Fostering M2M Services with IPv6

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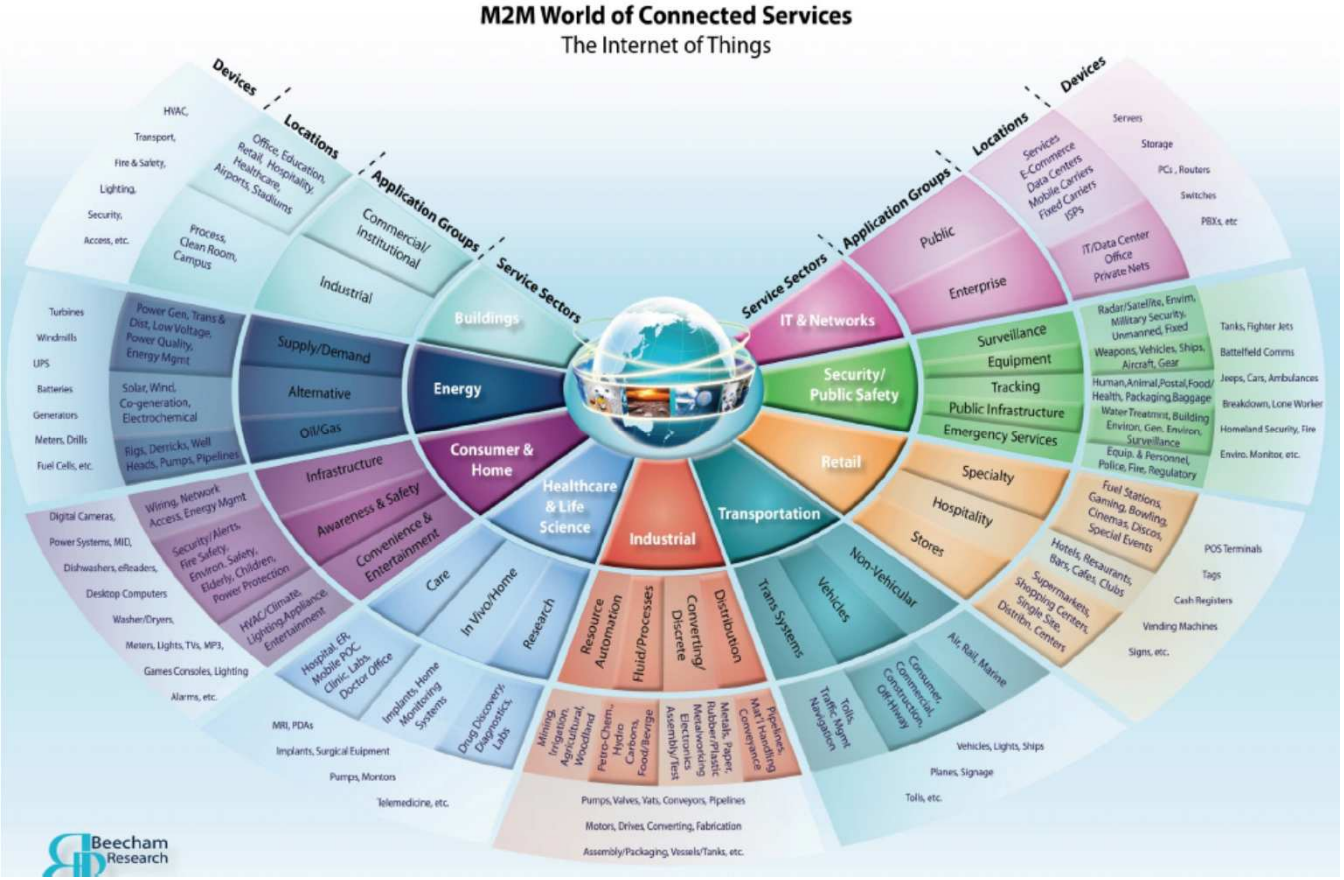
Outline

- Introducing IPv6 as a M2M business catalyst
- Why IPv6?
- Routing in sensor networks
- Early achievements
- On radar

IPv6 is a Business Catalyst

- A whole world of opportunities



Typical Environment

- Low Power and Lossy networks (LLN)
  - Composed of several hundreds, thousands+ of nodes connected through wireless links of unpredictable quality
- LLNs support a wide range of applications
  - Urban sensor networks, energy metering, home automation, health care, *etc*.

Why IP?

- A federative layer
  - Cornerstone of the “Internet of Things” for the sake of interoperability and E2E paradigm
- IP is ubiquitous and scalable
  - Anything can be transported over IP, covering both wireless and mobile environments
    - In particular, IP is a more straightforward option than E164 numbering
- Current SoA proves IP implementations are lightweight
  - Few kilobytes of ROM and RAM are well-suited for CPU- and energy-constrained devices

Why IPv6?

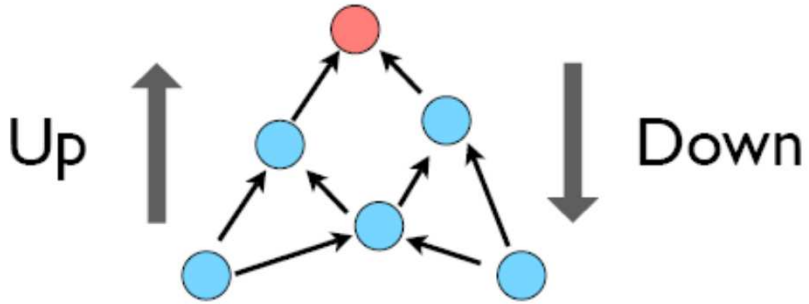
- An (almost) unlimited addressing capacity
  - M2M-inferred environments assume tens (*e.g.,* home services) to thousands (*e.g*., urban services) of connected devices
- Advanced self-configuration capabilities
  - Devices automatically form their IPv6 addresses, discover their neighbors and are up and running as per a plug'n play approach

Constraints

- IPv6 header size may jeopardize bandwidth optimization
  - Header compression *a la* RFC 4944
- Network size (possibly 1000+ nodes) and resource limitations (energy, CPU) suggest adapted routing machinery
  - ICMPv6-based, distance vector RPL protocol
- Network size also suggests specific management framework
  - Constrained Application Protocol (CoAP)

RPL Approach

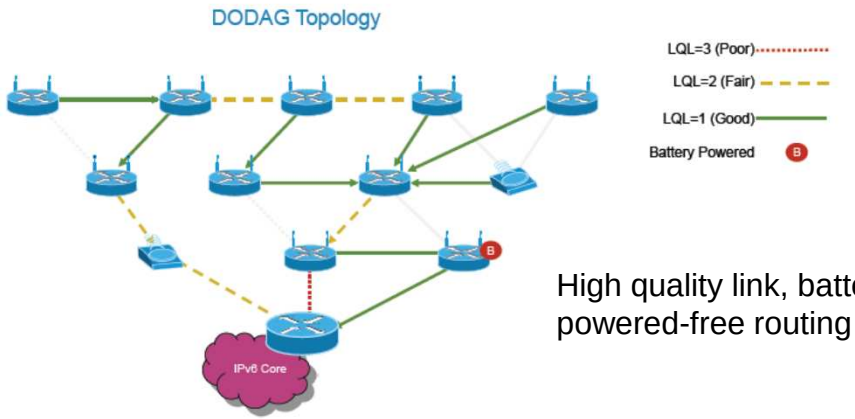
- A Distance-Vector routing protocol for constrained environments (RFC 6550)
  - Based upon Directed Acyclic Graph (DAG) computation and ICMPv6
    - Advertises path cost to root
    - Chooses parents that minimize path cost according to Objective Function (OF)



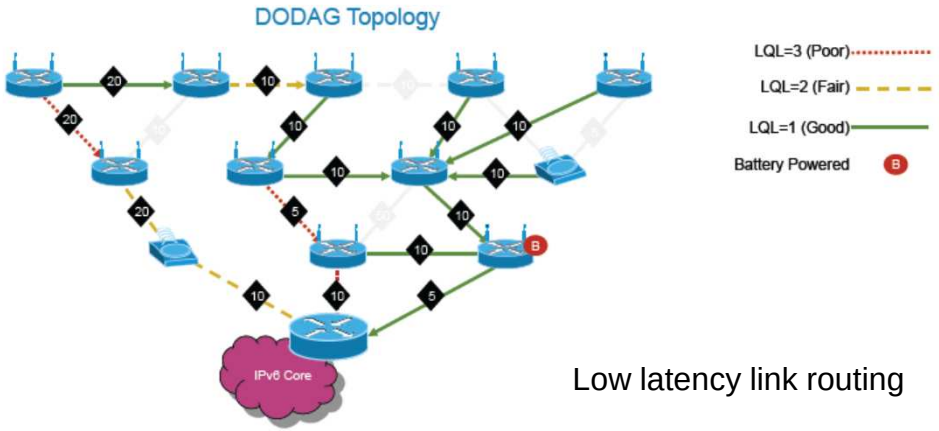
- Most traffic flows through a few nodes
  - DAG tree structures are rooted at these nodes

Multi-Metric, Service-Inferred Adaptive Routing Policies

- OF (RFC 6552) is the cornerstone of the RPL routing policy *e.g.*,:
  - Use high quality links and avoid battery-powered node
  - Use low latency paths only
- Use of combined metrics (RFC 6551) to address goals defined in OF, *e.g.*,:
  - Expected Transmission Count metric combined with Hop Count metric to preserve energy and privilege traffic load balancing



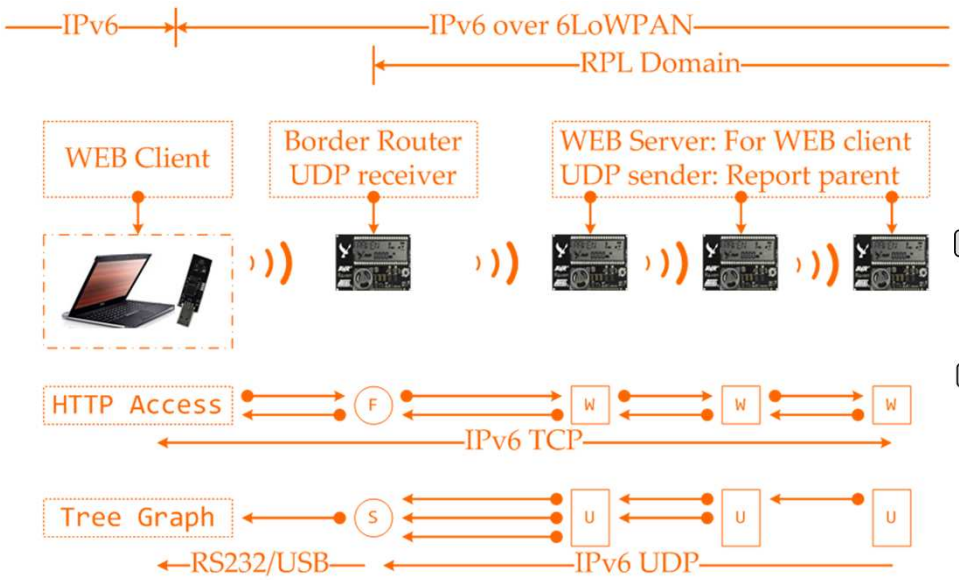
High quality link, battery-powered-free routing

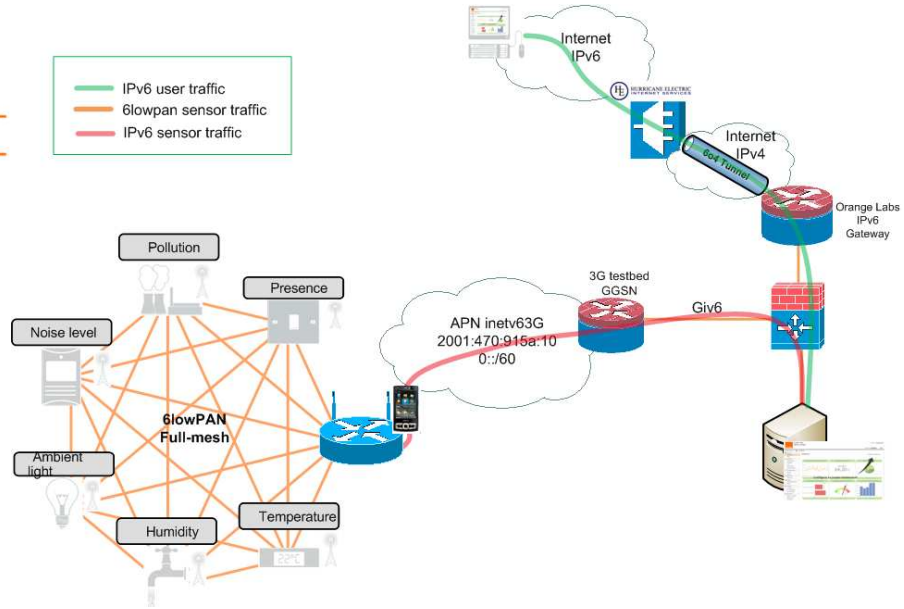


Low latency link routing

Early Achievements

- Beijing labs operate a temperature-metering RPL-enabled WSN for more than a year
  - Validation of management framework in progress
- Spanish labs demoed a sensor-networked city
  - Sensor-collected data retrieved through the IPv6 APN





On Radar

- Develop and strengthen IPv6-based M2M expertise
  - Assess RPL scalability under various use cases and different derived metrics
    - Including recent 6tsch-based optimized radio channel usage
  - Derive design recommendations accordingly
  - Pursue IPv6-focused standardization effort
- Conduct experiments beyond in-lab testing, *e.g.*,:
  - Evaluating opportunities with a couple of European affiliates to organize mobile-based M2M field trial in 2014

Thank You!