Enabling IoT Platform via MobilityFirst
Future Internet Architecture

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Motivations

• A big trend of Internet– Internet of Things (IoT)
  – Transforming today’s network of computers to tomorrow’s network of Things

• A big gap between physical objects and apps
  – Sensors (actuators, tags) are much more heterogeneous than computers, no standard interfaces

• Need IoT Middleware to bridge the gap

• What is the role of future Internet architecture?
IoT Middleware Functions

THINGS
- Sensors
- Tags
- Feeds
- Actuator
- Database

MIDDLEWARE
- Discovery Service (Semantic / Syntactic Resolution)
- Data Processing Services (Data analysis, event, context, security / privacy handling upon status, knowledge, rules)
- (Re)-distribution Service (CDN, Cloud, FIA)
- Resource Abstraction
- Application Abstraction

Future Internet (IoT Core Network)

APPS
- App 1
- App 2
- Service 1
- Service 2
- App N

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IoT Platform and MobilityFirst FIA
Today’s Middleware

• M2M Middleware
  – Specialized to vertical market apps
  – Low interoperability and scalability

• IoT Middleware
  – Generalized to any application
  – Increased interoperability and scalability

• Linked Data
  – Linking all databases created with semantic web technology in the cyberspace
  – A global information space
Semantic Web Technology

• Building up the relationships between data
  – Store web data with semantic links
  – Discover data from semantic query

• Basics
  – The relationship of data is represented in RDF (resource description framework) triples and graphs
  – The data source with semantic attributes can be query by SPARQL (an RDF query language)

• Linked Data
  – A huge collection of semantic databases over web
  – Sensors can also be linked data, live streaming data
An RDF graph sample

- The Glass Palace
  - 2000
- London
- Harper Collins
- Ghosh, Amitav
- http://www.amitavghosh.com
- http://…isbn/000651409X

- Source: Ivan Herman W3C, Oct. 2011
Linked Data (Sept. 2010)

Source: Christian Bizer
Freie Universität
Berlin, Germany
BNCOD'2011

■ Over 26.9 billion RDF triples
MobilityFirst Architecture

- Three protocol layers (baseline): Routing, DTN transport, GNRS
- Name assignment service (NAS)
- How MobilityFirst runs as an IoT platform?
GUID for Middleware Services

- Sensors and Middleware services are visible in core network

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IoT Platform and MobilityFirst FIA
GUID named context service

• Basic benefits from MobilityFirst
  – Multi-homing and mobility
    • One GUID to multiple URIs or IPs
  – Requests and data can be multicast, anycast
    • Request to GUID going to all mapped addresses
  – No end-to-end connectivity required
    • Hop-by-hop and late binding
  – Anti-spoofing
    • Verifying authentication with public key in GUID
A context-aware application

• UbiCab example
  – “James walks on NYC streets and wants to find an empty cab closest to his location”.

• Resources – phones with GPS values as data

• A location context service, as middleware, collects GPS sensor data and provides to application (a voice call app)

• What does it mean resources and service being assigned with GUIDs?
Location context publishing

- An RDF graph published via MobilityFirst NAS

http://GPSLocation.com/Cab

mf: GUID

GUID_c

http://NYCcab.com/cab1

http://NYCcab.com/cab2

GUID_2

a:Pubkey

8438435780327523478532

a:member

Global graph (searchable)

a:location

GPSvalue

Cab

Location

8438435780327523478532
Caching – from overlay to core

- Service is operated on GUIDs inside core network
Cached context service

• Requirements on routers
  – Storage available and support standard RDF SPARQL or a default query language
  – Cached service is a dynamic database – in RDF graph

• Benefits
  – Reduce traffic load, lower latency
  – Available when disconnected to overlays due to mobility or ad-hoc conditions
  – Efficiency for location dependent and high data rate services
MobilityFirst as IoT Platform

- Resource (GUID_s), Service (GUID_c) visible and cacheable in core
- Interface to Linked Data via MF NAS (Name Assignment Service)
Conclusions

- MobilityFirst can provide an IoT platform to connect Things
- Things are identifiable at MF core network layer via GUIDs
- Middleware functions (services) are identifiable at MF core network layer via GUIDs
- Middleware functions can be cached to enhance the efficiency of the service delivery