Fraunhofer
FOKUS

OpenMTC

M2M Solutions for Smart Cities and the Internet of Things

www.open-mtc.org
info@open-mtc.org

March 2, 2013

Understanding M2M

Machine-to-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.

M2M communication allows organizing, tracing, and managing communicating objects while minimizing related communication costs. The concept behind M2M is not a new one. Supervisory, Control and Data Acquisition (SCADA) systems have been used in manufacturing industries since the 1970s. However, it is predicted that in the next decade the M2M market will witness accelerated growth. The forecasts regarding revenue or number of M2M connections may vary, but it is expected that there will be more objects connected to the Internet than human beings, forming a global Internet of Things (IoT).

The rapidly increasing number of connected devices is based on the advancement of the semiconductor industry that continues to reduce chipset cost and power consumption. Also, network convergence and advanced wireless networks enable the provision of broadband data services at a significantly lower cost per transferred bit. The telecommunication industry will need to face the challenges associated with the inevitable paradigm shift from Human-to-Human communication towards M2M.

The Fraunhofer FOKUS OpenMTC platform is based on latest M2M standards and provides a realistic implementation of a cross-domain horizontal M2M platform enabling fast prototyping and know-how gain through practical experimentation. Through its openness and flexibility, OpenMTC provides a hands-on shortcut in understanding M2M technology, latest standards, novel concepts, and their development.

MACHINE	-- TO --	MACHINE
Communication terminal independent of human interaction	**Network facilitating the M2M communication**	**Core network (or terminal) automating the services**

▪ Acting automatically or on remote request
▪ Managed remotely
▪ Mobile and fixed terminals
▪ Monitoring device (sensor)
▪ Actuator device (e.g. switch)
▪ Associated order of magnitude: trillion = 10^{12}
	▪ Access & core network, backhaul, application server
	▪ Enabling connectivity (AAA & security, session management, QoS, charging, mobility management)
	▪ Supporting the data traffic of terminals (e.g. for direct and infrastructure communication)
	▪ Supporting the signaling of terminals
		▪ Sensor data aggregation, processing and presentation
		▪ Data caching and interpretation
		▪ Real-time communication
		▪ Automatic decision, processing, control followed by communication with other machines through:
		  ▪ Instructions
		  ▪ Notifications

Why Open Testbeds

Trust in research results has to be gained

One of the central issues of current R&D activities is related to equipment vendors' and operators' trust in the feasibility of new research concepts for deployment in running operator environments. Feasibility studies are often requested to justify the investment in new products and application domains. This issue affects applications especially tailored for wireless environments like VoLTE, M2M, Smart Grids, eHealth, etc.

A realistic testbed, mirroring operator networks and M2M platforms, enables users to customize general and specific network and service conditions and includes the means to reproduce the experiments in a deterministic manner, thus being a tool supporting proof-of-concept implementations.

Complexity limits testbed deployments

Today, realistic operator network and M2M service testbeds are very complex. They should support one of the 3GPP access technologies – LTE, HSPA or EDGE – along with non-3GPP accesses, such as WiFi, core network mobility support, subscriber-based authentication, and authorization. In addition, several M2M area network technologies such as ZigBee or Wireless M-Bus along with M2M gateways and cloud-based network platforms enabling device abstraction and data aggregation should be supported.

Developing or gathering such functionality from multiple sources and orchestrating it in a single testbed is highly time-consuming. Fraunhofer FOKUS toolkits that manage both core network complexity and service platform diversity in an integrated manner, will allow minimizing the time required for testbed establishment and customization.

Proprietary systems make innovation difficult

One of the main factors deterring innovation in the area of operator core networks and M2M platforms is related to the prototype equipment, which is usually delivered in closed boxes with proprietary APIs. The consequence is that customized usage and extensions are only possible with considerable efforts.

There is a stringent need for an open testbed, based on software components, running on cost-efficient off-the-shelf hardware, able to provide configuration flexibility, to change the system behavior during runtime, and to realize functional extensions. Additionally, software-based testbeds can be virtualized and replicated for multiple developers, bringing the laboratory environment to individual computers.

No easy Replication of Standard Components

Especially for equipment and application developers, a testbed should implement the internal and external interfaces according to standards. For R&D laboratories, which already employ part of the components, an M2M testbed should be able to provide the missing pieces and thus to quickly realize a complete working environment. Otherwise, the means to evaluate equipment in early phases of prototyping are strenuous.

From this perspective, a testbed toolkit should provide a reference implementation of the latest version of the standards, enabling the interaction of available and future components, as well as flexible adaptation towards novel features.

Open testbeds build the know-How

Open M2M testbeds help to understand and to evaluate M2M communication technologies. A testbed mirroring the end-to-end communication network, starting from mobile devices, radio access networks, and core network up to service platforms, provides an ideal tool for demonstrations and in-depth study of the M2M and all-IP communication evolution.

Source code access enables the easy access to a practical implementation of standard components and interfaces. Through this first-hand access to ETSI, 3GPP, OMA, and oneM2M standard components, the duration of bringing developers and R&D teams up-to-date is drastically reduced.

Easily configurable software toolkit implementation

Components inspired by standards bring trust in new functionalities and features and reduce the prototyping duration. However, they do not resolve the complexity issue.

Software-based M2M toolkits can be customized to adapt to specific network conditions, through configuration files and runtime commands, enabling proof of concept and validation of novel features.

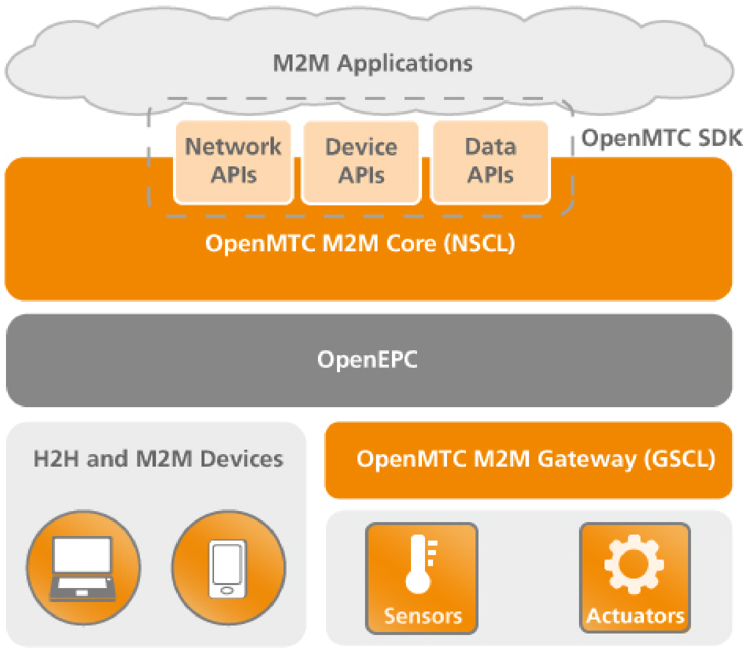
Through a modular toolkit structure, the development can be focused on the specific required items and does not have to span through the complete implementation. Existing features can be initially tested ”as they are”, to give an idea of the pitfalls that may be encountered later and to act as inspiration and guidance for further extensions, highly reducing the development time.

Fraunhofer FOKUS OpenMTC

The OpenMTC platform is a prototype implementation of an M2M middleware aiming to provide a standard-compliant platform for Smart City and M2M services. It has been designed to act as a horizontal convergence layer supporting multiple vertical application domains, such as transport and logistics, utilities, automotive, eHealth, etc., which may be deployed independently or as part of a common platform.

The OpenMTC features are aligned with the ETSI TC M2M specifications. The platform mainly consists of two service capability layers, a gateway service capability layer (GSCL) and a network service capability layer (NSCL). Those have been defined and specified by the ETSI Technical Committee M2M in [1] and [2]. OpenMTC will also support the standards that are currently produced by oneM2M [3] as an evolution of the ETSI work.

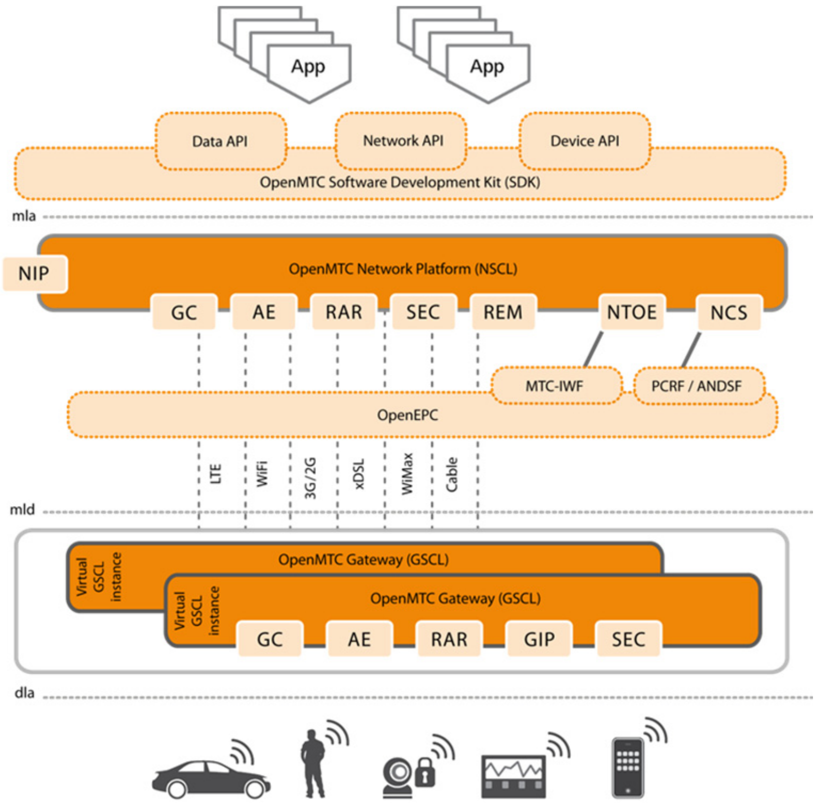
The GSCL is a flexible M2M gateway that supports various M2M area network technologies and communication protocols such as ZigBee and Wireless M-Bus. The NSCL is a cloud-based M2M platform that aggregates and stores data from various devices and acts as a device management and abstraction layer providing intuitive Application Programming Interfaces (APIs). Via the APIS and standardized data structures, fast application development can be enabled across various M2M segments such as Smart Cities, eHealth, Logistics, and Utility Metering.



OpenMTC supports a RESTful architecture with a hierarchical resource tree defined by ETSI. This style governs how M2M applications can exchange data with the OpenMTC M2M Core (NSCL) and the OpenMTC Gateway (GSCL). Each entity in the M2M system, i.e. applications, devices, data, is represented by uniquely addressable resource in the resource tree, which can be accessed and manipulated via the CRUD operations (create, retrieve, update, delete) over different transport protocols (e.g. HTTP).

Technical Background

ETSI defined three interfaces as part of the TC M2M specifications: mIa, dIa and mId, as depicted below, which offer generic and extendable mechanisms for interaction with the service capability layers (xSCL). The mIa interface resides between network applications (NA) and the NSCL; the dIa interface mediates the interactions between applications in the M2M network area, i.e. gateway applications (GA) or device applications (DA), and the GSCL; and the mId interface resides between the GSCL and NSCL.



Standard end-to-end M2M solution

In addition to the interfaces, a number of generic service capabilities have been specified providing recommendations for the logical grouping of M2M functions. OpenMTC supports the following capabilities as defined by ETSI:

- Generic Communication (GC)
- Application Enablement (AE)
- Reachability, Addressing and Repository (RAR)
- Remote Entity Management (REM)
- Interworking Proxy (IP)
- Security Capability (SEC)
- Network Communication Selection (NCS)
- Network Telco Operator Exposure (NTOE)

Communication over all interfaces is independent of the used transport protocol. HTTP is commonly used as a transport with RESTful-based services. The CRUD operations are mapped to the HTTP methods POST, GET, PUT, and DELETE. However, M2M devices are generally resource-constrained devices, i.e. they can be limited in memory, energy and computation power. Therefore, the constrained application protocol (CoAP) is currently gaining momentum to support essential features required for constrained M2M devices, such as low header overhead.

Associated software development kit (SDK)

To support the easy and quick development of innovative M2M applications, the OpenMTC toolkit provides an SDK to make the core assets and service capabilities available to third party developers. The OpenMTC SDK consists of a set of high-level APIs which hide internal system details and allow the developer to concentrate on implementing functional M2M application logic. This will stimulate the community and facilitate innovation in the telecommunications and Internet arena helping to deliver a rich application landscape in Smart Cities.

Interworking with telecommunication cores

OpenMTC optionally supports interworking with other telecommunication infrastructures, such as the IP Multimedia Subsystem (IMS) and the Evolved Packet Core (EPC). Translating the information exchanged from sensors and devices to Session Initiation Protocol (SIP) messages (either in the M2M gateway or on the NSCL layer by means of a NIP) enables the usage of IMS for various M2M applications. Through this means, the M2M communication can rely on the security, reliability, and existing deployments of IMS.

The EPC defined by 3GPP provides advanced networking capabilities such as Quality of Service (QoS), access network selection, and policy and charging control. OpenMTC can optionally rely on the OpenEPC [4] for connectivity selection management and carrier grade QoS on the mId interface.

[1] ETSI TS 102.690, "Machine-to-Machine communications (M2M); Functional architecture"

[2] ETSI TS 102.921, "Machine-to-Machine communications (M2M); mIa, dIa and mId interfaces"

[3] oneM2M [online] http://www.onem2m.org

[4] OpenEPC – Open Evolved Packet Core [online] http://www.openepc.net

More information about OpenMTC:
www.open-mtc.org

Contact the experts at:
info@open-mtc.org

Fraunhofer Institute for Open Communication Systems FOKUS
Kaiserin-Augusta-Allee 31, 10589 Berlin, Germany
www.fokus.fraunhofer.de