Machine Type Communication and M2M Platform Evolution: Horizontal Service Capabilities or Vertical Silo Mindset?

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- Fraunhofer FOKUS is the telecommunications institute within Fraunhofer
**M2M – Our Definition**

*Machine-2-Machine (M2M)* is a paradigm in which the end-to-end communication is executed without human intervention connecting non-IT objects to an IT infrastructure.

<table>
<thead>
<tr>
<th>MACHINE</th>
<th>-- TO --</th>
<th>MACHINE</th>
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</thead>
<tbody>
<tr>
<td>Communication terminal independent of human interaction</td>
<td>Network facilitating the M2M communication</td>
<td>Core network (or terminal) automating the services</td>
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<tr>
<td>- Acting automatically or on remote request</td>
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<td>- Managed remotely</td>
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<tr>
<td>- Mobile and fixed terminals</td>
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<td>- Monitoring device (sensor)</td>
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<td>- Actuator device (e.g. switch)</td>
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<td>- Associated order of magnitude: trillion = $10^{12}$</td>
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<tr>
<td>- Access &amp; core network, backhaul, application server</td>
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<td>- Enabling connectivity (AAA &amp; security, session management, QoS, charging, mobility management)</td>
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<td>- Supporting the data traffic of terminals (e.g. for direct and infrastructure communication)</td>
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<td>- Supporting the signaling of terminals</td>
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<tr>
<td>- Sensor data aggregation, processing and presentation</td>
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<td>- Data caching and interpretation</td>
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<tr>
<td>- Real-time communication</td>
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<tr>
<td>- Automatic decision, processing, control followed by communication with other machines through:</td>
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<tr>
<td>- Instructions</td>
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<tr>
<td>- Notifications</td>
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</tbody>
</table>
Pressure, Temperature, Throughput, ...
Current temperature, container opened? ...
To Become Smart Means to Make Sense out of the Raw Data
M2M Segments

- Automotive
- Security
- Payment
- Consumer Electronics
- Metering
- Tracking & Tracing
- Healthcare
- Remote Maintenance and Control
Communication Elements in M2M

Connected Devices

- Physical Vicinity
- Sensor Actuator
- (Sensor) Gateway

Operator Networks

- Operator Core Network
  - 3G

Mash-Up Service Platform

- Mash-Up Service Platform

Services and Applications

- Business Front-end
- Telecom Network
  - Delivery to multimedia warning device
  - Application mash-up
  - APIs, SDKs

Connected Devices

- Connected Devices
  - Sensor
  - Actuator

Operator Networks

- Operator Networks
  - Operator Core Network
    - 3G

Mash-Up Service Platform

- Mash-Up Service Platform
  - open mtc
    - fokus broker

Services and Applications

- Services and Applications
  - Business Front-end
  - Telecom Network
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    - APIs, SDKs

Network Elements

- Network Elements
  - Connected Devices
  - Operator Networks
  - Services and Applications

Key Features

- Light
- Temperature
- Movement
- Gateway to Core-Network
- Communication Management
- QoS & Charging
- Seamless Mobility
- Security
- M2M resources
- M2M session support
- Device and connectivity mgmt.
- M2M data handling
- Application mash-up
- APIs, SDKs
M2M Ecosystem

Standardization

Vendors

Operators
ETSI M2M Standardization Activities

- TR 102 691: Smart Metering
- TR 102 732: eHealth
- TR 102 857: Connected Consumer
- TR 102 898: Automotive
- TR 102 897: City Automation
- TR 102 935: Smart Grid Impacts

- TS 102 689: M2M Service Requirements
- TS 102 690: M2M Functional Architecture
- TS 102 921: mIa, dIa and mId Interfaces

- TS 103 092: OMA DM compatible Management Objects
- TS 103 093: BBF TR-069 compatible Management Objects

- TR 102 725: M2M Definitions
- TR 102 167: Threat analysis ...
- TR 101 531: Reuse 3GPP Nodes
- TR 101 584: Semantic support for M2M data
- TR 102 966: Interworking with M2M Area Networks
- TR 101 603: Interworking with 3GPP networks
Stop the Silo Mindset - Horizontal Approach for M2M

In line with ETSI TC M2M specifications
Example: Connected home

Wireless or Wired Networks

M2M Devices with Device Application (DA)

M2M Gateway (GSCL)

Network Application (NA)

M2M Network (NSCL)

mId

mIa

dIa
ETSI M2M Service Capabilities

- A set of standardized Service Capabilities (SC) is defined in M2M Core and M2M Device/Gateway, to provide functions that are to be shared by different M2M Applications

- M2M Service Capabilities:
  - provide recommendations of logical grouping of functions
  - expose functionalities through a set of open interfaces
  - use Core Network functionalities
  - simplified, optimized application development and deployment through hiding of network specificities from applications
  - can interface to one or several Core Networks

- M2M SCs provide recommendations of logical grouping of functions
- M2M SCs do not mandate an implementation

Not all M2M SCs are foreseen to be instantiated in the different parts of the system.

Only external interfaces are mandated and are required for compliance.
RESTful Style for Data Exchange

- Adopted for some of the procedures of the M2M ETSI procedures
- Four basic procedures:
  - CREATE: Create child resources
  - RETRIEVE: Read the content of the resource
  - UPDATE: Write the content of the resource
  - DELETE: Delete the resource
- Additional Procedures:
  - NOTIFY: on a change event
    - RETRIEVE for polling
    - UPDATE for pushing
  - EXECUTE: for executing a management command/task
Analysis of ETSI Data Model

- Extended map of the ETSI M2M resource tree
# Reporting Responses to a Request Issuer

<table>
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<tr>
<th>Mechanism</th>
<th>Description</th>
<th>Issuer Type</th>
<th>Receiver Type</th>
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<tr>
<td>Client-2-Server (Synchronous)</td>
<td>Issuer sends a request and receives the requested information in the response</td>
<td>Client • May be Server • The issuer blocks until response is received</td>
<td>Server</td>
</tr>
<tr>
<td>Client-2-Server (Semi-asynchronous)</td>
<td>Issuer sends a request and receives a confirmation for message received. Result is obtained through: • Short Polling • Long Polling</td>
<td>Client • High Signaling • Replacing receiving of notifications</td>
<td>Server</td>
</tr>
<tr>
<td>Server-2-Server (Asynchronous)</td>
<td>Response is received in a request from the receiver side</td>
<td>Server</td>
<td>Server</td>
</tr>
</tbody>
</table>
Aggregation of requests to access remotely hosted resources by store-and-forward handling

- Each 1-hop request (over the network) may include one of the following indications:
  - **TRPDT**: Tolerable Request Processing Delay Time
    - Enables local SCL to delay the request up to the time indicated
    - The time interval in which the local SCL waits should be governed by policies
  - **RCAT**: Request Category
    - Local SCL blocks forwarding of requests until a specific access network becomes available
    - Access network selection policies consider cost, power consumption, bandwidth etc.

- Policies are provisioned via xREM through MgmtObjects or are pre-provisioned
- Require **Store-And-Forward (SAF)** functionality
Processing a Request at the Local SCL

- **Goal:** Reducing the communication over the network (access and core) by considering that:
  - Devices are not always connected to the appropriate access network
  - Requests can be aggregated based on acceptable delay

- Each request receives a (default):
  - TRPDT value - delay
  - RCAT value – access category

- Requests are delayed until:
  - Connectivity becomes available
  - The appropriate access network is selected
Policies affecting Store-And-Forward (SAF) Handling

- M2M Service Provider and Access Network Providers have specific policies for the SAF handling
  - Policies are affecting different steps of the algorithm

Diagram:
- M2M Service Provider
  - Wait time as function of number and amount of pending requests
  - Selection among appropriate access networks
  - Default values for TRPDT and RCAT
- Access Network Provider
  - Schedule RCAT values vs. time
  - Blocking access attempts after failure of establishing connectivity
- Store and Forward (SAF) Handling
OpenMTC Architecture

Legend
GC: generic communication
AE: application enablement
RAR: resource repository
SEC: security
REM: remote management
NTOE: telco operator exposure
NCS: communication selection
N/GIP: interworking proxy
OpenMTC Architecture

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OpenMTC Application Enablement

- Exposes functionalities implemented in the service layers (N/GSCL) via the reference points
  - mIA
  - dIA

- Single contact point for
  - Network Applications (NA)
  - Gateway Applications (GA)
  - Device Applications (DA)

- Performs routing between applications and capabilities in the N/GSCL

- Routing is defined as the mechanism by which a specific request is sent to a particular capability
OpenMTC Communication Features

- Applications can store and receive data
- RESTful communication paradigm
- HTTP transport
- Applications can execute remote actions
- Single point of contact for communication with other SCLs
- Reports transmission errors
- Relays messages towards other SCLs
- Can inspect traffic generated by a particular M2M Device or M2M Gateway
- Verify if traffic is matching a given traffic pattern
  - e.g. number of connections/traffic per day
  - more than 20% of the monthly average traffic is generated in one day, etc.
- Other policies reg. traffic inspection possible
- Transport session establishment and teardown along with security key negotiation
OpenMTC Communication Features

- Upcoming in Rel. 2:
- Integration with OpenEPC
- Device and/or network triggered policy-based access network selection using the 3GPP ANDSF (e.g. if clients dispose of 3G, WiFi, LTE connectivity)
- Policy-based QoS on mId interface using the 3GPP PCRF (e.g. guaranteed bandwidth)
- NTOE capability connecting to the 3GPP MTC-IWF to execute device triggering (e.g. to wake up devices that are not attached to the 3G network)
OpenMTC Reachability, Addressing and Repository

- Implements the ETSI defined resource tree
- Store N/G/DA and D/G/NSCL related registration information
- Subscriptions Management
- Event notifications
- Store application and SCL data
- Provide data upon
  - requests
  - subscriptions
  - access rights and permissions
- Manage group of M2M devices or gateways
- Provides mapping between name of M2M Device, Gateway, or group and a set of information:
  - Reachability status of M2M Device or Gateway
  - Scheduling information pertaining to reachability of M2M Device or Gateway
OpenMTC Device Management

- Upcoming in Rel. 2
- Implements OMA DM
- Supports the ETSI defined Management Objects (MO) that map to
  - OMA DM (ETSI TS 103.092)
  - BBF TR-069 (ETSI TS 103.093)
- M2M device management
- Configuration Management
- Software and firmware upgrade of M2M Device or M2M Gateways
- M2M Area Network management
OpenMTC Device Interworking

- GIP capability provides interworking between non-ETSI compliant devices and the GSCL
- OpenMTC implements the following GIPs
  - ZigBee GIP
  - FS20 GIP
  - HTML 5, sensor API GIP
- GIPs provide the mapping from various devices to the respective ETSI defined resources inside the GSCL
- This allows for interoperability across various sensor network / M2M area network technologies
The New Value Chain

- Building on horizontal M2M middleware and associated SDKs, M2M infrastructure operators can cover large parts of the M2M value chain.
- Strong strategic partnerships will still be essential:
  - to cover system domain specific integration & application development
  - to cover domains with specific hardware requirements
OpenMTC
Licensing & Availability

- OpenMTC is available for licensing with binary or full source code either as a complete testbed or as individual components for research and development purposes.

- We are able to provide add-on services like on-site coaching, local deployment and integration activities, support, as well as extensions to OpenMTC components to meet specific customer requirements.

- Also, we are interested in setting up joint R&D projects based on the OpenMTC platform and integrate with your platforms.

- In order to receive information on licensing and prices for the components, please send us an email to info@open-mtc.org
Who can use OpenMTC

- **Universities**
  - OpenMTC offers an independent and extensive implementation to connect to the world of M2M and converged communications, interop with EPC and IMS
  - Empowering students to try their ideas
  - Affordable, comprehensive, trouble-free startup testbed

- **Vendors**
  - Product roadmapping
  - Technology field-trials
  - Hands-on experience of new standards
  - Ensure innovation through technology headstart

- **Operators**
  - Technology field-trials & Prototyping
  - In-house testbeds
  - Understand & evaluate new architectures
  - Early estimations / what verticals to address?
  - Fast functionality gap-filling
OpenMTC Releases and Roadmap

First Demos
Nov 2011
- IMS based demos
- Sensor integration in Telco world

OpenMTC Rel. 1
May 2012
- Generic communication
- Application enablement
- ETSI resource tree
- Remote management
- Integration with Telco Services

OpenMTC Rel. 2
April 2013
- New use case demos
- NSCL APIs & SDK
- Android D/GSCL
- Integration with 3GPP core network – EPC, PRCF/ANDSF, MTC-IWF
- Full REM SC, OMA DM
M2M Demo 1

- Detect mobile devices and hotspots at different locations using WiFi and Bluetooth
- Enable easy tracking of devices
- Gather statistics regarding device type, manufacturer, etc.
- Supported by a standard based M2M platform
- Usage scenarios:
  - Smart City Traffic
  - Location rating
  - Proximity marketing
M2M Demo 2

- Different stakeholder views on utility metering data
- Visualize the resource tree and metering data
- Third party access based on access rights and policies
- Enyport integration to connect various home appliances
- Policy based home automation including light, temperature, air conditioning, etc.
- Usage scenarios:
  - Utility metering
  - Value added services
  - Home Automation