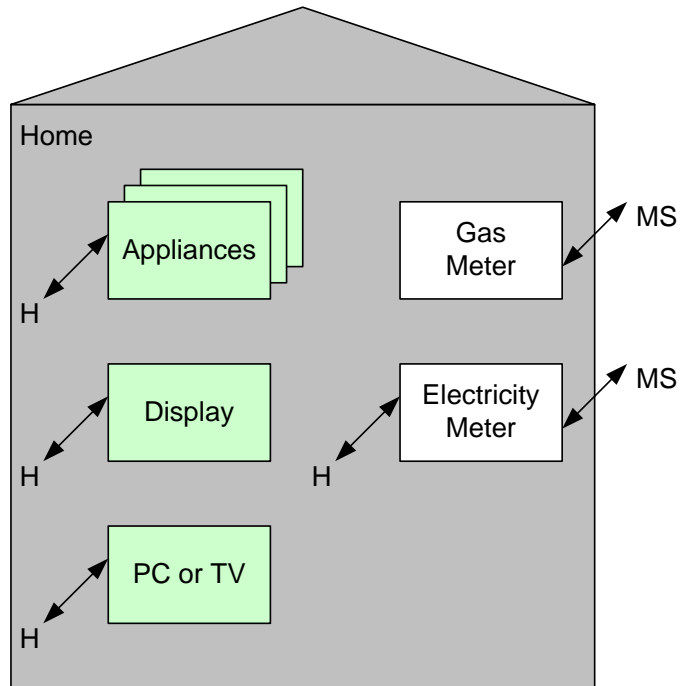
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- Remove Gateway
- Neighbouring houses may use different energy suppliers and meter manufacturers.
- S network must be open. Issues for PLC.

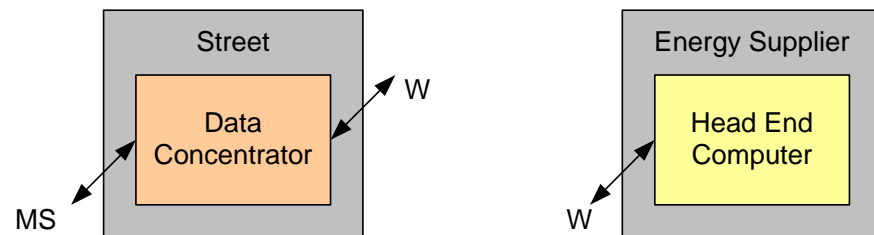
Comms Architecture 4



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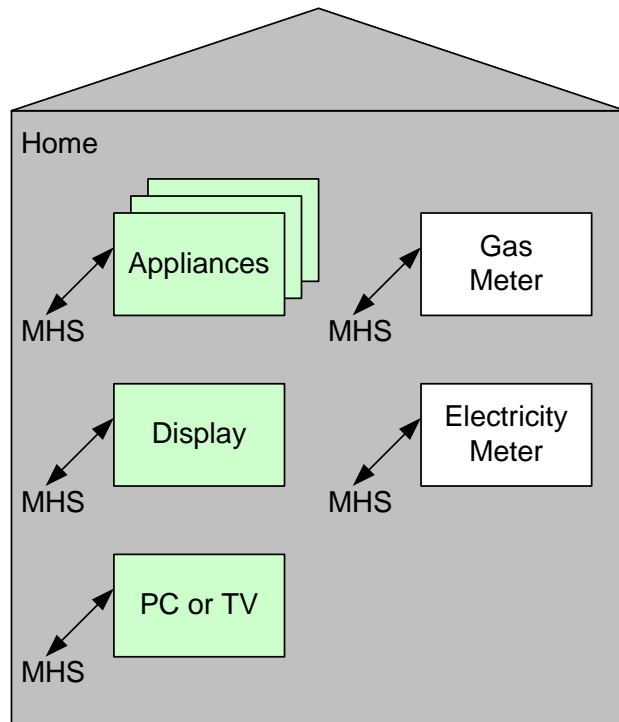
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- Merge M and S networks

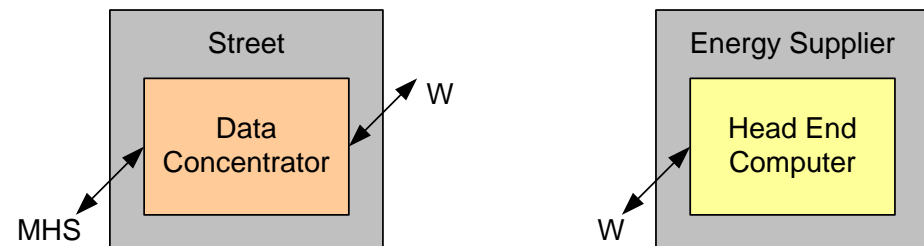
Comms Architecture 5



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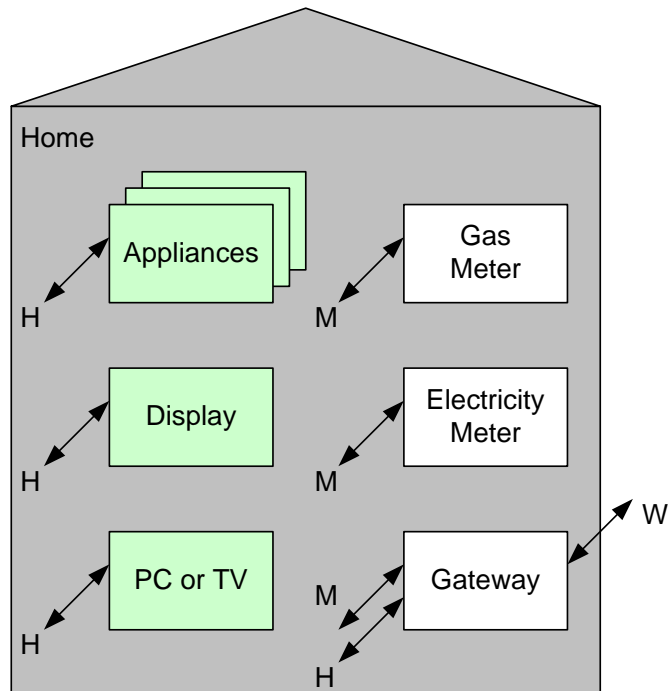
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- Merge M, H and S networks

Comms Architecture 6



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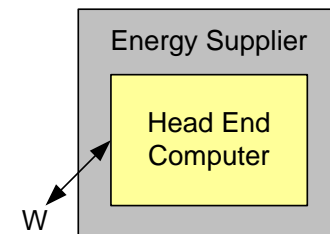
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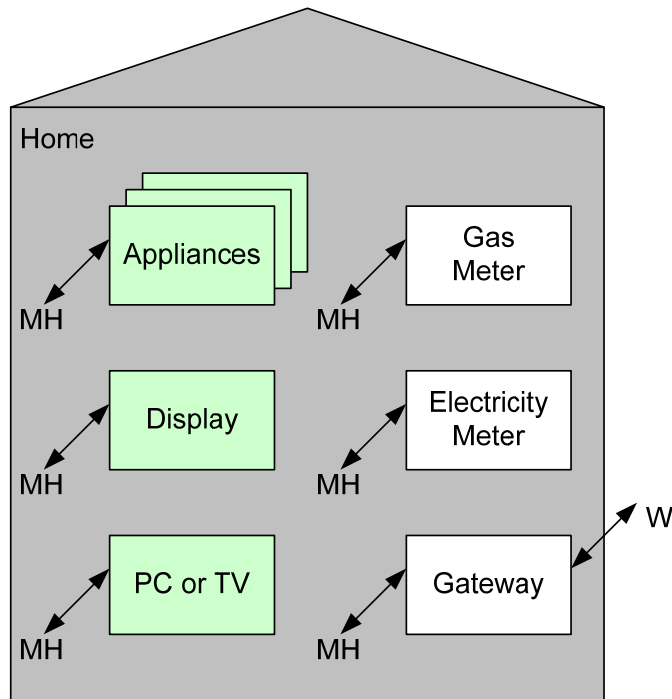
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- Remove Street Data Concentrator

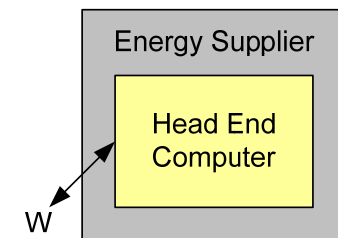
Comms Architecture 7



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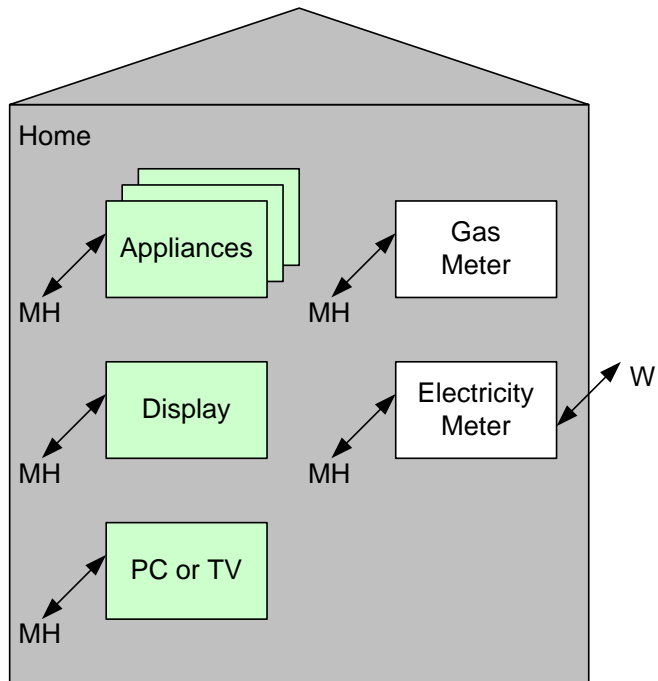
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- Merge M and H networks

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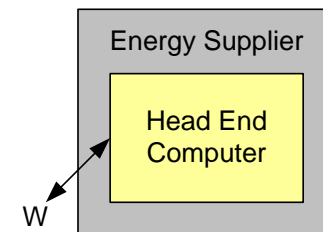
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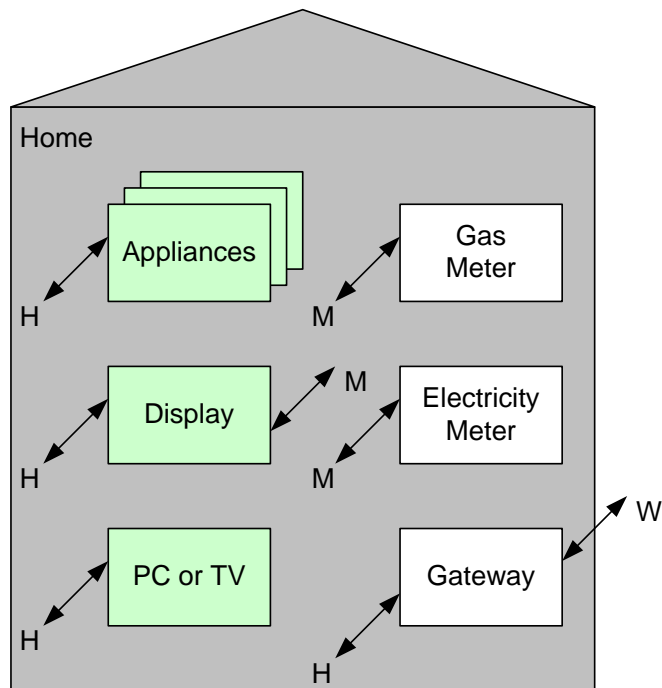
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- Remove Gateway

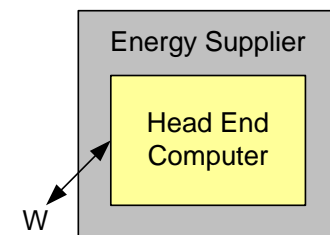
Comms Architecture 9



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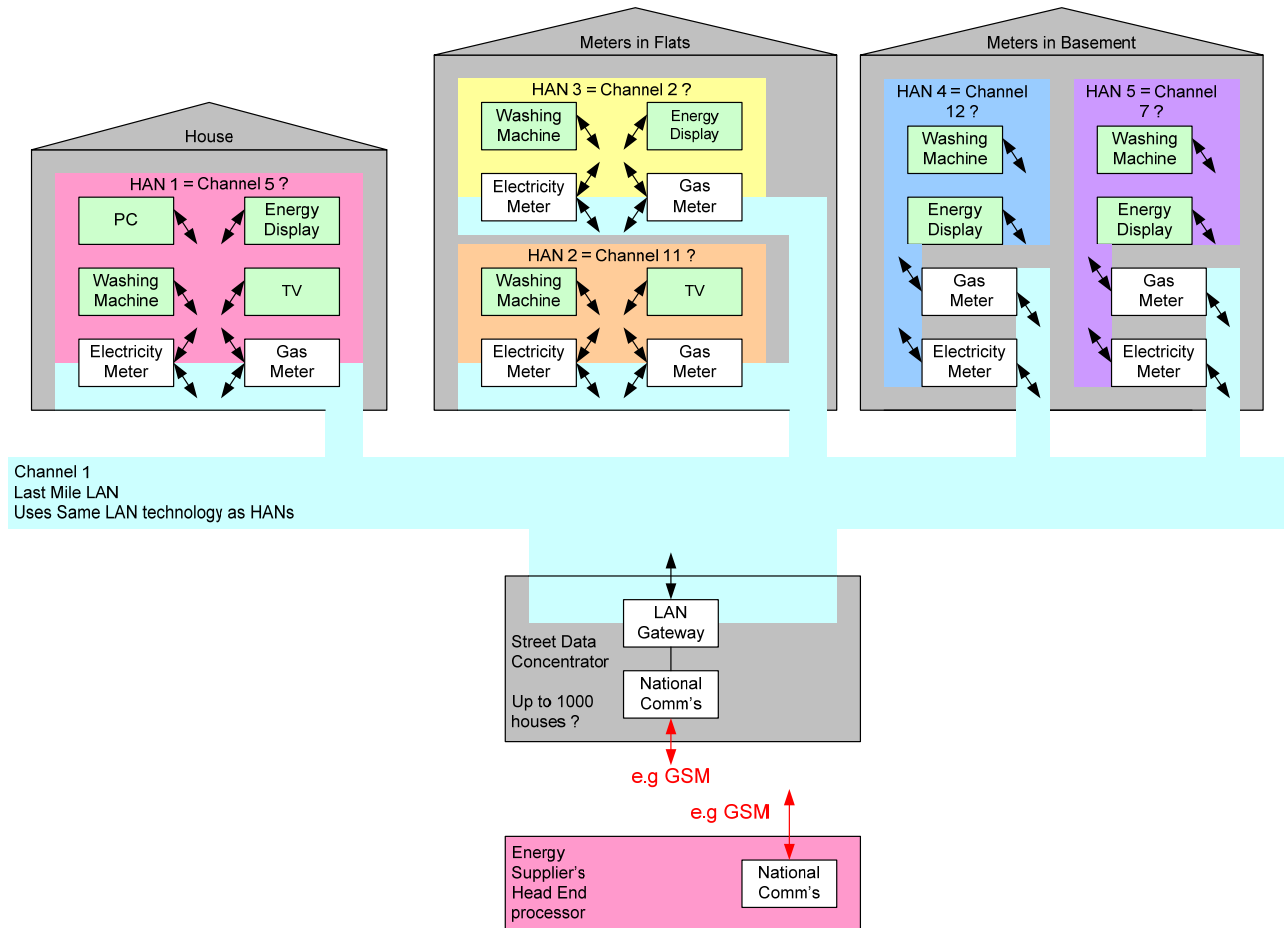
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- Display = M-H star point
- H could be WiFi, W could be ADSL (power supply questions ?)

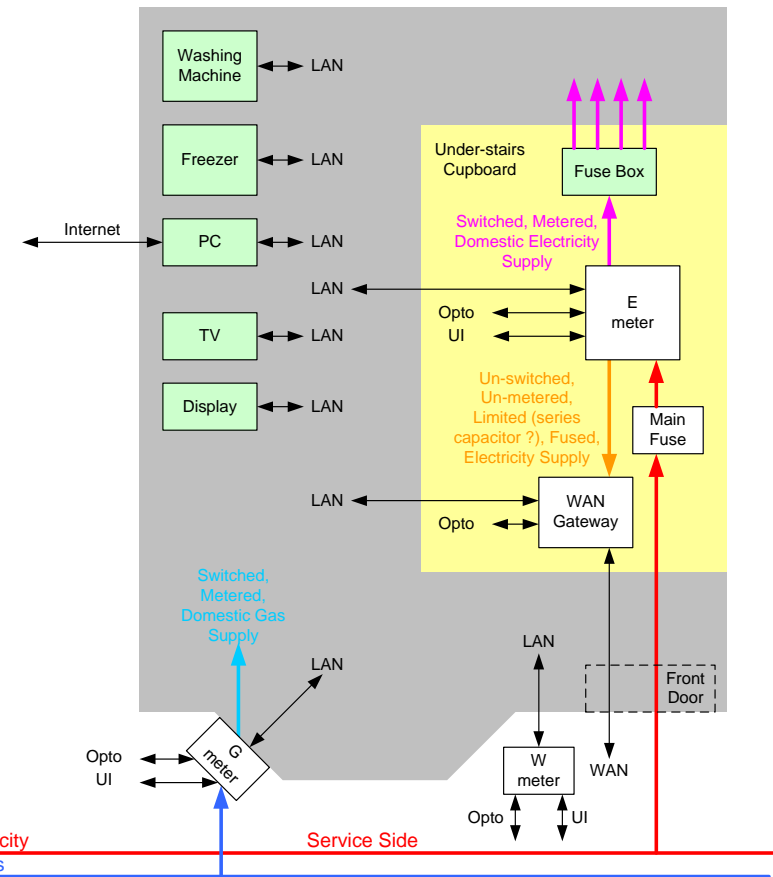
Network ownership and channel allocation in MHS solution ...

- Who owns and is responsible for :
 - MH network ?
 - S network ?
- How do White boxes behave at the interface ?
- Where are the Coordinator nodes :
 - for Network ?
 - for Security ?
- What channels can be used ?



Physical layout of smart meters in a Victorian terraced house ...

- Meters are still in the same locations :
 - Unfriendly for User access
 - Need wireless links to devices in Home
- Flat peer to peer LAN
 - More flexible than a Master-Slave hierarchical system :
 - New devices
 - New commercial model
- Pool of energy information enables more intelligent energy decisions :
 - Manually (User reads Display)
 - Automatically (Appliance chooses a cheap/low carbon time to run)
- Supports separate Gas and Electricity Suppliers
 - Gas suppliers do not like communications via E-meter



Conclusions



- UK should select a LAN technology that :
 - One ubiquitous LAN standard. Used in all G and E meters, with long backward compatibility (45 years for 3 meter installations)
 - Is chosen primarily for the G-meter (if it works for G-meter, it will easily work for E-meter).
 - Is intended for Home-automation as well as Metering (at physical layer)
 - Supports repeaters (for mesh or tree networks). This is necessary for big houses and for blocks of flats
 - Enables each node to support 2 networks simultaneously (such that one cannot corrupt the other). HAN should be owned/run by the Home occupier (for M and H purposes)
- UK should accept that it may not be possible to have one ubiquitous WAN standard :
 - Maybe one WAN standard could do 80% of installations
 - WAN links are likely to change during the 45 year operating life
 - Preferably keep the WAN out of the E and G meters (they should contain LAN only)
 - New LAN-WAN Gateways (translators) should be developed when new WAN technologies are wanted. Change of WAN technology should not force a change of meters
 - Choose the commercial model for the WAN (WAN technology selection depends on it)
- UK E-meters should contain a fused/limited/unswitched auxiliary power supply :
 - Needed for some LAN-WAN Gateways

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