Embedded IP(v6) Networks

The Internet of Things is on the way

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Enabling Technology – Why Now

- Advances in micro-controllers
  - Low power, more processing, lower cost
  - Thank you Gordon Moore
- Advances in RF technologies
  - 802.15.4 low power – battery operations
- IPv6
  - Addresses, Addresses, Addresses
IP Myths – Why the delay

- IP headers are too big
- IP code is too large
- IP requires too much RAM
- Gateways are easy
Why IP?

- Support for multiple Phys
  - 802.11, Ethernet, GPRS, PLC, Serial Lines
- Existing Resources
  - Tools, Protocols, Knowledge
- Established transport and application models
- Established naming and addressing

Don't reinvent the wheel
Why IPv6?

- Huge Address Space
- Stateless Address Autoconfiguration
  - DHCP servers not required
- No need for NAT
  - No NAT configuration
- No translation Gateways
  - Routers and Bridges
Wireless IP Sensors - 6LoWPAN

- A Standard
  - RFC4919 and RFC4944
  - ISA100 – Industrial Wireless Sensor Networks
  - IEEE 1451.5 – Wireless Transducers
- Efficient
  - Battery operation, header compression, small code footprint, “stacked” headers
- Available
  - Multiple independent implementations – 10+
  - Increasing number of deployments
## 6LoWPAN Comparison

<table>
<thead>
<tr>
<th></th>
<th>6LowPAN</th>
<th>Zigbee</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Packet Size</strong></td>
<td>3 to 12 bytes</td>
<td>14+ bytes</td>
</tr>
<tr>
<td><strong>Code Size</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>End Node (RFD)</td>
<td>11K</td>
<td>64K+</td>
</tr>
<tr>
<td>Routing Node (FFD)</td>
<td>17K</td>
<td>128K+</td>
</tr>
<tr>
<td><strong>RAM</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>End Node (RFD)</td>
<td>2K</td>
<td>8K</td>
</tr>
<tr>
<td>Routing Node (FFD)</td>
<td>4K-8K</td>
<td>8K+</td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td>OpenSource</td>
<td>???</td>
</tr>
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Vision: Ubiquitous Wireless Data Acquisition and Control

- Metropolitan Area Network formed of:
  - Low-cost ubiquitous IPv6 addressable sensor nodes
  - Highly scalable network
  - Support for low-power, battery operated or energy scavenging sensor nodes
  - High reliability of data delivery through advanced routing mechanisms
  - Wireless co-existence and spectrum management mechanisms
  - Leverages open standards that allow for multi-vendor interoperability
  - Guaranteed security and integrity of data transmissions
Pole-Top 6LoWPAN Network

- Nivis has deployed 100k+ IPv6 enabled wireless mesh sensor nodes in major US cities (Atlanta, New Orleans, Jersey City) as part of a Street Light monitoring and control network.
- Nodes reside on top of poles as part of the lighting fixture.
  - Wireless nodes operating in the 2.4 GHz band
  - Huge energy savings through remote dimming capabilities
  - Monitoring power consumption and proactive maintenance
- Sensors are organized in subnets that scale up to 20k nodes.
- Battery operated gas, water and parking meters located at ground level piggy back data over the Street Light monitoring and control networks.
- Yes – we have the power to remotely dim the streetlights during Mardi Gras.
Applicability of the IPv6MAN
Applications

- Street Lighting Monitoring and Control
- AMR (Electric, Gas, Water)
- AMI – Smart Grid applications, automated load balancing
- Parking Meter Monitoring
- Traffic Monitoring
- Environmental Monitoring
- Premise Security Monitoring
- Homeland Security Sensor Alarms
- Bridge Stress Monitoring Alarms
- In Home Power Usage display
- Vehicle/Asset Tracking
- Tank Level Monitoring
- Storm Drain Blockage Alarms
The IPSO Alliance
“Promoting the use of IP in networks of Smart Objects”

- Create awareness of available and developing technology
- Promote and market use of IP in embedded systems
- Generate tutorials, white papers, technology demonstrations and highlight use cases
- Complement the IETF and other standards groups
- Support and organize Interoperability events
  - March 4th – 11 companies; 7 countries
  - SixXS, Hurricane and Freenet6 Tunnels

WWW.IPSO-ALLIANCE.ORG
A Quiz
Looking Forward

- Plenty of address space to embed IP in nearly everything
- Smart device-to-device communications
- Nodes can easily “phone home”
- The “Internet of Things”
IPv6 Inside

*Apologies to Intel