SCALING THE INTERNET OF THINGS

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M2M Common Service Layer in a nutshell

A software “framework”

Located between the M2M applications and communication HW/SW that provide connectivity

Provides functions that M2M applications across different industry segments commonly need (eg. data transport, security/encryption, remote software update...)

Like an “Android” for the Internet of Things
But it sits both on the field devices/sensors and in servers
And it is a standard – not controlled by a single private company
OneM2M Architecture approach

Pipe (vertical):
1 Application, 1 NW, 1 (or few) type of Device
Point to point communications

Horizontal (based on common Layer)
Applications share common service and network infrastructure

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RESTful Architecture

Reference Point
One or more interfaces - Mca, Mcn, Mcc and Mcc’ (between 2 service providers)

Common Services Entity (CSE)
Provides the set of "service functions" that are common to the M2M environments

Application Entity (AE)
Provides application logic for the end-to-end M2M solutions

Network Services Entity
Provides services to the CSEs besides the pure data transport

Node
Logical equivalent of a physical (or possibly virtualized, especially on the server side) device

Multiple protocol bindings (HTTP, CoAP, MQTT, or WebSocket)
Smart City blue print example

Cloud apps
- City Apps
- 3rd party apps
- Analytics apps

Smart city Backend
- Group mgmt
- Location
- Discovery
- Device
- Interworking

Smart city frontend
- Security
- Device mgmt

Open data (Semantics)
- W3C
- SPARQL or REST APIs

Broker
- FIWARE
- Big Data Storage
- Big Data enablers
- Container/VM Mgmt

Data center
- I/F to other IoT platforms

Field domain
- Gateway
- Device

Dashboards
- City Apps
- 3rd party apps
- Analytics apps

IOT platforms
- Big Data
- Storage

I/O interfaces
- REST APIs
- FIWARE
- Location
- Security
- Device mgmt

DMP scope
- Adapter
- Existing deployments

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Strong Implementation Base

Industry-driven Open source implementations

Examples of Commercial implementations /demos

4 interop. events so far
Metcalfe’s law

The value of a network is proportional to the square of the number of its nodes – while the cost follows a more or less linear function.
What market research says

Nearly 40 percent of economic impact requires interoperability between IoT systems

<table>
<thead>
<tr>
<th>Potential economic impact of IoT</th>
<th>Value potential requiring interoperability</th>
<th>% of total value</th>
<th>Examples of how interoperability enhances value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$11.1 trillion</td>
<td>38%</td>
<td>1.3</td>
<td>Data from different types of equipment used to improve line efficiency</td>
</tr>
<tr>
<td></td>
<td>62%</td>
<td>0.7</td>
<td>Video, cellphone data, and vehicle sensors to monitor traffic and optimize flow</td>
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<tr>
<td></td>
<td></td>
<td>0.7</td>
<td>Payment and item detection system linked for automatic checkout</td>
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<tr>
<td></td>
<td></td>
<td>0.5</td>
<td>Linking worker and machinery location data to avoid accidents, exposure to chemicals</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.4</td>
<td>Equipment usage data for insurance underwriting, maintenance, pre-sales analytics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.3</td>
<td>Multiple sensor systems used to improve farm management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.3</td>
<td>Connected navigation between vehicles and between vehicles and GPS/traffic control</td>
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<tr>
<td></td>
<td></td>
<td>0.1</td>
<td>Linking chore automation to security and energy system to time usage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0^2</td>
<td>Data from different building systems and other buildings used to improve security</td>
</tr>
</tbody>
</table>

1. Includes sized applications only, includes consumer surplus.
2. Less than $100 billion.

NOTE: Numbers may not sum due to rounding.

SOURCE: Expert interviews; McKinsey Global Institute analysis

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IoT value will come through Metcalfe’s law, **if** we keep the cost linear

Point-to-point Integrations don’t scale

Monocultures lock you in

Creating new integrations is unpredictable

Past choices restrict present action and future vision

Source: CRYSTAL project/Philips
The issue with IoT interoperability is diversity

Source: AIOTI WG3 (IoT Standardisation) – Release 2.7
An horizontal IoT approach (not necessarily a single platform) can boost the value of the network

Network value $\sim N^2(M+1)^2$

Network value $\sim (N^2(M+1))^2$
Scalability

• The network has to scale

• Scaling the IoT platform
  – Horizontal scalability
  – High throughput
  – Low latency
  – Multi tenancy
  – No single point of failure
  – Edge and cloud clusters

Daily pattern for Radius access with M2M devices, source KPN
Scaling the network

• Before 5G: add-on improvement
  – Overload control
  – Power saving mode
  – Small data transmission
  – Device triggering
  – Group communications
  – Etc.

• 5G: built-in
  • 5G value propositions
    • Enhanced mobile broadband access
    • Support for ultra-reliable and low latency communications
    • Support for massive IoT
5G core service based architecture (SBA)
Cloud native IoT

ITU News

Big Data | Cloud | IoT | Network Management | Open Source
October 24, 2017

What is ‘cloud-native IoT’ and why does it matter?
Cloud Computing Features for IoT Virtualisation

• Functional Requirements
  – Multi-tenancy
  – Massive Data Processing

• Non-functional requirements
  – High-throughput
  – High Availability
  – Low latency
    • In-memory MapReduce
    • In-memory database
    • Edge Computing
  – Security

Source E. Darmois, STF 535
Implications of IoT Virtualisation

• **Microservices.**
  IoT system architectures based on microservices must be able to support the split of monolithic services into a number of microservices
  – That are able to evolve relatively independently from each other
  – Scale separately
  – And to communicate in a safe, secure and efficient manner

• **Architectures.**
  The possibility to split of an IoT system into microservices that can be implemented by various (OSS) components

Source E. Darmois, STF 535
Features in support of virtualized IoT implementations: Microservices

• Approach
  – An architectural approach to developing applications as a set of small services, where each service is running as a separate process, communicating through simple mechanisms.
  – State-of-the-art technologies: containers, orchestration, broker, ...

• Containment
  – Errors in monolithic IoT applications may crash the whole application, errors in microservices applications cause only the corresponding microservice to collapse.

• Flexibility, Heterogeneity
  – Microservices can be deployed and scaled independently. Microservice components help address the vast heterogeneity of IoT devices.

• Technology
  – Different microservices may use different technologies (e.g., language).

• Scalability
  – PaaS and IaaS can be used for the scaling of microservices, helping the developer to focus on the IoT features.

Source E. Darmois, STF 535
Features in support of virtualized IoT implementations: Inter-Process Communication

RESTful communication

Hybrid communication

Source: E. Darmois, STF 535
**Microservices Architecture: An example**

- The component structure of the system is implementation oriented.
- Different systems come with different component arrangements.

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Open source initiatives

Collect
- fluentd
- kafka
- logstash
- beats
- Amazon Kinesis

Process
- Spark
- Flink
- Storm
- Hadoop

Store
- cassandra
- Couchbase
- HDFS
- Hadoop

Retrieve
- elasticsearch
- Solr
- Lucene

Analyse
- kibana
- Grafana

Orchestration
- Kubernetes
- Mesos
- ZooKeeper

Container
- Docker
- Rocket

Infrastructure
- openstack
- Amazon Web Services
- Microsoft Azure
- IBM BlueMix

Source: sensinov.com
Value proposition: Partitioning messages over Kafka servers and distributing consumption over a cluster of consumer machines. Real-time streaming, high throughput, no single point of failure, horizontal scalability (comm./processing), partition replication, parallel data load into Hadoop.

Source: sensinov.com
Value proposition: Run anywhere (Cloud infrastructure neutral platform), up and down autoscaling based on policies, load balancing, fault tolerance, replication control, automating deployment, management of containerized applications.
Concluding remarks

• Scaling IoT has multiple dimensions:
  – Cloud native IoT
  – Cross platform or platform federation

• We identified symbIoTe, interiot and BIG IoT as important H2020 initiatives that could lead the way to solve cross IoT platform federation
  – Need to achieve convergence around most important concepts and seek wider adoption
  – Privacy protection and GDPR might be challenging