Protocols of The Internet of Things

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What's an IoT Protocol?











IoT Protocols for IoT Problems

- Device Constraints
 - Low Power
 - Low CPU
 - Small Size
- Network Constraints
 - Radio Propagation Issues
 - Radio Power Utilisation
 - Interference from Self, Other Devices





IoT Protocols: 6LoWPAN

- IPv6 (globally addressable sensors) for
 - Low Power
 - Wireless
 - Personal Area Networks
- Header compression
- Can have a smaller address space
- Allows for ad-hoc and mesh topologies
- Operates over 802.15.4





IoT Protocols: CoAP (IETF Proposed)

- Constrained Application Protocol
- New design for RESTful interaction
 - Representational state transfer (typically for HTTP)
 - Well-known methods like GET, POST, PUT, DELETE
- Binary protocol with

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- lower parsing complexity
- Small message size
- UDP with alternative transports available (SMS, USSD)



IoT Protocols: Dash7

- RFID standard for Wireless Sensor Networking
- BLAST: bursty, light, asynchronous, stealth, transitive
- 433 MHz ISM (industrial, scientific, medical) band
- Open Source Protocol Stack
- Shared key AES encryption
- Data transfer 10-200kbps
- 1-10km range
- Low cost hardware

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IoT Protocols: LoRa

- Low Power Wide Area Network
- Designed for wireless, battery operated devices
- Supports bi-directional comms, mobility, localisation
- Star or star of stars topology (not mesh or p2p)
- 0.3-50kbps via adaptive data rate scheme
- Multiple levels of encryption (Net/App/Device)
- Supports time slot scheduling of device transmission



IoT Protocols: Lo-Fi, Motenio, Etc.

- Serial across 433, 868, 915 MHz MHz
- Open Source RFM69 Libraries
- 1.2-300 kbps
- Rx Sensitivity to -120dBm at 1.2kbps
- Some support encryption using RFM69W chip
- Star topology
- Other Similar chips / protocols available





IoT Protocols: LWM2M

• OMA LWM2M

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- Open Mobile Alliance Light Machine to Machine
- Provides Common Object and Resource Definitions
- Specifies use of CoAP and DTLS on UDP or SMS
 - DTLS: Datagram Transport Layer Security
- Applicable to Cellular + Many IoT Wireless Protocols
- Plain-Text, Binary or JSON payloads



IoT Protocols: SigFox

- Proprietary at 868MHz & 915MHz in the US
- Low power consumption
- SigFox owns/operates the Receiver network
 - Covers 420k square miles in Europe
- Up to 140 12-byte messages a day
- 10-1000 bits per second
- Encryption?
- Target pricing US \$1/device/year





IoT Protocols: Weightless

- Open Standard at Multiple Frequency Bands
 - Standards for TVWS & now Narrowband 868MHz
- Low power consumption nodes can sleep for days
- From bits per second to megabits per second
- Intelligent scheduling at the tower end
- Public Key Encryption

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Supports itinerant nodes



IoT Protocols: Zigbee

- 802.15.4 across multiple frequency bands
- 20-250kbps depending on spectrum available
- Star, tree, mesh topologies
- Low power consumption
- Low cost at least in 2.4GHz band
- 128-bit encryption keys

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Several network simulators available



IoT Protocols: Z-Wave

- Proprietary across multiple frequency bands
- 9.6-100kbps
- Very low power use for end devices, 0.1% duty cycle
- Mesh topology devices individually added to mesh
- Mesh repeaters cannot sleep (so not battery powered)
- 32 bit addressing limits use to homes / businesses





Matching IoT Protocols to Applications

- Agriculture
- Food Safety
- Environmental Controls
- Retail Automation
- Smart Cities
- Transportation
- Utility Metering











Pivot Irrigator: IoT Applications

- Potential IoT Applications:
 - Flow Rate Monitoring
 - Position Monitoring
 - Flow Rate Control
 - Emergency Stop
 - Image Acquisition for Crop Health







Pivot Irrigator: IoT Problems

- Not a Problem:
 - Power
 - CPU
 - Storage
 - Size of Device

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- Radio Spectrum
- Radio Propagation





Pivot Irrigator: IoT Protocols

- WiFi/WiMAX/TVWS
- (Broadband Wireless)
- IPv4/IPv6
- HTTP
- REST
- JSON
- XML













Drip Irrigation: IoT Applications

- Soil Temperature
- Soil Moisture
- Soil Nutrient / Nitrogen Levels
- Solar Radiation





Drip Irrigation: IoT Problems

- Problems:
 - Power
 - Low CPU
 - Size of Device

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- Radio Spectrum
- Radio Propagation





Drip Irrigation: IoT Protocols

- Dash7 (Dash7 @ 433 MHz)
- RFM69 (Serial @ 433 MHz)

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- SigFox (Proprietary @ 868 MHz)
- Taggle (Proprietary @ 915 MHz)
- Weightless (Weightless @ Multiple Bands)











Retail Supermarkets: IoT Applications

- Potential IoT Applications:
 - Electronic Labels
 - Low Stock Alerts
 - Temperature Monitors
 - Gas Alerts
 - Mouse Traps

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Lighting Monitoring





Retail Supermarkets: IoT Problems

- Problems:
 - Power
 - Low CPU
 - Size of Device

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- Radio Spectrum
- Radio Propagation





Retail Supermarkets: IoT Protocols

Class Exercise







Smart City: IoT Protocols











