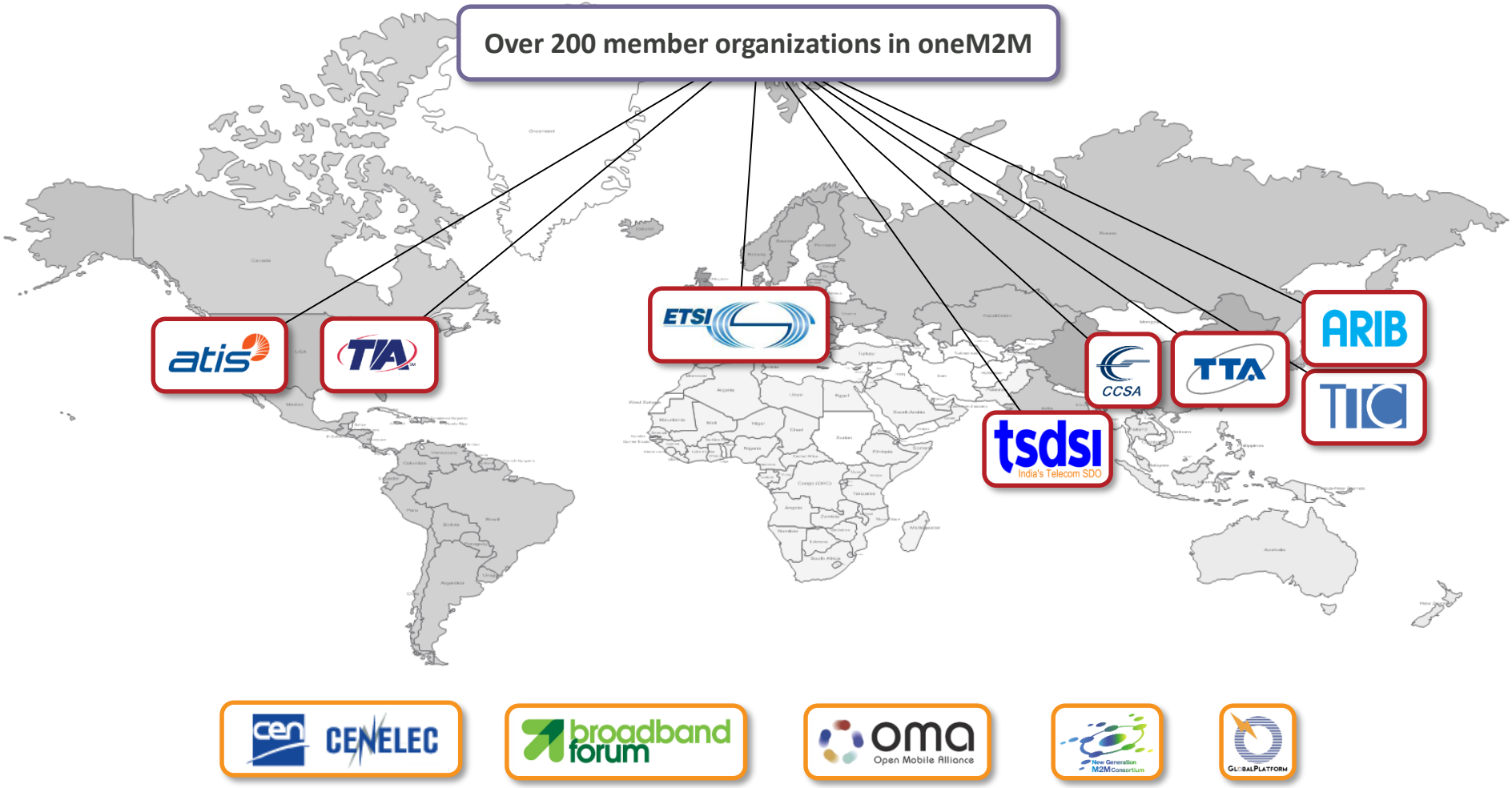
SCALING THE INTERNET OF THINGS

Presenter: Omar Elloumi, oneM2M TP Chair, Nokia Bell-Labs and CTO group
omar.elloumi@nokia.com

oneM2M www.oneM2M.org

oneM2M Partnership Project



www.oneM2M.org

All document are publically available

M2M Common Service Layer in a nutshell

A software “framework”

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

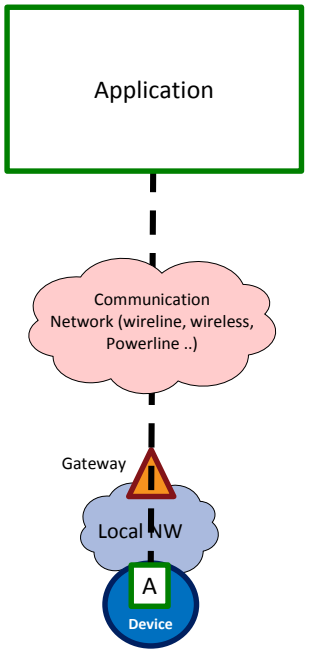
Provides functions that M2M applications across different industry segments commonly need (eg. data transport, security/encryption, remote software update...)

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

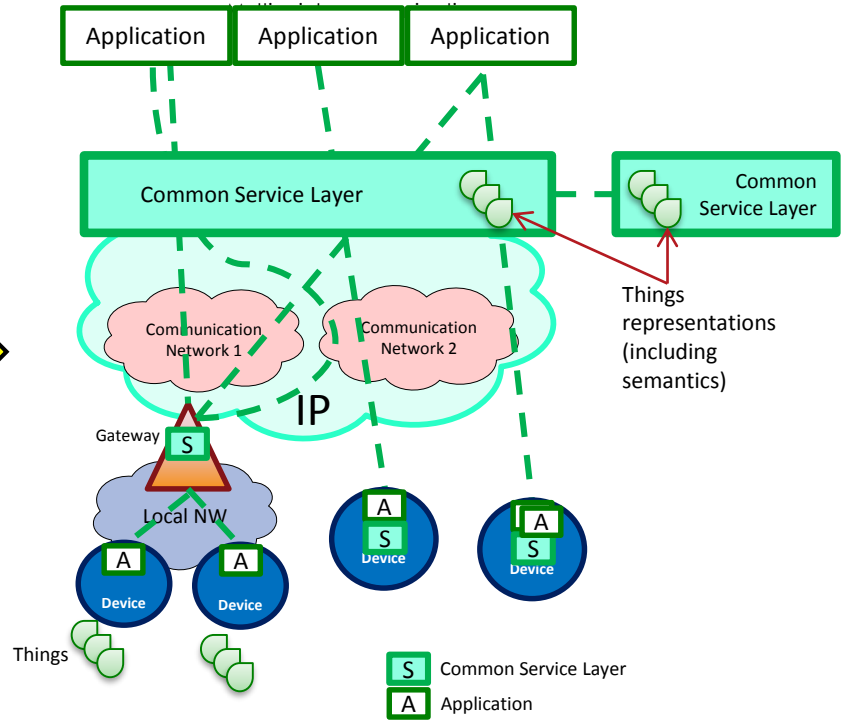
Pipe (vertical):

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



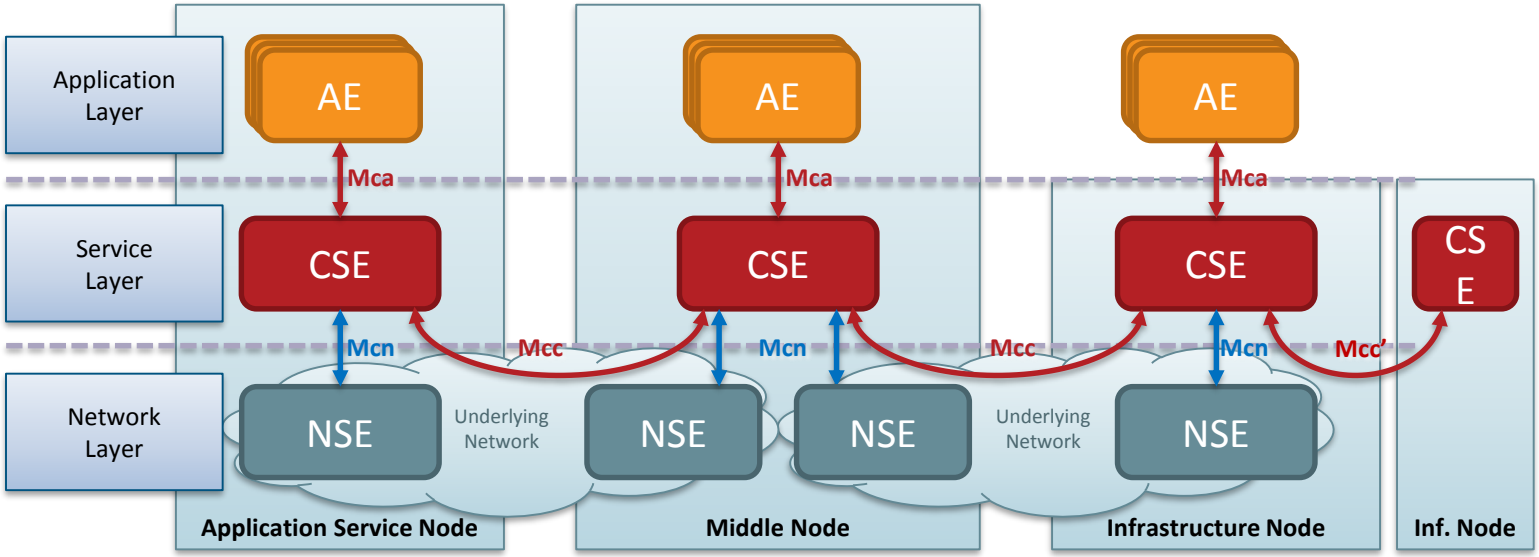
Horizontal (based on common Layer)

Applications share common service and network infrastructure



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

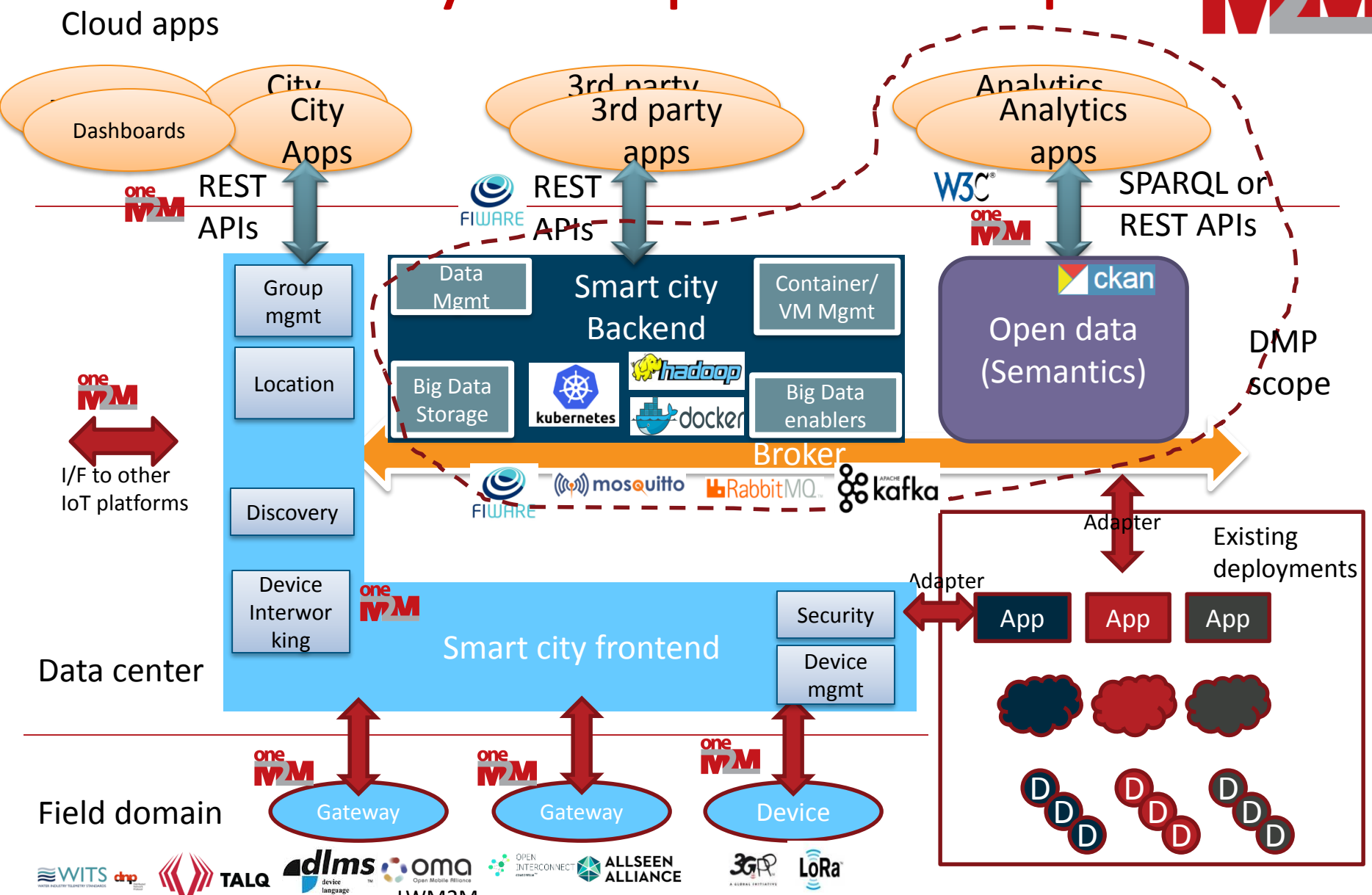


Multiple protocol bindings (HTTP, CoAP, MQTT, or WebSocket)

Common Service Functions

- Registration
- Discovery & Announcement
- Security
- Group Management
- Data Management & Repository
- Subscription & Notification
- Device Management
- Application & Service Management
- Communication Management
- Network Service Exposure
- Location
- Service Charging & Accounting
- Semantics
- Interworking

Smart City blue print example



Strong Implementation Base

Industry-driven Open source implementations

sensinov Global IoT Platform
LAAS-CNRS
OM2M Connecting things
Fraunhofer FOKUS
open mtc
KETI
OCEAN
CISCO
OPEN DAYLIGHT
IotDM
atis
OS-IoT

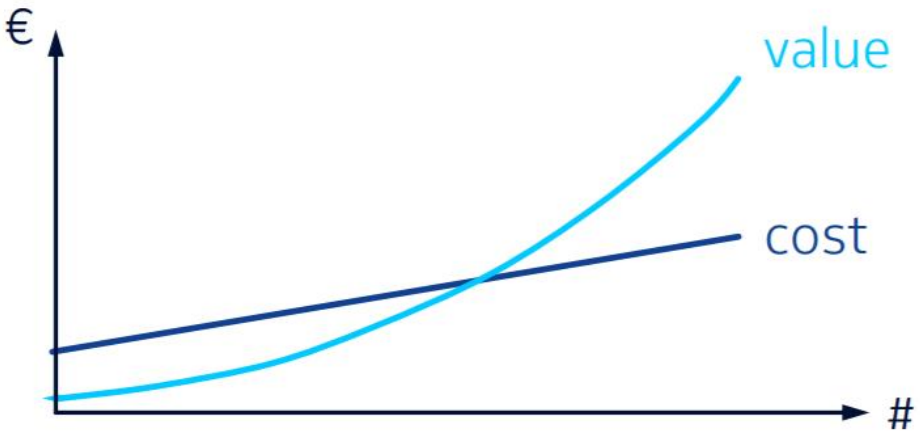
Examples of Commercial implementations /demos

सेंटर फॉर डेवलपमेंट ऑफ टेलीमैटिक्स
भारत सरकार का दूरसंचार प्रौद्योगिकी केन्द्र
सी-डॉट C-DOT
Centre for Development of Telematics
Telecom Technology Centre of Govt. Of India
LG
sensinov Global IoT Platform
InterDigital
QUALCOMM
kt
SK telecom
MODACOM
LG U+
Hewlett Packard Enterprise
HUAWEI
PILOT THINGS
SIERRA WIRELESS
Creative Convergence ntels
KEPCO

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

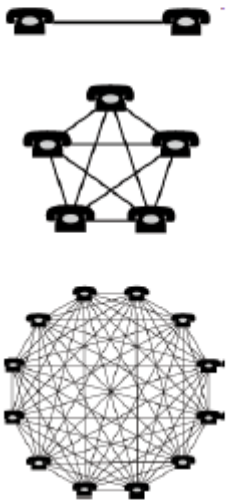
Value potential requiring interoperability ($ trillion)		% of total value	Examples of how interoperability enhances value
Factories	1.3	36	Data from different types of equipment used to improve line efficiency
Cities	0.7	43	Video, cellphone data, and vehicle sensors to monitor traffic and optimize flow
Retail environments	0.7	57	Payment and item detection system linked for automatic checkout
Work sites	0.5	56	Linking worker and machinery location data to avoid accidents, exposure to chemicals
Vehicles	0.4	44	Equipment usage data for insurance underwriting, maintenance, pre-sales analytics
Agriculture	0.3	20	Multiple sensor systems used to improve farm management
Outside	0.3	29	Connected navigation between vehicles and between vehicles and GPS/traffic control
Home	0.1	17	Linking chore automation to security and energy system to time usage
Offices	0[2]	30	Data from different building systems and other buildings used to improve security

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

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

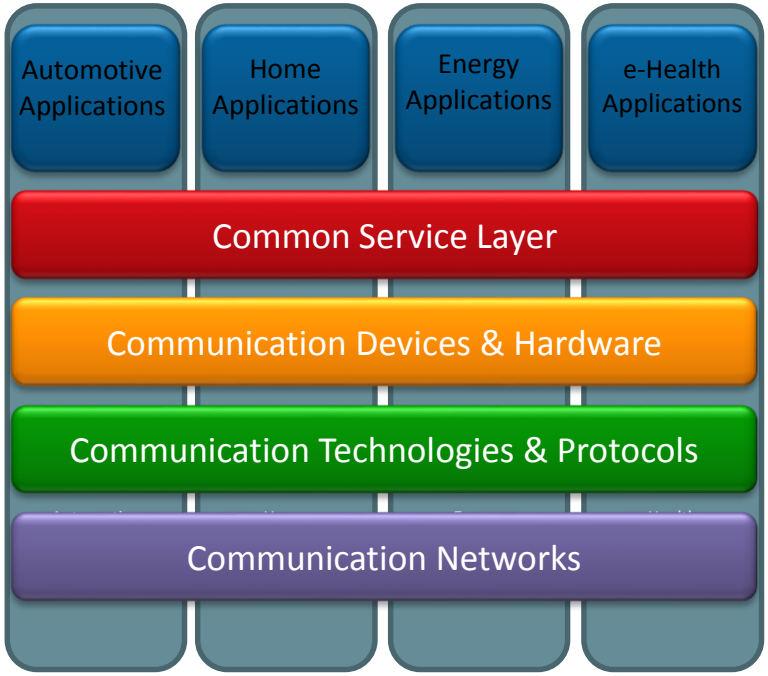
Point-to-point Integrations don't scale



Creating new integrations is unpredictable

Monocultures lock you in

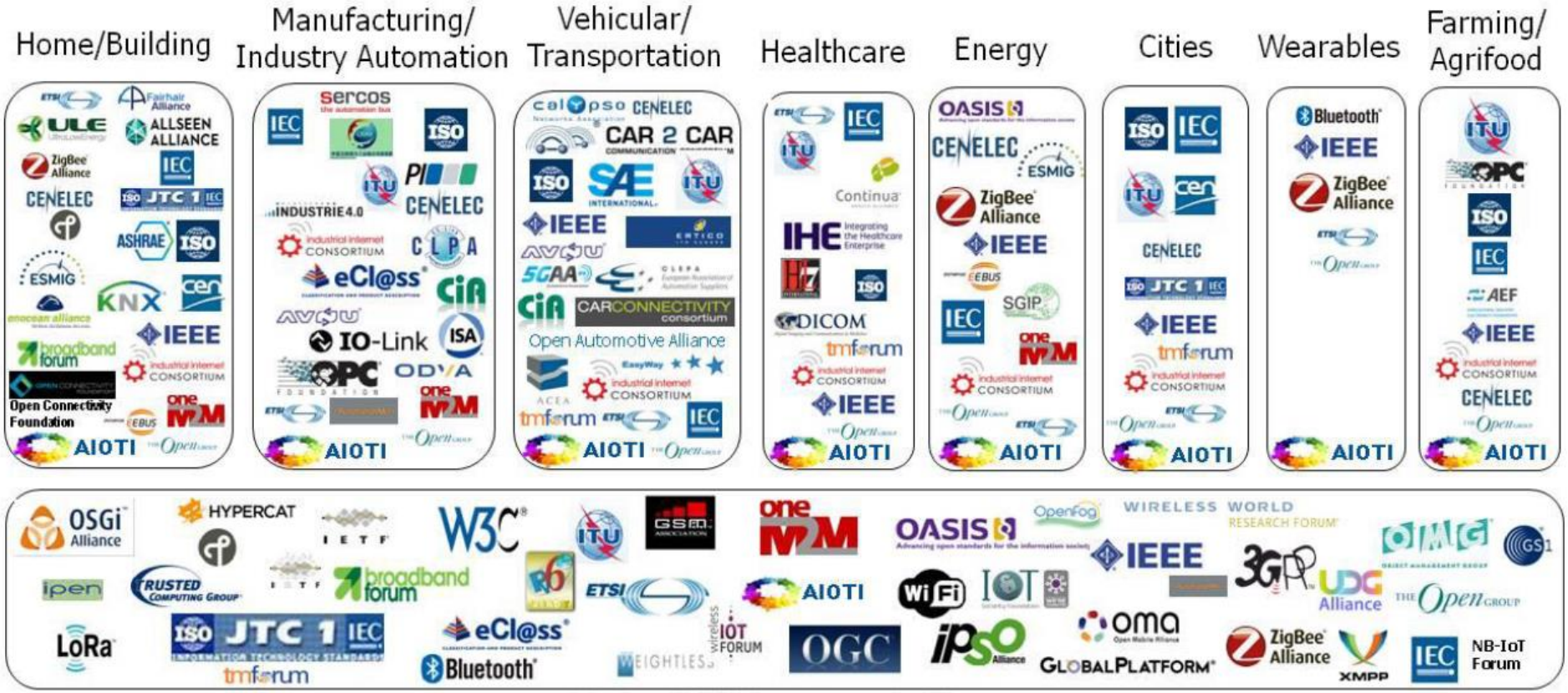
Past choices restrict present action and future vision



Platform based integration
open standards and open source are key

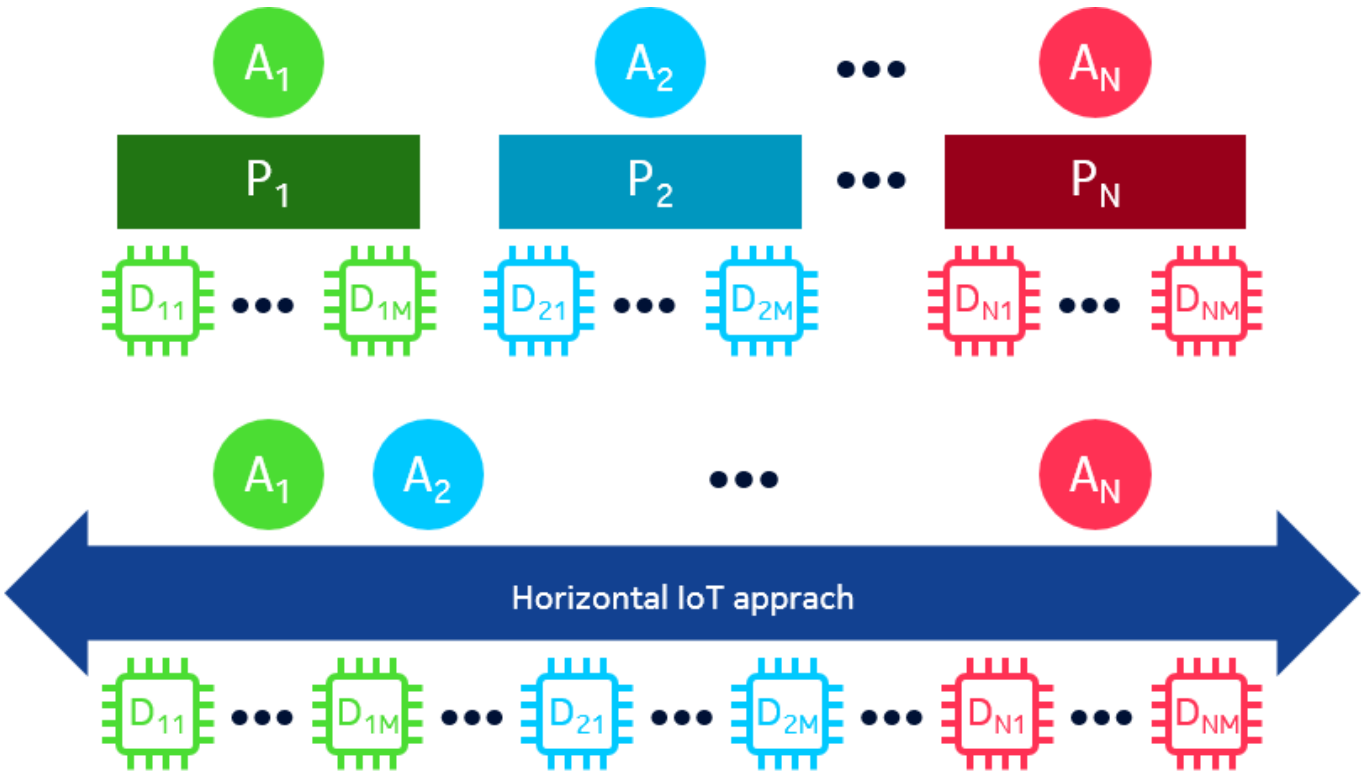
Source: CRYSTAL project/Philips

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 ~

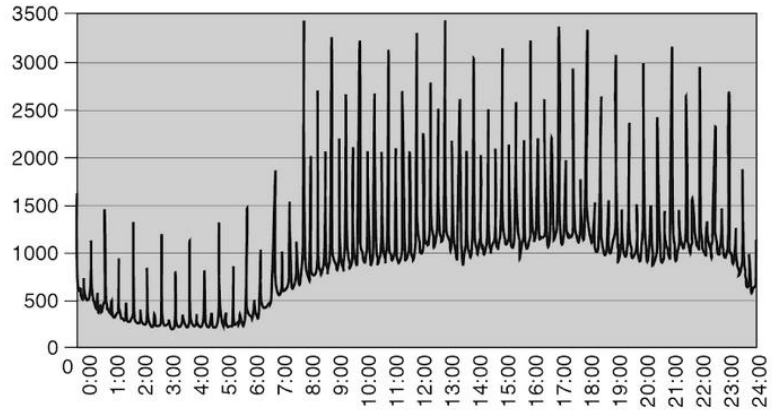
$$N*(M+1)^2$$

Network value ~

$$(N*(M+1))^2$$

Scalability

- The network has to scale



Daily pattern for Radius access with M2M devices, source KPN

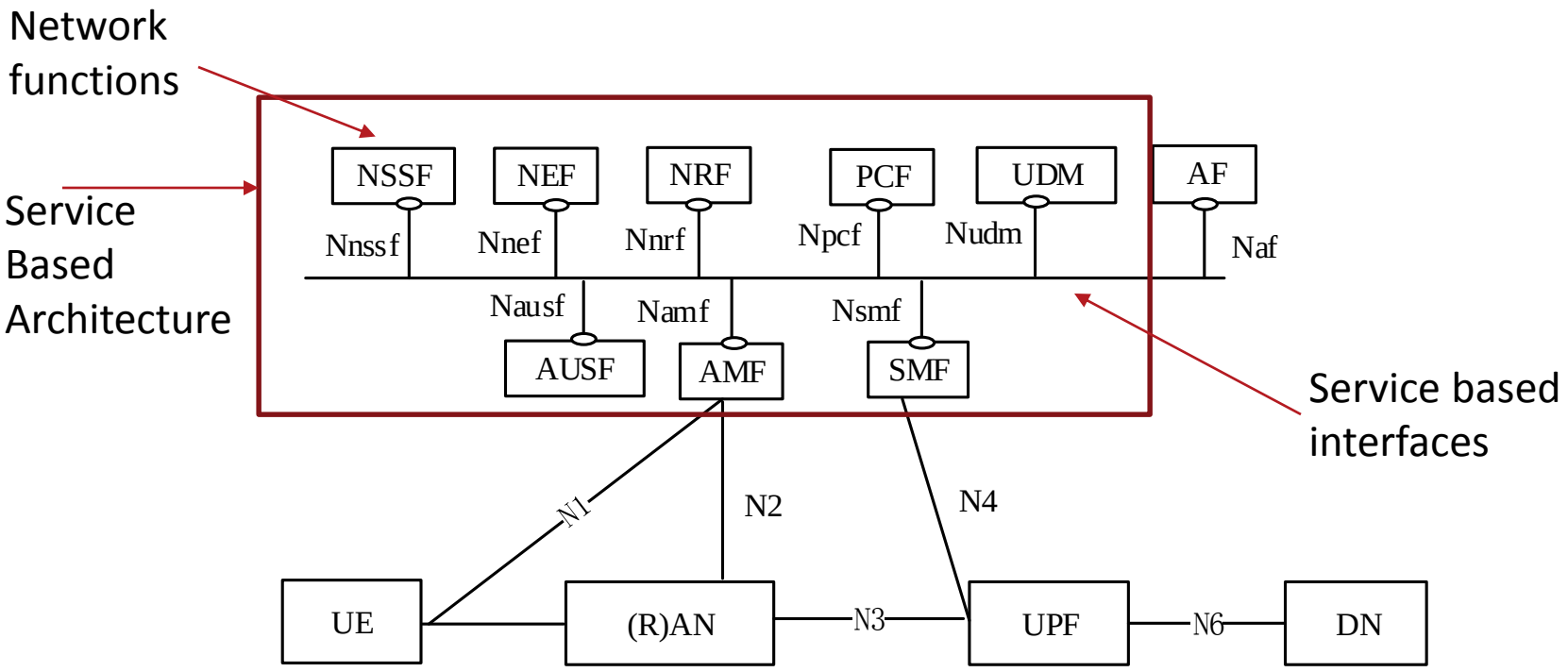
- Scaling the IoT platform
  - Horizontal scalability
  - High throughput
  - Low latency
  - Multi tenancy
  - No single point of failure
  - Edge and cloud clusters

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

ITUNews

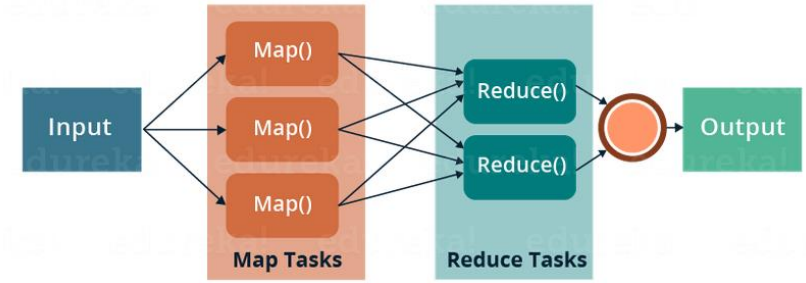
Big Data | Cloud | IoT | Network Management | Open Source

October 24, 2017

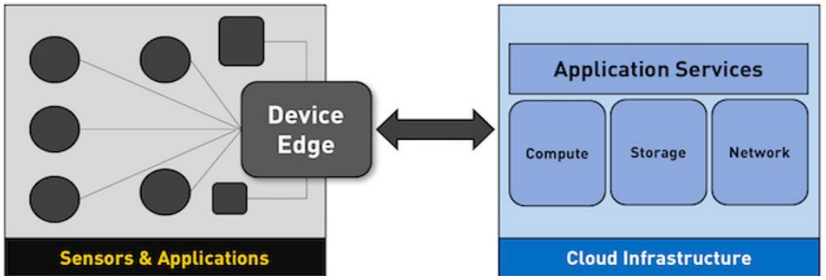
What is 'cloud-native IoT' and why does it matter?

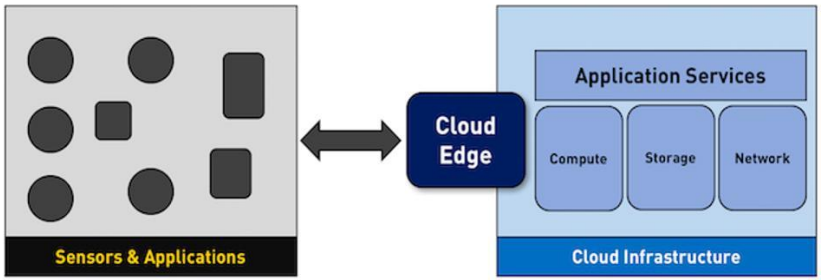
Cloud Computing Features for IoT Virtualisation

- 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

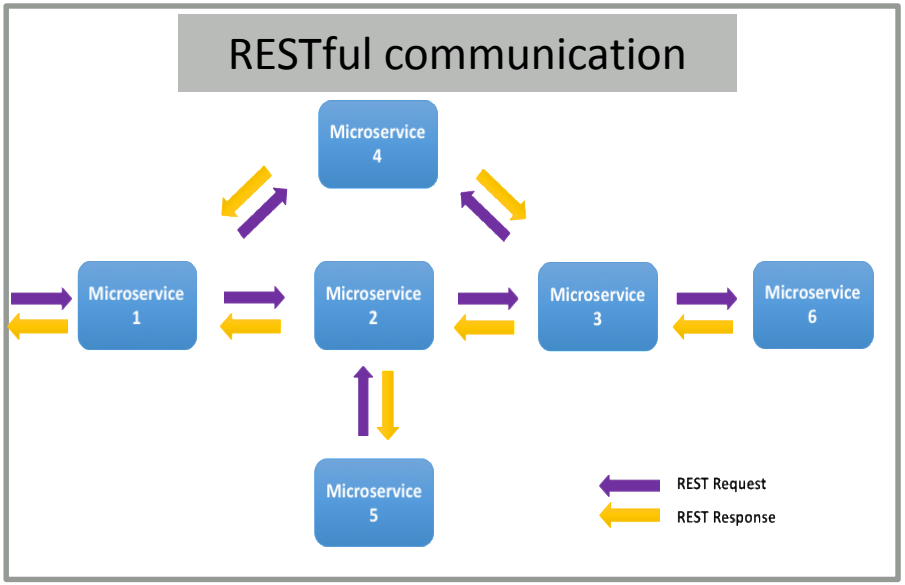
Source E. Darmois, STF 535

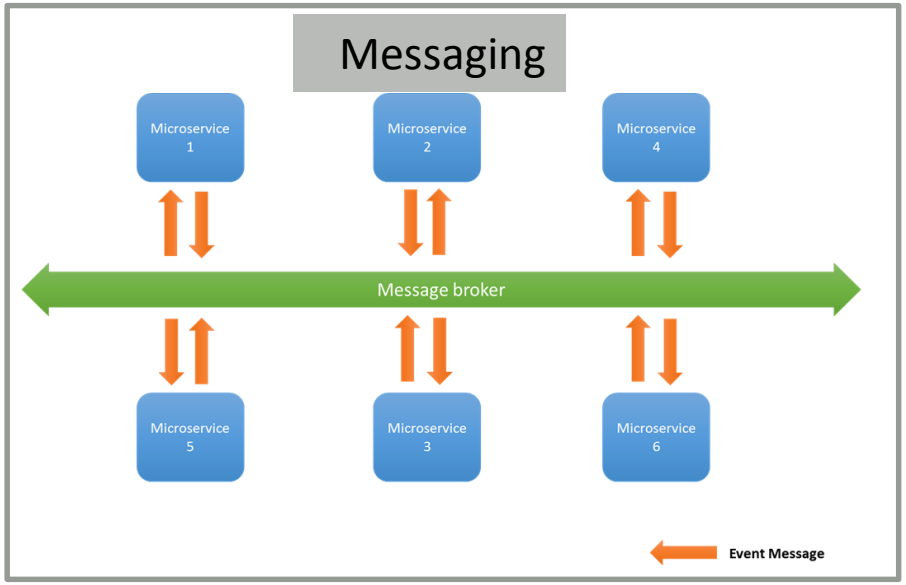
Features in support of virtualized IoT implementations: Microservices

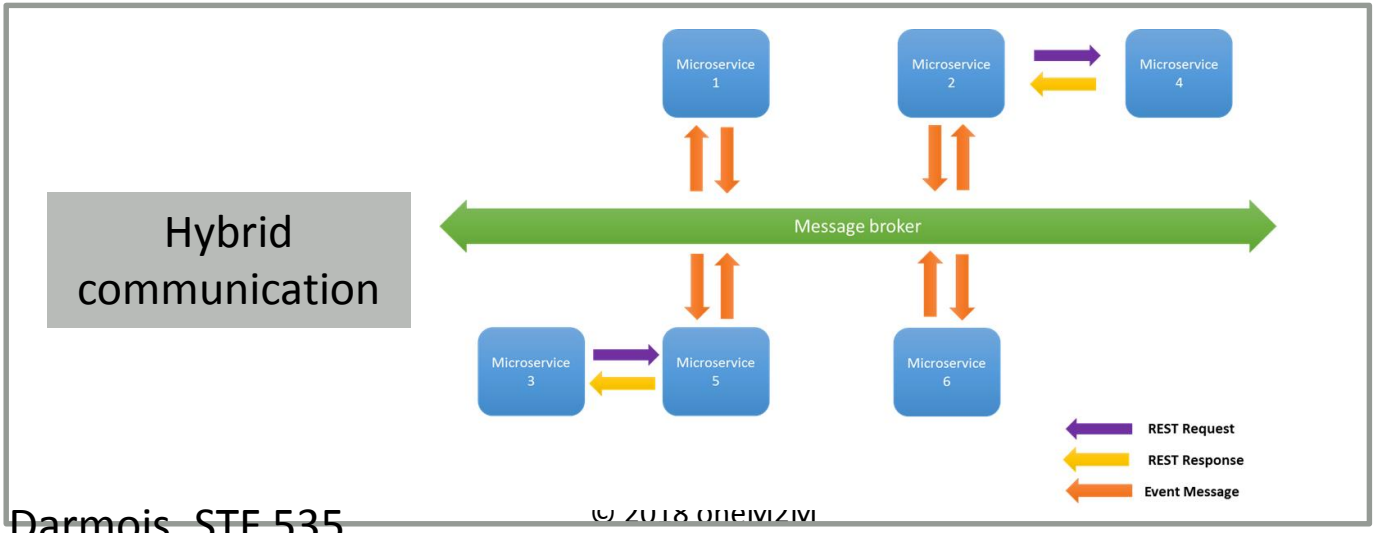
- Approach
  - An architectural approach to developing applications as a set of small services, where each service is running as a separate process, communicating through simple mechanisms.
  - State-of-the-art technologies: containers, orchestration, broker, …
- Containment
  - Errors in monolithic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

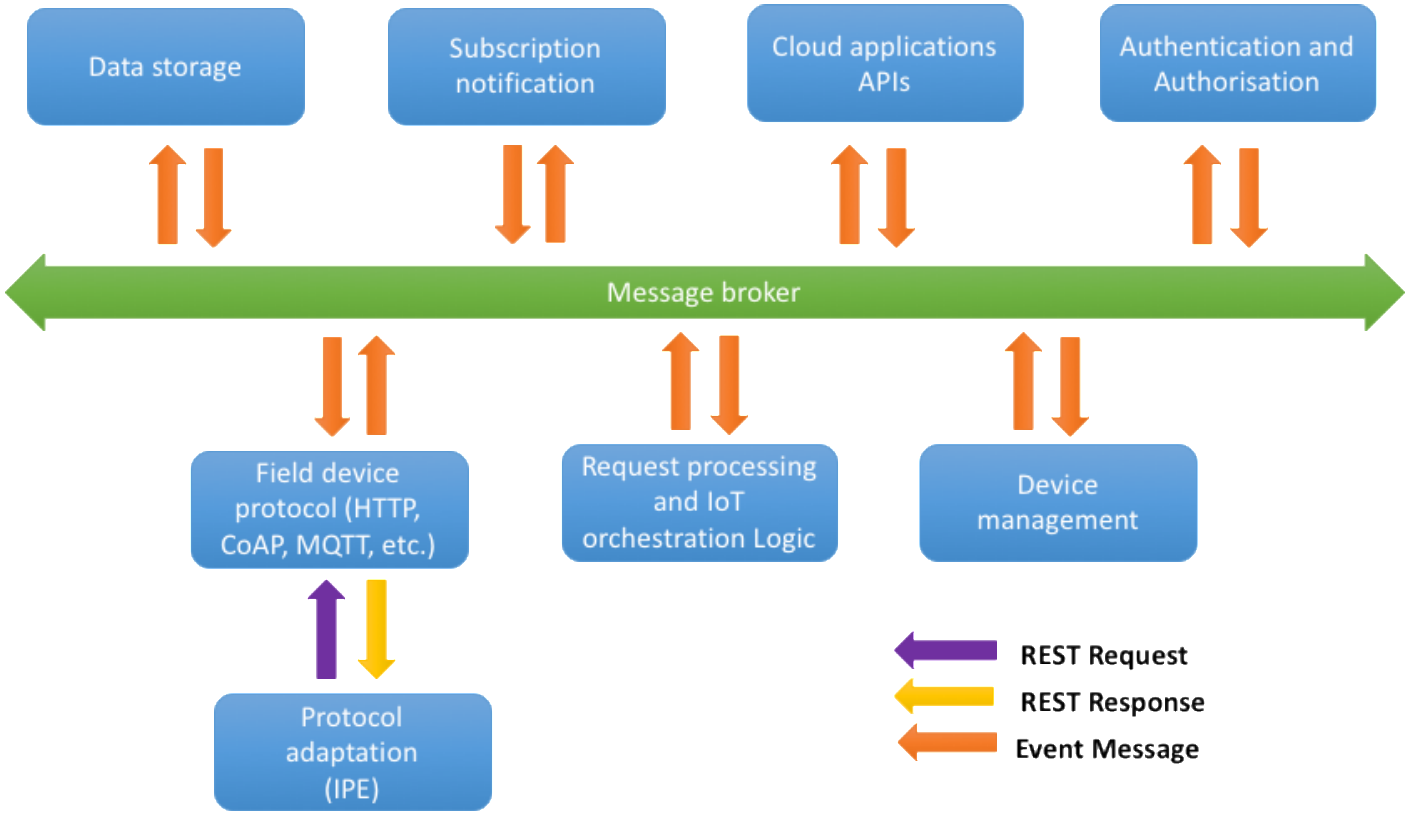






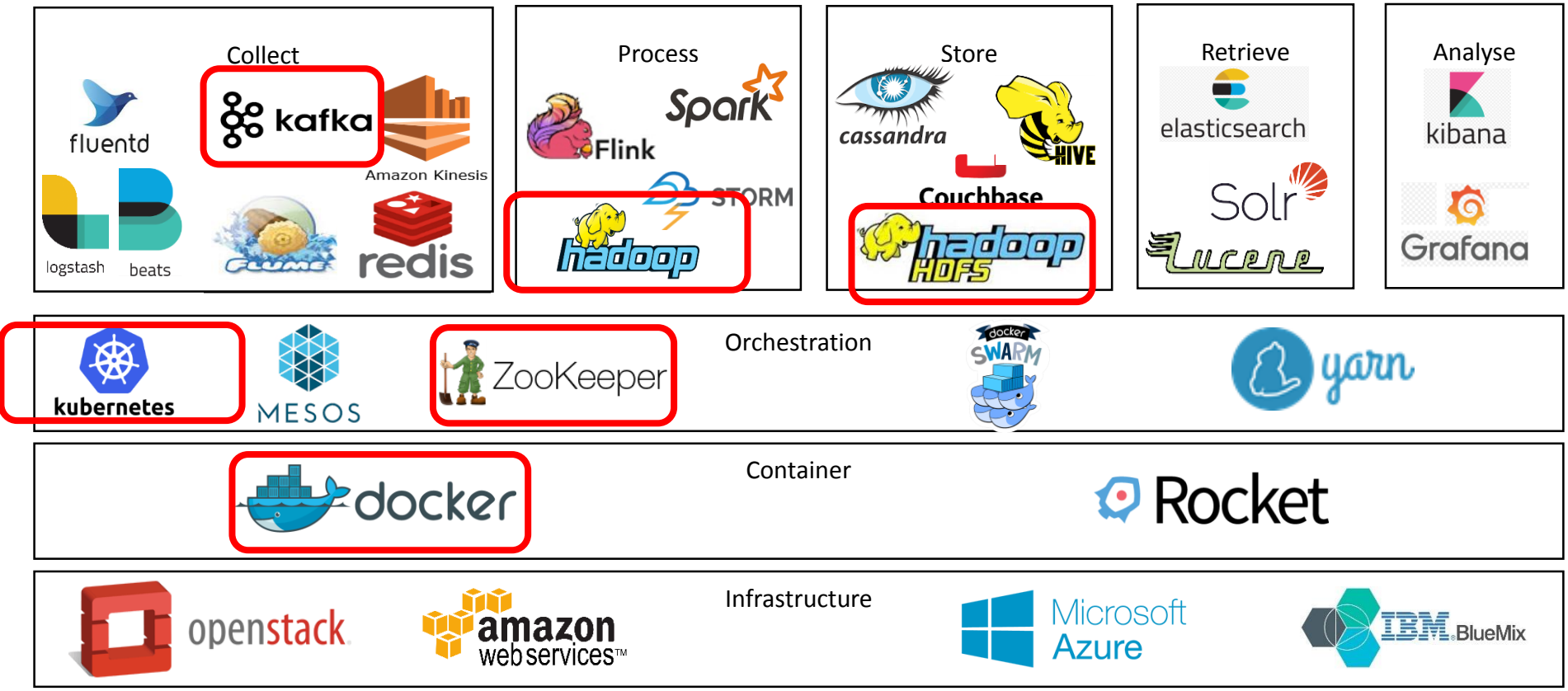
Source E. Darmois, STF 535

Microservices Architecture: An example



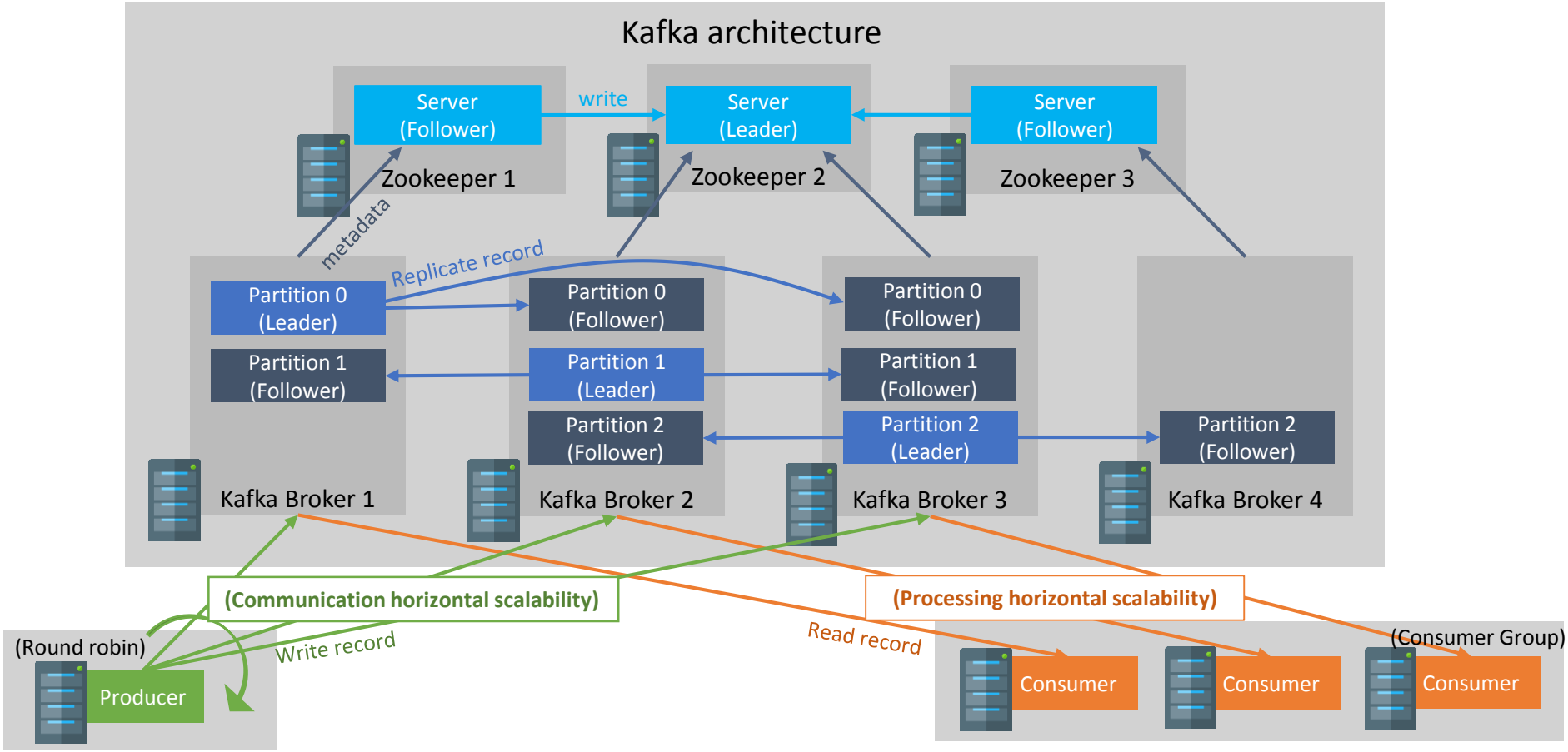
- The component structure of the system is implementation oriented
- Different systems come with different component arrangements

Open source initiatives



Source: sensinov.com

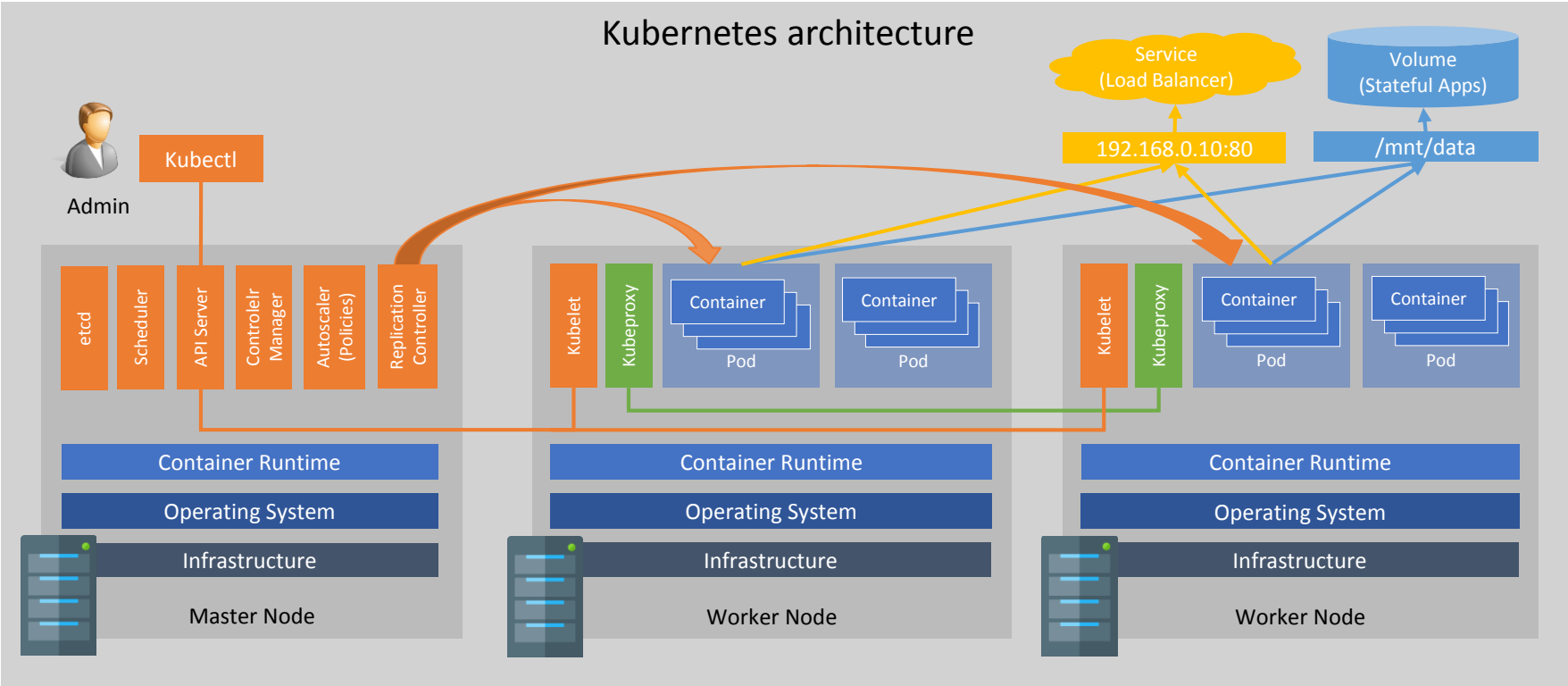
Zoom on Kafka, ZooKeeper



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

Zoom on Kubernetes, Docker



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