Web Services for the Internet of Things

T-106.5800 Seminar on Software Techniques (3 cr)
Presentation

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Presentation Outline

• Internet of Things
• CoAP
• CoAP protocol stack
• Web Services for the Internet of Things
• Conclusion
Internet of Things
What is Internet of Things?

Internet of Things = $10^{12}$

Fringe Internet = $10^9$

Core Internet = $10^6$

- AMI/AMR
- Utility Companies
- Home automation/Security
- Building Automation/Healthcare
- RFID Backbone
- Asset Tracking/Logistics

Source: Sensinode
Gartner’s Hype Cycle for Emerging Technologies, 2011
Challenges: How to…

• …connect physical environments/smart objects as part of the Internet?
• …cope with trillions of smart objects?
• …handle the problems with smart objects/small devices as they may have difficulties in dealing with protocols and technologies designed for full-powered computers?
• …integrate devices in constrained networks with Web applications?
Constrained Application Protocol (CoAP)
Google’s Hype Cycle for CoAP

Source: Google Insights for Search
Implementations

• libcoap (C), open source
  – http://libcoap.sourceforge.net/

• OpenCOAP (C), open source
  – https://code.google.com/p/opencoap/

• CoAPy (Python), open source, in progress
  – http://coapy.sourceforge.net/

• Copper (Firefox addon)

• Sensinode, The Contiki OS, TinyOS, etc.
CoAP Protocol Stack
Comparison of HTTP and CoAP Protocol Stacks

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<tr>
<th>Ethernet PHY</th>
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<th>Ethernet MAC</th>
<th>Data Link (L2)</th>
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Physical & Data Link Layers (L1 & L2): Ethernet → IEEE 802.15.4 (PHY & MAC)

- **Goal:** Get rid of wires
- **Methods:** Wireless
- **Solution:** IEEE 802.15.4
  - Specifies the physical layer and media access control for low-rate wireless personal networks (LR-WPANs)
  - Low-power, low-bandwidth communication technology
  - Basis for extensions, such as ZigBee
Network Layer (L3): IP → 6LoWPAN

- **Goal:** Integrate Wireless Sensor Networks (WSNs) and smart objects with the Internet
- **Method:** Optional protocol
- **Solution:** IPv6 over Low-Power Wireless Personal Area Networks (6LoWPAN)

  - Brings IP to the smallest of devices, such as sensors
  - Encapsulation and header compression mechanisms
Transport Layer (L4): TCP → UDP

- **Goal:** Reduce the overhead for short-lived transactions
- **Method:** Optional protocol
- **Solution:** User Datagram Protocol (UDP)
  - Fast but unreliable transport protocol
  - Optimal for exchanging very small data units
  - Supports multicasting
  - Used with the IP network layer protocol
Application Layer (L7): HTTP → CoAP

• **Goal:** Provide resource constrained devices with RESTful web service functionalities

• **Methods:** Optional protocol

• **Solution:** Constrained Application Protocol (CoAP)
  - REST-based architecture
  - Optimized for resource constrained networks typical of IoT and M2M applications
  - Takes into account the low processing power and energy consumption constraints of small embedded devices, such as sensors
Payload: XML ➞ EXI

- **Goal:** Reduce the overhead of XML
- **Methods:** Compression and encoding
- **Solution:** Efficient XML Interchange (EXI)
  - W3C Recommendation (EXI Format 1.0), March 2011, [http://www.w3.org/TR/exi/](http://www.w3.org/TR/exi/)
  - Very compact representation of the XML Information Set
  - Optimizes the performance and utilization of computational resources
  - *Extremely efficient* schema-informed mode
Web Services for the Internet of Things
About Web Services

• Today’s Web Services are *not* suitable to be used with the Internet of Things
  – TCP, HTTP, XML (SOAP)

• What is needed is
  – RESTful architecture for good Web integration
  – Native push model with subscribe and notify
  – UDP-based transport with multicast support
  – Overhead suitable for constrained networks
  – Complexity suitable for constrained nodes
  – Build-in Web discovery and security

• CoAP comes to the rescue!
CoAP and Web Services

Source: Sensinode
Conclusion
Conclusion

• Traditional Web protocols and technologies are not suitable for the Internet of Things
• The HTTP protocol stack needs to be optimized from the bottom to the top
• CoAP is the key technology in accessing constrained environments/nodes from Web applications
References

• Colitti, W., Steenhaut, K., and De Caro, N. Integrating Wireless Sensor Networks with the Web. 2011.
• Castellani, A. et al. Web Services for the Internet of Things through CoAP and EXI. In Communications Workshops (ICC). IEEE, 2011, 1-6.
Thank You!

Questions? Comments?
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