MACHINE TO MACHINE (M2M) / INTERNET OF THINGS (IOT) SERVICE LAYER

21 December 2012
Billions of ever-increasing “Things” are to be connected to the Internet to enable people’s smart life via smart cities, smart transportation, smart environment, smart shopping, smart health, smart home, etc.

Segmented various vertical applications with proprietary solutions which increase roll-out cost and speed and hinder mass-adoption.

Big “V” → Big “Challenge” → Big “Smart”
Some Applications & the Likely Technologies They will Use

- Smart Energy/Connected Home
- Appliance Control
- Healthcare
- Wellness
- Metering
- Appliance Control
- Home Entertainment
- Health Monitoring
- Infotainment
- Toll Collection
- Intelligent Highways & Vehicular Comms
- Safety Sensors
- Retail
- Point of Sale
- Tele-Vending
- Bluetooth
- WiFi
- Cellular
- ZigBee
- Zwave
- RFID
- PLC
- DSRC
- NFC
- NFC
- PLC
Not All Devices are Created Equal!

Requirements Unique to M2M...

- Constrained devices with low footprint: limitations in size, processing horsepower, memory, storage, bandwidth capability
- Devices with long lifetimes (years)
- Unmanned devices => plug-n-play installation, self-organization, device management requirements, security threats
- Unwired, un-chargeable devices => very low power consumption often a critical requirement
- Mobility requirements ranging from fixed -> pedestrian -> vehicular
- High delay sensitivity, reliability for mission-critical applications

Source: Harbor Research
And Not All Applications are Created Equal!

Requirements Vary Widely Based on Use Case

<table>
<thead>
<tr>
<th></th>
<th>Smart Energy</th>
<th>Healthcare</th>
<th>Transportation</th>
<th>Retail</th>
<th>Security &amp; Surveillance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Power Consumption</td>
<td>●</td>
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<tr>
<td>High Data Rate</td>
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<tr>
<td>Mobility</td>
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<td>Delay Sensitivity</td>
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<tr>
<td>Location Tracking</td>
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<tr>
<td>Long Replacement Cycle</td>
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<td>●</td>
<td>●</td>
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<tr>
<td>Persistent Service</td>
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- ● Critical Importance
- ○ Medium Importance
A Smorgasbord of Applications with Diverse Requirements

*The Intersection of Communications Networks With a variety of Industry Segments Each with its own unique Requirements*

*Forecast by Segment for 2013*

Source: Harbor Research
M2M Enabling Technologies

- Services and Applications
- Data Analytics
- RESTful Web
- IPv6/6LoWPAN
- Communications
- Embedded Devices
- Sensing

M2M
M2M/IoT Standardization – Protocol Stack

Higher Layer

Service Layer

App Protocol Layer

Transport Layer

Network Layer

PHY/MAC Layer

W3C (World Wide Web Consortium)
(HTML 5.0, RDF, OWL)

oneM2M (ARIB, ATIS, CCSA, ETSI, TIA, TTA, and TTC)
(Common Service Layer: Provide M2M Service Capabilities)
(Potentially evolve to IoT service)

IETF CoAP/HTTP

IETF TCP/UDP/SCTP

3GPP/3GPP2 MTC

IETF ROLL/6LoWPAN

3GPP/3GPP2 RAN

IEEE PLC

IEEE 802.11/15

Smart Profiles
(SE 2.0, Healthcare, Home Automation)

EPCglobal Standards for RFID

Control and Management
M2M - Existing Deployments

<table>
<thead>
<tr>
<th>Application Logic</th>
<th>Proprietary Service Functions</th>
<th>Communications Infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proprietary Application Logic Set A</td>
<td>Proprietary Service Function Set A</td>
<td>RFID</td>
</tr>
<tr>
<td>Proprietary Application Logic Set B</td>
<td>Proprietary Service Function Set B</td>
<td>RFID</td>
</tr>
<tr>
<td>Proprietary Application Logic Set C</td>
<td>Proprietary Service Function Set C</td>
<td>GPS, Cellular</td>
</tr>
<tr>
<td>Proprietary Application Logic Set D</td>
<td>Proprietary Service Function Set D</td>
<td>WiFi, BT, WSN</td>
</tr>
</tbody>
</table>

Smart City in Oulu

Vertical and Proprietary Solution
M2M/IoT – Common Service Layer

- **Common Service Layer**
  - Network & Application-agnostic, but aware
  - Easy to integrate different vertical applications
  - Expedite application development
  - Decrease roll-out cost and speedup deployment
  - Interoperability
  - Scalability

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ETSI M2M Service Architecture
ETSI M2M Service Architecture

Architecture Standardizes an Access Aware But Agnostic M2M Service Layer Architecture

- ETSI-defined protocols to enable M2M service capabilities (e.g. device registration, service discovery, etc);
- Core service capabilities available to multiple applications via standardized APIs;
- Network-agnostic protocol, with bindings possible to HTTP and CoAP;
- Allows application access to Service Platform and Device, as well as local application control on Gateway;
ETSI M2M – RESTful Resource Tree

M2M Area Network 1
- eHealth / mHealth (Bluetooth / ZigBee...)
- M2M Applications

M2M Area Network 2
- Smart Energy (WiFi / ZigBee / ...)
- M2M Applications

M2M Area Network N
- Home Automation (ZigBee / Bluetooth / ...)
- M2M Applications

M2M Gateway
- M2M Applications
  - `<sclBase>`
  - `n`
  - `scls`
  - `applications`
  - `containers`
  - `groups`
  - `accessRights`
  - `subscriptions`
  - `discovery`

M2M Server
- M2M Service Provider Applications
  - `<sclBase>`
  - `n`
  - `scls`
  - `applications`
  - `containers`
  - `groups`
  - `accessRights`
  - `subscriptions`
  - `discovery`

M2M Device
- M2M Applications
  - `<sclBase>`
  - `n`
  - `scls`
  - `applications`
  - `containers`
  - `groups`
  - `accessRights`
  - `subscriptions`
  - `discovery`
Integration of 3GPP MTC and ETSI M2M

3GPP/LTE RAN

3GPP Core Network

NodeB

Cellular M2M Device

Cellular M2M GW

3GPP MTC Functionalities

ETSI M2M Service Capabilities

3GPP Protocols

ETSI M2M & 3GPP MTC Applications

ETSI M2M Service Capabilities

3GPP MTC Functionalities

3GPP Protocols

ETSIM2M Service Capabilities

3GPP MTC Functionalities

Networking Protocols

3GPP MTC Interface

ETSIM2M Reference Points

Application Server

(3GPP Network Applications)
3GPP MTC Architecture

- **Tsp**: Reference point used by a SCS to communicate with the MTC-IWF related control plane signaling

- **MTC-IWF**: hides the internal PLMN topology and relays or translates signaling protocols used over MTCsp to invoke specific functionality in the PLMN
  - Supports device trigger functionality
  - Selection of the most efficient and effective device trigger delivery mechanism and shielding this detail from SCS
  - Generation of device trigger CDRs
  - Perform protocol translation
InterDigital’s M2M Software Development Platform

IP-based End-to-End M2M Software Development Platform
(M2M Device + M2M Gateway + M2M Server)

→ Network and application agnostic but aware
→ Middleware providing common M2M API
→ Enabling horizontal solutions

- RESTful Application API
- Configurable Charging
- Interworking with Cellular MTC
- Capillary Network Integration (ZigBee)
- M2M Gateway Proxy
- Device Management
- Semantic Services
- Service Discovery
- Security (Integrity Validation)
- Cloud-based M2M Server
InterDigital’s M2M Software Development Platform

Web-based Customizable SDK

Interworking with Legacy M2M

Lightweight Device Management

Automated Service Discovery
What the Internet of Things Entails…

A Diversity of Applications

Interacting With a Myriad of Device Types

Via The Web and Multiple Heterogeneous Networks
M2M Evolution to IoT

M2M is communication among machines to manipulate content/data

Current M2M

• **Connectivity**: connection for machines;
• **Content**: massive raw data from things;

Evolution to IoT

• **Cloud**: cloud service and XaaS for IoT;
• **Context**: context-aware design;
• **Collaboration**: collaborative services;
• **Cognition**: semantics and autonomous system adjustment

IoT is communication to/from things which offer new services via cloud/context/collaboration/cognition technologies

M2M Service Platform → IoT Service Platform with C6 Capabilities
M2M Evolution to IoT – Architecture

M2M/IoT Device Domain

M2M Area Networks (Smart Metering)
M2M GW (Windriver)
3GPP/LTE
WiFi
802.15.4
Home Automation
M2M Device (Android/Linux)
M2M/IoT GW (RFID Reader)
Ethernet
RFID
NFC
Bluetooth
3GPP/LTE
Mobility
RFID
M2M/IoT GW (RFID Reader)

M2M/IoT Network Domain

DNS Server (VM)
DM Server (VM)
MAS Server (VM)

M2M/IoT SC1 (VM)
M2M/IoT SC2 (VM)
M2M/IoT SC3 (VM)
M2M/IoT SCn (VM)

M2M/IoT SC Mgmt (VM)
M2M/IoT Application (VM)
WMMP (VM)

M2M / IoT Cloud + Vertical Cloud
(Cross-VM and Cross-Cloud Collaborations)
(Context-based Service Grouping and Orchestration)
(Cognitive Semantic Services)

M2M Evolution to IoT Prototype Development

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