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Two-Way Narrowband Communications Considerations for D/R Applications

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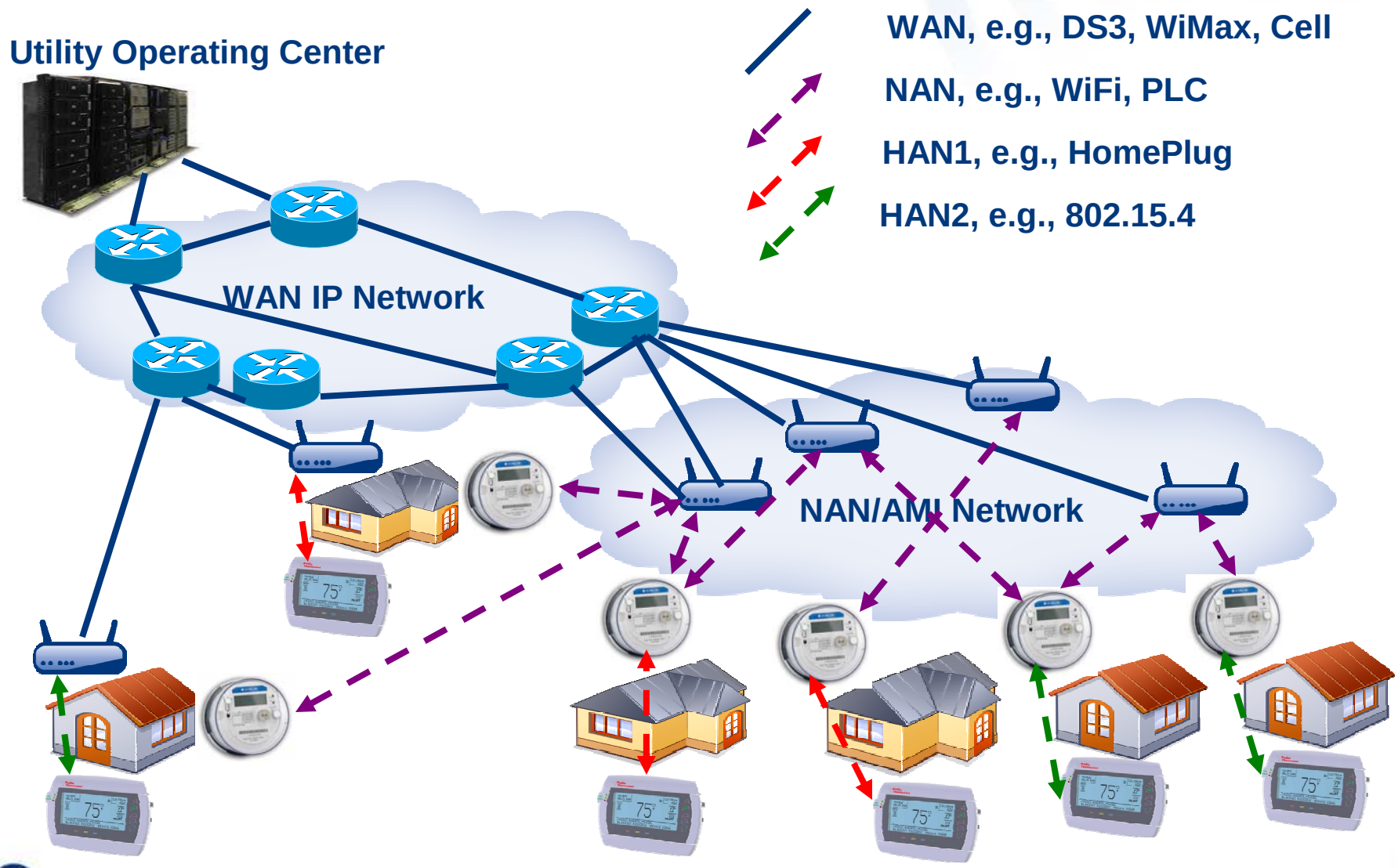
AMI and HAN Networks



Alphabet Soup

- **6LoWPAN**
- **Ethernet**
- **HomePlug/CC**
- **IEEE 802.15.4**
- **LonTalk**
- **WiFi**
- **Z-Wave**
- **Zigbee**
- **… (dozens more)**

Rough Technology Characterization

	6LoWPAN/802.15.4	Zigbee/802.15.4	HomePlug	LON
• Medium/Spectrum	RF/2.4G or 900M	RF/2.4G or 900M	PLC	PLC
• Maximum Bandwidth	250K or 40K	250K or 40K	1K-100M	1-10K
• Power Consumption	Ultra Low (mW)	Ultra Low (mW)	High (W)	Med?
• Indoor Per-Hop Reach	10's of meters	10's of meters	10's m	10's m
• Mesh/Relay Capability	Yes	Yes	Yes	Yes
• Network and Transport	TCP/IP	Zigbee	TCP/IP	LON
• D/R Profiles Specified	No: re-use	Yes	No: re-use	WIP?
• Scope of App. Profiles	Global	Local only	Global	Local only
• Scope of Security	Global	Local only	Global	Local only
• Need Edge Translation	No	Yes	No	Yes
• Comm. Module Costs ($)	Low 10's	Low 10's	High 10's	Low 10's

Key Considerations (I)

- The dwelling's "media", as a whole
  - Is the desired electric wiring of a "PLC" grade? → Depends on modulation, speeds
  - Is the desired RF spectrum available and "clean"? → 900MHz robust, 2.4GHz universal
  - Do distances or obstacles allow good comms? → PLC and 802.15.4: 10's of meters
  - Can "relay" nodes (PLC or Radio) extend reach? → Repeating usually possible

- The individual target device's "reach-ability"
  - Is the device plugged into AC wiring? → No for 24VAC T-STAT
  - Is the device reachable via radio? → From where? Meter? GW? Without relays?

- Required application bandwidth
  - Demand/Response transactions are generally low bit-rate…
  - Most demanding transaction is likely download of new SW
  - Units of kbps? → PLC, HomePlug/CC
  - Tens of kbps? → 900MHz radio (e.g. IEEE 802.15.4)
  - Hundreds of kbps? → 2.4GHz radio (e.g. IEEE 802.15.4)
  - Higher? → Ethernet, WiFi, HomePlug

- Wide-area transport network (path to dwelling)
  - Dedicated AMI? → May gate end-to-end bandwidth
  - Broadband Internet? → Always useful, at least for backup
  - Phone? → Ubiquitous, though long-in-tooth

Key Considerations (II)

- **For given link layer, choice of upper layers (network/transport):**
  - **WiFi:** TCP/IP on all devices
  - **HomePlug:** TCP/IP on all devices
  - **IEEE 802.15.4:** TCP/IP (6LoWPAN) or Zigbee or proprietary
  - **Other PLC:** LonTalk or other standards or proprietary

- **End-to-end (non-mediated) transactions to targeted devices?**
  - **Real "actors in the Demand/Response play":**
    - **Load-impacting end-devices (PCT. LCM, IHD), ←→ Utility operations center (servers)**
  - **Leave network elements (gateways) out of the secure relationship between utility ops center and devices**
    - **Possible only when using IP on target D/R devices (PCT, LCM) → IP/6LoWPAN for 802.15.4**
    - **Necessary if reaching D/R devices through shared home network → Can't "splice" on foreign GW**
  - **Or "splice" sessions with translations and mappings at intermediary points (gateways, meters, ESPs)**
    - **Possible with TCP/IP but necessary with all non-IP approaches**
    - **Possible only when using dedicated and utility-controlled GW**

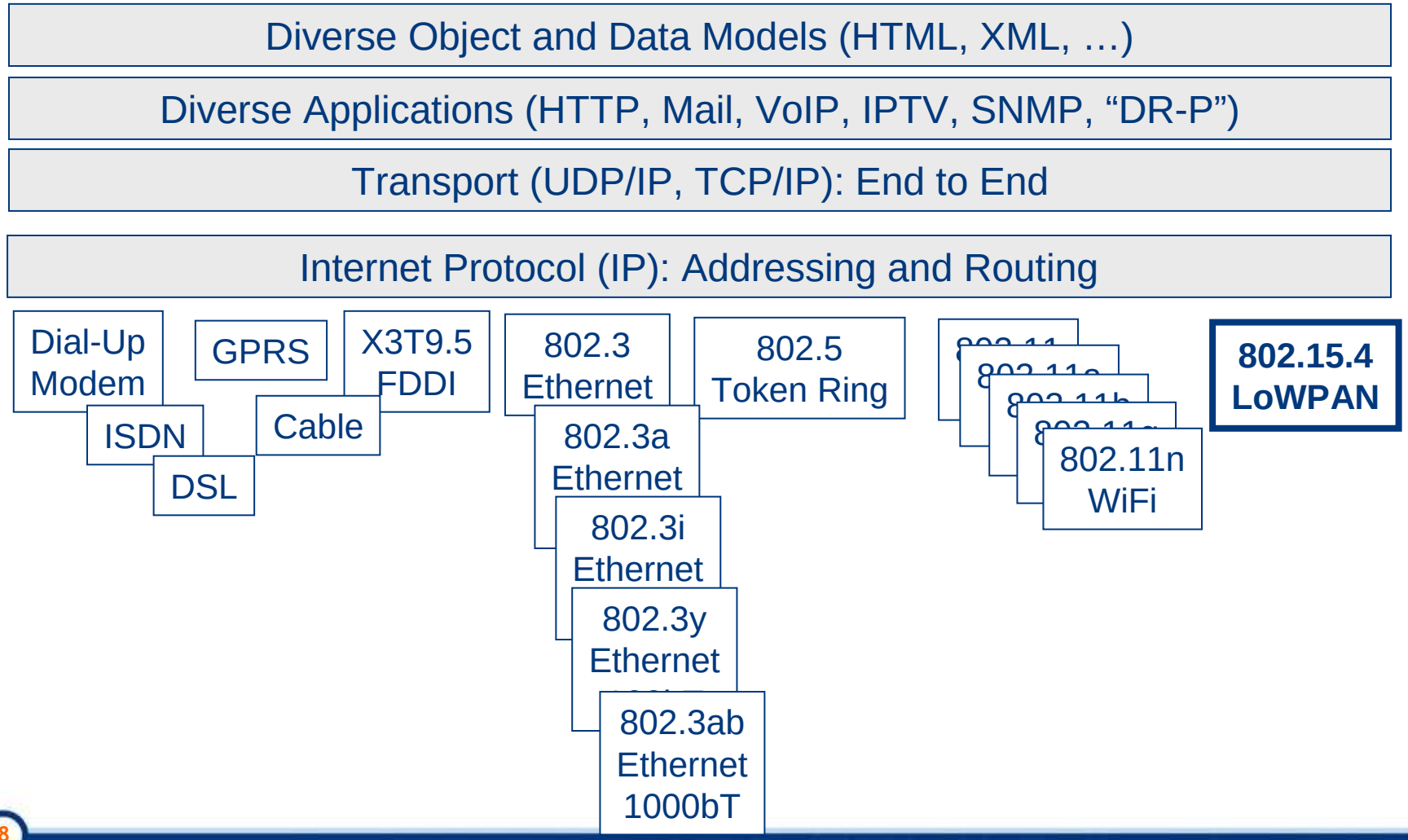
- **Demarcating end-point (last point of utility ownership)**
  - **Pole-top access point? → Nice if have common comm. network with devices**
  - **Meter? → Nice for ubiquity – Modularity? Common network?**
  - **Home Gateway? (Energy Services Portal?) → Dedicated to D/R? Costs? Support?**
  - **D/R Device? (PCT, LCM, IHD) → "Shared" ownership (utility, user) issues?**
  - **D/R Device's Comm. Module? → Nice for modularity, security, IF standard network**

- **Installation "ownership"**
  - **Send D/R device or comm. module by mail and let user "DIY"? → What about network?**
  - **Utility responsible for installation and performance of system? → Issue at large scale**

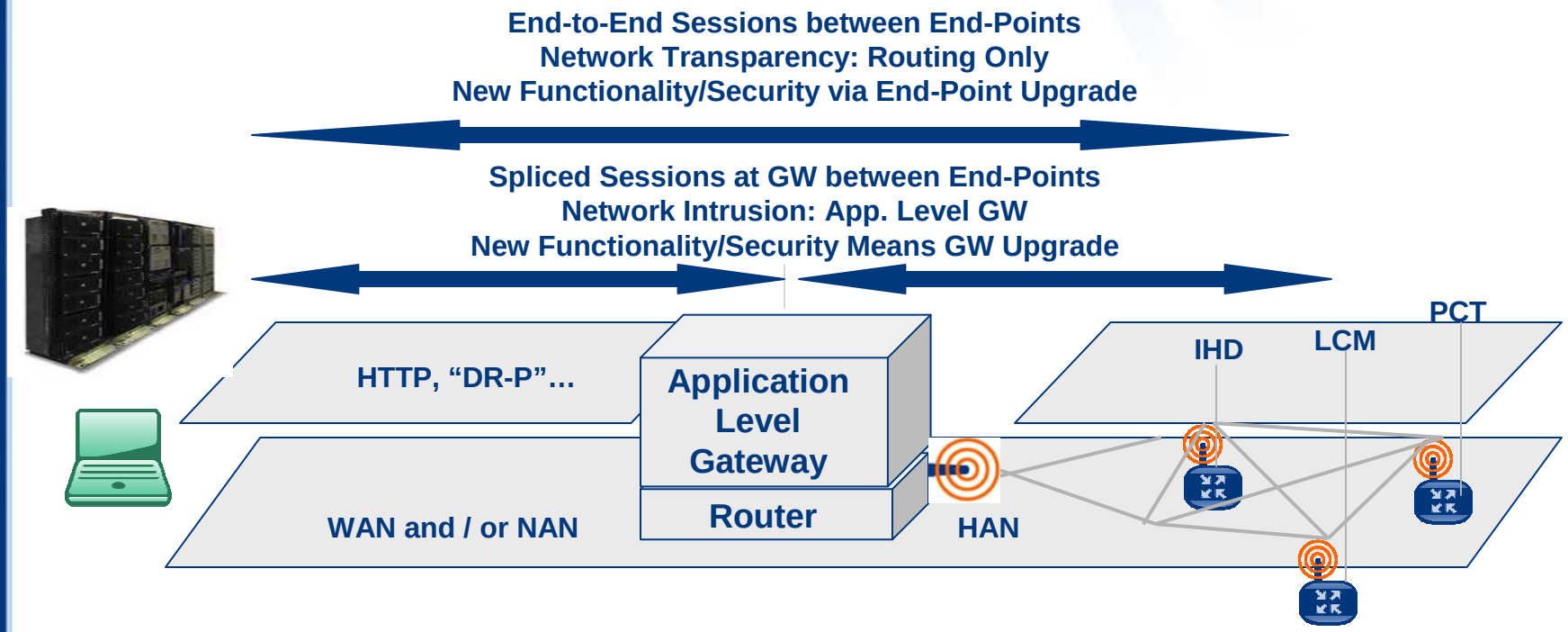
Highlights of IP Architecture – …or Benefits of "Going Postal"

- Build a global identification, addressing and routing mechanism: "IP"
  - Analogy: postal addressing system with streets, zip codes, cities, etc.
  - Consequence: global reach, local sorting and ultimate scale and flexibility
- Provide end-to-end transport protocols, reliable or best effort: "TCP, UDP"
  - Analogy: regular mail, certified mail, express, signature required, etc.
  - Consequence: universal footprint yet individual choice for each application
- Allow proxies, firewalls, network address translators, where useful
  - Analogy: "care-of" mail delivery, apartments, guest rooms in hotel, etc.
  - Consequence: local decision, typically not "minded" by remote end or network
- Co-opt all link technologies and mix-and-match them judiciously
  - Analogy: user indifference to how mail carried (planes, trains, trucks or all of the above)
  - Consequence: locally develop optimum transportation mechanism, at each leg of journey
- Leave applications and data models to end-systems and leave the network out of them
  - Analogy: postal indifference to what I write, in what language, and whether crypto-coded
  - Consequence: network doesn't need upgrades when I change languages or crypto-codes

Highlights of IP Architecture



End-to-End IP Transactions vs IP-to-??? Translation Gateways



Wide Area Network:

- Almost Universally IP-based
- Endpoints: Servers, etc.
- Highly Standard Apps
- Heterogeneous Links
- As Redundant as Needed
- Private or Public or Both

Home Area Network:

- Choice of IP or non-IP
- Endpoints: PCT, LCM, IHD
- Resource/Cost Efficiency
- Simple Manageability
- Dedicated (to D/R) or Shared
- Ownership, Security, Life Time

Why should infrastructure providers care about IP?

- **The test of TIME and investment protection:**
  - The IP architecture has stood the test of time over a 25+ year history
  - Several utility deployment decisions are 20-year (or longer) decisions
- **The test of SCALE and ability to expand:**
  - The IP architecture is the only demonstrated ~1 billion node scale network
  - Has gracefully evolved and accommodated diverse and tough applications
- **The test of SCOPE with MEDIA diversity (below TCP/IP):**
  - The IP architecture has embraced dozens of legacy and new links, in ONE network
  - Any-to-any communication: Dial, BPL, Ethernet, DSL, Cable, WiFi, Cell, 802.15.4…
- **The test of SCOPE with APPLICATION diversity (above TCP/IP):**
  - Architectural diversity: Client-Server, Peer-to-Peer, Web Services…
  - Application diversity: Email, File Transfers, VoIP, Web, Video, Signaling…
  - Device and operating system diversity: PC, PDA, Phone, Server, Sensor…
  - Industrial applications: BACnet over IP, LonTalk over IP, SP100.11a …
- **The test of LEVERAGE and non-reinvention:**
  - Management tools, security tools, deployment and configuration tools
  - Naming (DNS), Addressing (DHCP), Management (SNMP)
- **The test of SECURITY:**
  - Highest security networks on IP: DoD, DoE, NSA, Treasury, Health, Banking/SWIFT
  - Understood threat models and remedies: Firewalls, Intrusion Prevention, Encryption