ICN based Architecture for IoT

ICNReq/IETF 88, 2013

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IoT Motivation and Challenges

Popular scenarios

- Smart Homes
  - Policy based seamless interaction between heterogeneous control systems (climate/security/health/entertainment etc.); service composition; mobility.

- Smart Grid
  - Reliability, Real-time Control, Secure Communication to achieve energy efficiency

- Smart Transportation
  - Very short Response time Ad-hoc + Infrastructure communication with mobility, secure data collection and exchange

- Smart Healthcare
  - Security/Privacy/Trust, High Reliability, short-communication latency

Scale + Energy + Variable-Context + Open-API: Service Realization/User Experience
IoT Architectural Requirements

• Naming
  • Application Centric (Secure or not), Persistent considering Mobility, Context Changes.

• Scalability
  • Scale to billions on devices (passive/active), name/locator split, local/global services, resolution infrastructure, efficient context update.

• Resource Constraints
  • Compute/Storage/Bandwidth constrains, Protocols being application/context aware, Infrastructure support (edge computing, polling on demand)

• Traffic Characteristics
  • Separate Local versus Wide Area traffic based on Application logic ; Many-to-Many (Multicasting/Anycasting)

• Contextual Communication
  • Key to create several meaningful IoT services

• Handling Mobility
  • Fundamental Design Criteria
IoT Architectural Requirements

- **Storage and Caching**
  - Leverage as much as possible being sensitive to application/service producer requirements

- **Security and Privacy**
  - Takes precedence over any communication paradigm (ICN or not)

- **Communication Reliability**
  - Application centric (e.g. Health)

- **Self-Organization**
  - Ability to self-organize in Ad Hoc/Infrastructure setting to discover resources (services/content/users/devices) and Communicate.

- **Ad hoc and Infrastructure Mode**
  - Seamless transitions between the two worlds, user/application driven.
Legacy IoT systems

- Silo IoT Architecture (Fragmented, Proprietary), e.g. DF-1, MelsecNet, Honeywell SDS, BACnet, etc
- Fundamental Issues: Co-existence, Inter-operability, Service level interaction
State of the Art

- Overlay Based Unified IoT Solutions
- Coupled control/data functions
- Centralized and limits innovation
State of the Art

Weaknesses of the Overlay-based Approach

• **Naming**: Resources visible at Layer 7

• **Mobility**: Inherited by IP based communication

• **Scalability**: Merges control + forwarding path in central servers (bottleneck)

• **Resource constraints**: Network insensitive to device constraints.

• **Traffic Characteristics**: Overlaid support for multicasting (in-efficient & complexity)
• ICN has a potential to influence this emerging area of IoT as a unified platform for interaction between Consumers, ASPs, Network Operators.
  • Potential ICN as Network layer in the edges?

• Potential technology to glue heterogeneous applications/services/devices (CIBUS)
  • CIBUS [SIGGCOMM, 2013]

• ICN is Contextual, Content Level Security (Access control/Privacy), Multicast/Anycast is naturally enabled.
Proposed ICN-Centric Unified IoT Platform

Strengths of ICN-IoT

- **Naming**
  - Application Centric (Hierarchical/Secure/Hybrid)

- **Scalability**
  - Name-Location Split, Localizes Communication where required

- **Resource Constraints**
  - Application aware communication

- **Context-aware communications**
  - Adaptation at Network Level (at all levels)

- **Seamless mobility handling**
  - Flexible Name Resolution (Late Binding)
Proposed ICN-Centric Unified IoT Platform

- Data Storage
  - Enables Edge Computing/Multicasting

- Security and privacy
  - Very Flexible (User/Device/Service/Content Level)

- Communication reliability
  - Adaptable to Best Effort to DTN

- Ad hoc and infrastructure mode
  - De-coupling of Application from Transport Layer
Proposed ICN-Centric Unified IoT Platform

- Name space mgmt.
- Resource Discovery
- Communication Reliability
- Scalable Name Resolution System
- Mobility
- Caching/Storage
- Multicasting

In-network Computing
Proposed ICN-Centric Unified IoT Platform

• The ICN-IoT Service Middleware
Proposed ICN-Centric Unified IoT Platform

• ICN-IoT Data and Services
Proposed ICN-Centric Unified IoT Platform

- ICN-IoT Scenario: Location context service in RDF

Cabs publishing their availability

User search queries matched against the service attributes.
Proposed ICN-Centric Unified IoT Platform

- Location context application scenario