Internet of Interconnected Objects
Standardization view @ IETF / IRTF

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Internet of Interconnected Objects: General view

- The Internet always connected "things"
  - The question now is: scalability; availability

- Initial plan: extend IP to any device/object
  - IP is very mature, but we have to make sure that technology scales to meet the challenges.
  - Start with solutions that work fine in a certain environment: for example with low power requirements
  - Ending up with "One Internet" is important

- Current Working groups at IETF:
  - *Constrained RESTful Environments (CoRE)*: framework for resource-oriented applications to run on constrained IP networks
  - *IPv6 over Low power WPAN (6LoWPAN)*: Provide IP operation on top of IEEE 802.15.4 wireless networks
  - *Routing Over Low power and Lossy networks (ROLL)*: IPv6 routing architectural framework for specific application scenarios; pays particular attention to routing security and manageability issues

- Example of actions to be pursuit:
  - Standards for data formats: Useful to build abstractions where data and names have a central role
  - Protocols that scale down to IoT devices
  - Routing (is ROLL enough?)
  - Security infrastructure and privacy considerations
  - Management of large numbers of network elements (including control of sleeping nodes)
  - Discovery protocol to advertise local resources and resources in other subnets:
    - Should not rely on multicast for this (battery-powered devices won't respond anyway)
Internet of Interconnected Objects: IETF View

• Currently working on:
  – Applications over constraints IP networks; IP over IEEE 802.15.4 networks; IP routing for constraint networks

• Transport issues:
  – A different model from the Internet today
  – Need to figure out how to put multiple applications on one network
  – Interconnection of intermittently connected networks → IRTF DTNRG

• Identity Issues:
  – Device identity and attribute discovery
  – Credential management and provisioning
  – Object owner’s privacy and data privacy
  – Crypto algorithms on constrained devices

• Routing issues:
  – Is the existing IETF routing protocol (ROLL) one-size-fits-all? Most likely not...
    • Suitable for scenarios with end-to-end connectivity
    • IPv6 neighbor discovery assumes deterministic link characteristics – links between objects aren’t
    • Latency and reliability can vary greatly: e.g. devices in different administrative domains
    • RPL optimized for upward traffic – anything else uses source routing or potentially stores full network topology
  – Address aggregation mechanisms
    • Considerations about routing table (maybe an IRTF issue)
  – Awareness of sleeping nodes
  – Other identity schemes: e.g. based on identification of data chunks
Internet of Interconnected Objects: IRTF View

• Working groups that have an IoT related agenda:
  – NONE

• Working groups that could have an IoT related agenda:
  – Delay-Tolerant networks (DTNRG)
  – Network Management Research Group (NMRG)
  – Crypto Forum Research Group (CFRG)

• Potential new Groups:
  – Deployable security for smart objects
  – Proposed Information-Centric Networking Research Group (ICNRG) -- meetings @IETF81-83

• Initially, the ICNRG is focusing on two main research areas:
  – Name resolution and routing scalability, including naming schemes
  – Caching strategies and corresponding performance optimizations

• ICNRG and DTNRG may have complementary goals in what concerns networked objects:
  – ICNRG: focus on data communications, which may be the most used ones by constraints devices/objects
  – DTNRG: focus on the operation of intermittent networks, as the ones created by constrained devices/objects
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What should be the working focus?

- Extension of end-to-end IP connectivity
- Inclusion of intermittently connect objects
- Data exchange