5G System and Service Providers (SP)
New Services
Data-centric approach

to

LF Edge Akraino
API TSC Sub-committee

Ike Alisson
LF Edge Akraino Documentation Sub-committee
TSC Chair
2021-02-19 Rev PA10

Table of Contents

Introduction

Two (2) Questions on APIs & Data-centric Platforms/Systems/Solutions

Nr. 1 Functional Process - **HOW?**

Nr. 2 Purpose / Intent - **WHAT?**

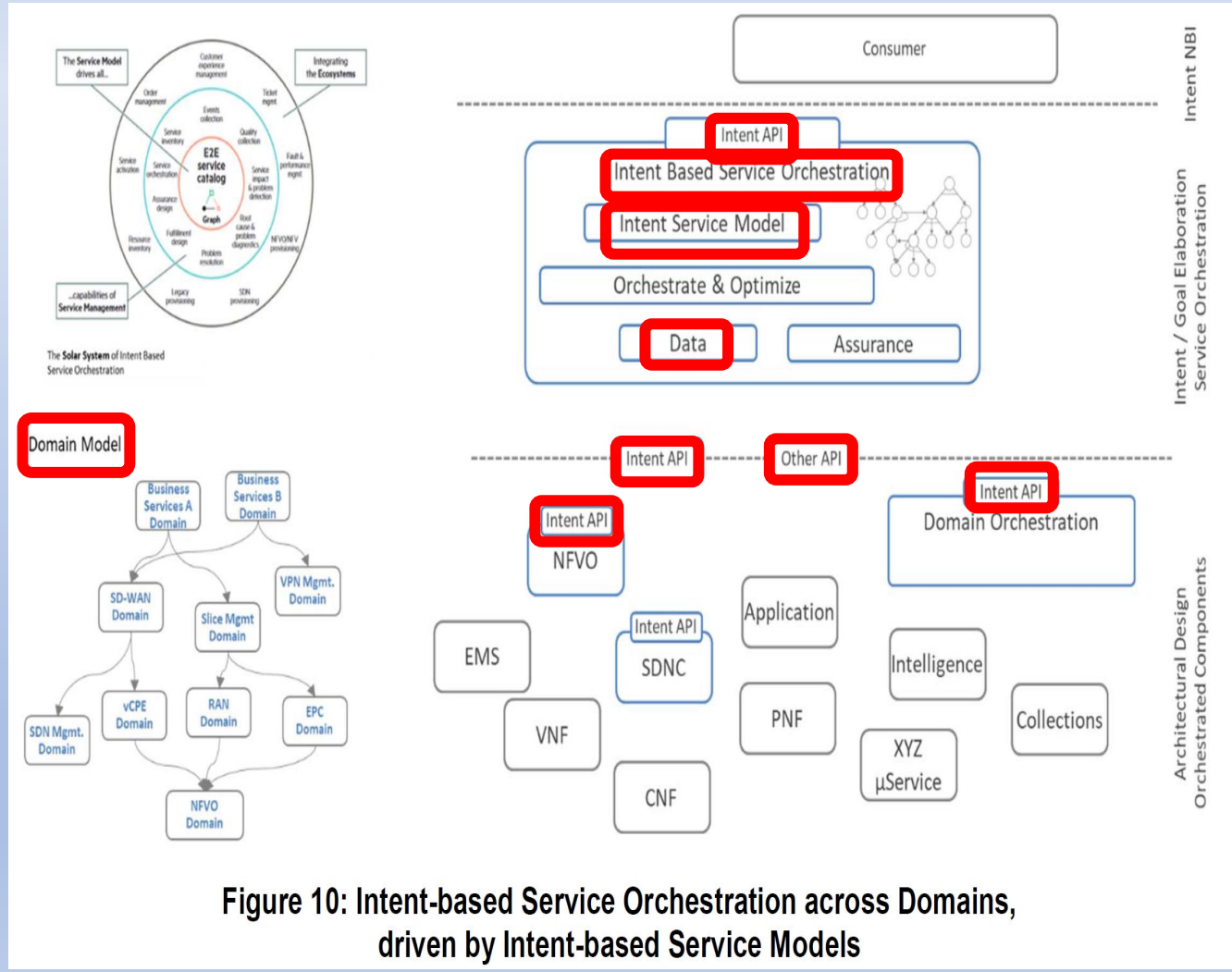


Figure 10: Intent-based Service Orchestration across Domains, driven by Intent-based Service Models

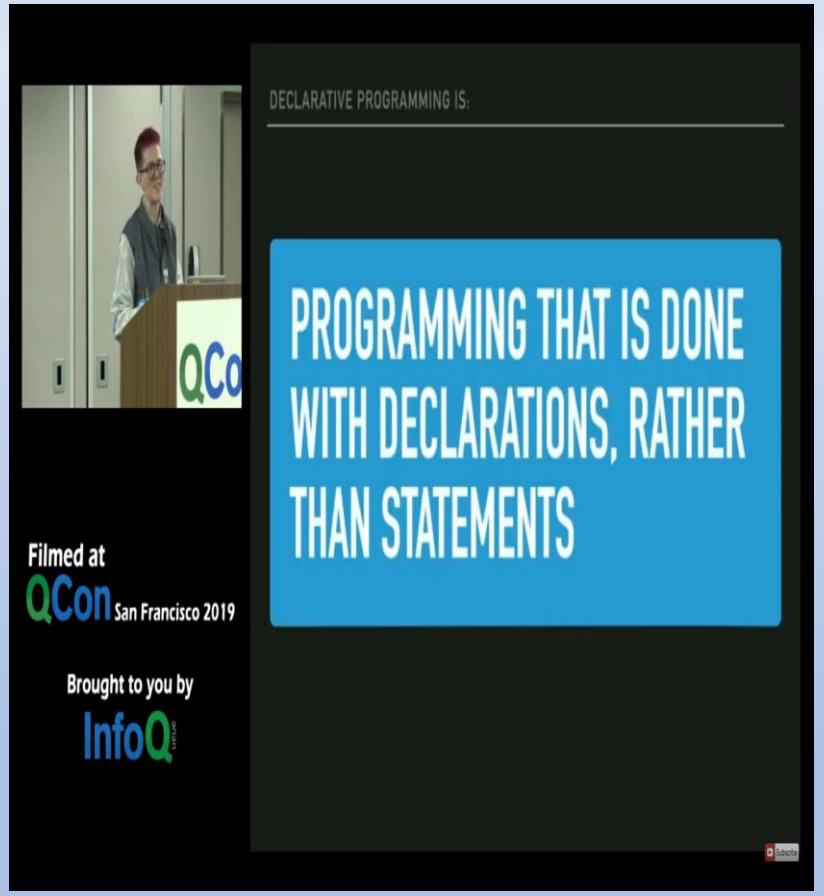
Ref: ETSI ZSM GR 005 Means of Automation May 2020: 22, 26

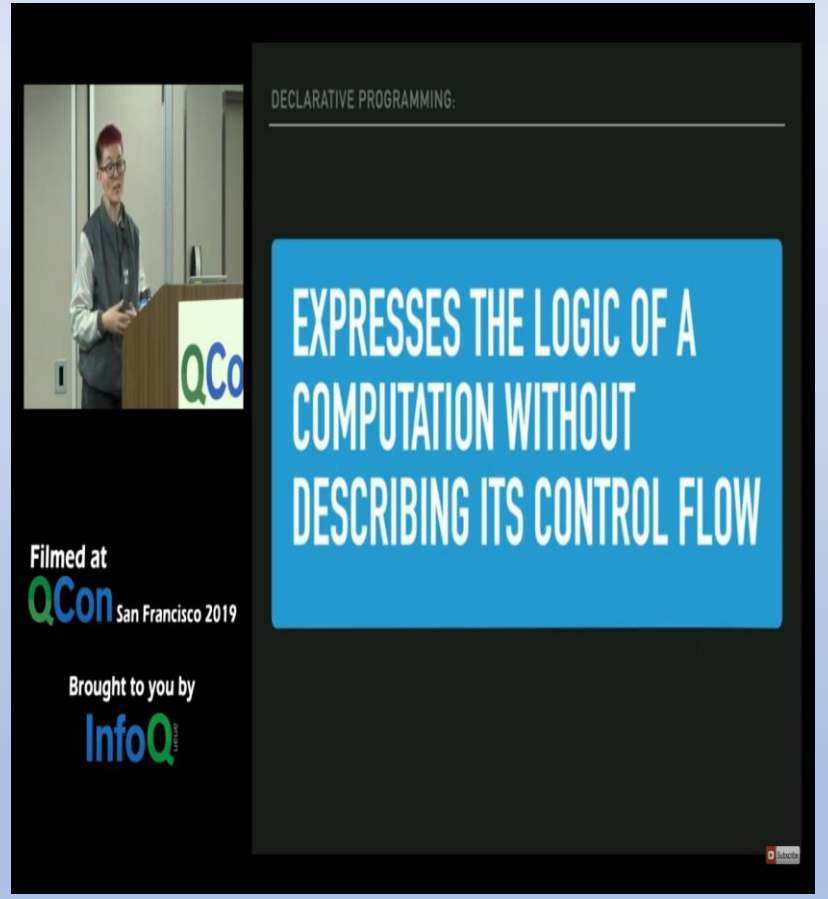
Two (2) Questions on APIs:

Nr. 1 APIs: Type and Functions - **HOW?**

APIs

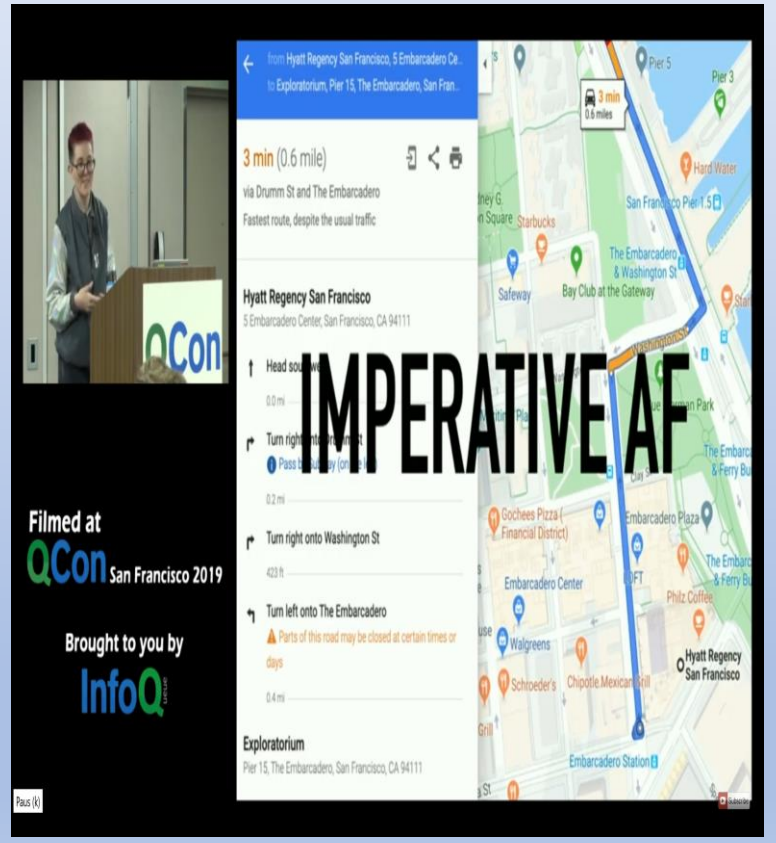
1. Declarative APIs & YAML - 1



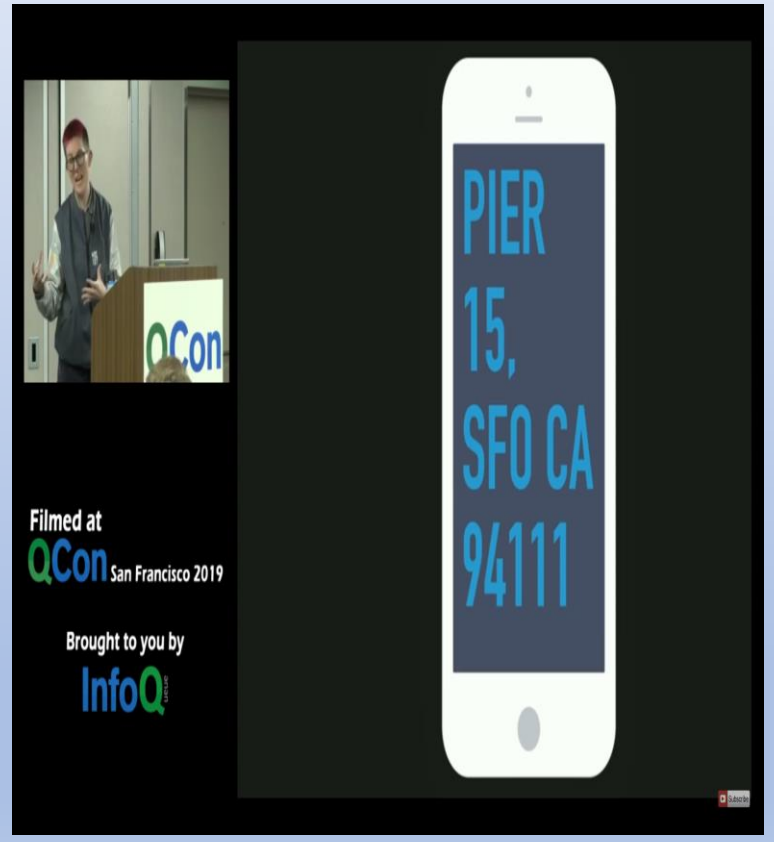


1. Declarative APIs & YAML - 2

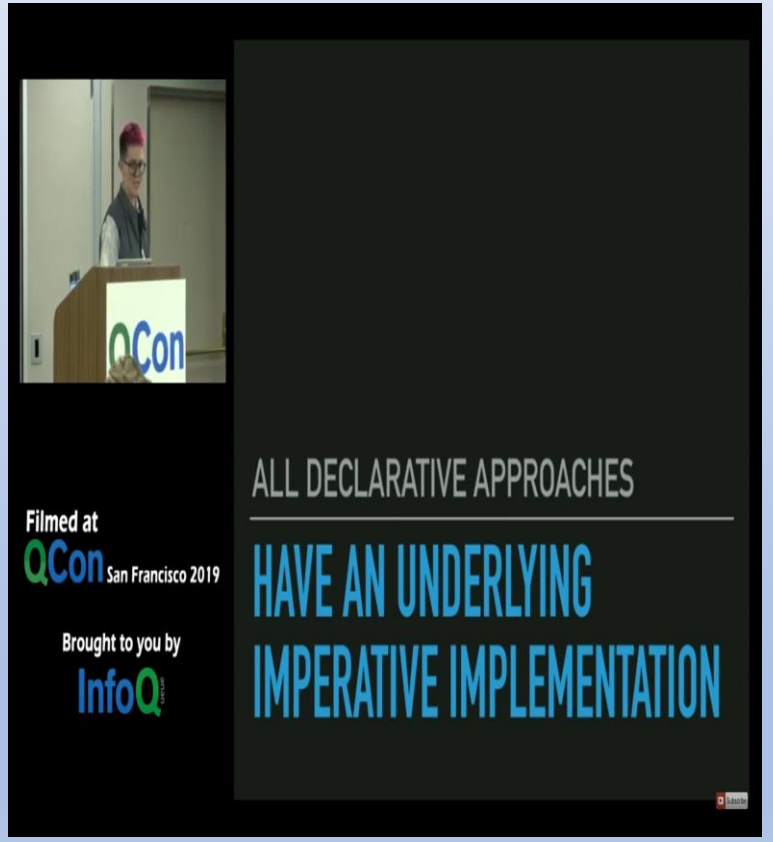
1. Imperative



2. Declarative



3. All Declarative Approaches have Imperative Implementation



1. Declarative APIs & YAML - 4

Declarative Kubernetes Lifecycle Management with Kubernetes Cluster API v1alpha1

Kubernetes Declarative API

Cluster API is a Declarative API Specification.

Cluster API is the API Specification that helps provide **Uniform and Consistent Management for Kubernetes Clusters** regardless of the underlying Infrastructure.

For v1alpha1, the API comprises 5 Custom Resource Definitions (CRDs):

1. Cluster,
2. Machine,
3. Machine Set,
4. Machine Deployment, and
5. Machine Class. Kubernetes

Declarative APIs & YAML - 3

1. The Non-RT RIC is deployed in a **Service Management & Orchestration Framework (SMO)** & provides **Declarative Policy Guidance** for Cell-level Optimization by providing the optimal configuration values for cell parameters over the O1 Interface.

2. The Non-RT RIC also **sends Declarative Policies** for UE-level optimization to the Near-RT RIC via the A1 interface.

3. The Near-RT RIC then translates the recommended **Declarative Policy** from the Non-RT RIC over A1 interface into per-UE Control and **imperative policy over the E2 interface**.

4. The Non-RT RIC develops **ML/AI-driven Models** for Policy Guidance and non-RT Optimization as rApp Microservices.

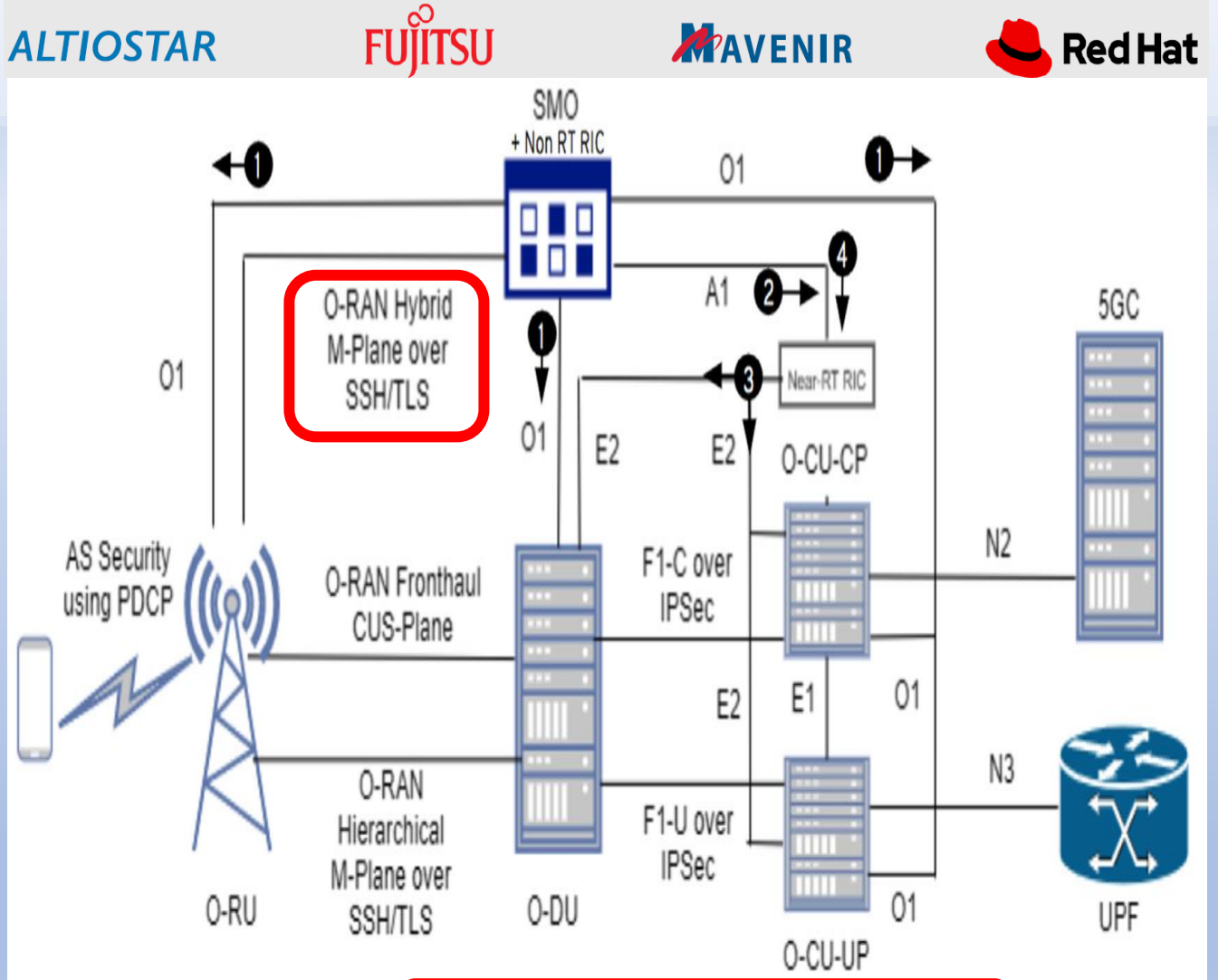


Fig. 6: Non-Real-Time RIC Declarative Policies and Objective Intents

1. Declarative APIs & YAML - 4a

The OS Virtualisation Technology allows partially shared execution Context for different Containers. Such a shared Execution Context is frequently referred to as a Container Pod.

In addition to Hypervisor-based Execution Environments that offer HW Abstraction & Thread Emulation Services, **the OS Container Execution Environment provides Kernel Services that include:**

1. **Process Control.** EXAMPLE 1: OS process creation; scheduling; wait and signal events; termination.
2. **Memory Management.** EXAMPLE 2: Allocation and release of regular and large pages; handling memory- mapped objects and shared memory objects.
3. **File System Management.** EXAMPLE 3: Creation, removal, open, close, read and write file objects.
4. **Device Management.** EXAMPLE 4: Request, release, configuration and access.
5. **Communication Services.** EXAMPLE 5: *Protocol Stack Services,* Channel Establishment and Release, PDU Transmission and Reception.
6. **System Information Maintenance.** EXAMPLE 6: Time and date, system and OS Resource Data, performance and fault indicators.

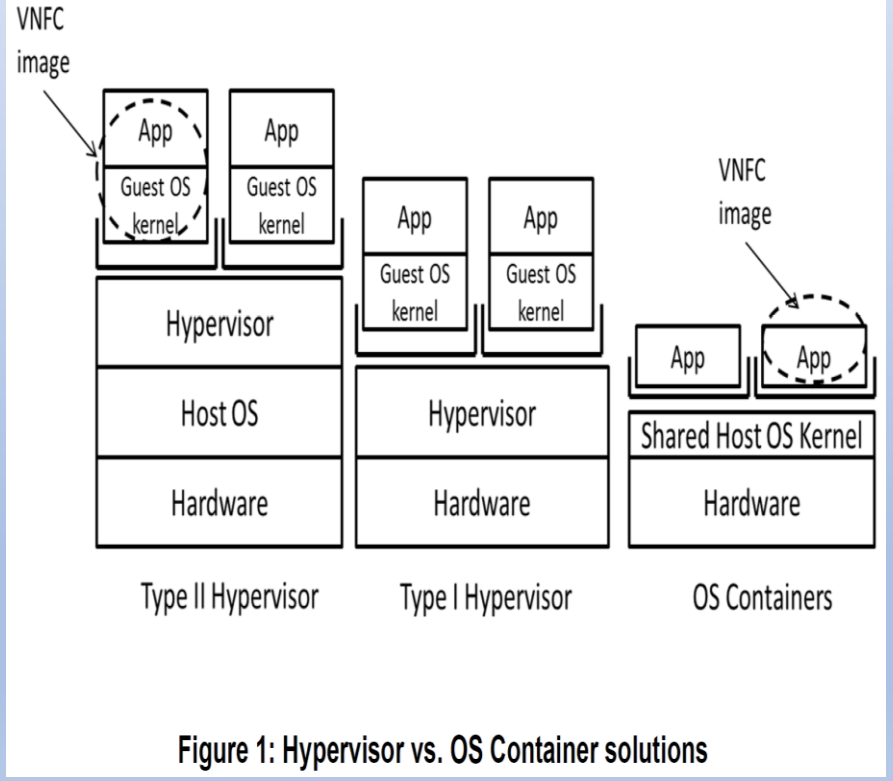


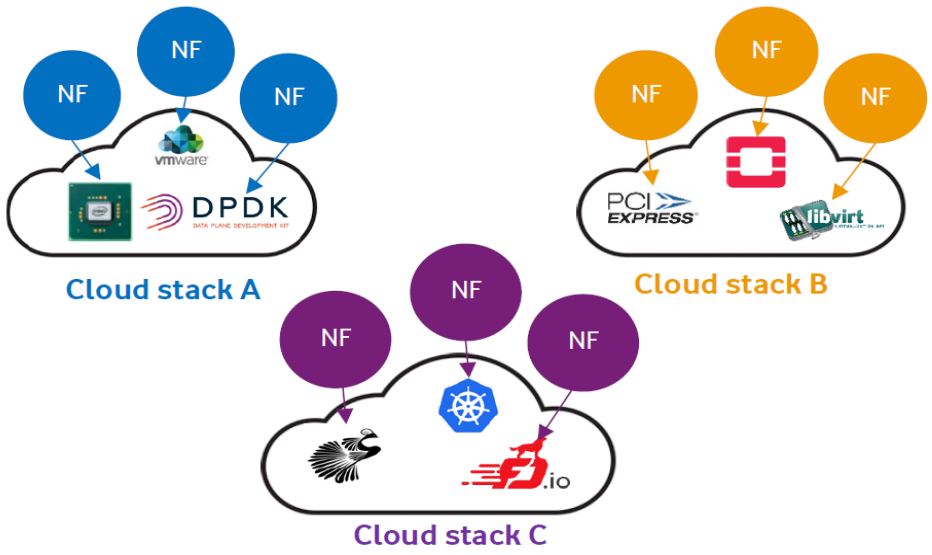
Figure 1: Hypervisor vs. OS Container solutions

OS Virtualisation provides Storage Abstraction on File System Level rather than on Block Device Level.

Each container has its separate file system view, where the guest file system is typically separated from the host file system. Containers within the same pod might share file systems where modifications made in one container are visible in the others.

1. Declarative APIs & YAML - 4b

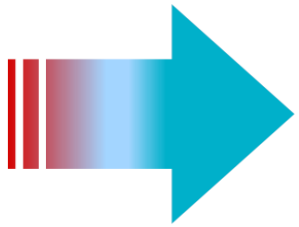
Anuket | Problem Statement



Many combinations

=

silo deployments



NF Vendor A

NF Vendor B

NF Vendor C

Cloud native VNFs

Infrastructure Abstraction

(Common Shared Infrastructure)

- ✓ Reduced TCO
- ✓ Consistent Operating Model
- ✓ Better Utilized Infrastructure
- ✓ Scalable
- ✓ Easy to automate
- ✓ Unified Verification and Testing

1. Declarative APIs & YAML - 5

ETSI GS MEC 009 V2.2.1 (2020-10)

Multi-access Edge Computing (MEC);
General principles, patterns and common aspects of MEC Service APIs

1. Declarative APIs & YAML - 6

ETSI ISG MEC
World Class Standards

5.3 Provision of an OpenAPI definition

An ETSI ISG MEC GS defining a RESTful MEC service API should provide a supplementary description file (or supplementary description files) compliant to the OpenAPI specification [i.14], which inherently include(s) a definition of the data structures of the API in JSON schema or YAML format. A description file is machine readable facilitating content validation and autocreation of stubs for both the service client and server. A link to the specific repository containing the file(s) shall be provided. All API repositories can be accessed from https://forge.etsi.org. The file (or files) shall be informative. In case of a discrepancy between supplementary description file(s) and the underlying specification, the underlying specification shall take precedence.

5.4 Documentation of the API data model

5.4.1 Overview

Clause 5.4 and its clauses specify provisions for API data model documentation for ETSI ISG MEC GSs defining RESTful MEC service APIs. Clause 5 in annex D provides a related data model template.

The data model shall be defined using a tabular format as described in the following clauses. The name of the data type shall be documented appropriately in the heading of the clause and in the caption of the table, preferably as defined in clause 5.2.2 and in annex D.

1. Declarative APIs & YAML - 7

What is APIs YAML: Machine Readable Specification

YAML 1.2 is a superset of JSON (JavaScript Object Notation) with some built-in advantages, e.g.

YAML can

- Self-reference,
- **Support Complex Datatypes,**
- Embed Block Literals,
- Support comments, and more.

YAML tends to be more readable than JSON.

1. Declarative APIs & YAML - 8

OpenAPI Specification

Version 3.0.3

4.2 Format

An OpenAPI document that conforms to the OpenAPI Specification is itself a JSON object, which may be represented either in JSON or YAML format.

In order to preserve the ability to round-trip between YAML and JSON formats, YAML version 1.2 is *RECOMMENDED* along with some additional constraints.

Note: While APIs may be defined by OpenAPI documents in either YAML or JSON format, the API request and response bodies and other content are not required to be JSON or YAML.

Swagger Supported by SMARTBEAR Why Swagger? Tools Resources

OpenAPI Specification

Version 3.0.3

Format

An OpenAPI document that conforms to the OpenAPI Specification is itself a JSON object, which may be represented either in JSON or YAML format.

In order to preserve the ability to round-trip between YAML and JSON formats, YAML version 1.2 is RECOMMENDED along with some additional constraints.

Note: While APIs may be defined by OpenAPI documents in either YAML or JSON format, the API request and response bodies and other content are not required to be JSON or YAML.

Access Context Manager documentation

Access Context Manager allows enterprises to configure access levels which map to a policy defined on request attributes. Learn more

Guides

Quickstart

Creating a basic access level

Managing access levels

IAM Roles for Administering Access Context Manager

Creating an access policy

Reference

Access level attributes

Example YAML for an access level

Custom access level specification

REST API

RPC API

Resources

Quotas and limits

Release Notes

Pricing

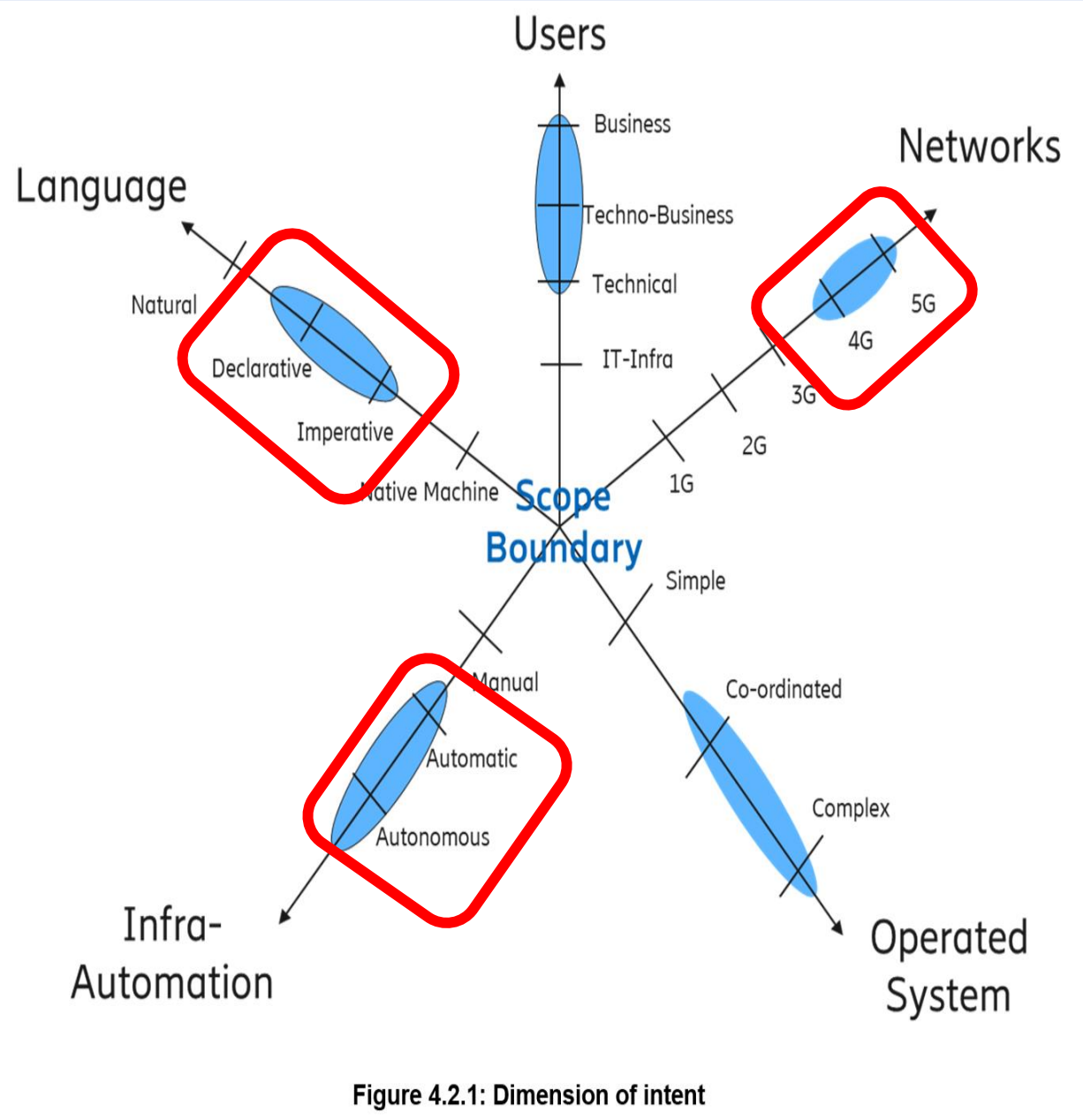


Figure 4.2.1: Dimension of intent

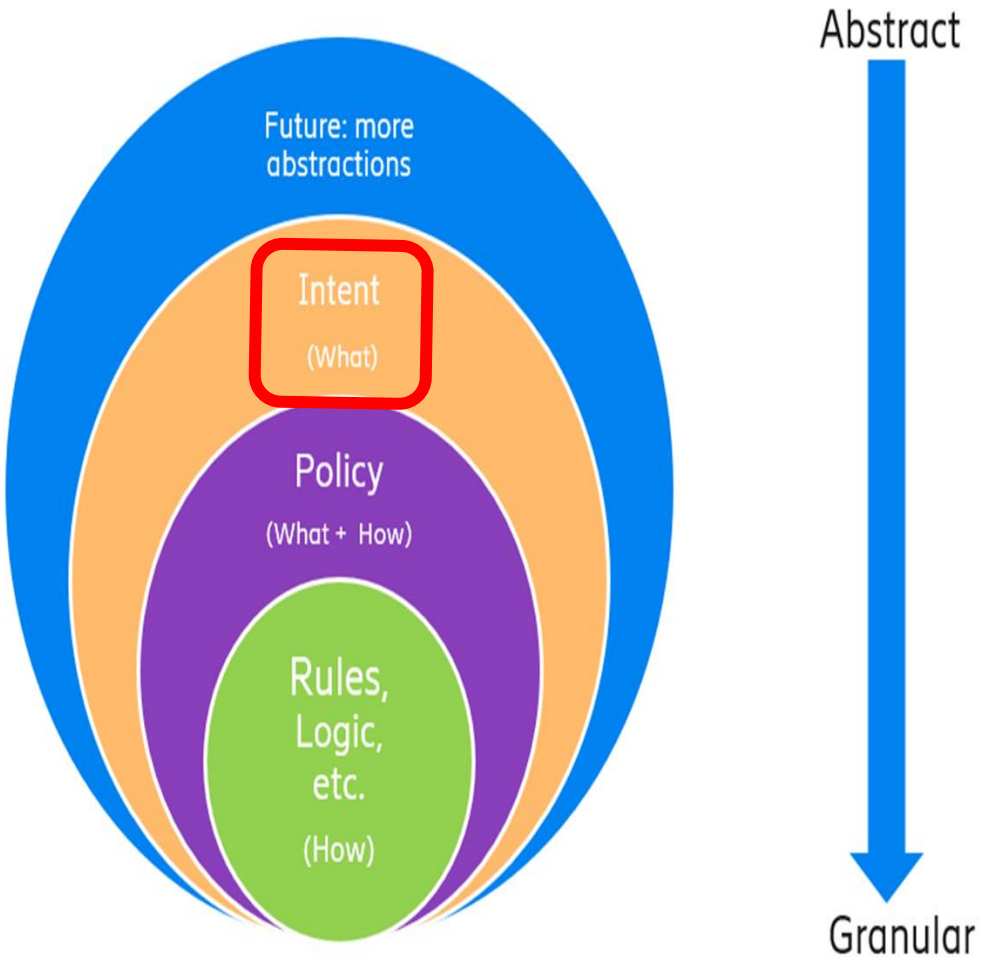


Figure 4.6.1: Intent driven management vs Policy driven management

Use of the Policy Continuum

Declarative Policies are used in the service, administrator, and device views, since they enable logic programs to express and act on Goals that are applicable to the needs of these actors:

Declarative policies are likely not applicable to the instance view, since that would require a device that could evaluate declarative logic.

Declarative policies could, of course, be used in the Business view. However, Declarative policies use formal logic, which is difficult for business actors to use.

Imperative Policies are used in the Service, administrator, device, and instance views, since they enable actors to specify a Policy using a simple syntax:

Imperative policies could, of course, be used in the business view. However, Intent policies are judged to be easier to use.

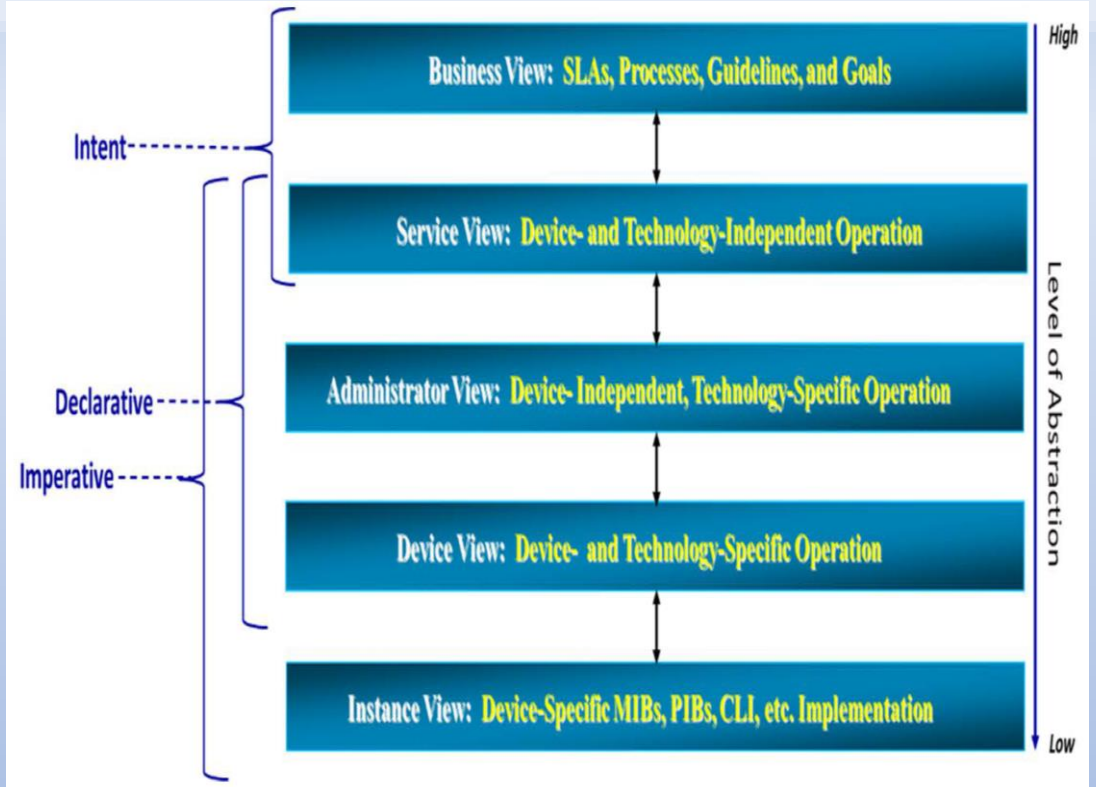


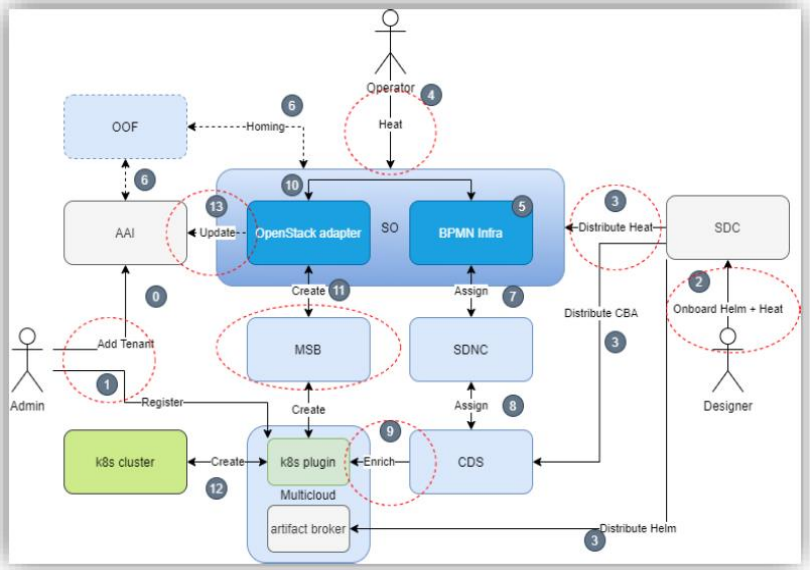
Figure 5.1-1: Mapping Actors to Different Policy Paradigms

ONAP CNF Journey (REQ-341)

Prepared by Lukasz Rajewski (Orange), Seshu Kumar (Huawei)

LF NETWORKING Virtual Technical Meetings

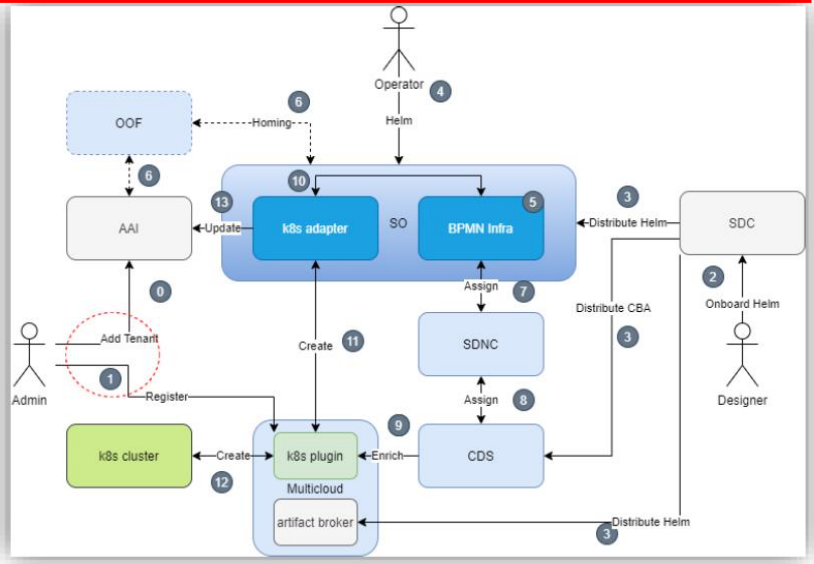
Completed



Till Frankfurt

- ✓ Embedding the Helm into the Heat package distro
- ✓ CLOUD_TECHNOLOGY_SPECIFIC artifact distributes Helm
- ✓ Installation of Helm package(s) into K8s cluster
- ✓ Basic Helm enrichment through CDS - Introduced

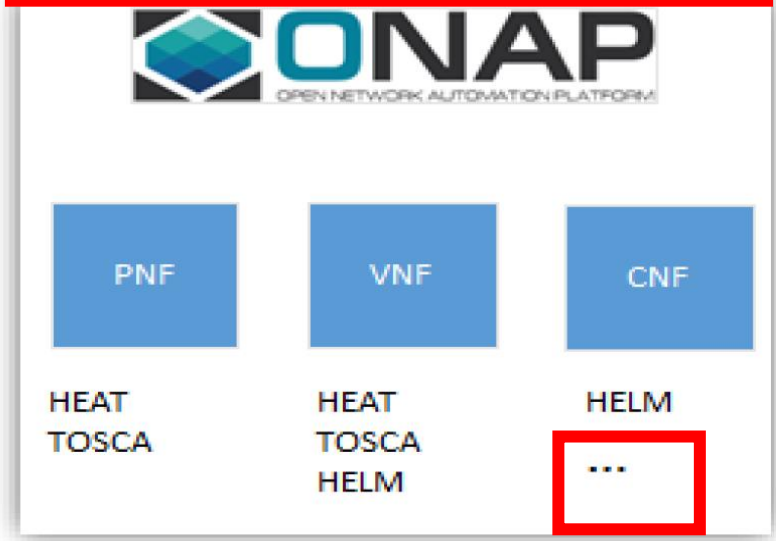
On-Going



Guilin Brings

- ✓ HELM artifact is Introduced to make Helm charts a first class citizen
- ✓ HELM artifacts supported in Day 0 and Day 1
- ✓ Native Helm support in E2E Orchestration
- ✓ Enhanced native Helm enrichment through CDS, K8s Plugin interactions.

Expected



Beyond

- ✓ Cross community Integration and SDO Compliance
- ✓ Extension to CNF model with Health Check and Monitoring of CNF resources
- ✓ Auto discovery of K8S cluster in ONAP
- ✓ Intent Driven orchestration and Service Control Loop Inc. CNFs

Release Requirements / REQ-329

Guilin-R7 - Support for Intent-based Network

Clone++ Export

Details

Type:	Epic	Status:	DONE
Priority:	High	Resolution:	Done
Affects Version/s:	None	Fix Version/s:	Guilin Release
Labels:	None		
Epic Name:	Intent-based Network		
Requirement Type:	Requirement (DEPRECATED)		
PoC:	PoC		
TSC Priority:	4		
Arch Review:	Not yet performed		
Scope Status:	Original Scope		
T-Shirt Size:	XL		
M1 Scorecard:	Green		
M1 Approval:	GO		
M2/3 Scorecard:	Green		
M2/3 Approval:	GO		
M4 Scorecard:	Green		
M4 Approval:	GO		

People

Assignee:	Huang ZongHe
Reporter:	Huang ZongHe
Votes:	0 Vote for this issue
Watchers:	9 Start watching this issue

Dates

Created:	20/May/20 2:29 AM
Updated:	06/Jan/21 8:56 AM
Resolved:	02/Dec/20 8:32 AM

MEF and TM Forum Collaborate on Open APIs for Service Automation

Media Contact:
Ashley Schulte
Connect2 Communications for MEF
MEF@connect2comm.com

MEF and TM Forum align to bring consistency and ease-of-use to standardized APIs for inter-provider services

Los Angeles, 7 October 2020 – MEF and TM Forum have completed initial efforts to ensure that both organizations are aligned to use open standard APIs to automate inter-provider services for digital transformation. This collaboration will help service providers accelerate their transition from operating within limited ecosystems/islands to being integral players in a worldwide federation of networks supporting on-demand digital services across multiple providers.

TM Forum and MEF have specifically aligned on the following:

- TM Forum is developing Domain Context Specialization Guidelines that enable MEF LSO Sonata APIs to conform to TM Forum Open API standards.
- TM Forum API tooling is now being used by MEF to build the set of LSO Sonata APIs.
- LSO Sonata API product payloads work in alignment with TM Forum API standards using a polymorphic approach.
- The organizations have established a framework for ongoing collaboration.

1. "5G Network Mobility at "Cell" & "Cloud" Edge - NGMN WP Feb 2015 - 1

tmforum

Themes | Member Resources | Collaboration | Education & Services | Research

Member Resources

- Open Digital Framework
- Open Digital Architecture
- Frameworx
- Open APIs
- Toolkits

Join the Project

Open APIs

Delivering business agility within companies and across digital ecosystems

TM Forum's suite of 50+ REST-based Open APIs has been collaboratively developed to be used in a range of scenarios, internally enabling service providers to transform their IT and operational agility and customer centricity, while externally delivering a practical approach to seamless end-to-end management of complex digital services.

Learn more about the program.

Explore the Open APIs:

3GPP 5G

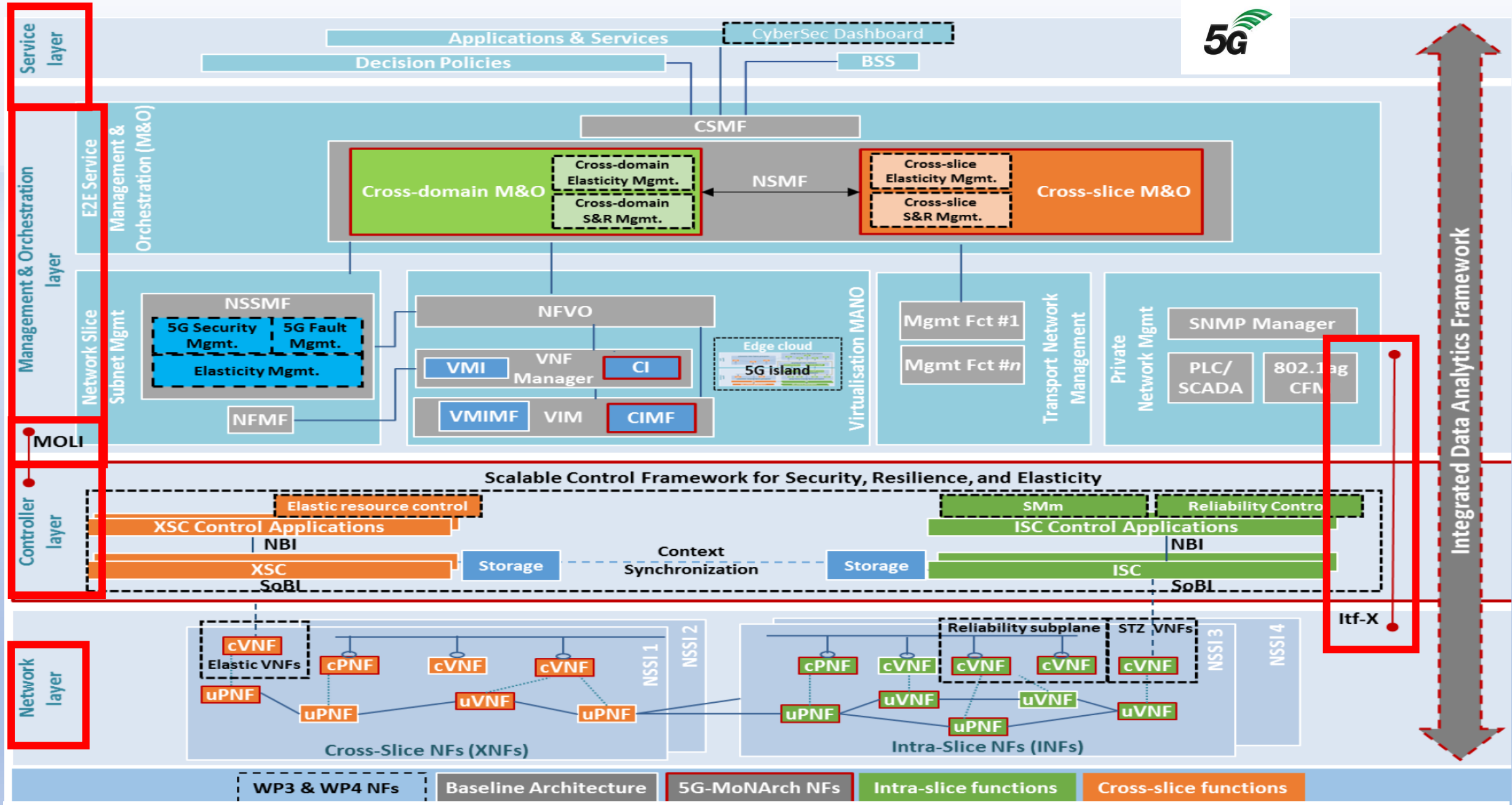


Figure 2-2: 5G Mobile Network overall Architecture

1. 5G NF as a Service "Producer" and "Consumer" (+ Intent)

Communication between consumer and producer	Service discovery and request routing	Communication model
Direct communication	No NRF or SCP; direct routing	A
	Discovery using NRF services; no SCP; direct routing	B
Indirect communication	Discovery using NRF services; selection for specific instance from the Set can be delegated to SCP. Routing via SCP	C
	Discovery and associated selection delegated to an SCP using discovery and selection parameters in service request; routing via SCP	D

Table E.1-1: Communication models for NF/NF Services interaction

2. 5G NDL - Network Data Layer - separation of the 5G "Compute" from "Storage" via 5G UDM in NFs implementation into VNFs & PNFs related

(NF) Application Context (Unstructured Data in UDSF)
from
(NF) Application Business Logic (Structured Data in UDR)

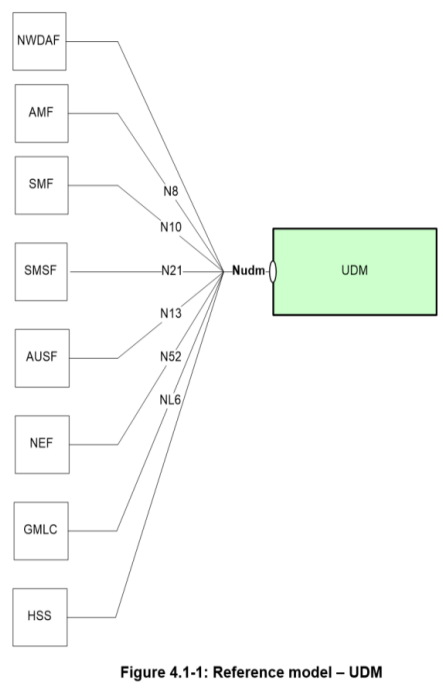


Figure 4.1-1: Reference model – UDM

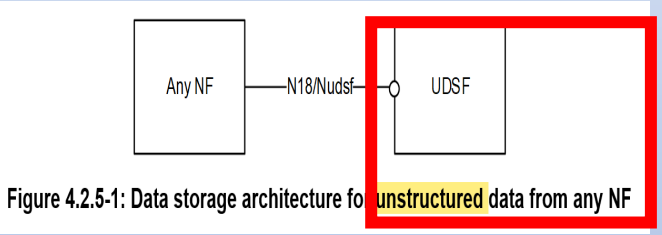


Figure 4.2.5-1: Data storage architecture for unstructured data from any NF

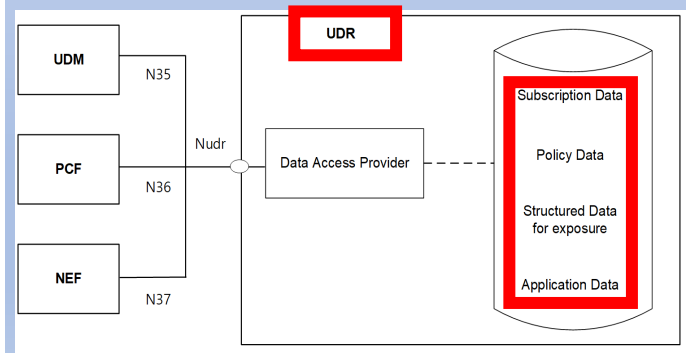


Figure 4.2.5-2: Data storage architecture

5G NF/NF Services Interaction as Producer and Consumer

Model A - Direct communication without NRF interaction:
Neither NRF nor SCP are used. **Consumers** are configured with **Producers' "NF Profiles"** and directly communicate with a **Producer** of their choice.

Model B - Direct communication with NRF interaction:

Consumers do discovery by querying the NRF. Based on the discovery result, the **Consumer** does the selection. The **Consumer** sends the request to the selected **Producer.**

Model C - Indirect Communication without Delegated Discovery:
Consumers do discovery by querying the NRF. Based on discovery result, the C**onsumer** does the selection of an **NF Set or a specific NF instance of NF instance set.** The Consumer sends the request to the SCP containing the **address of the selected Service Producer pointing to a NF Service Instance or a set of NF Service Instances.** In the latter case, the SCP selects an **NF Service Instance**. If possible, the SCP interacts with NRF to get selection parameters such as location, capacity, etc. The SCP routes the request to the **selected NF Service Producer Instance.**

Model D - Indirect communication with delegated Discovery: Consumers do not do any discovery or selection. The **Consumer** adds any **necessary Discovery and Selection Parameters required to find a suitable Producer to the Service** request. The SCP uses the request address and the discovery and selection parameters in the request message to route the request to a suitable producer instance. The SCP can perform discovery with an NRF and obtain a discovery result.

Communication between consumer and producer	Service discovery and request routing	Communication model
Direct communication	No NRF or SCP; direct routing	A
	Discovery using NRF services; no SCP; direct routing	B
Indirect communication	Discovery using NRF services; selection for specific instance from the Set can be delegated to SCP. Routing via SCP	C
	Discovery and associated selection delegated to an SCP using discovery and selection parameters in service request; routing via SCP	D

Table E.1-1: Communication models for NF/NF Services interaction summary

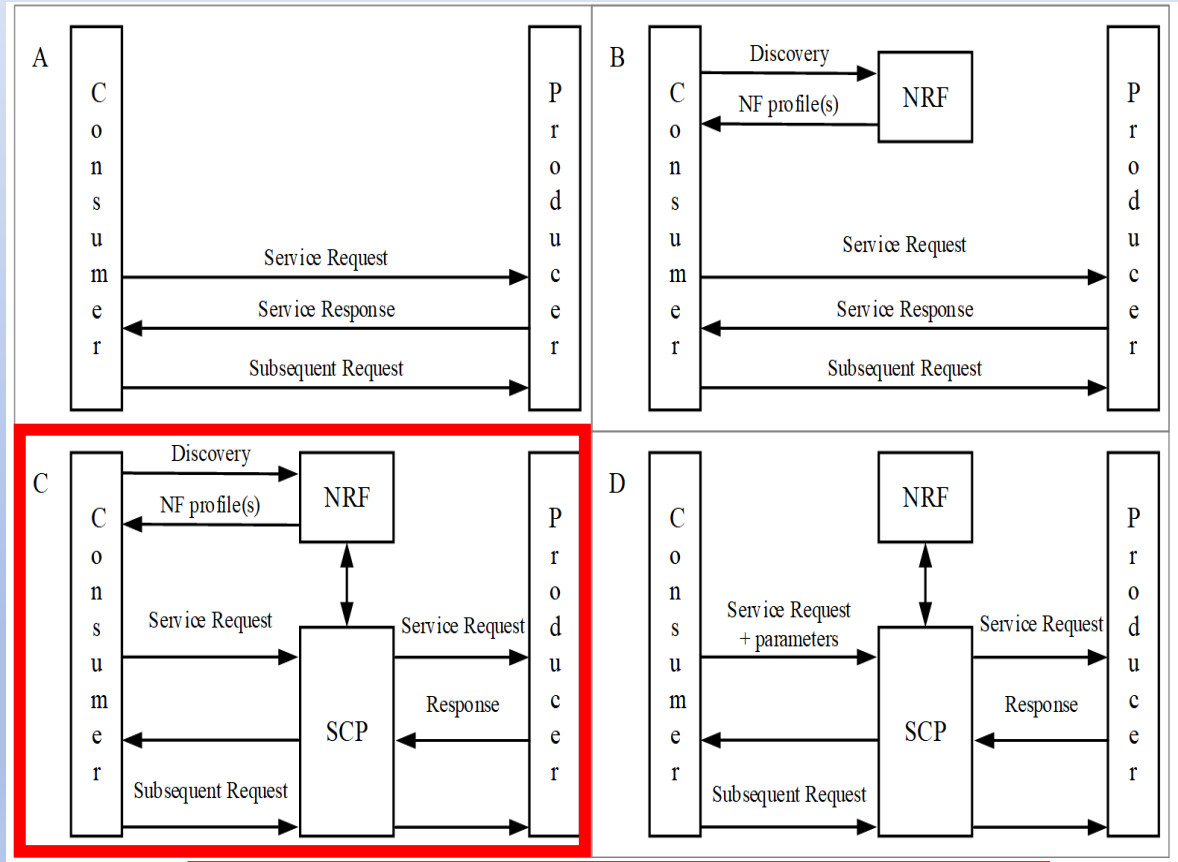


Figure E.1-1: Communication models for NF/NF services interaction

Management Services (MnS)

An Management Service (MnS) offers Capabilities for Management and Orchestration of Network and Service.

The entity producing an MnS is called **MnS Producer.**

The entity consuming an MnS is called **MnS Consumer.**

An MnS provided by an MnS Producer can be consumed by any entity with appropriate Authorisation and Authentication.

An MnS Producer offers its services via a Standardized Service Interface composed of individually specified MnS Components.

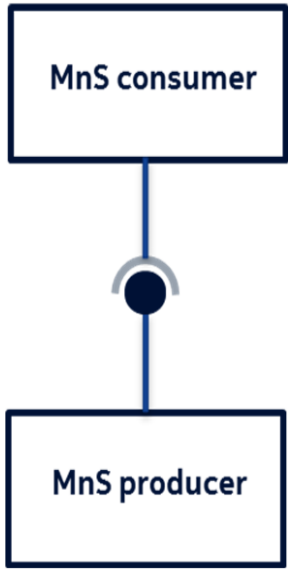


Figure 4.1.1: MnS producer and MnS consumer

5G NFs Services as Producer and Consumer

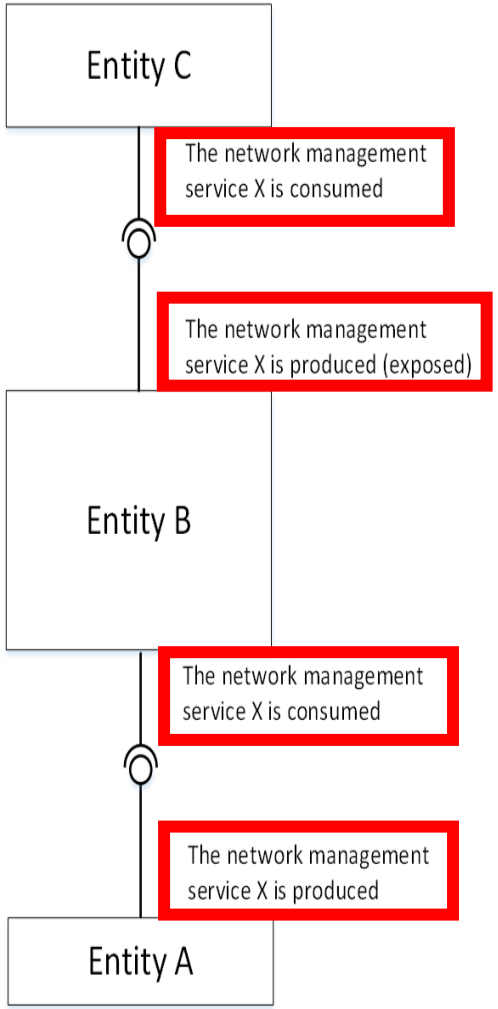


Figure 5.1.1-1. Example of producers and consumers of the management service

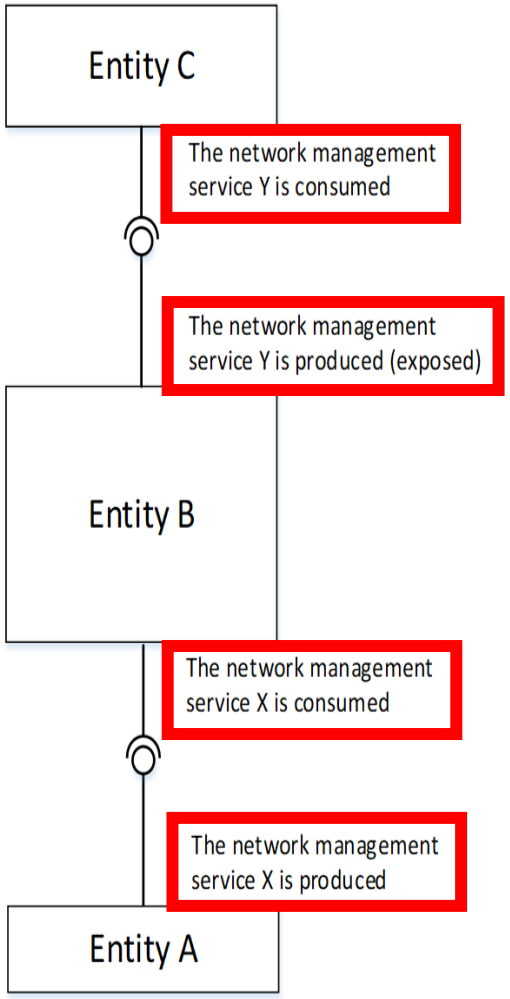


Figure 5.1.1-2. Example of producers and consumers of management services

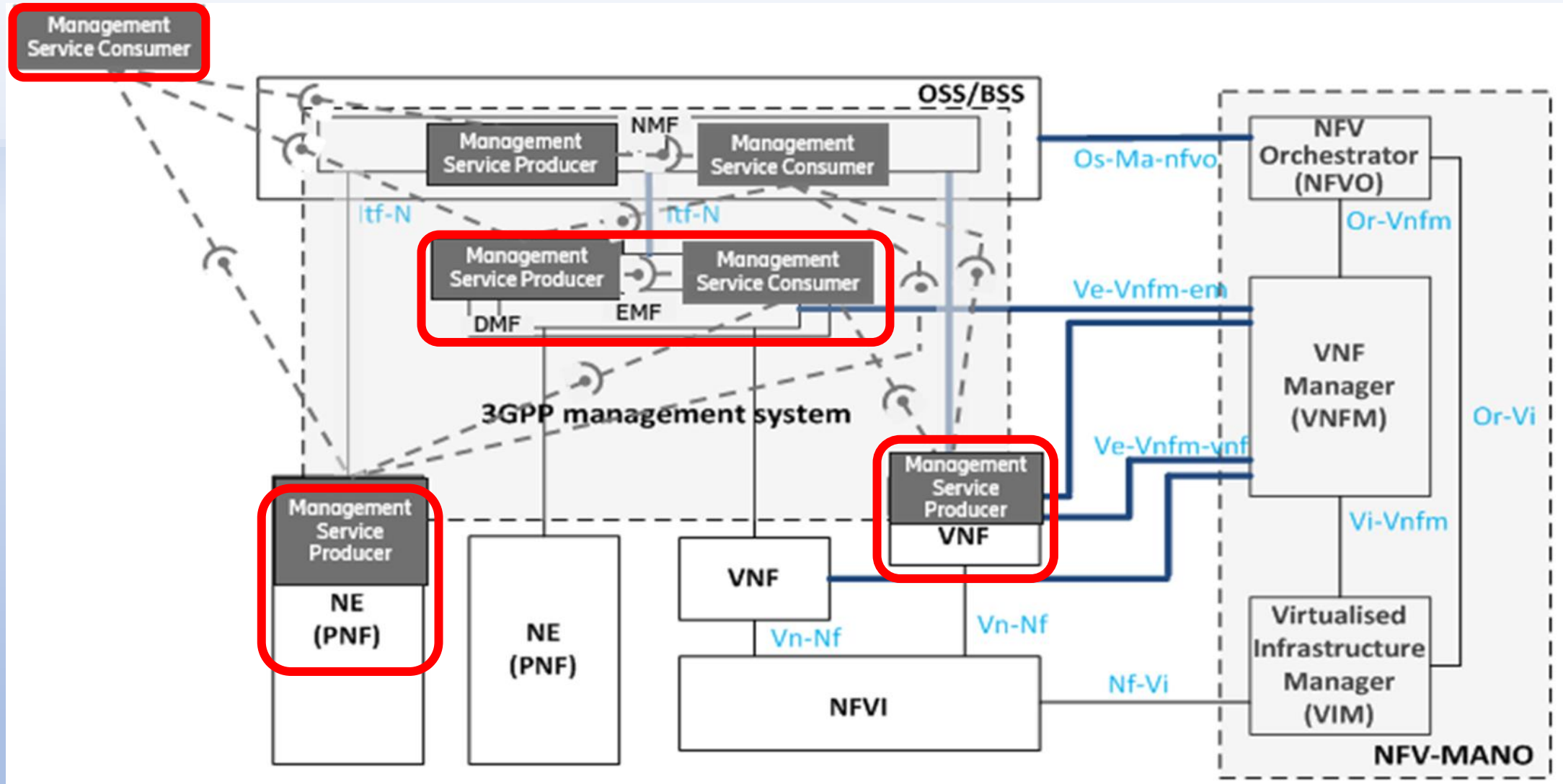


Figure C.1: Example of Management service producer and consumer interaction mapped into the pre-Rel-15 management reference model [10]

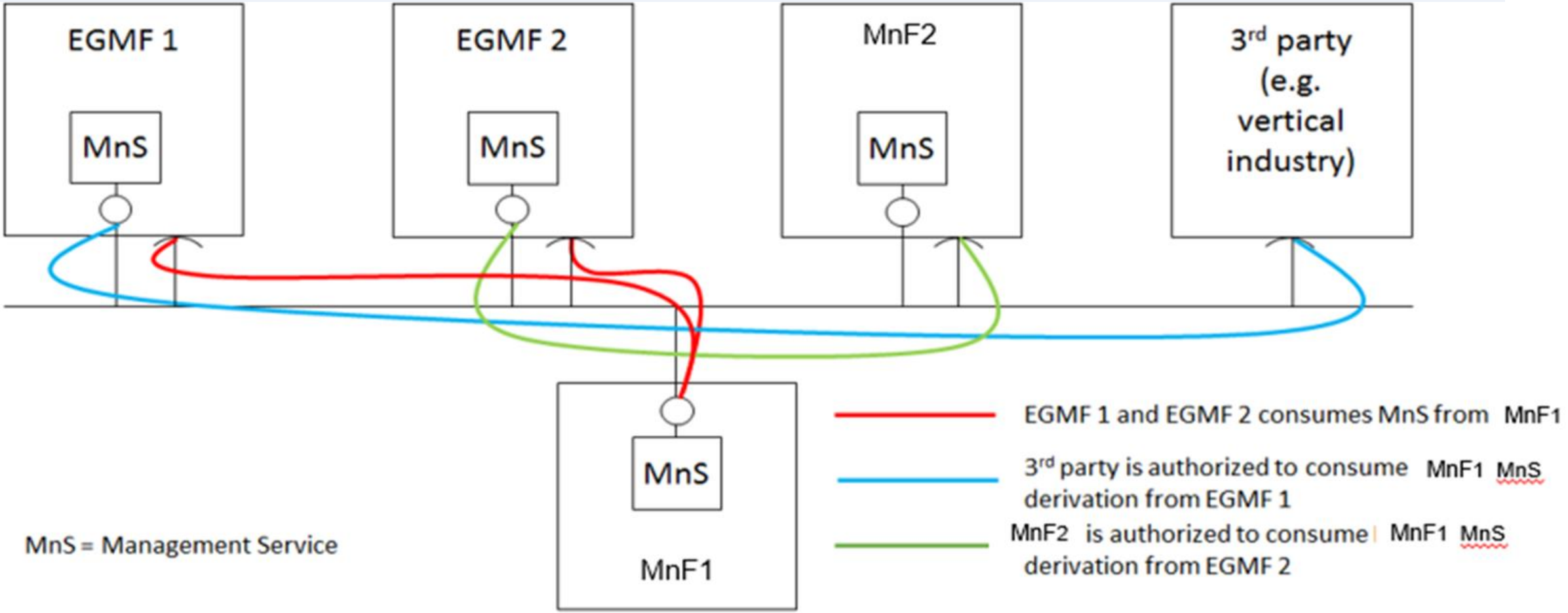


Figure A.3.1: MnF-1 Management Service (MnS) exposed through Exposure Governance Management Function 1 (EGMF 1) and through Exposure Governance Management Function 2 (EGMF 2)

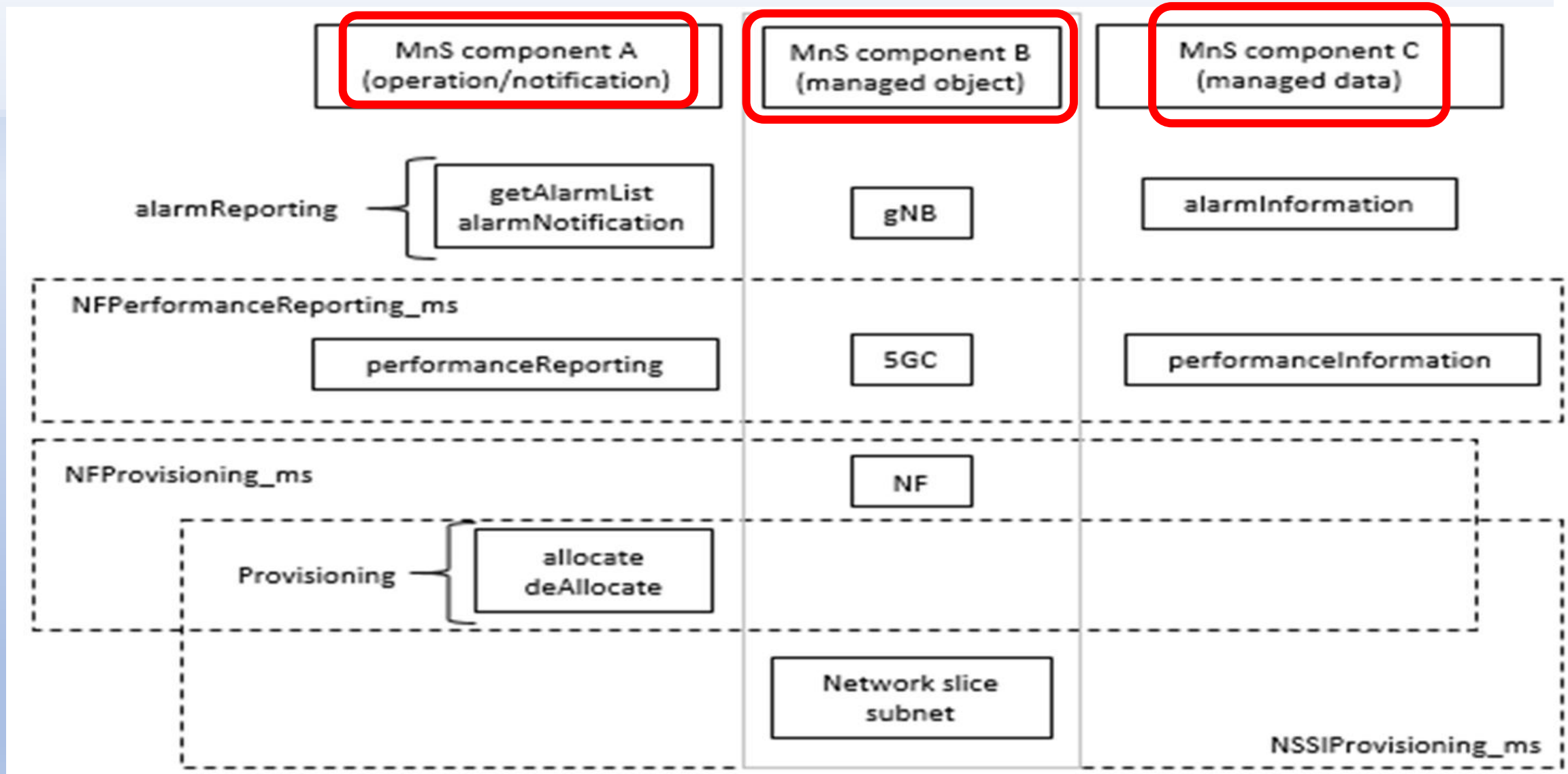


Figure 4.3.1: Example of Management Service and component type A, B and C

Intent driven Management Service (Intent driven MnS) concept

Perform Network Management Tasks

Identifying, Formulating and Activating Network Management Policies

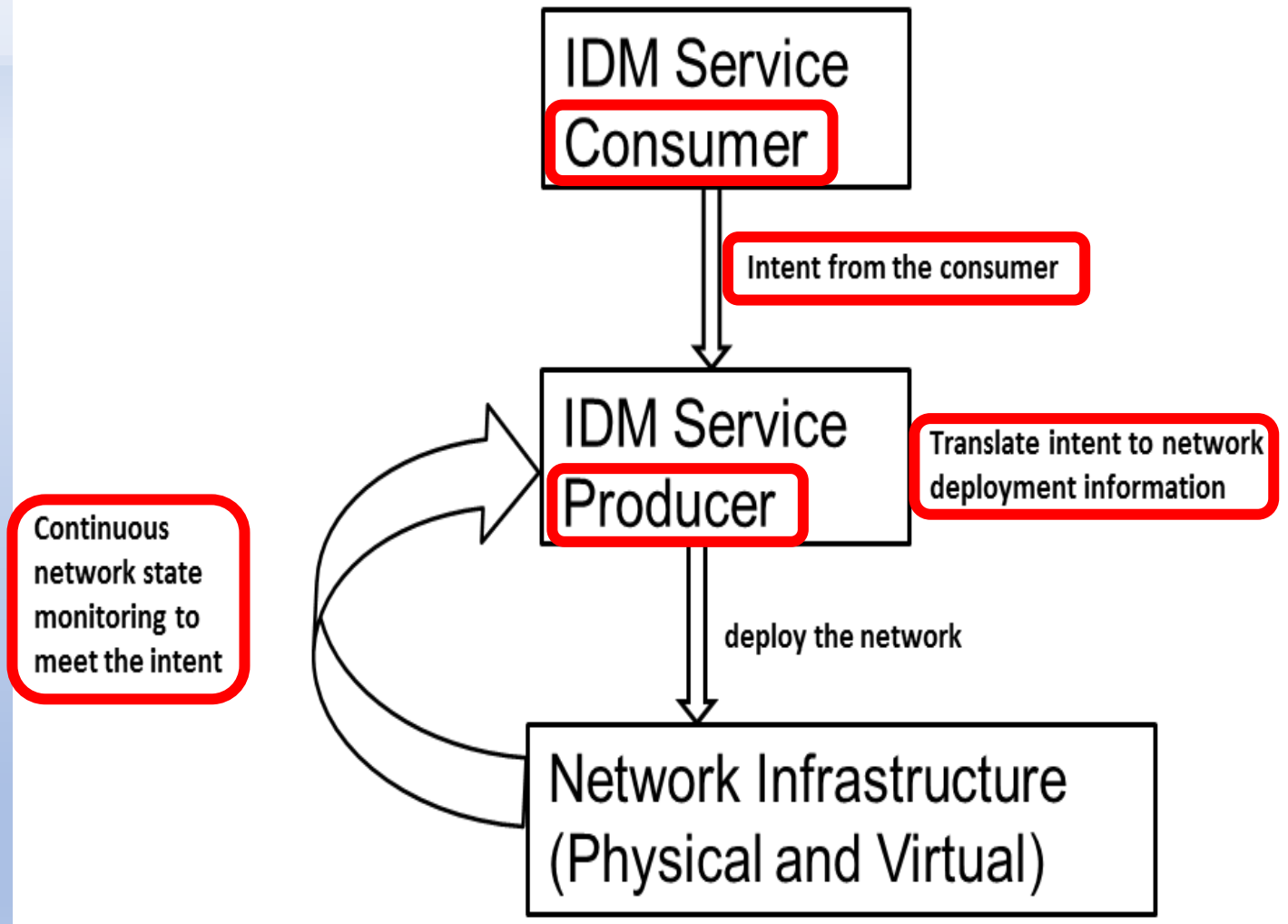


Figure 4.1.2.1-2: An example of using Intent driven management service for network provisioning

- Intent from Communication Service Provider (Intent-CSP)
- Intent from Network Operator (Intent-NOP)

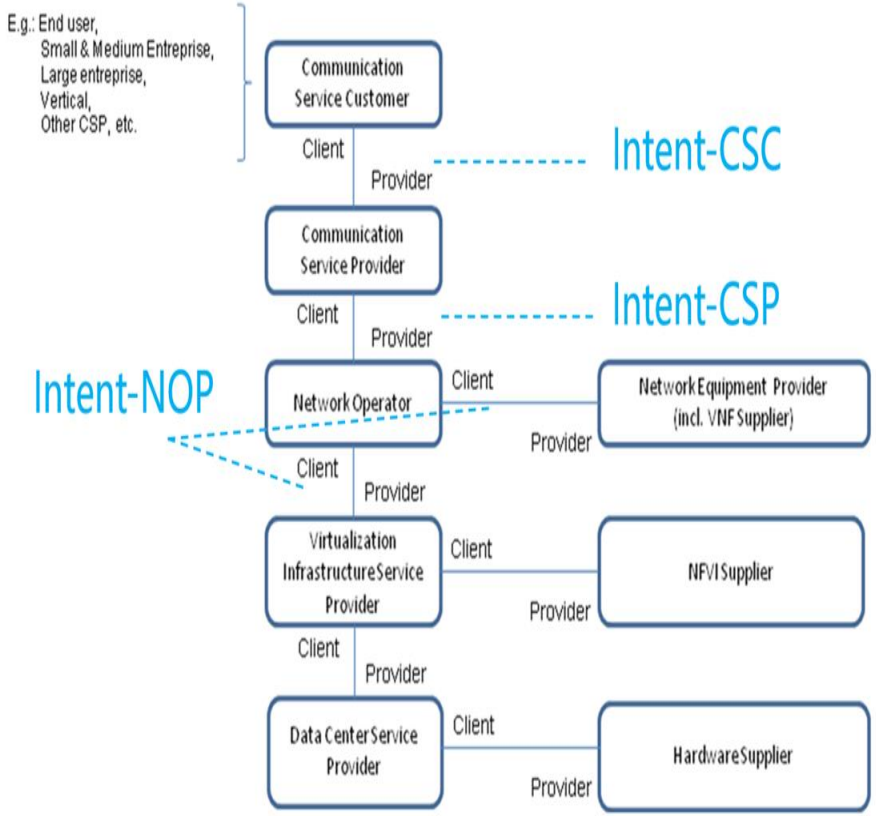


Figure 4.1.2.4-1: Concept for utilization of intent

4.1.2.5 Intent driven Management Service (MnS) interactions with 3GPP management functions

The following figure shows the interaction of intent driven management service (MnS) with management functions.

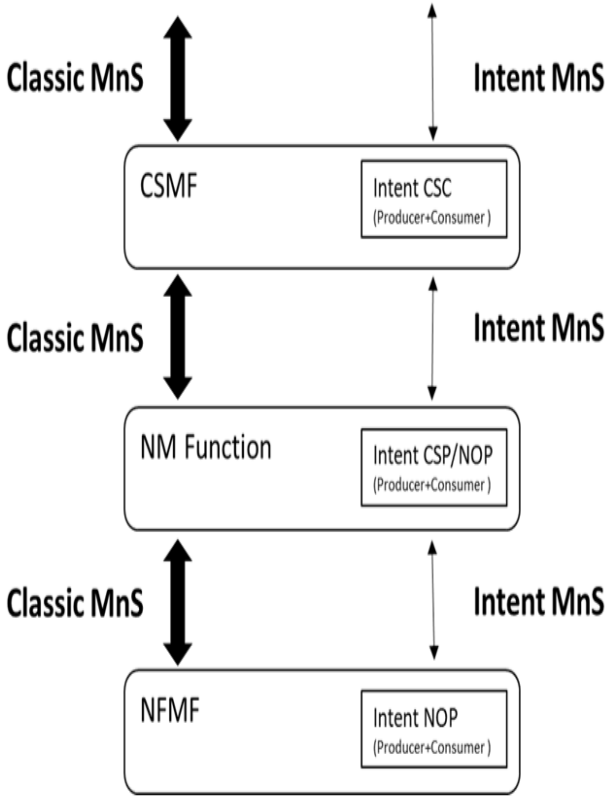


Figure 4.1.2.5.1: The intent driven management service (MnS) vs classic MnS

1. "5G Network Mobility at "Cell" & "Cloud" Edge - NGMN WP Feb 2015 - 8

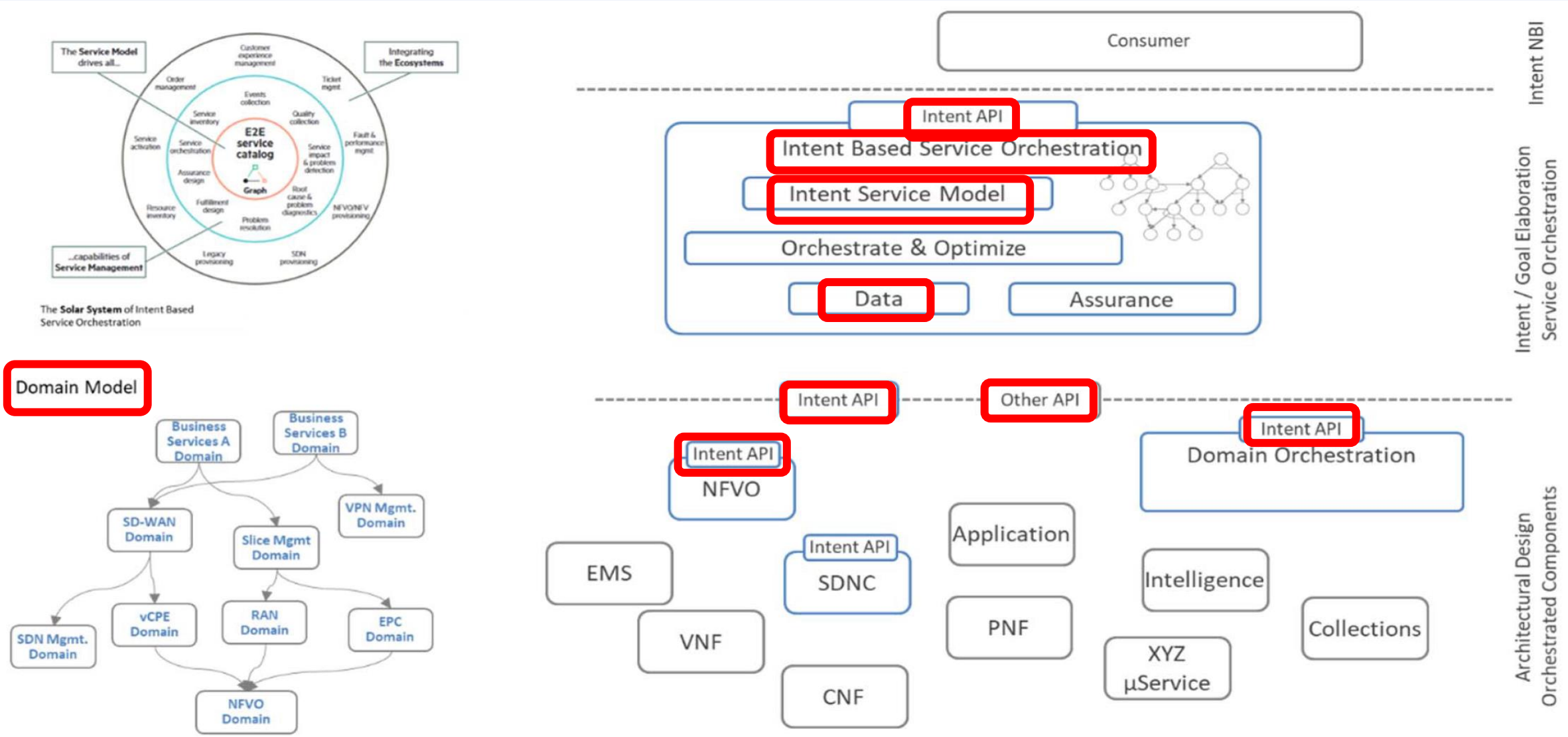


Figure 10: Intent-based Service Orchestration across Domains, driven by Intent-based Service Models

Interface 1: NWDAF interacts with AF (via NEF) using NW layer SBI.

Interface 2: N1/N2 interface.

Interface 3: O&M layer configures the NF profile in the NRF, and NWDAF collect the NF capacity information from the NRF.

Interface 4: MDAF interacts with Application/Tenant using Northbound Interfaces (NBI).

Interface 5: MDAF interacts with RAN DAF using O&M layer SBI.

Interface 6: NWDAF consumes the services provided by MDAF using cross layer SBI.

Interface 7: MDAF consumes the services provided by MWDAF using cross layer SBI.

Interface 8: MDAF collects data from NW layer via trace file/monitoring services.

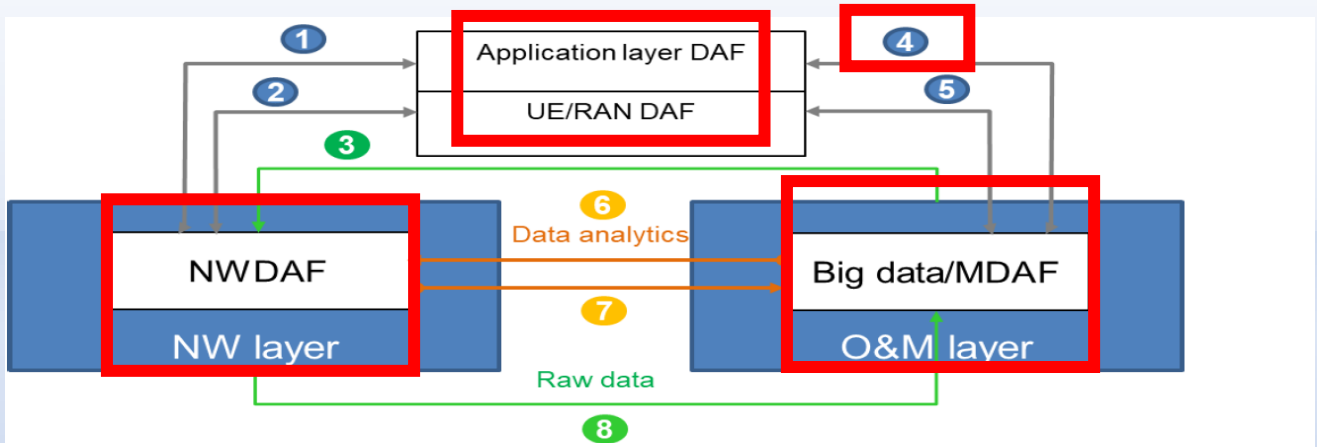


Figure 4-3: Data Analytics framework in 5G Mobile Network Architecture

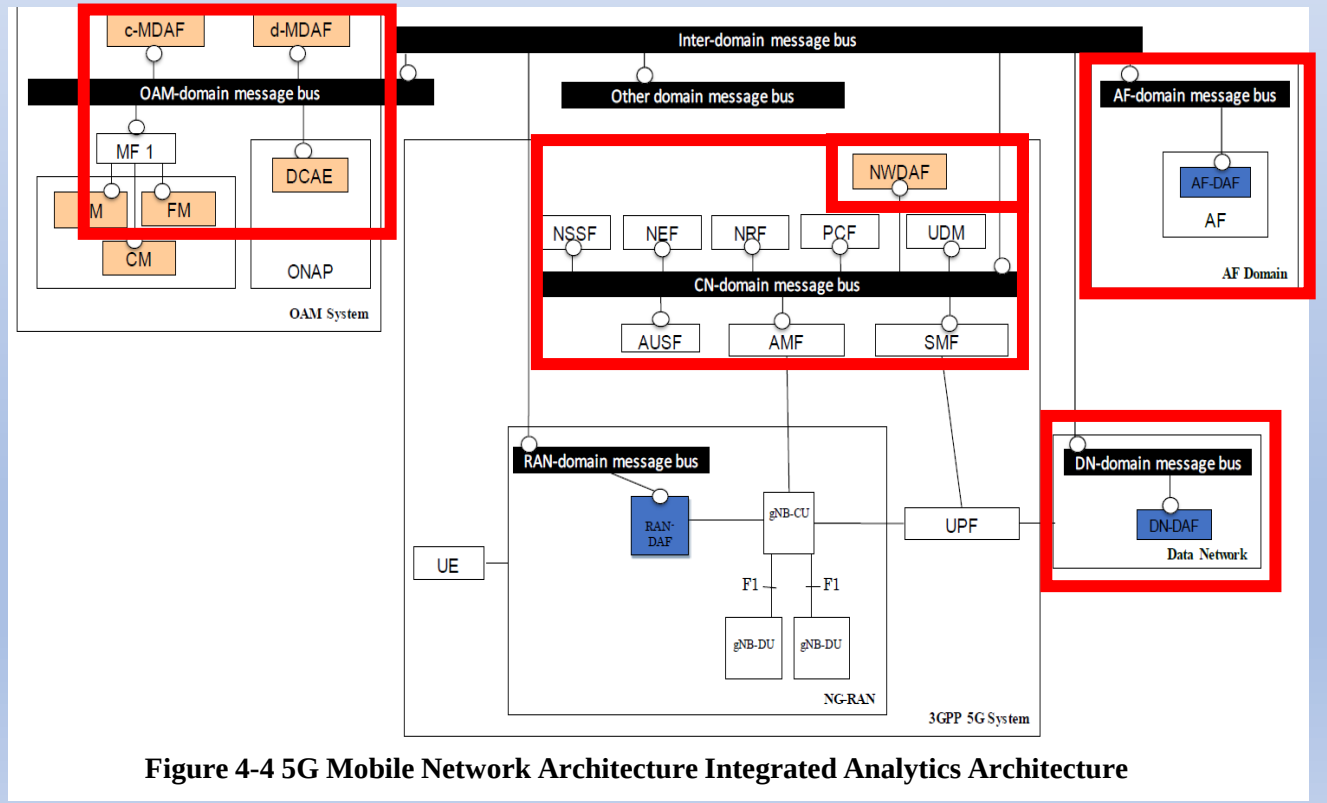


Figure 4-4 5G Mobile Network Architecture Integrated Analytics Architecture

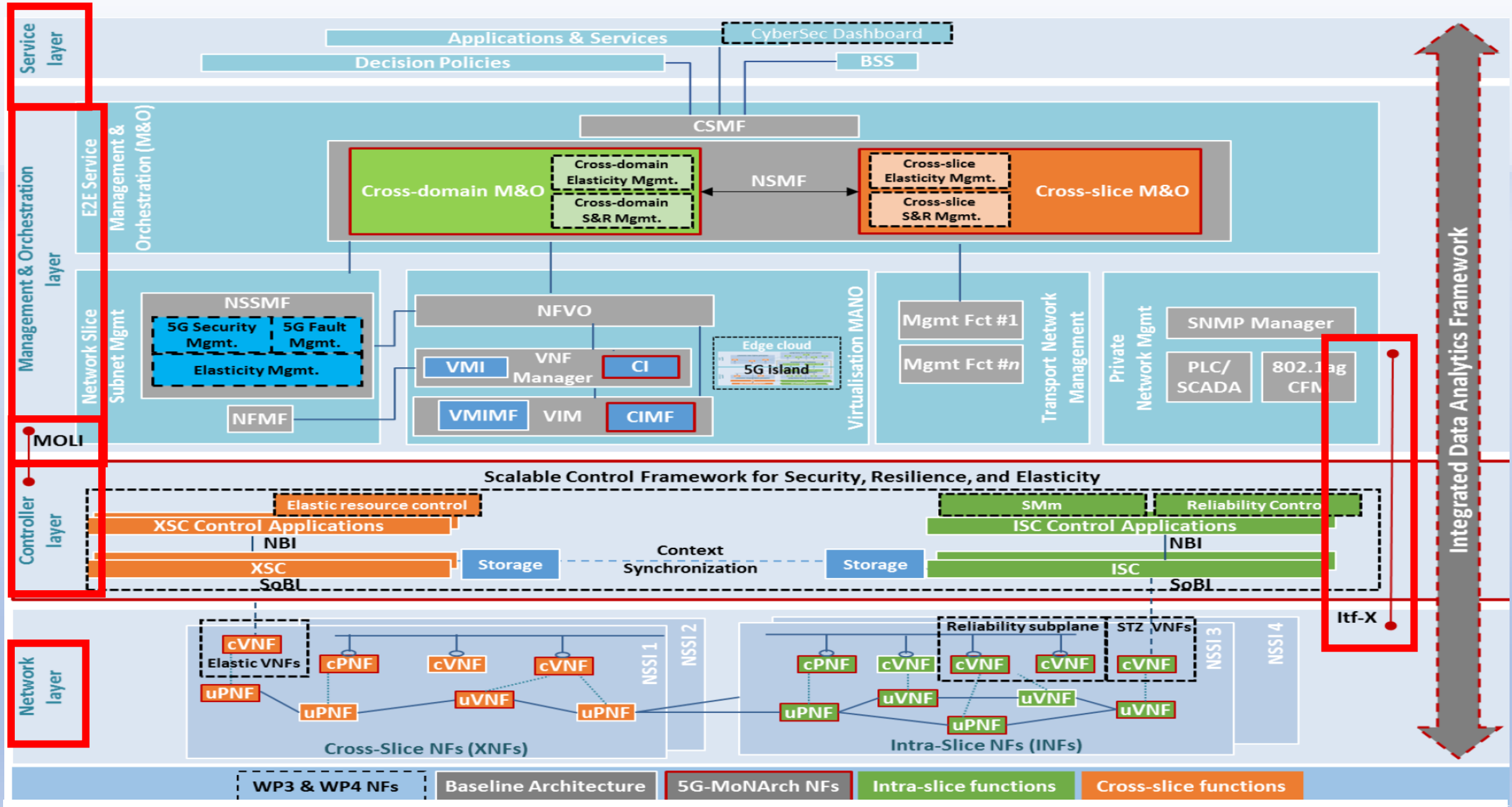


Figure 2-2: 5G Mobile Network overall Architecture

2. **5G NDL - Network Data Layer** - separation of the 5G "Compute" from "Storage" via 5G UDM in NFs implementation into VNFs & PNFs related

(NF) Application Context (Unstructured Data in UDSF)

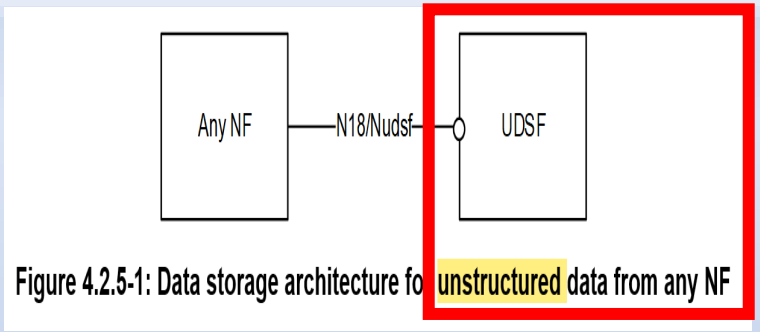


Figure 4.2.5-1: Data storage architecture for unstructured data from any NF

from

(NF) Application Business Logic (Structured Data in UDR)

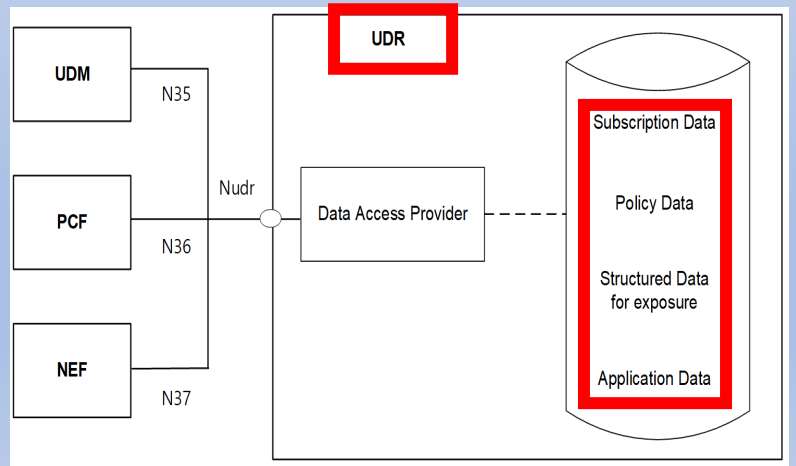


Figure 4.2.5-2: Data storage architecture

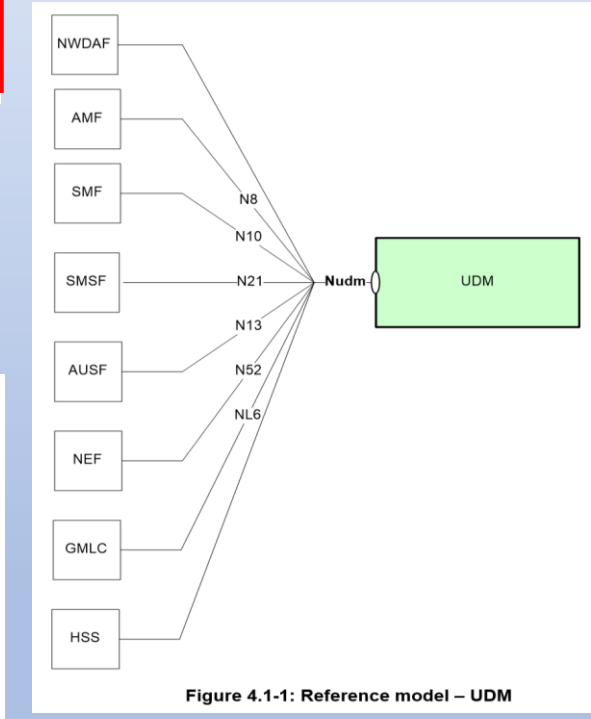


Figure 4.1-1: Reference model – UDM

Stateless NFs (for any 5GC NF type)

An NF may become Stateless by Storing its Contexts as Unstructured Data in the UDSF.

An UDM, PCF and NEF may also Store own Structured Data in the UDR.

An UDR and UDSF cannot become stateless.

An NF may also be deployed such that several stateless network function instances are present within a set of NF instances. Additionally, within an NF, an NF service may have multiple instances grouped into a NF Service Set if they are interchangeable with each other because they share the same context data. See clause 5.21 of 3GPP TS 23.501 [3].

.

6.5.3 Stateless NFs (for any 5GC NF type)

6.5.3.1 General

An NF may become stateless by storing its contexts as unstructured data in the UDSF.An UDM, PCF and NEF may also store own structured data in the UDR. An UDR and UDSF cannot become stateless.

An NF may also be deployed such that several stateless network function instances are present within a set of NF instances. Additionally, within an NF, an NF service may have multiple instances grouped into a NF Service Set if they are interchangeable with each other because they share the same context data. See clause 5.21 of 3GPP TS 23.501 [3].

A UDM / AUSF / UDR / PCF group may consist of one or multiple UDM / AUSF / UDR / PCF sets.

6.5.3.2 Stateless NF as service consumer

1. When the NF service consumer subscribes (explicitly or implicitly) to notifications from another NF service producer, the NF service consumer may provide a binding indication to the NF service producer as specified in clause 6.3.1.0 of 3GPP TS 23.501 [3] and clause 4.17.12.4 of 3GPP TS 23.502 [4], to enable the related notifications to be sent to an alternative NF service consumer within the NF (service) set, in addition to providing the Callback URI in the subscription resource.

2. A NF service producer or SCP may use the Nnrf_NFDiscovery service to discover NF service consumers within an NF (service) set.

3. An NF service producer may become aware of a NF service consumer change, via receiving an updated binding information (i.e. when the binding entity corresponding to the binding level is changed), or via an Error response to a notification, via link level failures (e.g. no response from the NF), or via a notification from the NRF that the NF service consumer has deregistered. The HTTP error response may be a 3xx redirect response pointing to a new NF service consumer.

NOTE: When the binding entity other than the one corresponding to the binding level is changed, it indicates the

Stateless NFs (for any 5GC NF type) - AMF stores the Context for registered UE(s) in the UDSF

Table 5.2.14-1: NF Services provided by UDSF

NF service	Service Operations	Operation Semantics	Example Consumer(s)
Unstructured Data Management	Query	Request/Response	Any NF
	Create	Request/Response	Any NF
	Delete	Request/Response	Any NF
	Update	Request/Response	Any NF

NOTE: Nudsf is different compared to other service-based interfaces due to dynamic data access performance requirements.

5.2.14.2 Nudsf_UnstructuredDataManagement service

5.2.14.2.1 General

5.2.14.2.2 Nudsf_UnstructuredDataManagement_Query service operation

Service operation name: Nudsf_UnstructuredDataManagement_Query.

Description: NF service consumer intends to query data from UDSF.

Inputs, Required: Data Identifier.

Data Identifier uniquely identifies the data to be retrieved from the UDSF

Inputs, Optional: None.

Outputs, Required: Requested data.

Outputs, Optional: None.

5.2.14.2.3 Nudsf_UnstructuredDataManagement_Create service operation

Service operation name: Nudsf_UnstructuredDataManagement_Create.

Description: NF service consumer intends to insert a new user data record into the UDSF, e.g. AMF stores the context for registered UE(s) in the UDSF.

Context Definition

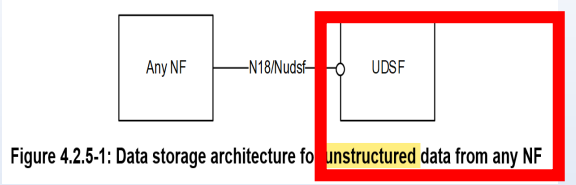


Figure 4.2.5-1: Data storage architecture fo unstructured data from any NF

One of the most popular definitions of context is: **"Context** is any information that can be used to **characterize the situation of an entity**.

An "Entity" is a Person, Place, or Object that is considered relevant to the interaction between a user and an application, including the user and application themselves" .

The updated definition of Context is:

"***The Context of an Entity*** *is a* ***Collection of Measured and Inferred Knowledge that describe the State and Environment in which an Entity exists or has existed".***

This definition emphasizes two (2) Types of Knowledge

1. **Facts** (which can be measured) and
2. ***Inferred*** **Data, which results from ML & Reasoning Processes applied to Past & Current Context.**

It also includes Context History, so that current decisions based on Context may benefit from past decisions, as well as Observation of How the Environment has changed.

5G Guidelines & Principles for Compute - Storage Separation

Data Storage Architectures

As depicted in Figure 4.2.5-1, the 5G System Architecture allows any **NF to store and retrieve its Unstructured Data into/from a UDSF (e.g. UE Contexts**).

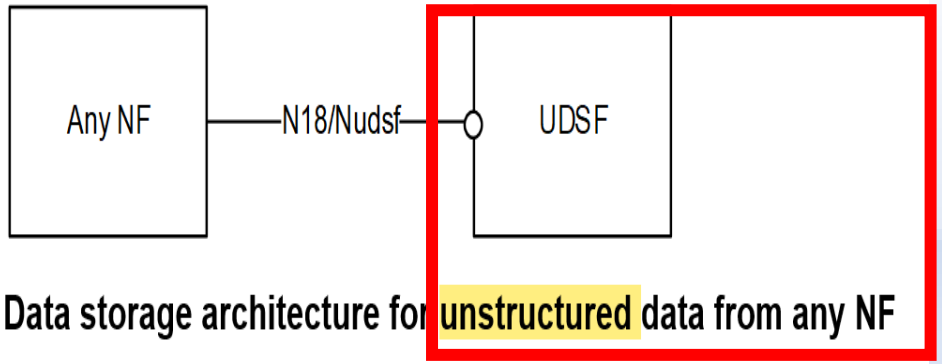


Figure 4.2.5-1: Data storage architecture for unstructured data from any NF

As depicted in Figure 4.2.5-2, the 5G System Architecture allows the **UDM, PCF and NEF** to store data in the **UDR** (Fig. 4.2.5-2), including:

Subscription Data and Policy Data by UDM and PCF,

Structured Data for Exposure and

Application Data (including Packet Flow Descriptions (PFDs) for Application Detection, AF request information for multiple UEs) by the NEF.

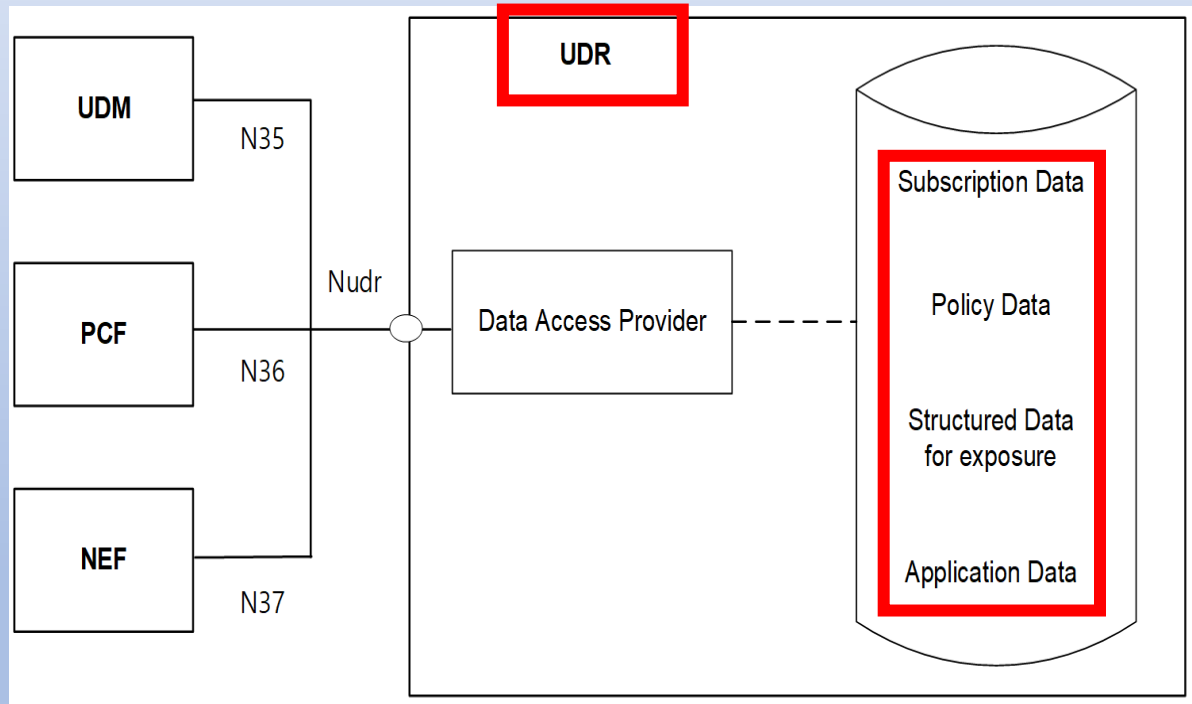


Figure 4.2.5-2: Data storage architecture

5G System Architecture Rel 16 Access Traffic Steering, Switch and Splitting (ATSSS)

The ATSSS feature enables a Multi-Access (MA) PDU Connectivity Service, which can exchange PDUs between the UE and a Data Network (DN) by simultaneously using one (1) 3GPP Access Network and one (1) non-3GPP Access Network and two (2) independent N3/N9 tunnels between the PSA and RAN/AN.

The Multi-Access PDU Connectivity Service is realized by establishing a Multi-Access PDU (MA PDU) Session, i. e. **a PDU Session that may have User-Plane (UP) Rsource on two(2) Access Networks (ANs).**

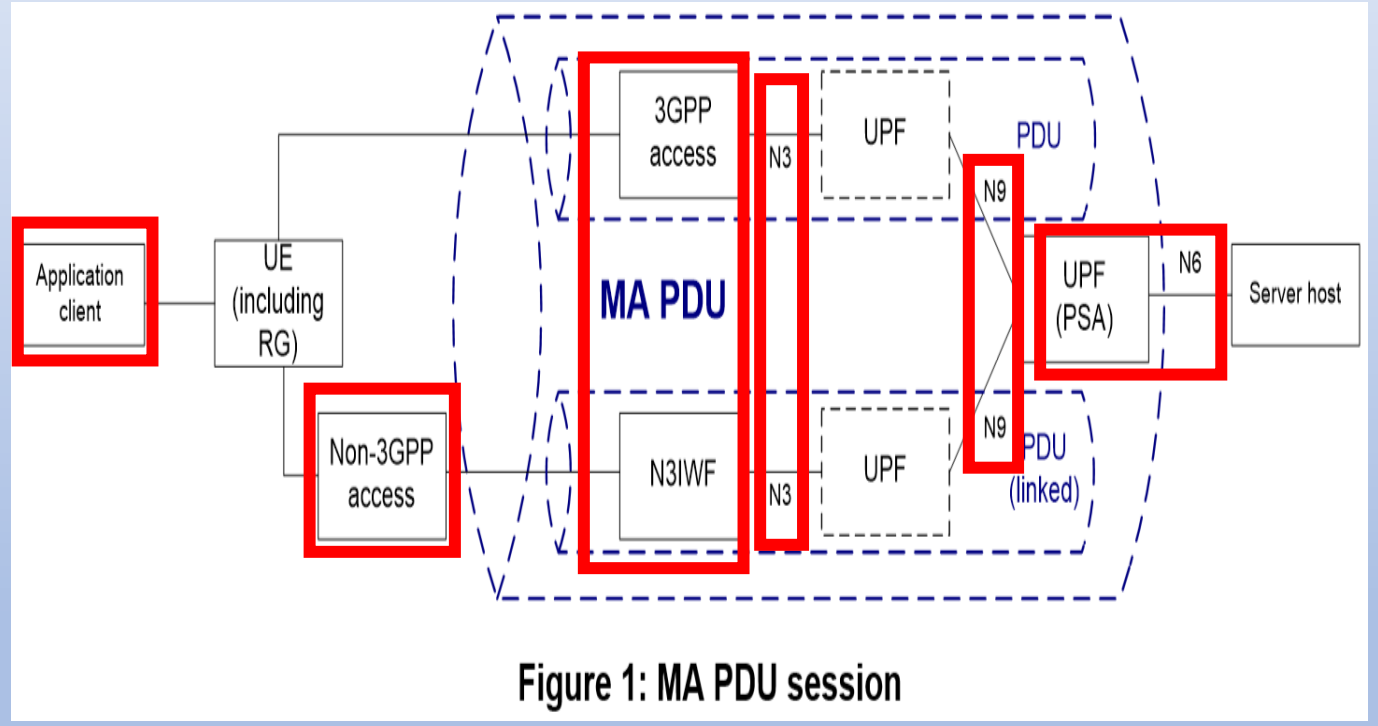


Figure 1: MA PDU session

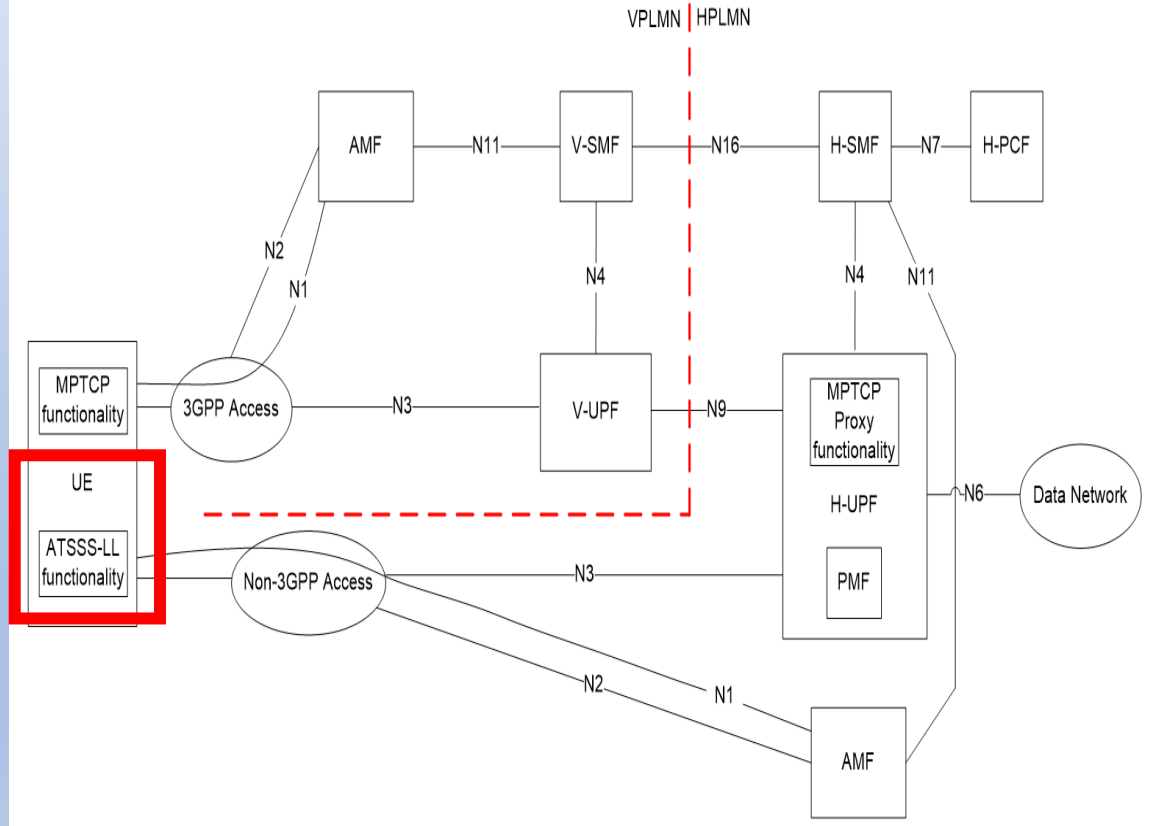


Figure 4.2.10-3: Roaming with Home-routed architecture for ATSSS support (UE registered to different PLMNs)

3GPP 5G Network and Wi-Fi Network Communication Availability and Reliability

Relation of Communication Service: **Availability and Reliability**

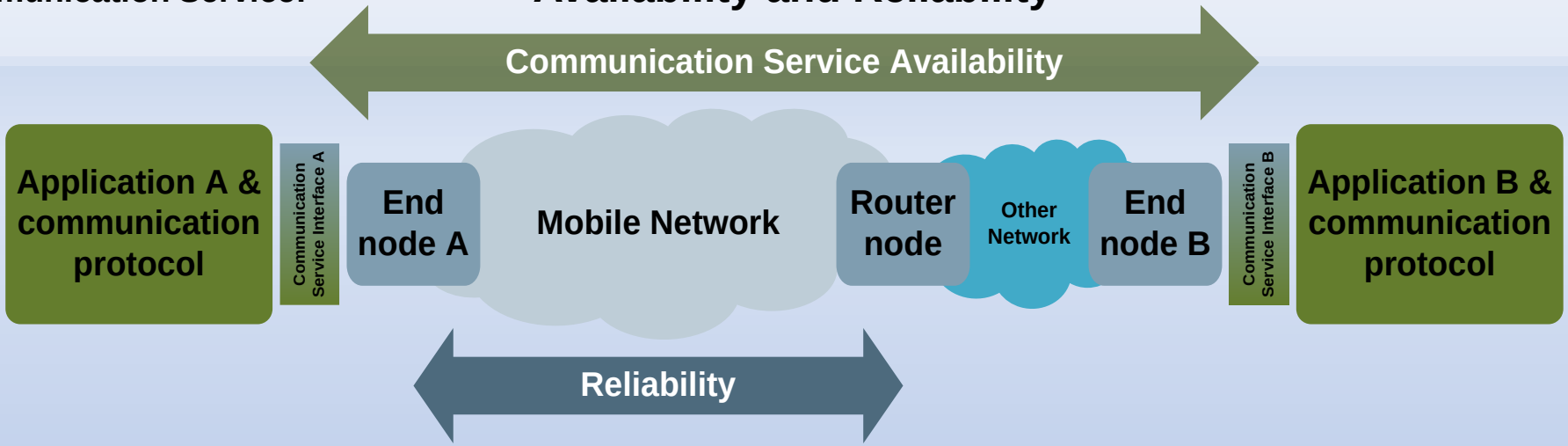


Figure C-4: Example in which communication Service Availability & Reliability have different values.

Packets are delivered over a daisy chain of a Mobile Network and another Network (e.g. IEEE 802.11n based).

Reliability is evaluated for the Mobile Network only,
Availability depends on the performance of both Networks.

Communication Service **Availability** - measured between the two (2) Communication Service Interfaces,

Reliability - measured between End Node A and the Router Node.

This has implications for, e.g. the maximum communication latency allowed for each network. In case the agreed end-to-end latency between the service interfaces is, for instance, 100 ms, and the 802.11n network has a latency of 30 ms, the maximum allowable latency for packages in the mobile network is 70 ms (NOTE). So, if the latency in the mobile network exceeds 70 ms, the communication service availability is 0%, despite the agreed QoS stipulating a larger end-to-end latency, i.e. 100ms.

NOTE: The transit time through the router node is not considered here. It is assumed to be very small and much less than 100 ms.

Service Subscriptions related to Latency in Standardized and Private Slice Types

Network Slice Providers can build their Network Slice Product offering based on S-NESTs (Standardized Network Slice Type) and/or their P-NESTs (**Private NESTs).**

Standardized Network Slice Type (S-NEST) NST-A, for which the attribute Packet Delay Budget Value Range is between **1 ms and 100 ms is specified by 3GPP.**

Network Slice Provider **(NSP)** may offer 3 products based on **NST-A**:

- **Platinum NST-A** based Network Slice Product, where the attribute ‘ **Packet Delay Budget’ Value Range is between 1 ms and 10 ms**

- **Gold NST-A** based Network Slice Product, where the attribute **Packet Delay Budget’ Value Range is between 11 ms and 50 ms**

- **Silver NST-A** based Network Slice Product, where the attribute **Packet Delay Budget’ Value Range is between 51 ms and 100 ms.**

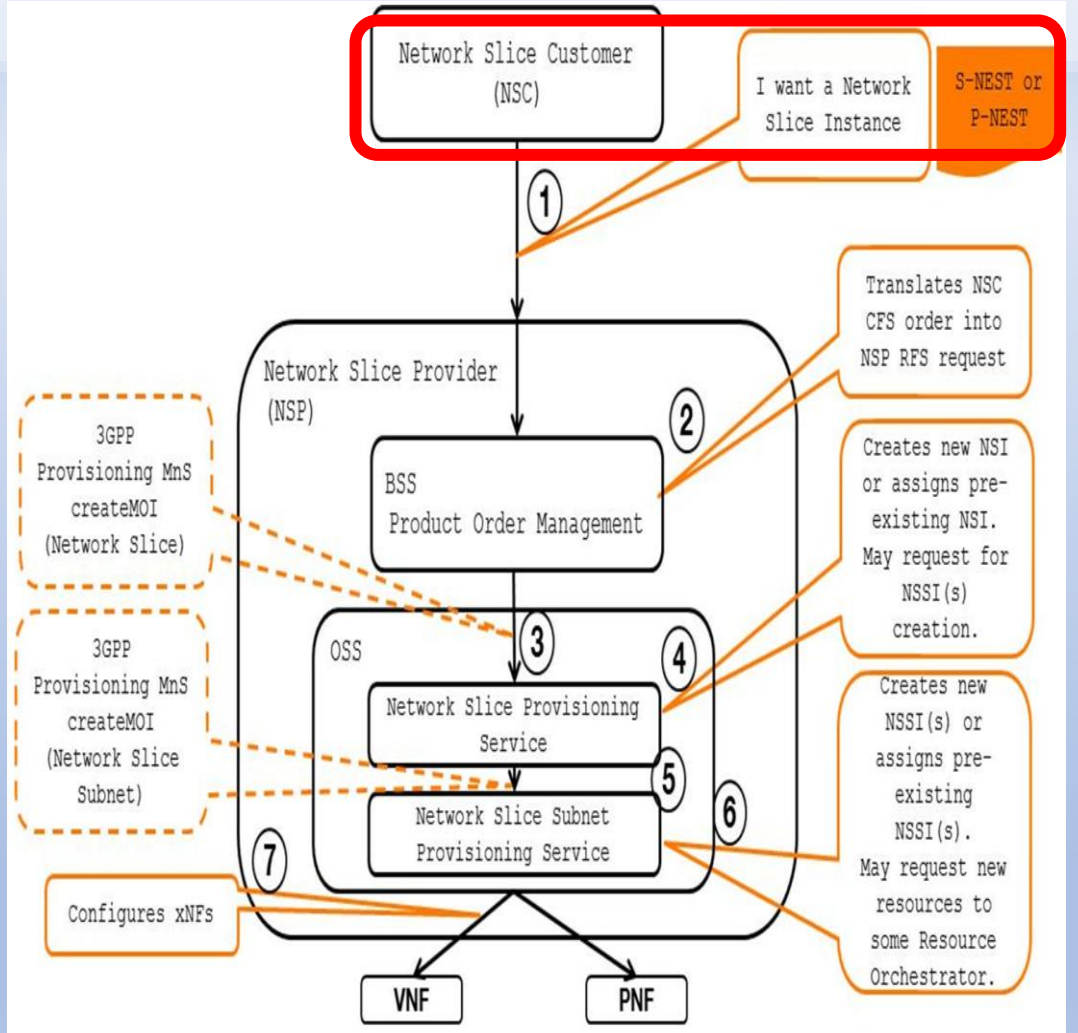


Figure A.2: Network Slice journey (NSaaS model) – high-level call flow

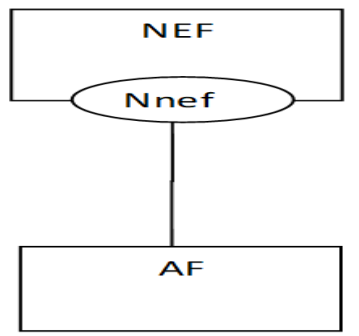
3GPP 5G NAPS -Northbound Application Program Interfaces (APIs) - 1

5G NAPS Reference model

The NEF Northbound Interface resides between the NEF and the AF.

It specifies RESTful APIs that allow the AF to access the Services and Capabilities provided by 3GPP Network Entities and securely exposed by the NEF.

An AF can get services from multiple NEFs, and an NEF can provide services to multiple AFs.



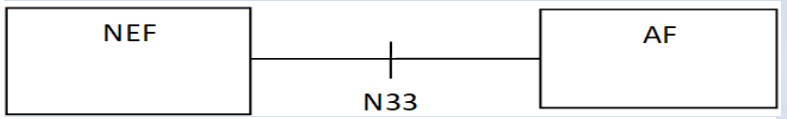


Fig. Reference Architecture for the Nnef Service SBI & Reference Point representation

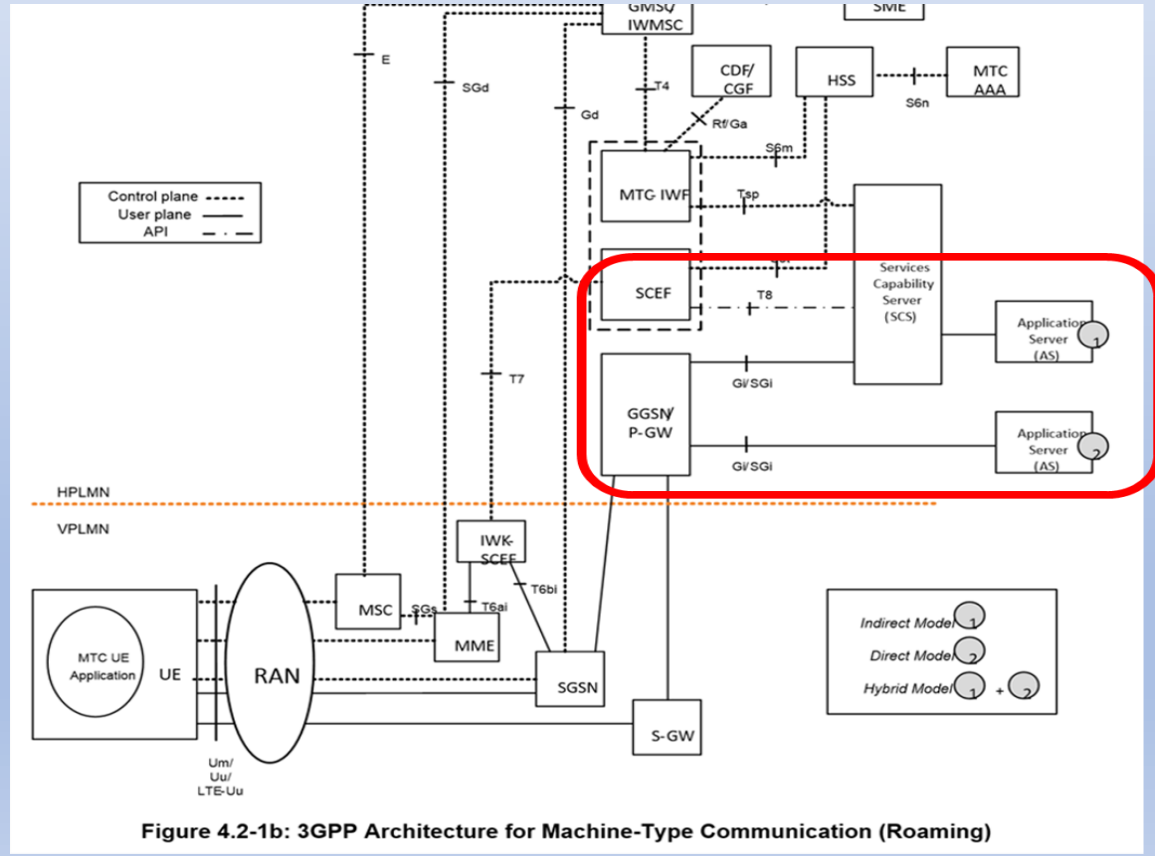


Figure 4.2-1b: 3GPP Architecture for Machine-Type Communication (Roaming)

3GPP 5G Rel. 18 SNA - SEES and FMSS NAPS to 5G Subscriber -2

"The Operator shall be able to provide to a 3rd Party Service Provider secure and chargeable access to the Exposed Services/Capabilities i.e. to Authenticate, Authorize and Charge the 3rd Party entities."

MNO can allow the API access of an 3rd Party entity by taking into account the 5GS Subscriber-based check.

Possibility of utilizing those APIs can be open directly to the 5GS subscriber. MNOs need to be cautious of securing its 5GS Subscribers' Privacy.

3GPP TSG SA Meeting # 89e SP-200797
Electronic Meeting, September 15th – 21st 2020

Source:	SA1 (from S1-203296)
Title:	New WID on Subscriber-aware Northbound API access (SNA)
Document for:	Approval
Agenda Item:	6.6

3GPP™ Work Item Description

Information on Work Items can be found at http://www.3gpp.org/Work-Items
See also the 3GPP Working Procedures, article 39 and the TSG Working Methods in 3GPP TR 21.900

Title: Subscriber-aware Northbound API access

Acronym: SNA

Unique identifier: 890024

Potential target Release: Rel-18
Note that this field above indicates the proposed Release at the time of submission of the WID to TSG approval. It can later be changed without a need to revise the WID. The updated target Release is indicated in the Work Plan.

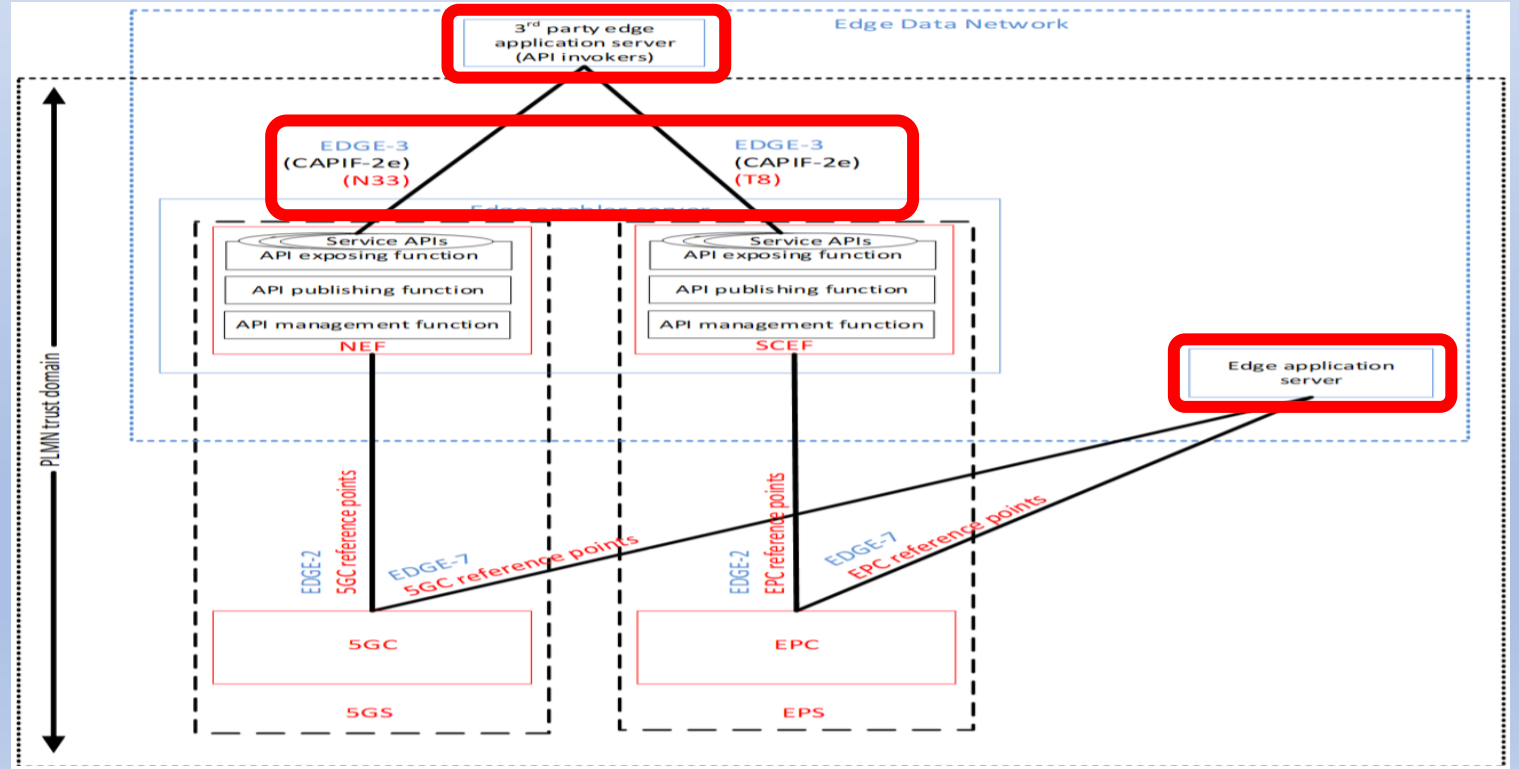


Figure 7.10.1.4.-1: EES and EAS direct interaction with 3GPP Core Network

2. ETSI MEC renamed in March 2017 & 3GPP 5G NSA Rel. 15 Mobility - 4

Selected security enhancements

Authentication improvements

2G/3G/4G: authentication done by VPLMN only
5G: both in VPLMN and HPLMN
5G AKA for 3GPP and non-3GPP access
EAP-AKA' for non-3GPP access only

K on USIM

When challenged, calculate response, NAS/AS keys, verify serving network.

VPLMN

UE authentication: verify UE response

HPLMN

UDM

K

UDR

UE authentication: verify UE response

Generate authentication vector(s) upon serving node(s) request(s).

Identity protection improvements

2G/3G/4G: occasionally network asks UE to send permanent id (IMSI) unencrypted over the air

5G: permanent id (SUPI) never sent unencrypted over the air interface

Identity Request

Identity Response
SUCI

SUPI

HPLMN public key

UE ephemeral key

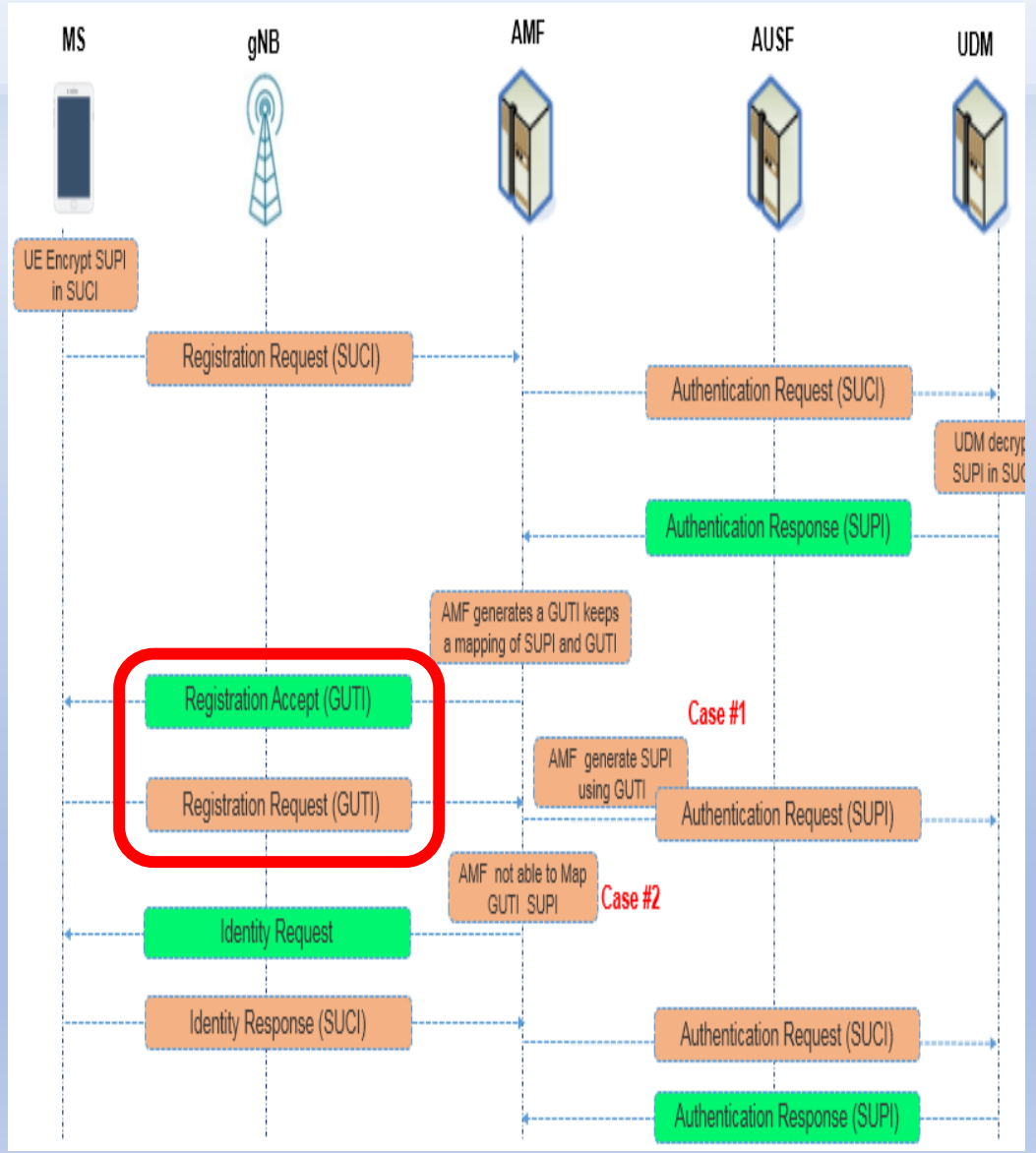
encryption

SUCI

- HPLMN id unencrypted to allow routing of requests VPLMN → HPLMN
- SUCI de-concealment done by UDM in HPLMN using HPLMN private key

AKA Authentication and Key Agreement
AS Access Stratum
EAP Extensible Authentication Protocol
IMSI International Mobile Subscriber Identity
NAS Non-Access Stratum

SUCI Subscription Concealed Identifier
SUPI Subscription Permanent Identifier
UDR Unified Data Repository
USIM Universal Subscriber Identity Module



GSMA Operator Platform (OP) Telco Edge Proposal

User to Network Interface - UNI

User-Network Interface (UNI): enables the User Client (UC) hosted in the UE to communicate with the OP.

1. The primary function of the UNI is to enable a User Client to interact with the OP, to enable the matching of an Application Client with an Application Instance on a Cloudlet.

2. User Client should be capable of being implemented on User Equipment SW, e.g. as an SDK or OS add-on.

3. The UNI shall allow the User Client to discover the existence of an Edge Cloud service.

4. The OP's UNI shall allow the User client registration process with the Operator Platform SRM.

Federation Broker Role for Federation and Platform Interconnection

GSMA

Operator Platform Telco Edge Proposal
Version 1.0
22 October 2020

1.3 Reference Architecture

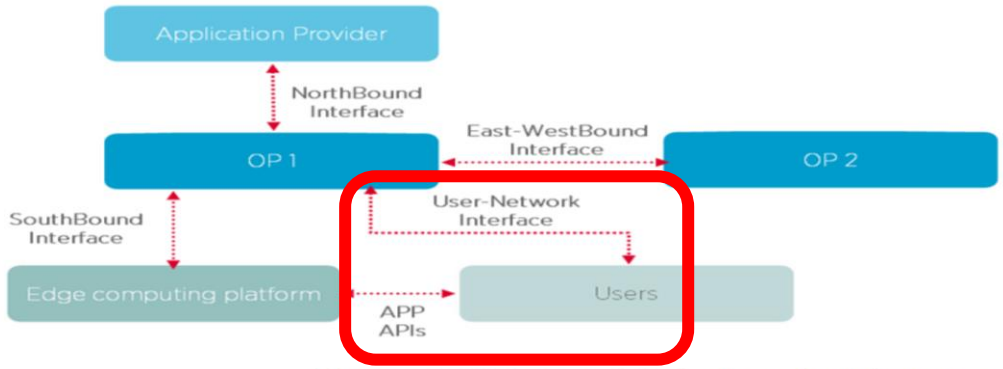


Figure 1: High-Level Reference Architecture

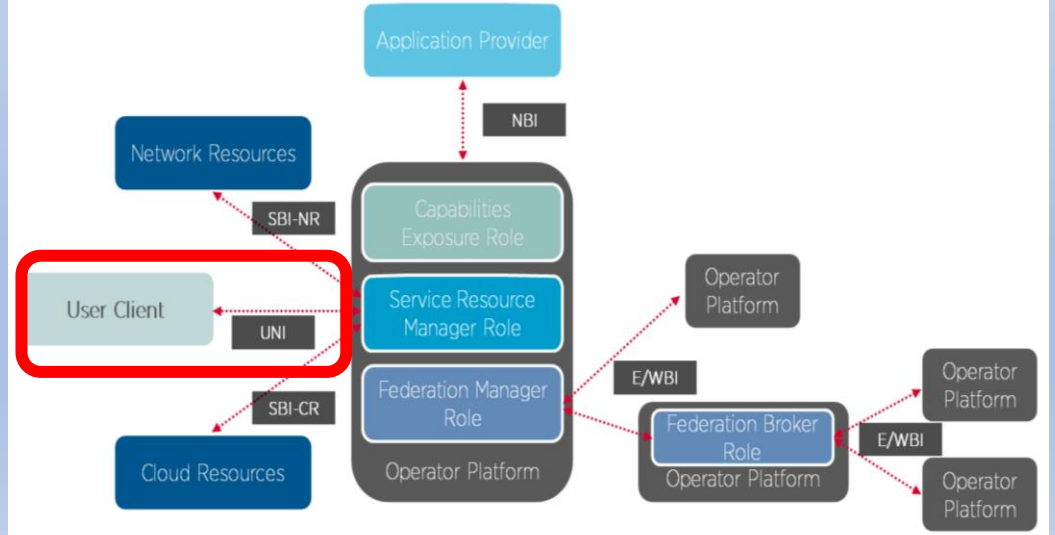


Figure 2: OP Roles and Interfaces Reference Architecture

ETSI MEC use of Federaion Broker enabling Edge Services across MEC System

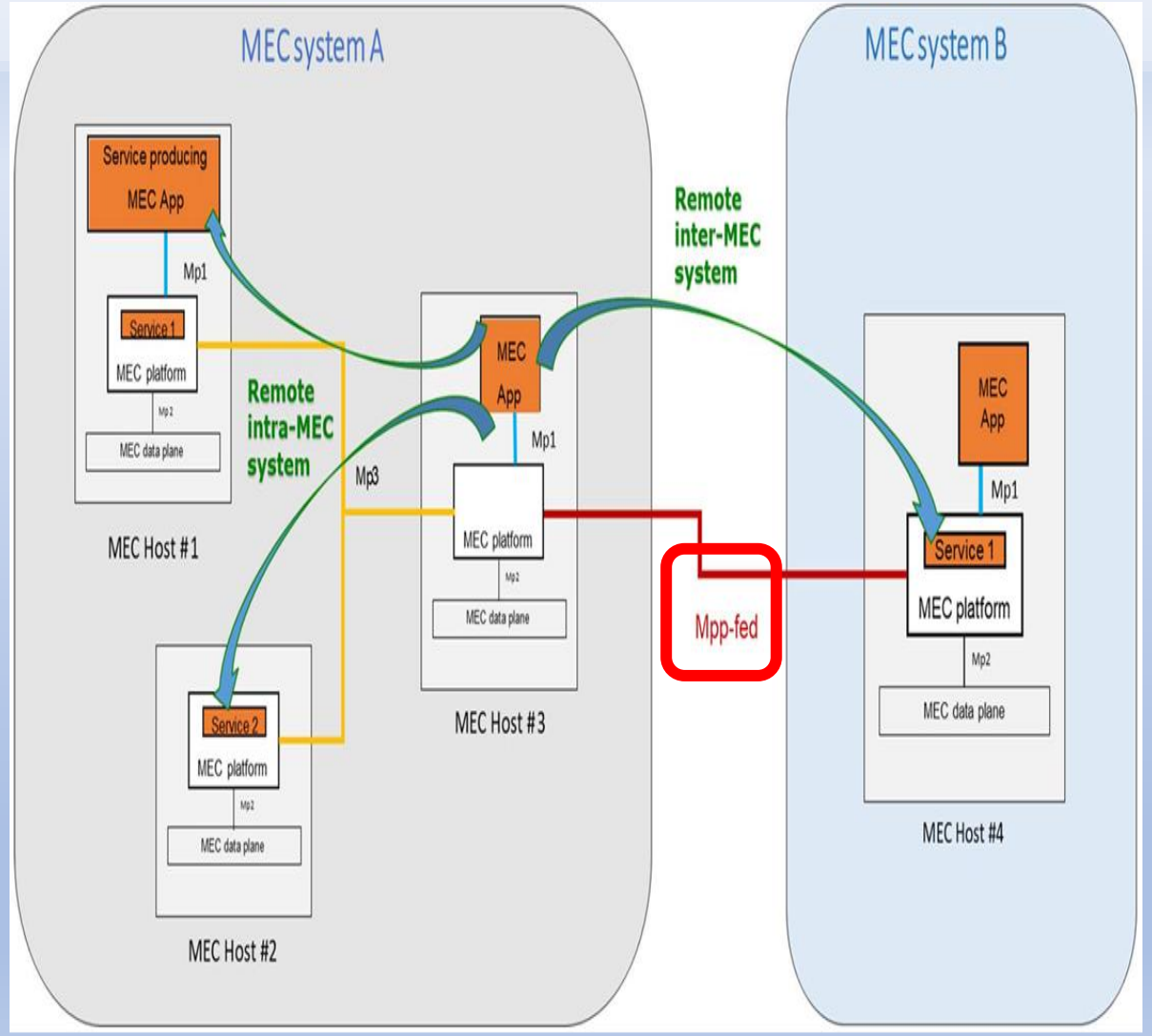


Fig. 6.5.2-1: MEC Federation Scenario enabling Edge Service consumption across MEC Systems.

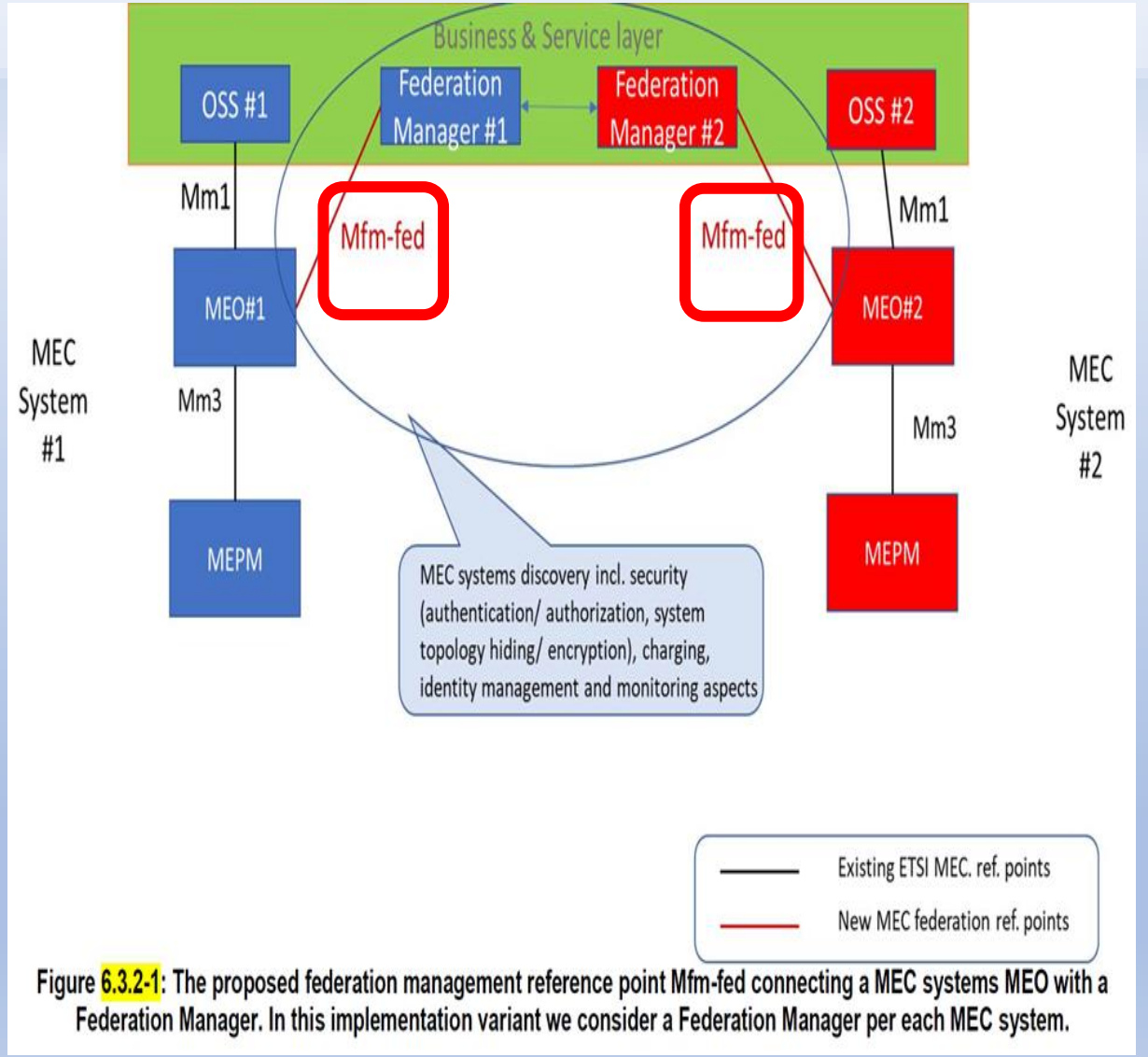


Figure 6.3.2-1: The proposed federation management reference point Mfm-fed connecting a MEC systems MEO with a Federation Manager. In this implementation variant we consider a Federation Manager per each MEC system.

NBI for E2E Service Management in ETSI ZSM

Figure 4-2 illustrates the set of technology domains considered in the present document. In deployments, there may be additional technology domains. Clause 6 documents the Northbound Interfaces of Management domains based on different technologies.

The NBIs of the E2E Service Management domain are to be defined.

One candidate: TM Forum Interfaces.

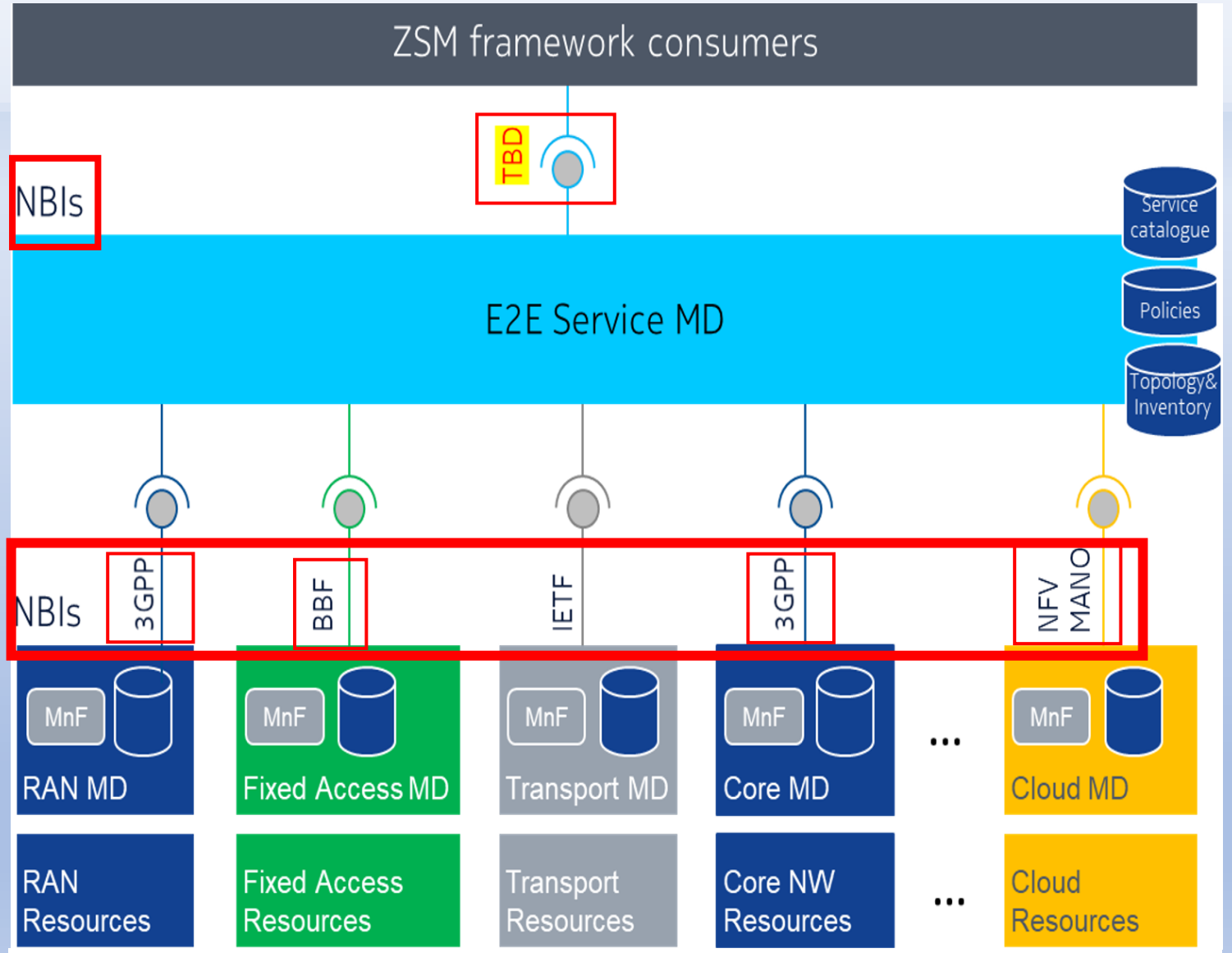


Figure 4-2: Domain NBIs consumed during the Management of the Lifecycle of E2E Services

IoT

Ref 3GPP TS 23.222 & TS 29.222 CAPIF for NAPS Rel 16 & 17, Dec 2020: 24,16

oneM2M Service Layer (SL) - Horizontal Architecture providing a Common Framework for IoT,

oneM2M has identified a **Set of Common Functionalities**, that are **applicable to all the IoT domains**.

Think of these functions as a large toolbox with special tools to solve a number of IoT problems across many different domains. The oneM2M CSFs are applicable to different IoT UCs in different industry domains.

oneM2M has standardized how these Functions are being executed, i.e. is has defined Uniform APIs to access these Functions.

Figure 6.2.0-1 shows a grouping of these Functions into a few different scopes.

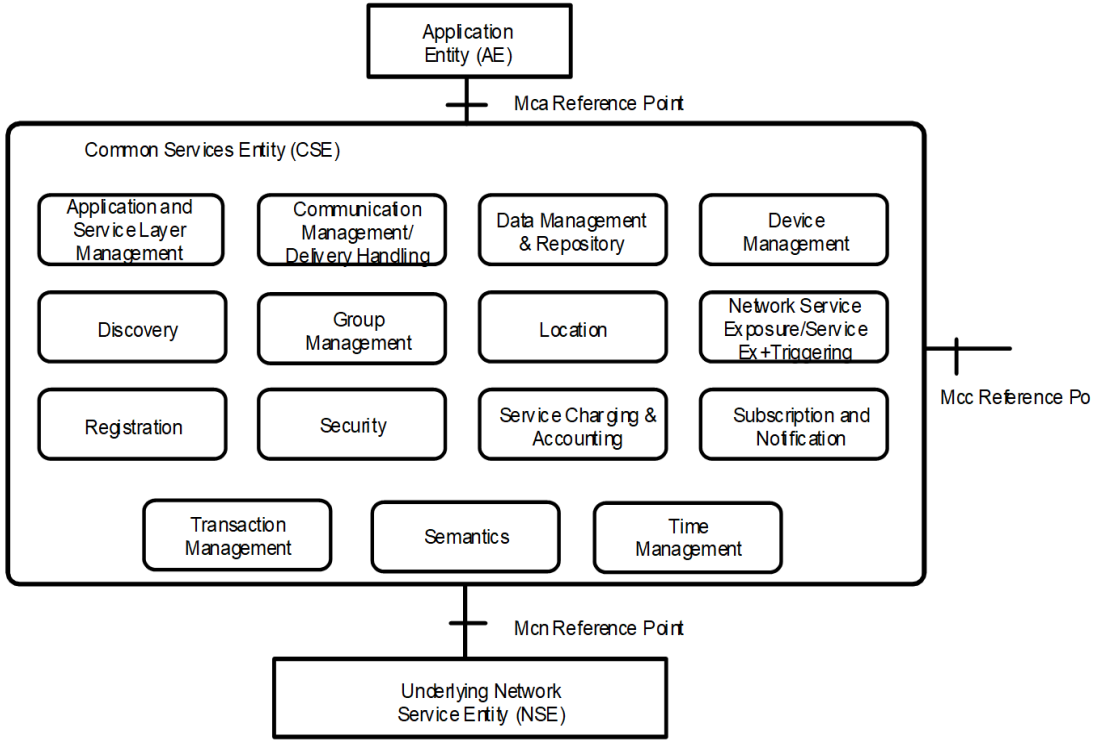


Fig. 6.2.0-1: Common Service Functions

SAREF - Smart Applications REFerence Ontology

SAREF is the Reference Ontology for Smart Applications and contains recurring concepts that are used in several Domains. SAREF has a close relation with the oneM2M Base Ontology, for which a mapping is defined in clause 5.

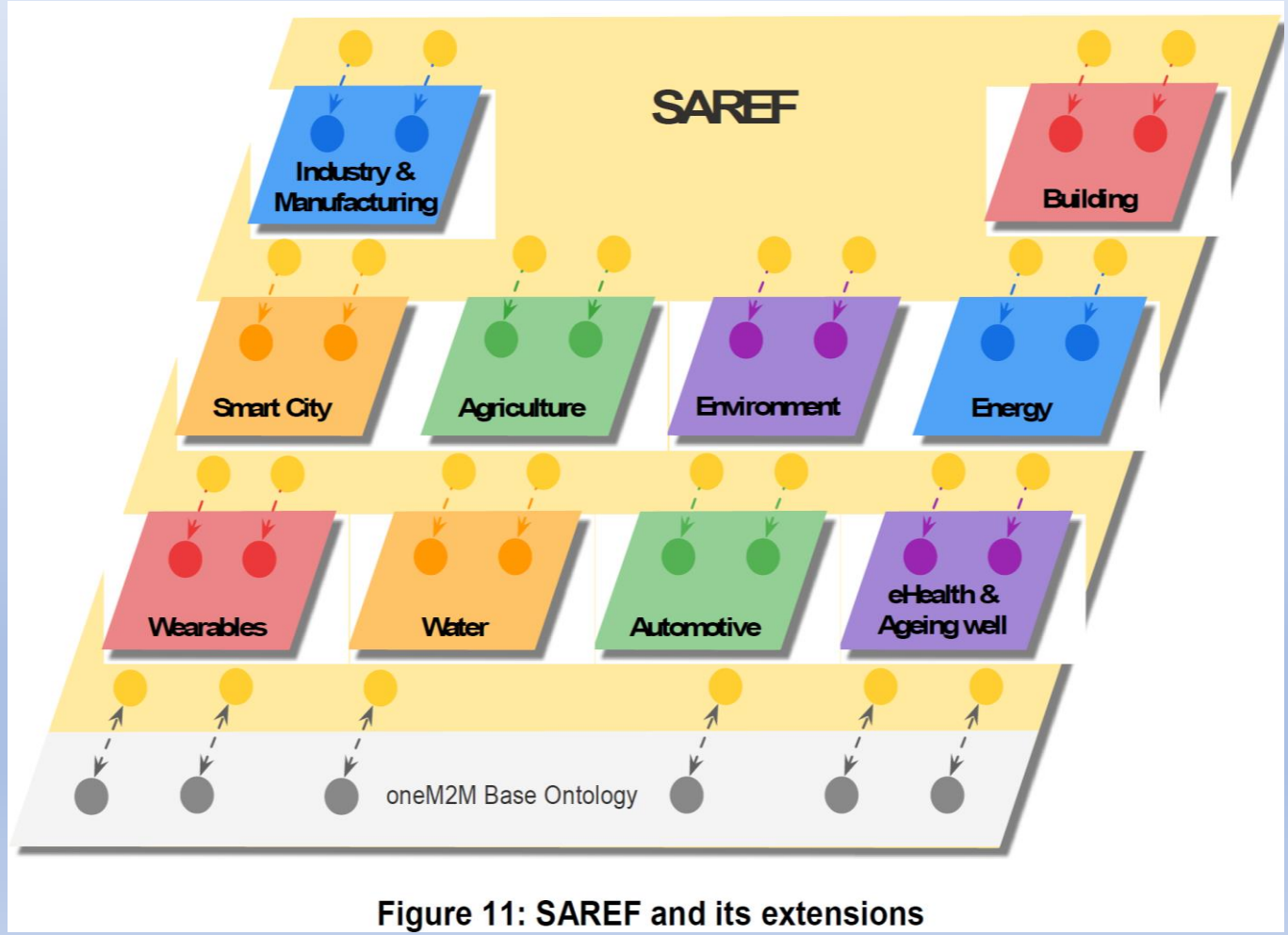


Figure 11: SAREF and its extensions

3.2 5GS Network Capabilities & MEC Integration - 1: Management Host & System Level

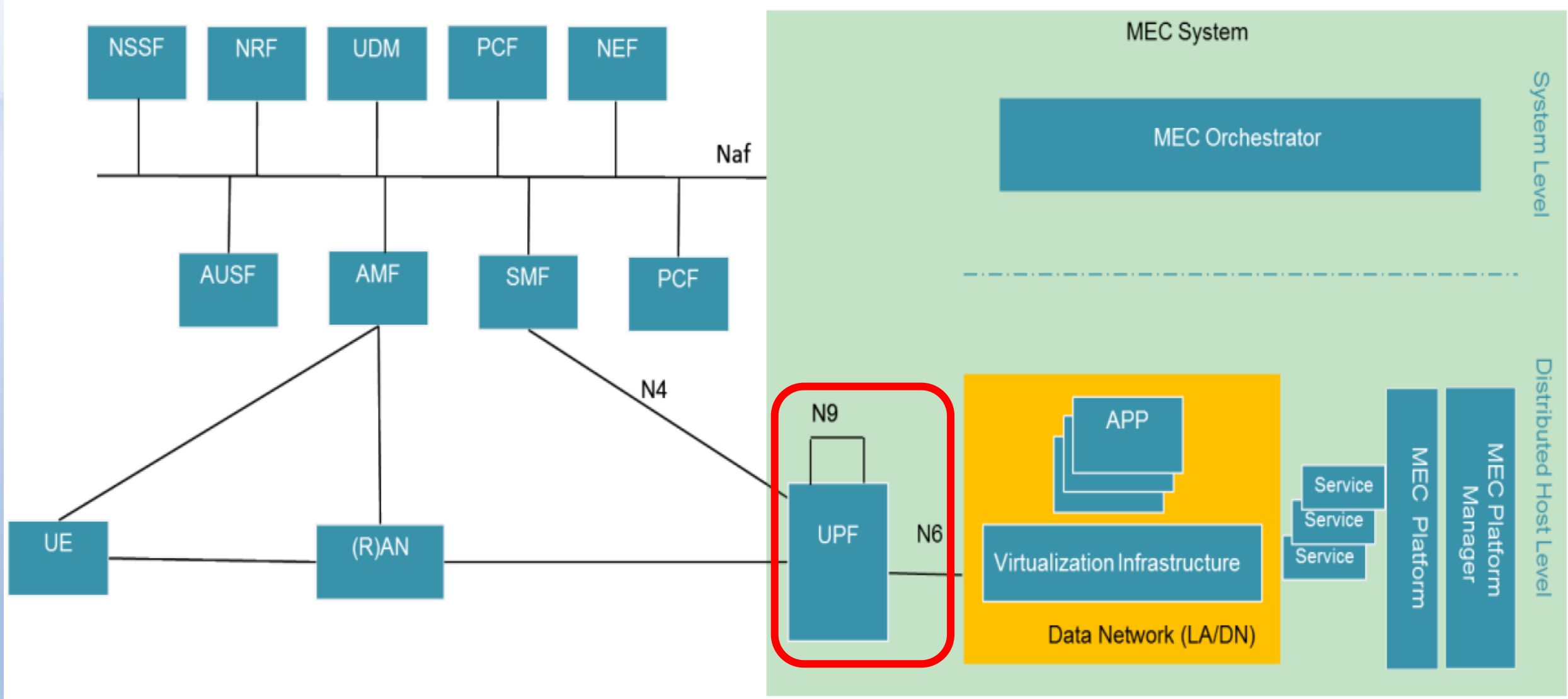


Figure 2. Integrated MEC deployment in 5G network

3.4 3GPP EDGEAPP & ETSI MEC SW for developing MEC Applications - 8 MEC in LADN

1. MEC & the local UPF collocated with the eNB/gNB Base Station
2. MEC collocated with a Transmission Node, possibly with a local UPF
3. MEC & the local UPF collocated with a Network Aggregation Point
4. MEC collocated with the CN Functions (i.e. in the same DC)

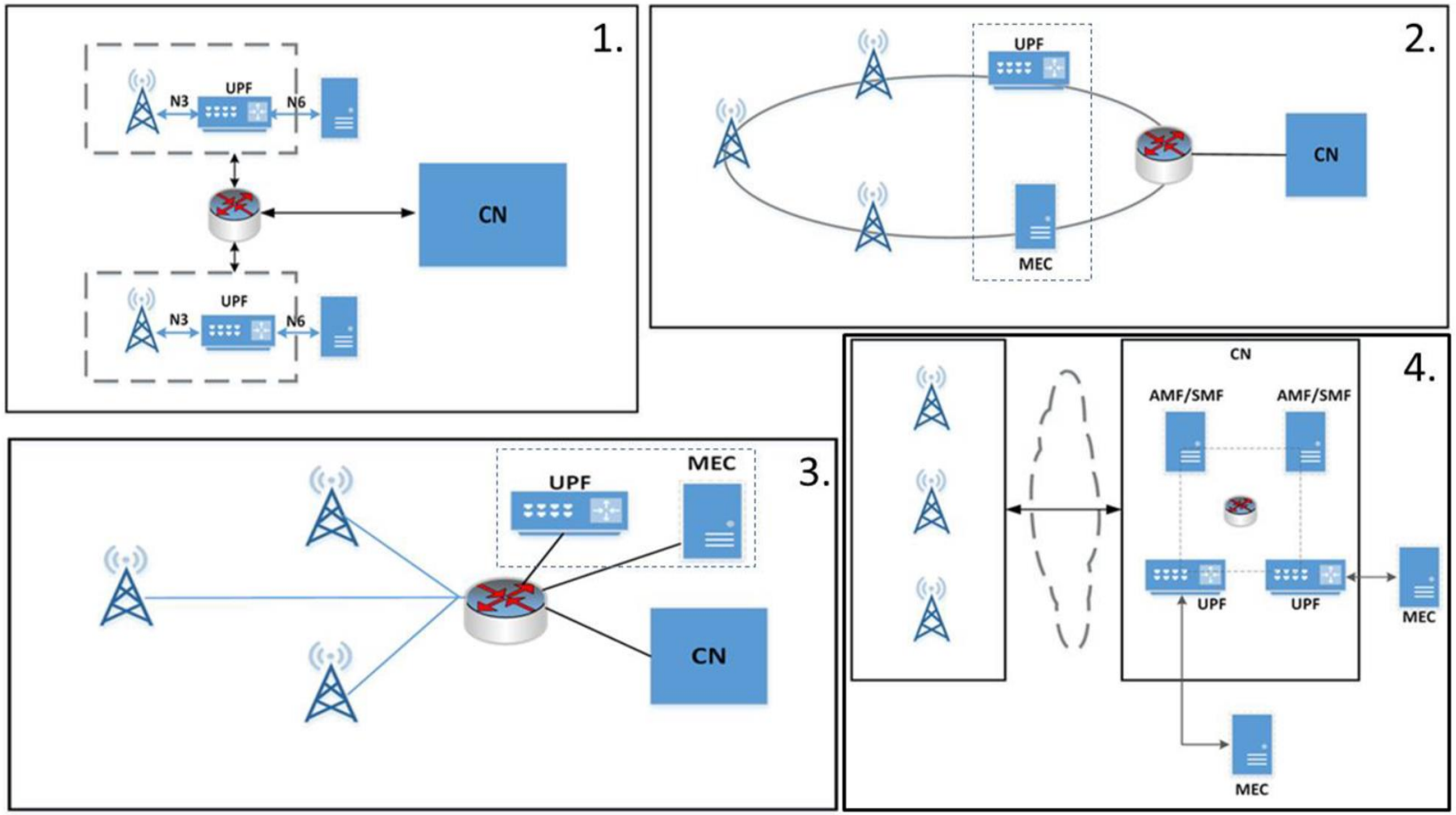


Figure 3. Examples of the physical deployment of MEC.

A.2.3 Option 3. Use of LADN

Edge computing services can be provided via Edge-dedicated Data Networks deployed as LADNs. The PLMN supports edge computing services in the EDN service areas which can be identified by the service area corresponding to the respective LADN DNNs or LADN DNN and subset of Tracking Areas corresponding to the LADN service area. The LADN service area is the service area that the Edge Computing is supported. Each individual EAS in the LADN may support the same or smaller service area than the LADN.

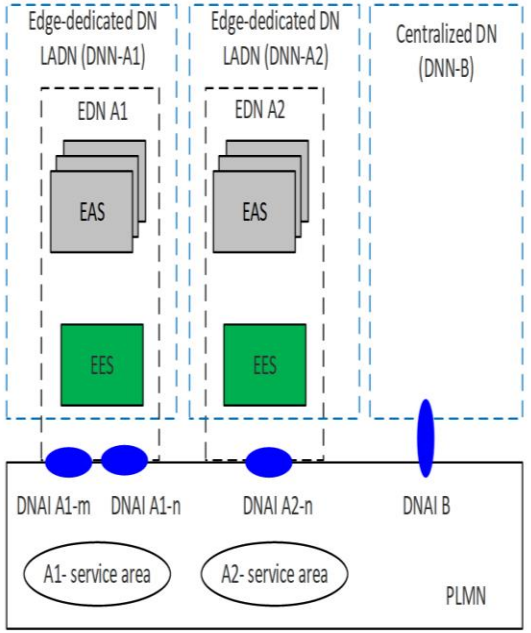


Figure A.2.3-1: Option 3: Use of LADN(s)

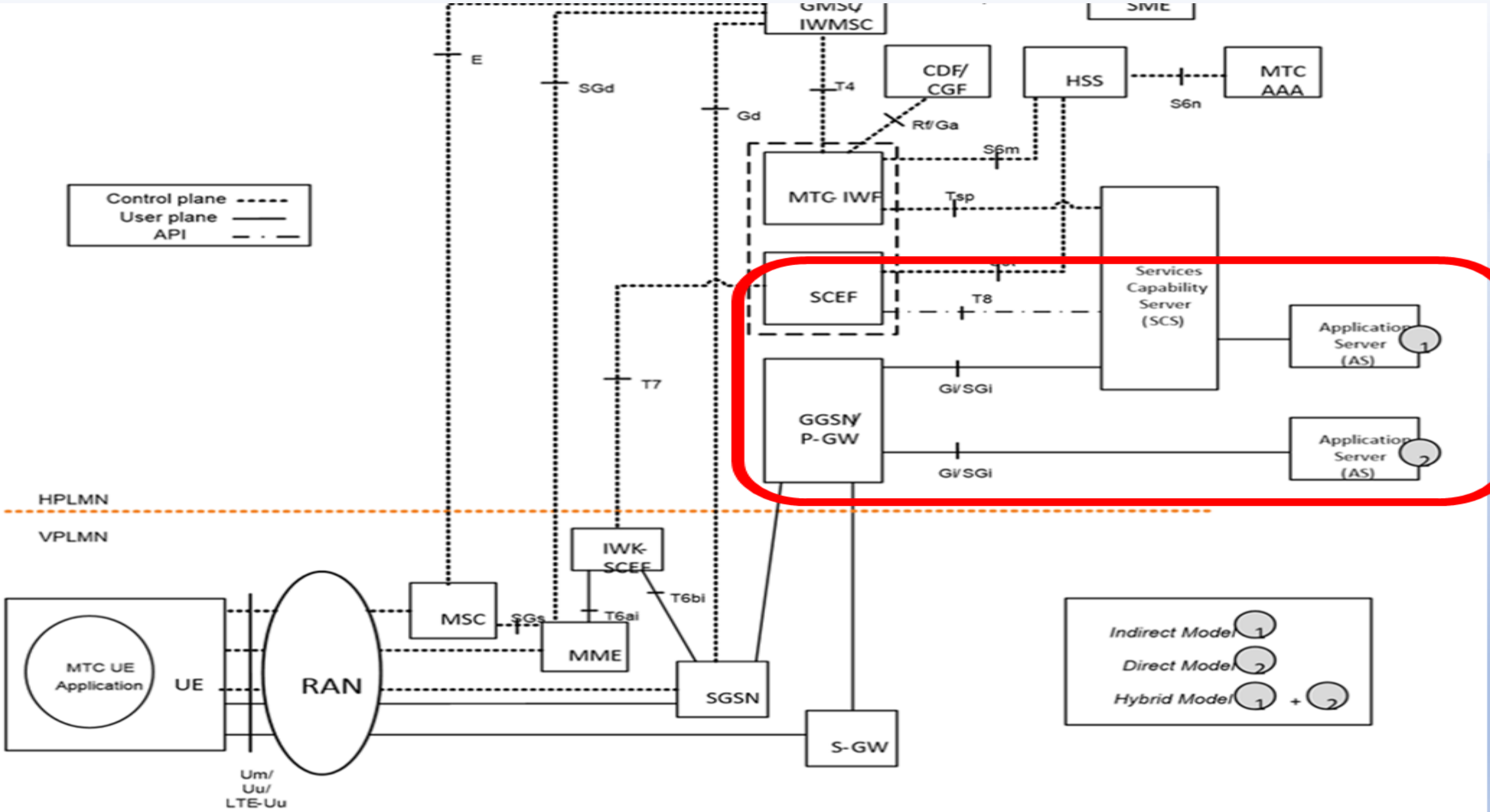


Figure 4.2-1b: 3GPP Architecture for Machine-Type Communication (Roaming)

Standardised SST values

Standardized SST values provide a way for establishing global interoperability for slicing so that PLMNs can support the roaming use case more efficiently for the most commonly used Slice/Service Types.

The SSTs which are standardised are in the following Table 5.15.2.2-1.

Table 5.15.2.2-1 - Standardised SST values

Slice/Service type	SST value	Characteristics
eMBB	1	Slice suitable for the handling of 5G enhanced Mobile Broadband.
URLLC	2	Slice suitable for the handling of ultra- reliable low latency communications.
MIoT	3	Slice suitable for the handling of massive IoT.
V2X	4	Slice suitable for the handling of V2X services.

NOTE: The support of all standardised SST values is not required in a PLMN. Services indicated in this table for each SST value can also be supported by means of other SSTs.

3GPP 5G SCEF/SCS for IoT Platform integrated with IoT SL across 10 UCs - 1

Functional mapping between 3GPP and oneM2M

Figure 5.2-1 shows an Architecture and Functional mapping for the 3GPP Trust Domain which describes how oneM2M Functional Entities may access Features and Services that are exposed by 3GPP.

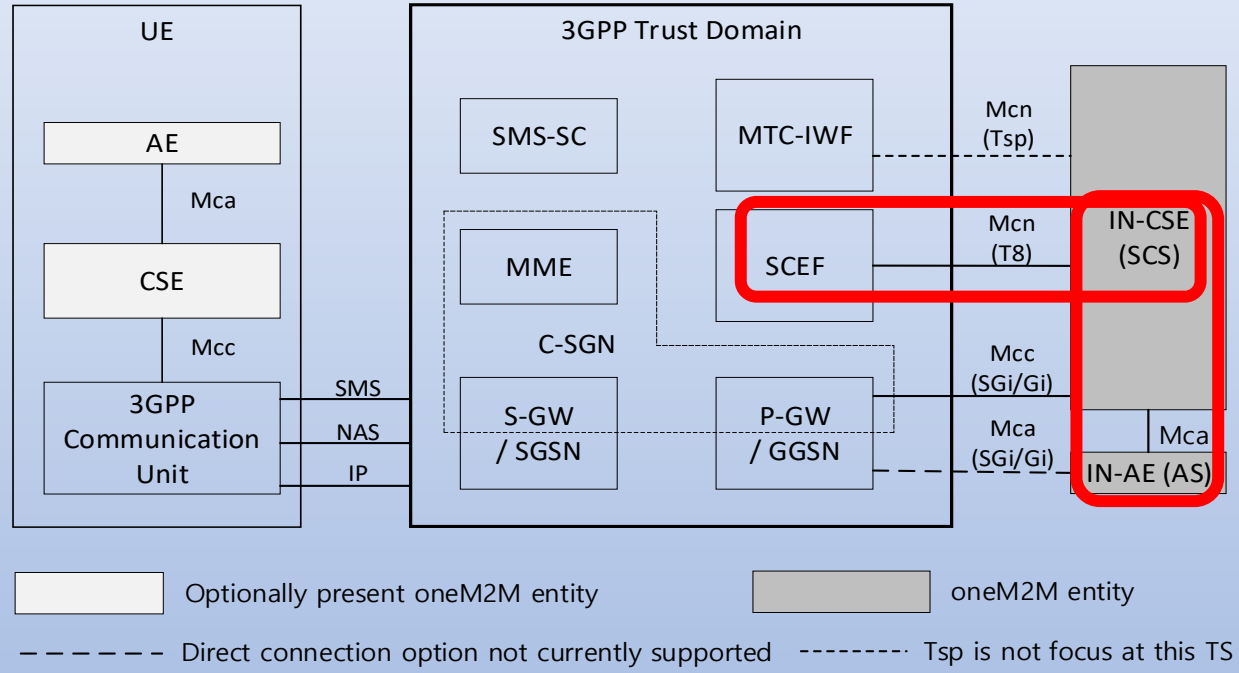


Figure 5.2-1: oneM2M Interfaces to the underlying 3GPP Network

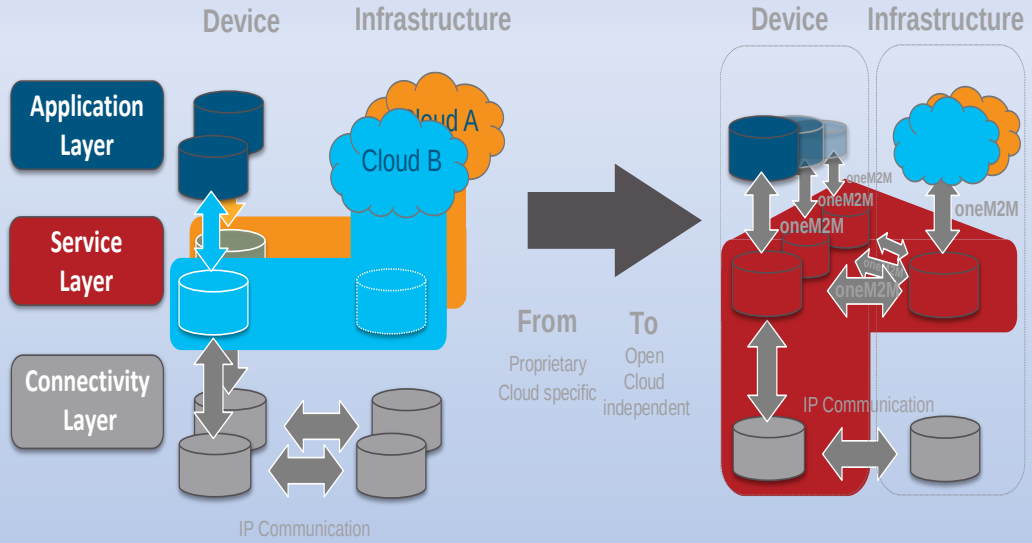


Figure 5.1.1-3: Cloud provider independent

Several implementation options for the placement of the oneM2M IN-CSE relative to the SCEF and the underlying 3GPP network are envisioned. In all implementations, the SCEF always resides within 3GPP domain.

In some options the IN-CSE and the SCEF are deployed by a MNO and are both part of the operator domain. In other options the SCEF is part of the 3GPP domain and the IN-CSE is not part of the operator domain.

In all options, services within the IN-CSE may access the network services that are exposed by the SCEF via the T8 reference point APIs.

Table 1: 5G User Equipment (UE) Service Access Identities Configuration

Access Identity number	UE configuration
0	UE is not configured with any parameters from this table
1 (NOTE 1)	UE is configured for Multimedia Priority Service (MPS).
2 (NOTE 2)	UE is configured for Mission Critical Service (MCS).
3	UE for which Disaster Condition applies (note 4)
4-10	Reserved for future use
11 (NOTE 3)	Access Class 11 is configured in the UE.
12 (NOTE 3)	Access Class 12 is configured in the UE.
13 (NOTE 3)	Access Class 13 is configured in the UE.
14 (NOTE 3)	Access Class 14 is configured in the UE.
15 (NOTE 3)	Access Class 15 is configured in the UE.

NOTE 1: Access Identity 1 is used by UEs configured for MPS, in the PLMNs where the configuration is valid. The PLMNs where the configuration is valid are HPLMN, PLMNs equivalent to HPLMN, and visited PLMNs of the home country.
Access Identity 1 is also valid when the UE is explicitly authorized by the network based on specific configured PLMNs inside and outside the home country.

NOTE 2: Access Identity 2 is used by UEs configured for MCS, in the PLMNs where the configuration is valid. The PLMNs where the configuration is valid are HPLMN or PLMNs equivalent to HPLMN and visited PLMNs of the home country. Access Identity 2 is also valid when the UE is explicitly authorized by the network based on specific configured PLMNs inside and outside the home country.

NOTE 3: Access Identities 11 and 15 are valid in Home PLMN only if the EHPLMN list is not present or in any EHPLMN. Access Identities 12, 13 and 14 are valid in Home PLMN and visited PLMNs of home country only. For this purpose, the home country is defined as the country of the MCC part of the IMSI.

NOTE 4: The configuration is valid for PLMNs that indicate to potential Disaster Inbound Roamers that the UEs can access the PLMN. See clause 6.31.

Table 2: 5G User Equipment (UE) Service Access Categories Configuration

Access Category number	Conditions related to UE	Type of access attempt
0	All	MO signalling resulting from paging
1 (NOTE 1)	UE is configured for delay tolerant service and subject to access control for Access Category 1, which is judged based on relation of UE's HPLMN and the selected PLMN.	All except for Emergency, or MO exception data
2	All	Emergency
3	All except for the conditions in Access Category 1.	MO signalling on NAS level resulting from other than paging
4	All except for the conditions in Access Category 1.	MMTEL voice (NOTE 3)
5	All except for the conditions in Access Category 1.	MMTEL video
6	All except for the conditions in Access Category 1.	SMS
7	All except for the conditions in Access Category 1.	MO data that do not belong to any other Access Categories (NOTE 4)
8	All except for the conditions in Access Category 1	MO signalling on RRC level resulting from other than paging
9	All except for the conditions in Access Category 1	MO IMS registration related signalling (NOTE 5)
10 (NOTE 6)	All	MO exception data
11-31		Reserved standardized Access Categories
32-63 (NOTE 2)	All	Based on operator classification

NOTE 1: The barring parameter for Access Category 1 is accompanied with information that define whether Access Category applies to UEs within one of the following categories:
a) UEs that are configured for delay tolerant service;
b) UEs that are configured for delay tolerant service and are neither in their HPLMN nor in a PLMN that is equivalent to it;
c) UEs that are configured for delay tolerant service and are neither in the PLMN listed as most preferred PLMN of the country where the UE is roaming in the operator-defined PLMN selector list on the SIM/USIM, nor in their HPLMN nor in a PLMN that is equivalent to their HPLMN.
When a UE is configured for EAB, the UE is also configured for delay tolerant service. In case a UE is configured both for EAB and for EAB override, when upper layer indicates to override Access Category 1, then Access Category 1 is not applicable.

NOTE 2: When there are an Access Category based on operator classification and a standardized Access Category to both of which an access attempt can be categorized, and the standardized Access Category is neither 0 nor 2, the UE applies the Access Category based on operator classification. When there are an Access Category based on operator classification and a standardized Access Category to both of which an access attempt can be categorized, and the standardized Access Category is 0 or 2, the UE applies the standardized Access Category.

NOTE 3: Includes Real-Time Text (RTT).

NOTE 4: Includes IMS Messaging.

NOTE 5: Includes IMS registration related signalling, e.g. IMS initial registration, re-registration, and subscription refresh.

NOTE 6: Applies to access of a NB-IoT-capable UEto a NB-IOT cell connected to 5GC when the UE is authorized to send exception data.

Table 3: Performance Requirements for High Data Rate and Traffic Density Scenarios

	Scenario	Experienced data rate (DL)	Experienced data rate (UL)	Area traffic capacity (DL)	Area traffic capacity (UL)	Overall user density	Activity factor	UE speed	Coverage
1	Urban macro	50 Mbit/s	25 Mbit/s	100 Gbit/s/km^2 (note 4)	50 Gbit/s/km^2 (note 4)	10 000/km^2	20 %	Pedestrians and users in vehicles (up to 120 km/h	Full network (note 1)
2	Rural macro	50 Mbit/s	25 Mbit/s	1 Gbit/s/km^2 (note 4)	500 Mbit/s/km^2 (note 4)	100/km^2	20 %	Pedestrians and users in vehicles (up to 120 km/h	Full network (note 1)
3	Indoor hotspot	1 Gbit/s	500 Mbit/s	15 Tbit/s/km^2	2 Tbit/s/km^2	250 000/km^2	note 2	Pedestrians	Office and residential (note 2) (note 3)
4	Broadband access in a crowd	25 Mbit/s	50 Mbit/s	[3,75] Tbit/s/km^2	[7,5] Tbit/s/km^2	[500 000]/km^2	30 %	Pedestrians	Confined area
5	Dense urban	300 Mbit/s	50 Mbit/s	750 Gbit/s/km^2 (note 4)	125 Gbit/s/km^2 (note 4)	25 000/km^2	10 %	Pedestrians and users in vehicles (up to 60 km/h)	Downtown (note 1)
6	Broadcast-like services	Maximum 200 Mbit/s (per TV channel)	N/A or modest (e.g. 500 kbit/s per user)	N/A	N/A	[15] TV channels of [20 Mbit/s] on one carrier	N/A	Stationary users, pedestrians and users in vehicles (up to 500 km/h)	Full network (note 1)
7	High-speed train	50 Mbit/s	25 Mbit/s	15 Gbit/s/train	7,5 Gbit/s/train	1 000/train	30 %	Users in trains (up to 500 km/h)	Along railways (note 1)
8	High-speed vehicle	50 Mbit/s	25 Mbit/s	[100] Gbit/s/km^2	[50] Gbit/s/km^2	4 000/km^2	50 %	Users in vehicles (up to 250 km/h)	Along roads (note 1)
9	Airplanes connectivity	15 Mbit/s	7,5 Mbit/s	1,2 Gbit/s/plane	600 Mbit/s/plane	400/plane	20 %	Users in airplanes (up to 1 000 km/h)	(note 1)

NOTE 1: For users in vehicles, the UE can be connected to the network directly, or via an on-board moving base station.
NOTE 2: A certain traffic mix is assumed; only some users use services that require the highest data rates [2].
NOTE 3: For interactive audio and video services, for example, virtual meetings, the required two-way end-to-end latency (UL and DL) is 2-4 ms while the corresponding experienced data rate needs to be up to 8K 3D video [300 Mbit/s] in uplink and downlink.
NOTE 4: These values are derived based on overall user density. Detailed information can be found in [10].
NOTE 5: All the values in this table are targeted values and not strict requirements.

Table 4: Performance Requirements for Horizontal and Vertical Positioning Service Levels

Positioning service level	Absolute(A) or Relative(R) positioning	Accuracy (95 % confidence level)		Positioning service availability	Positioning service latency	Coverage, environment of use and UE velocity		
		Horizontal Accuracy	Vertical Accuracy (note 1)			5G positioning service area	5G enhanced positioning service area (note 2)	
							Outdoor and tunnels	Indoor
1	A	10 m	3 m	95 %	1 s	Indoor - up to 30 km/h Outdoor (rural and urban) up to 250 km/h	NA	Indoor - up to 30 km/h
2	A	3 m	3 m	99 %	1 s	Outdoor (rural and urban) up to 500 km/h for trains and up to 250 km/h for other vehicles	Outdoor (dense urban) up to 60 km/h Along roads up to 250 km/h and along railways up to 500 km/h	Indoor - up to 30 km/h
3	A	1 m	2 m	99 %	1 s	Outdoor (rural and urban) up to 500 km/h for trains and up to 250 km/h for other vehicles	Outdoor (dense urban) up to 60 km/h Along roads up to 250 km/h and along railways up to 500 km/h	Indoor - up to 30 km/h
4	A	1 m	2 m	99,9 %	15 ms	NA	NA	Indoor - up to 30 km/h
5	A	0,3 m	2 m	99 %	1 s	Outdoor (rural) up to 250 km/h	Outdoor (dense urban) up to 60 km/h Along roads and along railways up to 250 km/h	Indoor - up to 30 km/h
6	A	0,3 m	2 m	99,9 %	10 ms	NA	Outdoor (dense urban) up to 60 km/h	Indoor - up to 30 km/h
7	R	0,2 m	0,2 m	99 %	1 s	Indoor and outdoor (rural, urban, dense urban) up to 30 km/h Relative positioning is between two UEs within 10 m of each other or between one UE and 5G positioning nodes within 10 m of each other (note 3)		

NOTE 1: The objective for the vertical positioning requirement is to determine the floor for indoor use cases and to distinguish between superposed tracks for road and rail use cases (e.g. bridges).

NOTE 2: Indoor includes location inside buildings such as offices, hospital, industrial buildings.

NOTE 3: 5G positioning nodes are infrastructure equipment deployed in the service area to enhance positioning capabilities (e.g. beacons deployed on the perimeter of a rendezvous area or on the side of a warehouse).

Table 5: UE to Satellite Propagation Delay

	UE to satellite Delay [ms]		One-Way Max propagation delay [ms]
	Min	Max	
LEO	3	15	30
MEO	27	43	90
GEO	120	140	280

Table 6: Performance Requirements for Satellite Access

Scenario	Experienced data rate (DL)	Experienced data rate (UL)	Area traffic capacity (DL) (note 1)	Area traffic capacity (UL) (note 1)	Overall user density	Activity factor	UE speed	UE type
Pedestrian (note 2)	[1] Mbit/s	[100] kbit/s	1,5 Mbit/s/km^2	150 kbit/s/km^2	[100]/km^2	[1,5] %	Pedestrian	Handheld
Public safety	[3,5] Mbit/ss	[3,5] Mbit/s	TBD	TBD	TBD	N/A	100 km/h	Handheld
Vehicular connectivity (note 3)	50 Mbit/s	25 Mbit/s	TBD	TBD	TBD	50 %	Up to 250 km/h	Vehicle mounted
Airplanes connectivity (note 4)	360 Mbit/s/ plane	180 Mbit/s/ plane	TBD	TBD	TBD	N/A	Up to 1000 km/h	Airplane mounted
Stationary	50 Mbit/s	25 Mbit/s	TBD	TBD	TBD	N/A	Stationary	Building mounted
Narrowband IoT connectivity	[2] kbit/s	[10] kbit/s	8 kbit/s/km^2	40 kbit/s/km^2	[400]/km2	[1] %	[Up to 100 km/h]	IoT

Note 1: Area capacity is averaged over a satellite beam.
Note 2: Data rates based on Extreme long-range coverage target values in clause 6.17.2. User density based on rural area in Table 7.1-1.
Note 3: Based on Table 7.1-1
Note 4: Based on an assumption of 120 users per plane 15/7.5 Mbit/s data rate and 20 % activity factor per user
Note 5: All the values in this table are targeted values and not strict requirements.
Note 6: Performance requirements for all the values in this table should be analyzed independently for each scenario.

Table 7: Performance Requirements for Highly Reliable Machine Type Communication

Profile	Characteristic parameter					Influence quantity					
	Communication service availability: target value in %	Communication service reliability (Mean Time Between Failure)	End-to-end latency: maximum	Bit rate	Direction	Message Size [byte]	Transfer Interval	Survival Time	UE speed (km/h)	# of UEs connection	Service Area
Medical monitoring (note 2)	> 99,9999	<1 year (>> 1 month)	< 100 ms	< 1 Mbit/s	Uplink	~ 1000	50 ms	Transfer Interval	< 500	10/km^2 to 1000/km^2	Country wide including rural areas and deep indoor. (note 1)

NOTE 1: "deep indoor" term is meant to be places like e.g. elevators, building's basement, underground parking lot, …

NOTE 2: These performance requirements aim energy-efficient transmissions performed using a device powered with a 3.3V battery of capacity < 1000 mAh that can last at least 1 month without recharging and whereby the peak current for transmit operations stays below 50 mA.

Table 8 KPI Table for additional High Data Rate and Low Latency Service

Use Cases	Characteristic parameter (KPI)			Influence quantity		
	Max allowed end-to-end latency	Service bit rate: user-experienced data rate	Reliability	# of UEs	UE Speed	Service Area (note 2)
Cloud/Edge/Split Rendering (note 1)	5 ms (i.e. UL+DL between UE and the interface to data network) (note 4)	0,1 to [1] Gbit/s supporting visual content (e.g. VR based or high definition video) with 4K, 8K resolution and up to120 frames per second content.	99,99 % in uplink and 99,9 % in downlink (note 4)	-	Stationary or Pedestrian	Countrywide
Gaming or Interactive Data Exchanging (note 3)	10ms (note 4)	0,1 to [1] Gbit/s supporting visual content (e.g. VR based or high definition video) with 4K, 8K resolution and up to120 frames per second content.	99,99 % (note 4)	≤ [10]	Stationary or Pedestrian	20 m x 10 m; in one vehicle (up to 120 km/h) and in one train (up to 500 km/h)
Consumption of VR content via tethered VR headset (note 6)	[5 to 10] ms (note 5)	0,1 to [10] Gbit/s (note 5)	[99,99 %]	-	Stationary or Pedestrian	–

NOTE 1: Unless otherwise specified, all communication via wireless link is between UEs and network node (UE to network node and/or network node to UE) rather than direct wireless links (UE to UE).
NOTE 2: Length x width (x height).
NOTE 3: Communication includes direct wireless links (UE to UE).
NOTE 4: Latency and reliability KPIs can vary based on specific use case/architecture, e.g. for cloud/edge/split rendering, and may be represented by a range of values.
NOTE 5: The decoding capability in the VR headset and the encoding/decoding complexity/time of the stream will set the required bit rate and latency over the direct wireless link between the tethered VR headset and its connected UE, bit rate from 100 Mbit/s to [10] Gbit/s and latency from 5 ms to 10 ms.
NOTE 6: The performance requirement is valid for the direct wireless link between the tethered VR headset and its connected UE.

Table 9: Key Performance for UE to Network Relaying

Scenario	Max. data rate (DL)	Max. data rate (UL)	End-to-end latency (note 7)	Area traffic capacity (DL)	Area traffic capacity (UL)	Area user density	Area	Range of a single hop (note 8)	Estimated number of hops
InHome Scenario (note 1)	1 Gbit/s	500 Mbit/s	10 ms	5 Gbit/s/ home	2 Gbit/s /home	50 devices /house	10 m x 10m – 3 floors	10 m indoor	2 to 3
Factory Sensors (note 2)	100 kbit/s	5 Mbit/s	50 ms to 1 s	1 Gbit/s /factory	50 Gbit/s /factory	10000 devices /factory	100 m x 100 m	30 m indoor / metallic	2 to 3
Smart Metering (note 3)	100 bytes / 15 mins	100 bytes / 15 mins	10 s	200 x 100 bytes / 15 mins /hectare	200 x 100 bytes / 15 mins /hectare	200 devices /hectare	100 m x 100 m	> 100 m indoor / deep indoor	2 to 5
Containers (note 4)	100 bytes / 15 mins	100 bytes / 15 mins	10 s	15000 x 100 bytes / 15 mins /ship	15000 x 100 bytes / 15 mins /ship	15000 containers /ship	400 m x 60 m x 40 m	> 100 m indoor / outdoor / metallic	3 to 9
Freight Wagons	100 bytes / 15 mins	100 bytes / 15 mins	10 s	200 x 100 bytes / 15 mins /train	200 x 100 bytes / 15 mins /train	120 wagons /train	1 km	> 100 m outdoor / tunnel	10 to 15
Public Safety (note 5)	12 Mbit/s	12 Mbit/s	30 ms	20 Mbit/s /building	40 Mbit/s /building	30 devices /building	100 m x 100 m – 3 floors	> 50 m indoor (floor or stairwell)	2 to 4
Wearables (note 6)	10 Mbit/s	10 Mbit/s	10 ms	20 Mbit/s per 100 m^2	20 Mbit/s per 100 m^2	10 wearables per 100 m^2	10 m x 10 m	10 m indoor / outdoor	1 to 2

NOTE 1: Area traffic capacity is determined by high bandwidth consuming devices (e.g. ultra HD TVs, VR headsets), the number of devices has been calculated assuming a family of 4 members.
NOTE 2: Highest data rate assumes audio sensors with sampling rate of 192 kHz and 24 bits sample size.
NOTE 3: Three meters (gas, water, electricity) per house, medium density of 50 to 70 houses per hectare.
NOTE 4: A large containership with a mix of 20 foot and 40 foot containers is assumed.
NOTE 5: A mix of MCPTT, MCVideo, and MCData is assumed. Average 3 devices per firefighter / police officer, of which one video device. Area traffic based on 1080 p, 60 fps is 12 Mbit/s video, with an activity factor of 30% in uplink (30% of devices transmit simultaneously at high bitrate) and 15% in downlink.
NOTE 6: Communication for wearables is relayed via a UE. This relay UE may use a further relay UE.
NOTE 7: End-to-end latency implies that all hops are included.
NOTE 8: 'Metallic' implies an environment with a lot of metal obstructions (e.g. machinery, containers). 'Deep indoor' implies that there may be concrete walls / floors between the devices.
NOTE 9: All the values in this table are example values and not strict requirements.

Latency needs to support example Use Cases (UCs) from Vertical Industries

Services/ Use cases	Automotive use cases	Transport, logistics, IoT use cases	Health and wellness, smart cities use cases	Media and entertainment
Description	Expand detectable range beyond on board sensor capability by sharing views or detected objects among traffic participants, coordinate trajectories among vehicles, sharing coarse driving intention, real-time remote operation of vehicles	Real-time sensing, reporting, feedback, control, remote, asset tracking, monitoring; context-aware services, recommendations at shopping mall, airport	Live video feed (4K, 8K, 3D for remote healthcare (consultation, monitoring) and assisted surgery, real-time commands to control medical devices for treatment (e.g. medication, surgery); remote monitoring, surveillance and guidance for citizens and law enforcement officers.	Media production services based on aggregation of various media feeds at servers; real-time peer-to-peer or server-client sharing of data (object information) for collaborative gaming, live streaming at live events
Latency	For mid/long-term environment modelling (dynamic high-definition digital map update): Not critical (100 ms end-to-end) For short term environment modelling (sensor sharing): <20 ms end-to-end For cooperation (coordinated control): - <3 ms end-to-end for platooning , - <10 ms end-to-end for cooperative manoeuvres , - <100 ms end-to-end for coarse driving intention For remote vehicle operation: 10-30 ms end-to-end	For massive connectivity for time-critical sensing and feedback: <30 ms end–to-end. For remote drone operation and cooperative farm machinery: 10-30 ms end-to-end Real-time control for discrete automation: ≤1 ms end-to-end	For real-time video/ telepresence/augmented reality for remote healthcare and assisted surgery, for monitoring and guidance (smart cities): 100 ms end-to-end Real-time command and control for remote medication and surgery: 10-100 ms end-to-end For smart grid: - <5 ms end-to-end for transmission/grid backbone, - <50 ms end-to-end for distribution/grid backhaul, Time-critical sensing and feedback for smart cities: 30 ms end-to-end	For live streaming in crowded areas, services for media production, augmented reality for collaborative gaming etc.: 20 ms end–to-end

Table 11: Standardized 5QI to QoS Characteristics mapping

5QI Value	Resource Type	Default Priority Level	Packet Delay Budget (NOTE 3)	Packet Error Rate	Default Maximum Data Burst Volume (NOTE 2)	Default Averaging Window
1	GBR (NOTE 1)	20	100 ms (NOTE 11, NOTE 13)	10^{-2}	N/A	2000 ms
2		40	150 ms (NOTE 11, NOTE 13)	10^{-3}	N/A	2000 ms
3		30	50 ms (NOTE 11, NOTE 13)	10^{-3}	N/A	2000 ms
4		50	300 ms (NOTE 11, NOTE 13)	10^{-6}	N/A	2000 ms
65 (NOTE 9, NOTE 12)		7	75 ms (NOTE 7, NOTE 8)	10^{-2}	N/A	2000 ms
66 (NOTE 12)		20	100 ms (NOTE 10, NOTE 13)	10^{-2}	N/A	2000 ms
67 (NOTE 12)		15	100 ms (NOTE 10, NOTE 13)	10^{-3}	N/A	2000 ms
75 (NOTE 14)						
71		56	150 ms (NOTE 11, NOTE 13, NOTE 15)	10^{-6}	N/A	2000 ms
72		56	300 ms (NOTE 11, NOTE 13, NOTE 15)	10^{-4}	N/A	2000 ms
73		56	300 ms (NOTE 11, NOTE 13, NOTE 15)	10^{-8}	N/A	2000 ms
74		56	500 ms (NOTE 11, NOTE 15)	10^{-8}	N/A	2000 ms
76		56	500 ms (NOTE 11, NOTE 13, NOTE 15)	10^{-4}	N/A	2000 ms
5	Non-GBR (NOTE 1)	10	100 ms NOTE 10, NOTE 13)	10^{-6}	N/A	N/A
6		60	300 ms (NOTE 10, NOTE 13)	10^{-6}	N/A	N/A
7		70	100 ms (NOTE 10, NOTE 13)	10^{-3}	N/A	N/A

Discrete automation – Motion Control

Industrial Factory Automation - Closed-Loop Control Applications.

e.g. Motion Control of Robots, Machine Tools, as well as Packaging and Printing Machines.

The pertinent standard suite is IEC 61158. Note that clock synchronization is an integral part of fieldbuses used for motion control.

In motion control applications, a controller interacts with a large number of sensors and actuators (e.g. up to 100), which are integrated in a manufacturing unit. The resulting sensor/actuator density is often very high (up to 1 m^{-3}). Many such manufacturing units may have to be supported within close proximity within a factory (e.g. up to 100 in automobile assembly line production).

The Cycle Time can be as low as 2 ms, setting stringent E2E Latency constraints on telegram forwarding (1 ms).

The communication service has also to be highly available (99,9999%).

Service area and connection density

Factory halls can be rather large and even quite high. We set the upper limit at 1000 x 1000 x 30 m.

Main SCEF Capabilities

A) Applying AAA to the 3rd Party/Enterprises API's use (and in particular Accounting)
- vital for Charging & therein new revenues) for the Enterprise (SCS/AS) use of the API (dedicated SCEF T8 interface)

B) Use of Externa Id (e.g "name-of-device@domain.com").
- no need/requirement to use the UE MSISDN as an Id, enhancement/improvement of Security.

C) NIDD (Non IP Data Delivery) Capability
- extending the NAS Protocol to communicate from the UE via MME and SCEF with the SCS/AS and avoid using resource demanding IP Protocol for sending small data messages over the Control Plane (CP).

D) New Services Capabilities
- **e.g.** functions such as "Network Configuration Parameters" enabling Enterprises SCS/AS to use the Network Functions e.g. for UE **PSM** (*Power Save Mode*), **DRX** (*Discontinuous Reception*), **TAU** (less *Tracking Area Updates*).

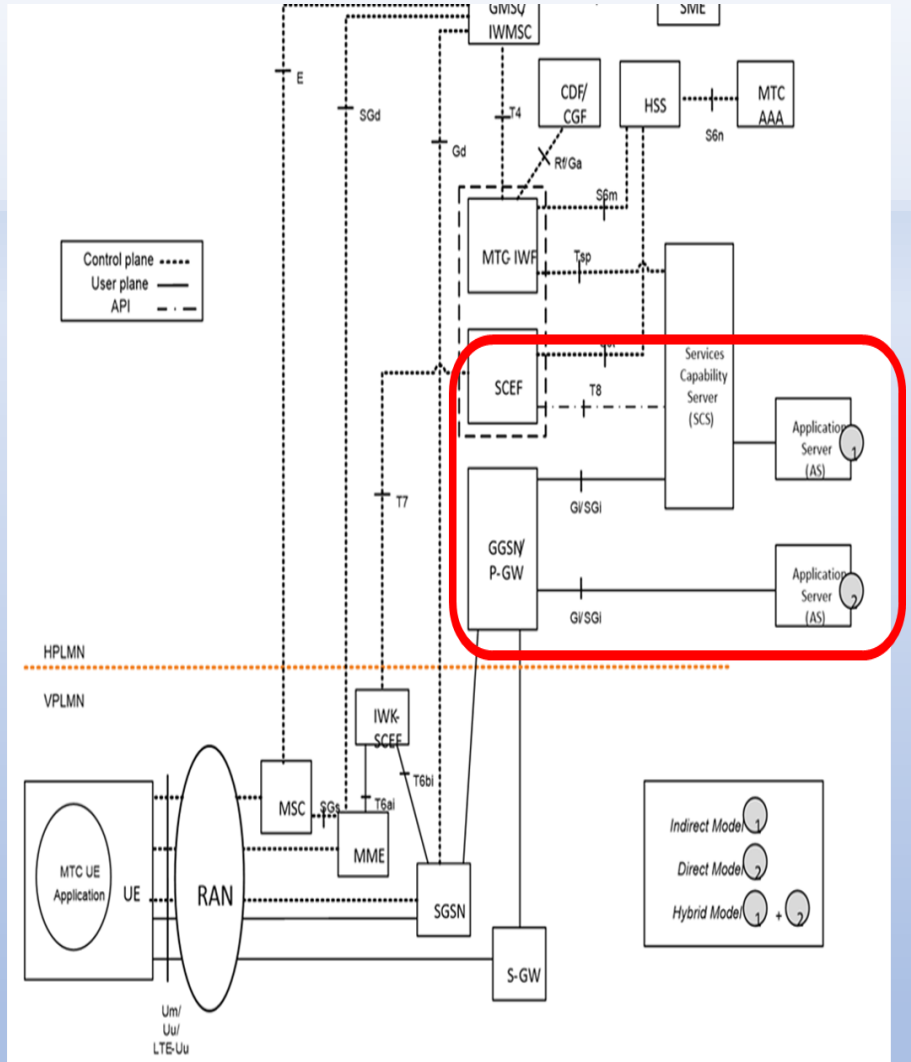


Figure 4.2-1b: 3GPP Architecture for Machine-Type Communication (Roaming)

Summary of 3GPP SCEF Services

1. *The APIs enable many use cases for applications by the Enterprise.*
2. Device Trigger Delivery
3. Sponsored Data
4. UE Reachability and Monitoring
5. Inform 3rd Party of Network Issues and set QoS for the UE session
6. UE Footprint
7. 3rd Party Interaction for UE Patterns
8. Group Message Delivery
9. Background Data Transfer
10. Packet Flow Descriptor (PFD) Management
11. MSISDN-less MO-SMS
12. Enhanced Coverage Restriction Control
13. Network Configuration Parameters

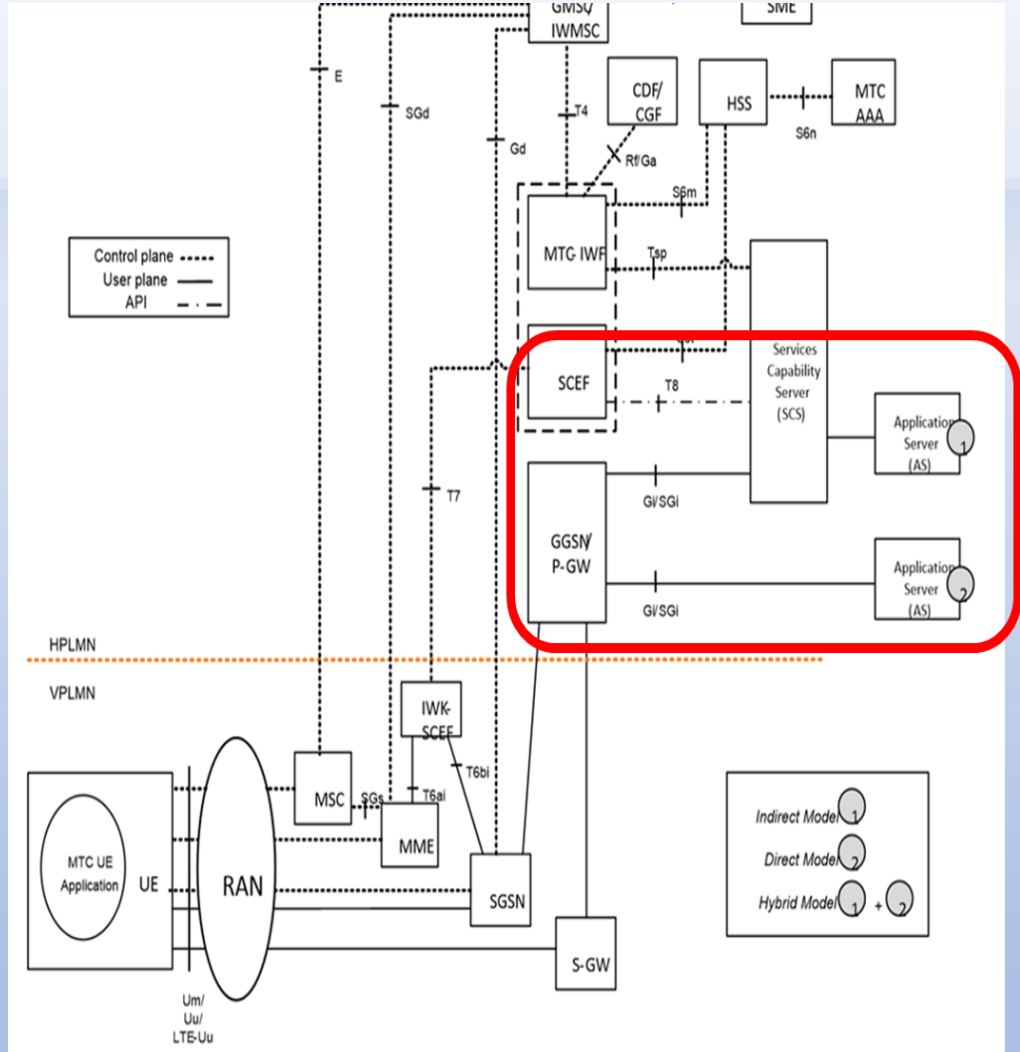


Figure 4.2-1b: 3GPP Architecture for Machine-Type Communication (Roaming)

3GPP 5G SCEF/SCS for IoT Platform integrated with IoT SL across 10 UCs - 1

Functional mapping between 3GPP and oneM2M

Figure 5.2-1 shows an Architecture and Functional mapping for the 3GPP Trust Domain which describes how oneM2M Functional Entities may access Features and Services that are exposed by 3GPP.

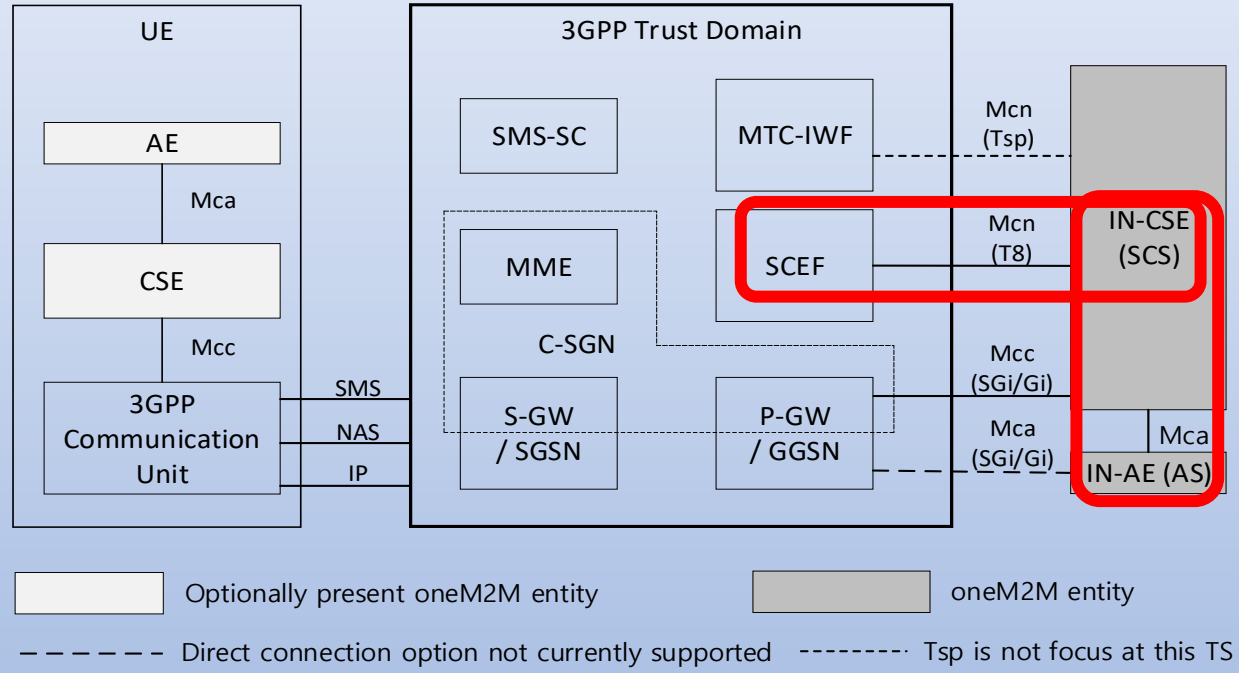


Figure 5.2-1: oneM2M Interfaces to the underlying 3GPP Network

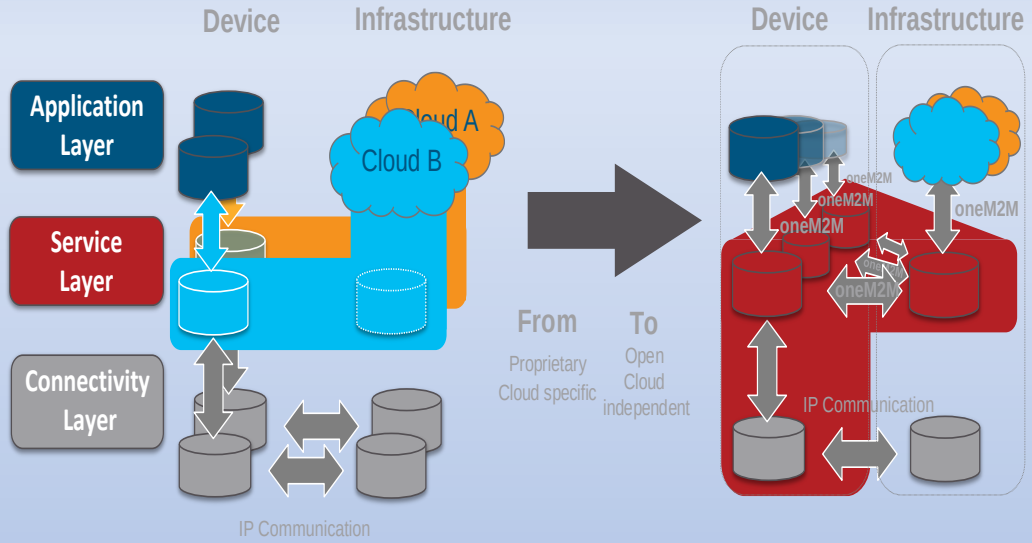


Figure 5.1.1-3: Cloud provider independent

Several implementation options for the placement of the oneM2M IN-CSE relative to the SCEF and the underlying 3GPP network are envisioned. In all implementations, the SCEF always resides within 3GPP domain.

In some options the IN-CSE and the SCEF are deployed by a MNO and are both part of the operator domain. In other options the SCEF is part of the 3GPP domain and the IN-CSE is not part of the operator domain.

In all options, services within the IN-CSE may access the network services that are exposed by the SCEF via the T8 reference point APIs.

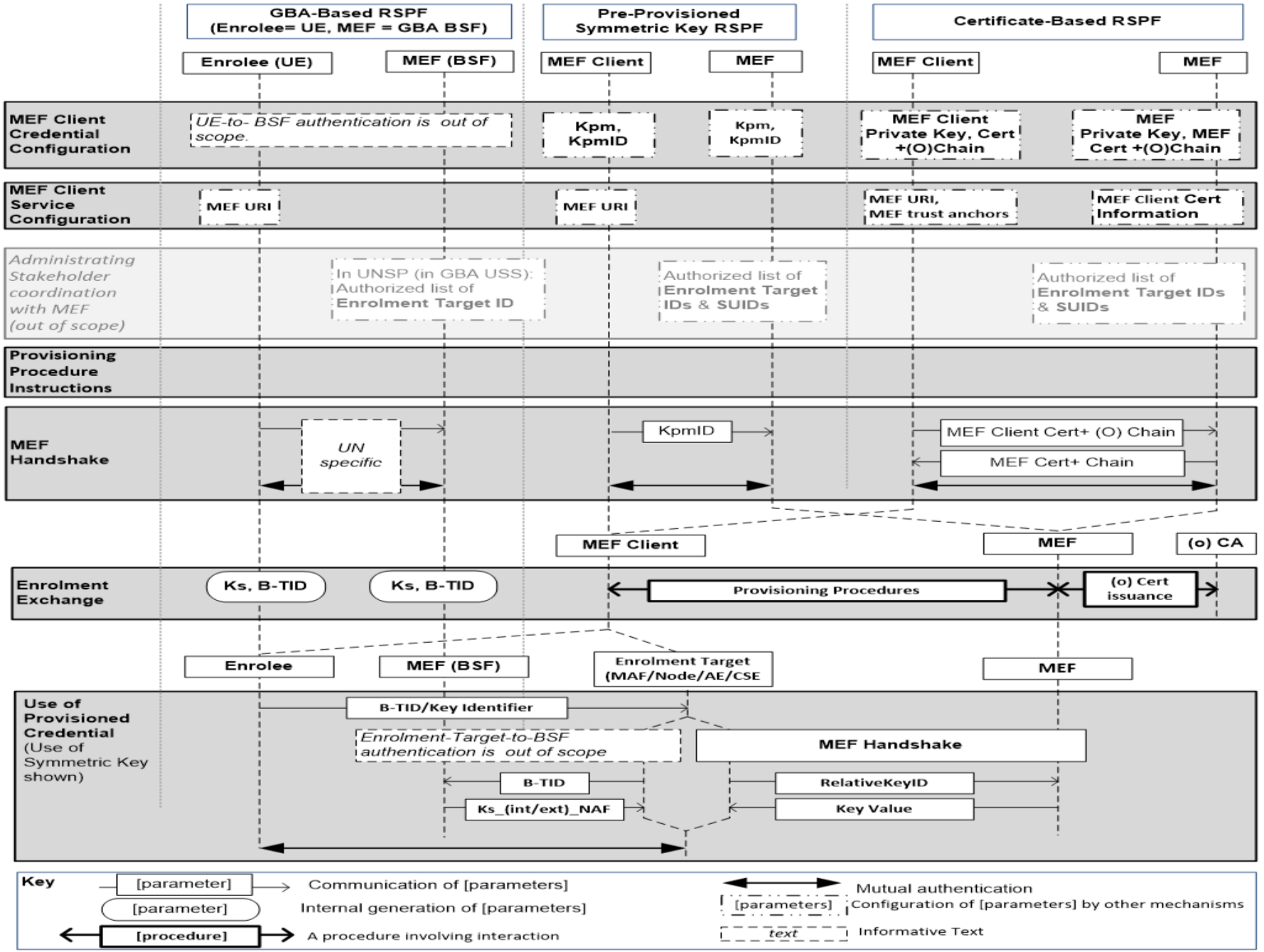


Figure 8.3.1.2-1: Overview of the Remote Security Provisioning Frameworks supported by oneM2M

oneM2M Service Layer (SL) - Horizontal Architecture providing a Common Framework for IoT,

Fig 5.1-1: oneM2M Layered Model

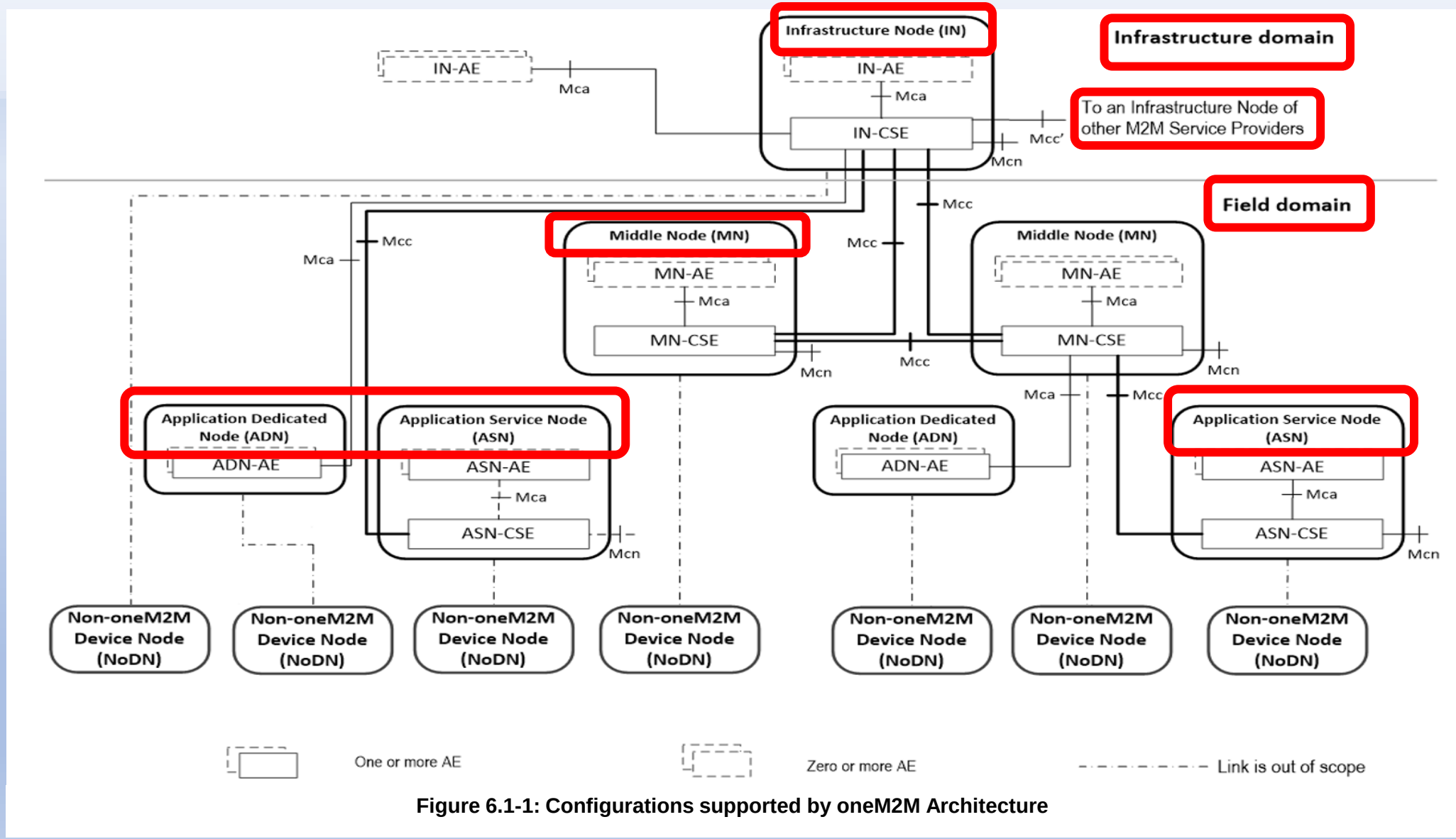


Figure 6.1-1: Configurations supported by oneM2M Architecture

oneM2M Service Layer (SL) - Horizontal Architecture providing a Common Framework for IoT,

oneM2M has identified a **Set of Common Functionalities**, that are **applicable to all the IoT domains**.

Think of these functions as a large toolbox with special tools to solve a number of IoT problems across many different domains. The oneM2M CSFs are applicable to different IoT UCs in different industry domains.

oneM2M has standardized how these Functions are being executed, i.e. is has defined Uniform APIs to access these Functions.

Figure 6.2.0-1 shows a grouping of these Functions into a few different scopes.

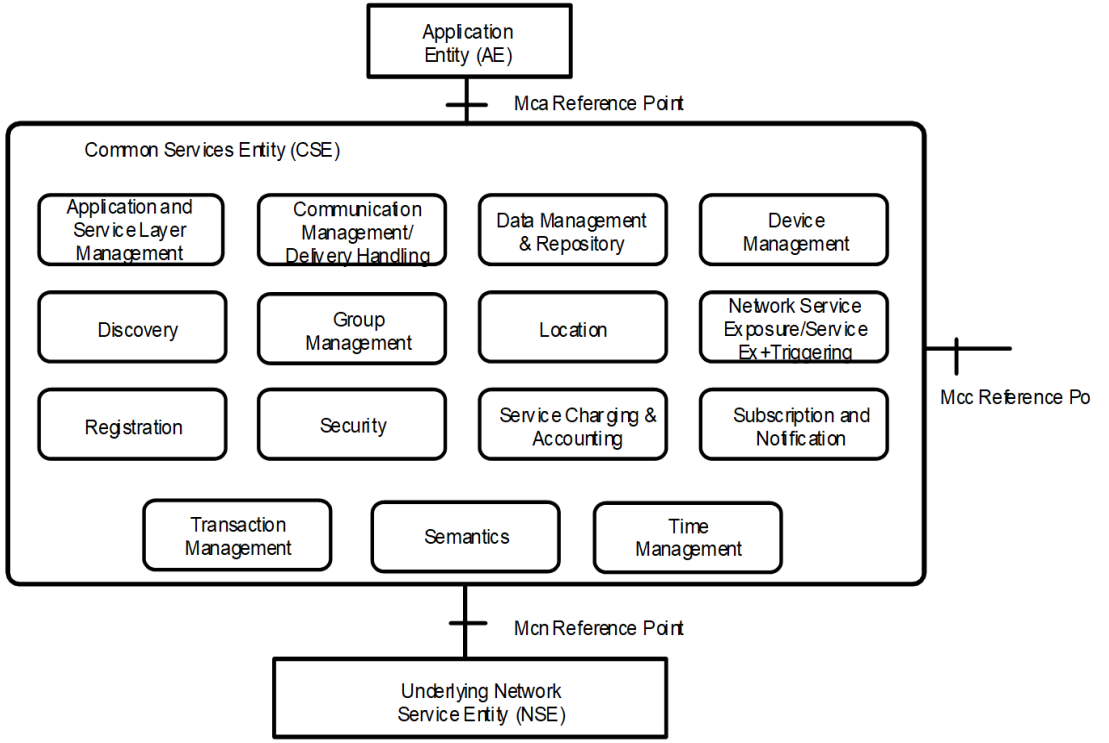


Fig. 6.2.0-1: Common Service Functions

SAREF - Smart Applications REFerence Ontology

SAREF is the Reference Ontology for Smart Applications and contains recurring concepts that are used in several Domains. SAREF has a close relation with the oneM2M Base Ontology, for which a mapping is defined in clause 5.

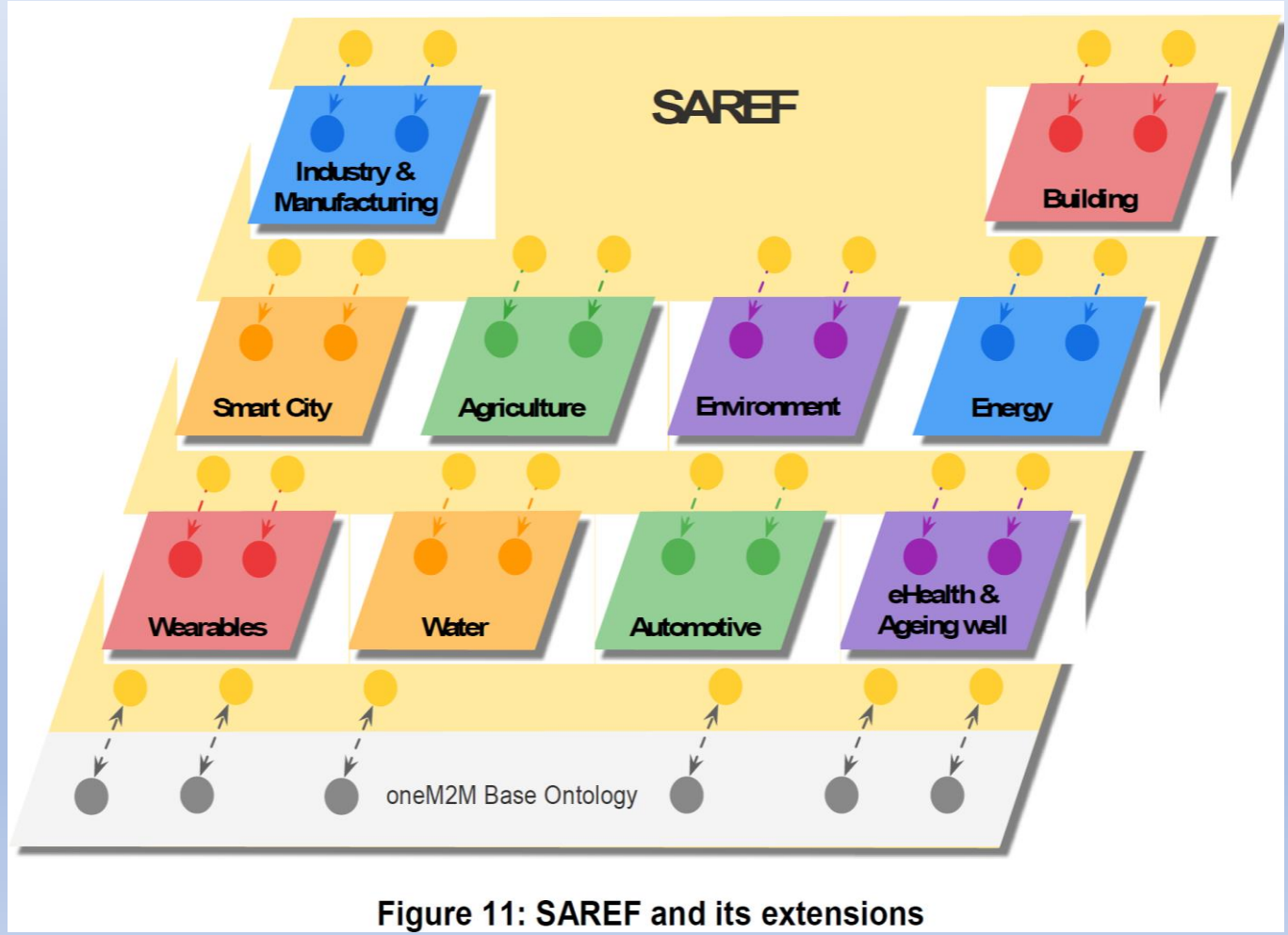


Figure 11: SAREF and its extensions

oneM2M IoT SL Platform Layered Model and Cloud provider Independent

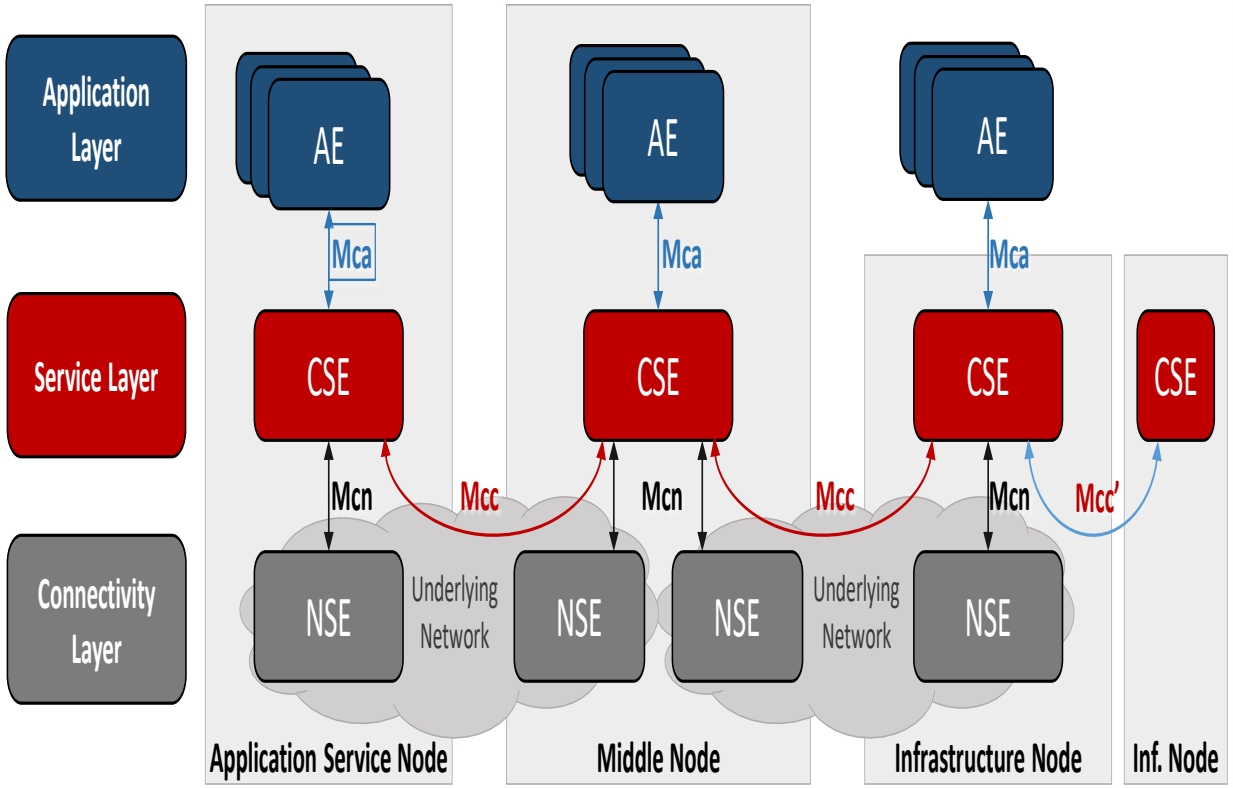


Figure 5.1.2-1: oneM2M Layered Model

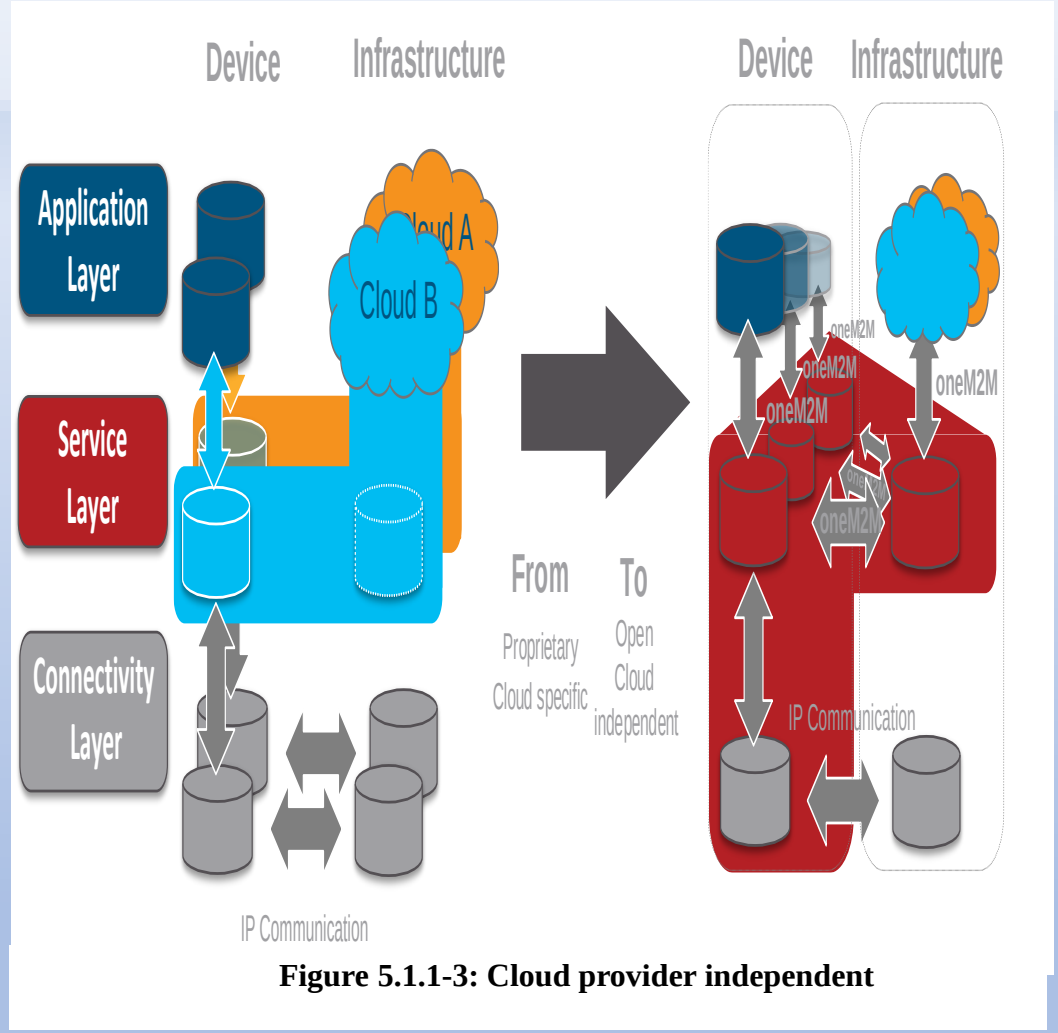


Figure 5.1.1-3: Cloud provider independent

oneM2M Service Layer (SL) - Horizontal Architecture providing a Common Framework for IoT,

Fig 5.1-1: oneM2M Layered Model

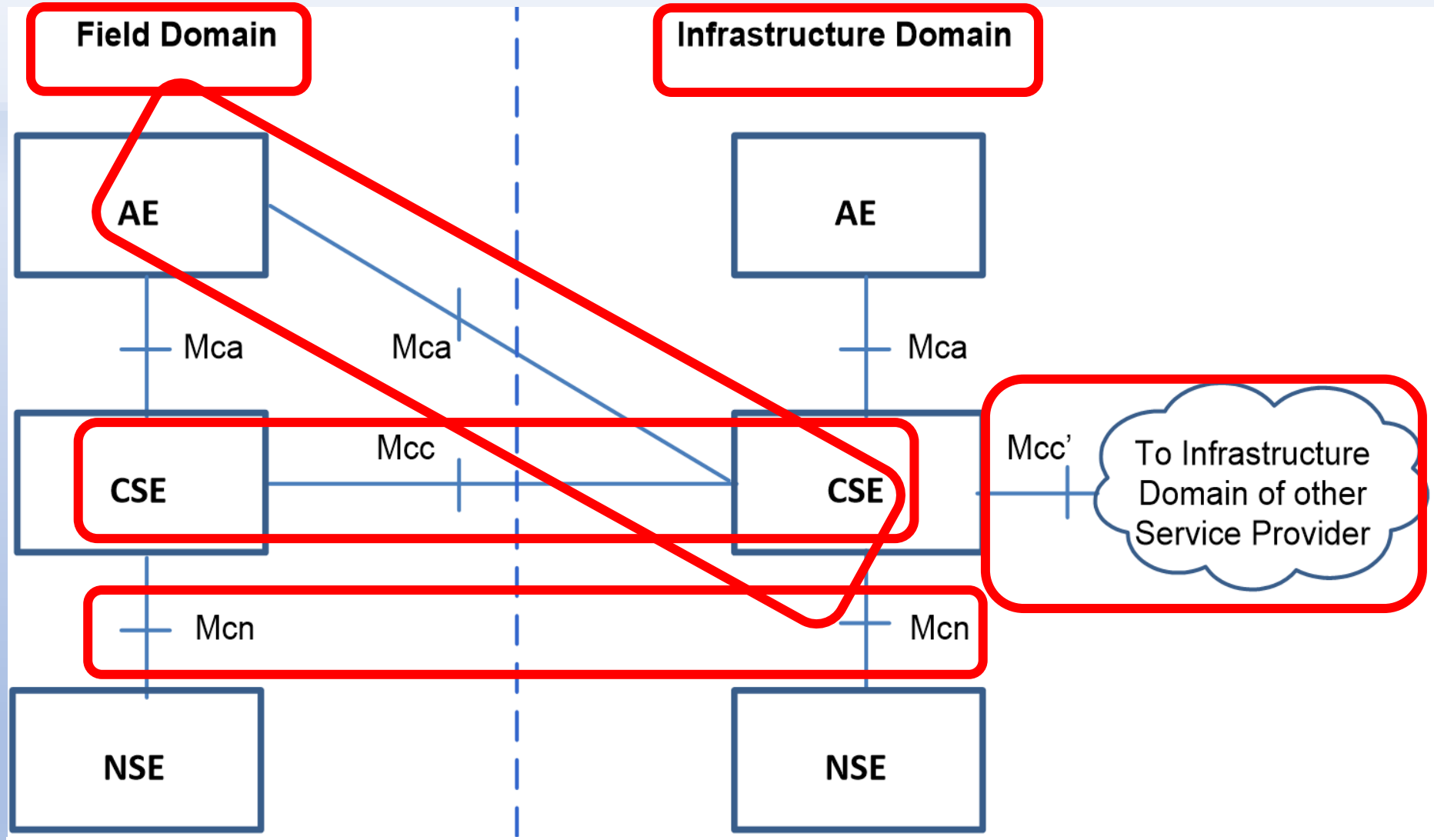
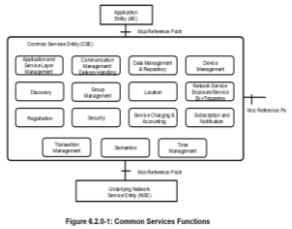


Figure 5.2.1-1: oneM2M Functional Architecture

oneM2M Functional Architecture



6.2 Common Services Functions

This clause describes the services provided by the Common Services Layer in the M2M System. Such services reside within a CSE and are referred to as Common Services Functions (CSFs). The CSFs provide services to the AEs via the Mca reference point and to other CSEs via the Mcc reference point. CSEs interact with the NSE via the Mcn reference point. An instantiation of a CSE in a Node comprises a subset of the CSFs from the CSFs described in the present document.

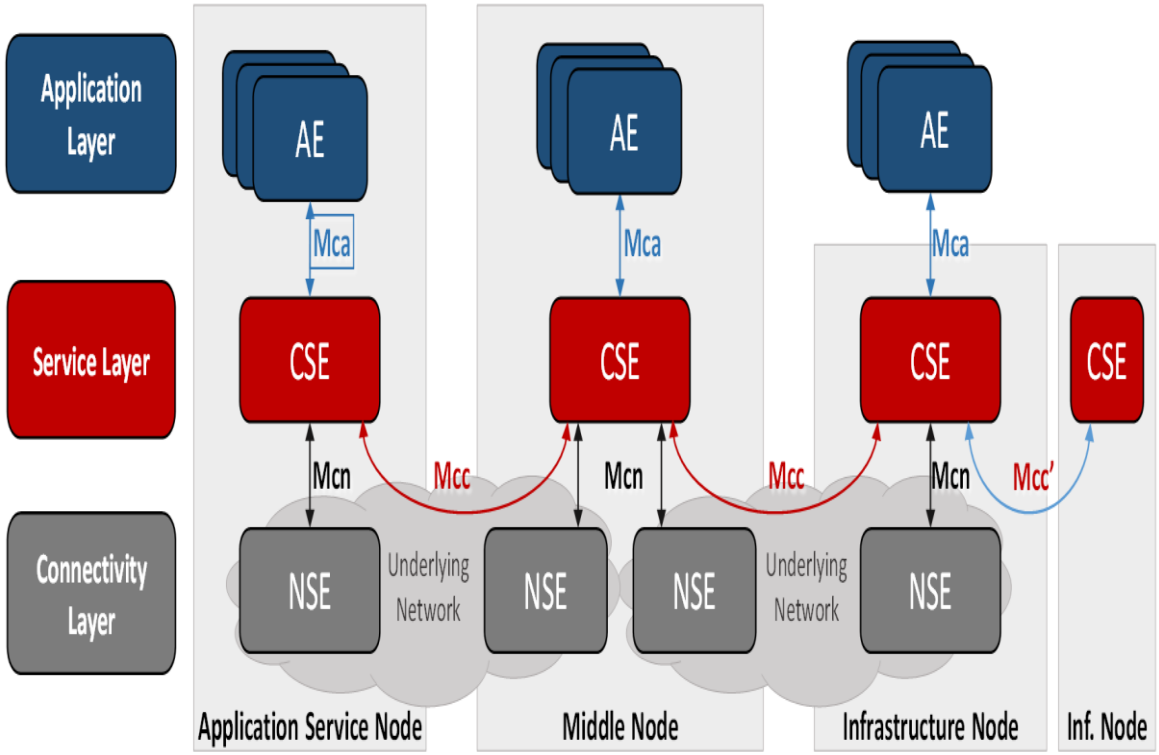


Figure 5.1.2-1: oneM2M Layered Model

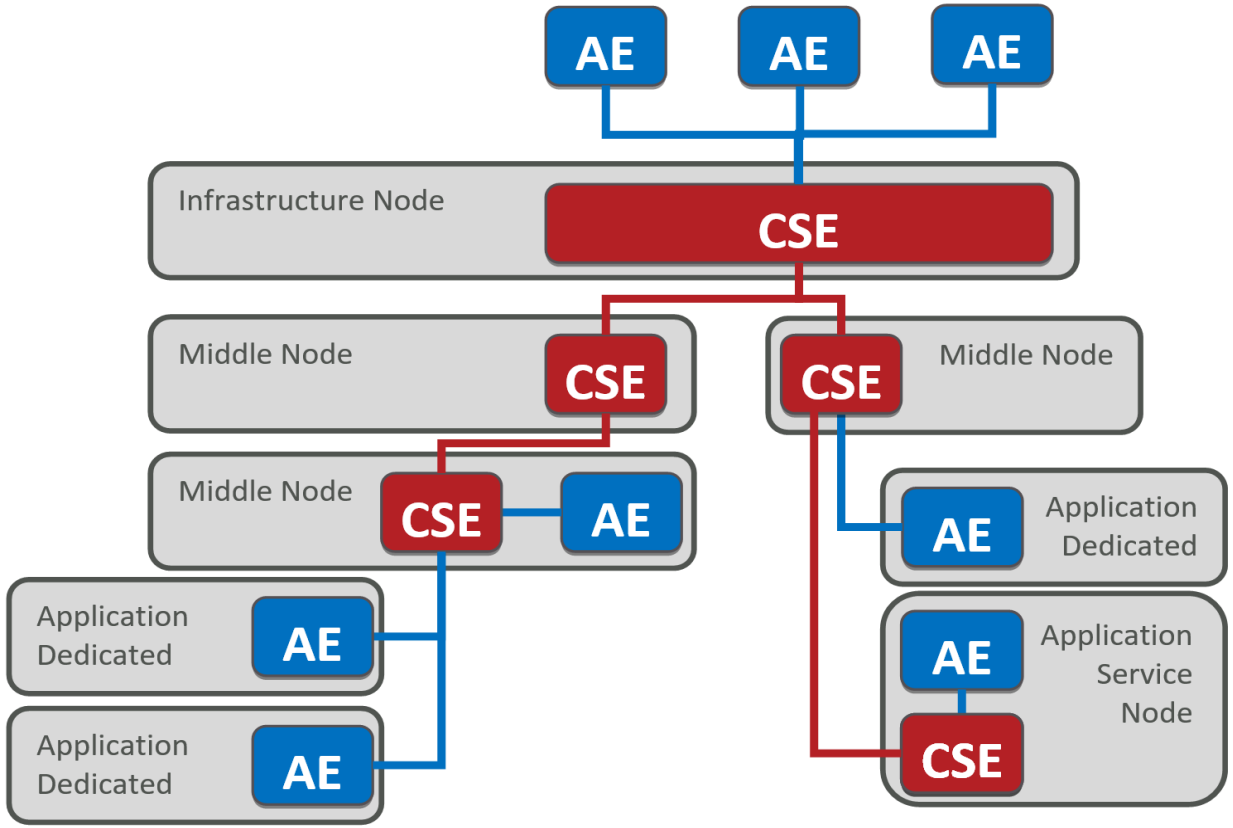


Figure 5.1.2-3: oneM2M node topology

Semantic discovery in presence of a "Network" of M2M Service Providers (M2MSPs)

The oneM2M system should integrate already Standardized Ontology extensions to the current oneM2M Ontology to cope with new specific domains:

SAREF Core and its extensions:

SAREF4BLDG,
SAREF4ENVI,
SAREF4ENERGY ,
SAREF4CITY,
SAREF4AGRI,
SAREF4WATER….

2) Based on Semantic information, the oneM2M System shall take routing decisions for forwarding a received

ASDQ (Advanced Semantic Discovery Query).

The Semantic information will allow the oneM2M system to maximize and to accelerate the Semantic Discovery Process.

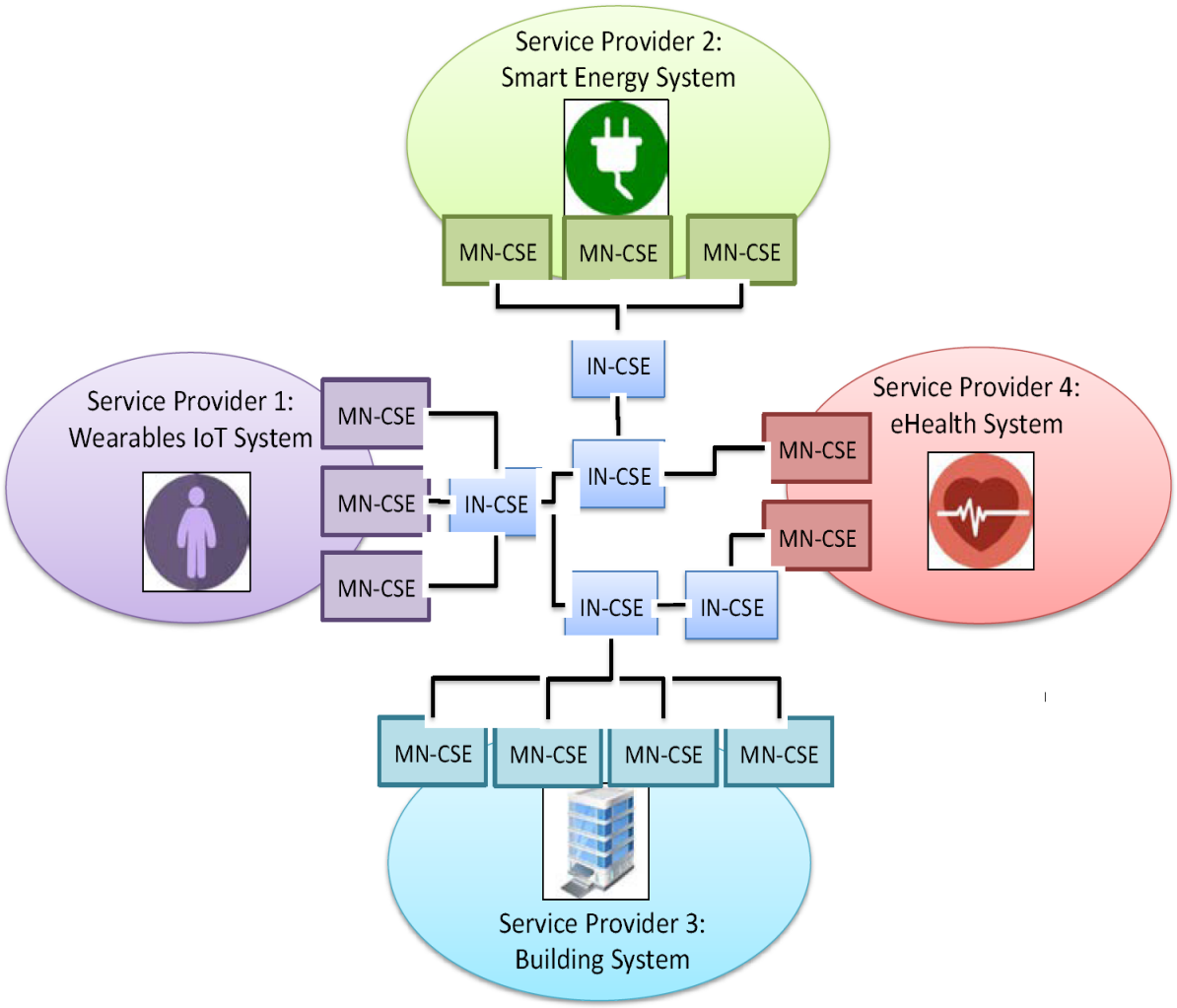


Figure 6.9-1: Semantic Recommendation in CSEs for Discovery

Semantic discovery in presence of a "network" of M2M Service Providers (M2MSPs)

Ontologies and their OWL representations are used in oneM2M to provide syntactic and semantic interoperability of the oneM2M System with External Systems.

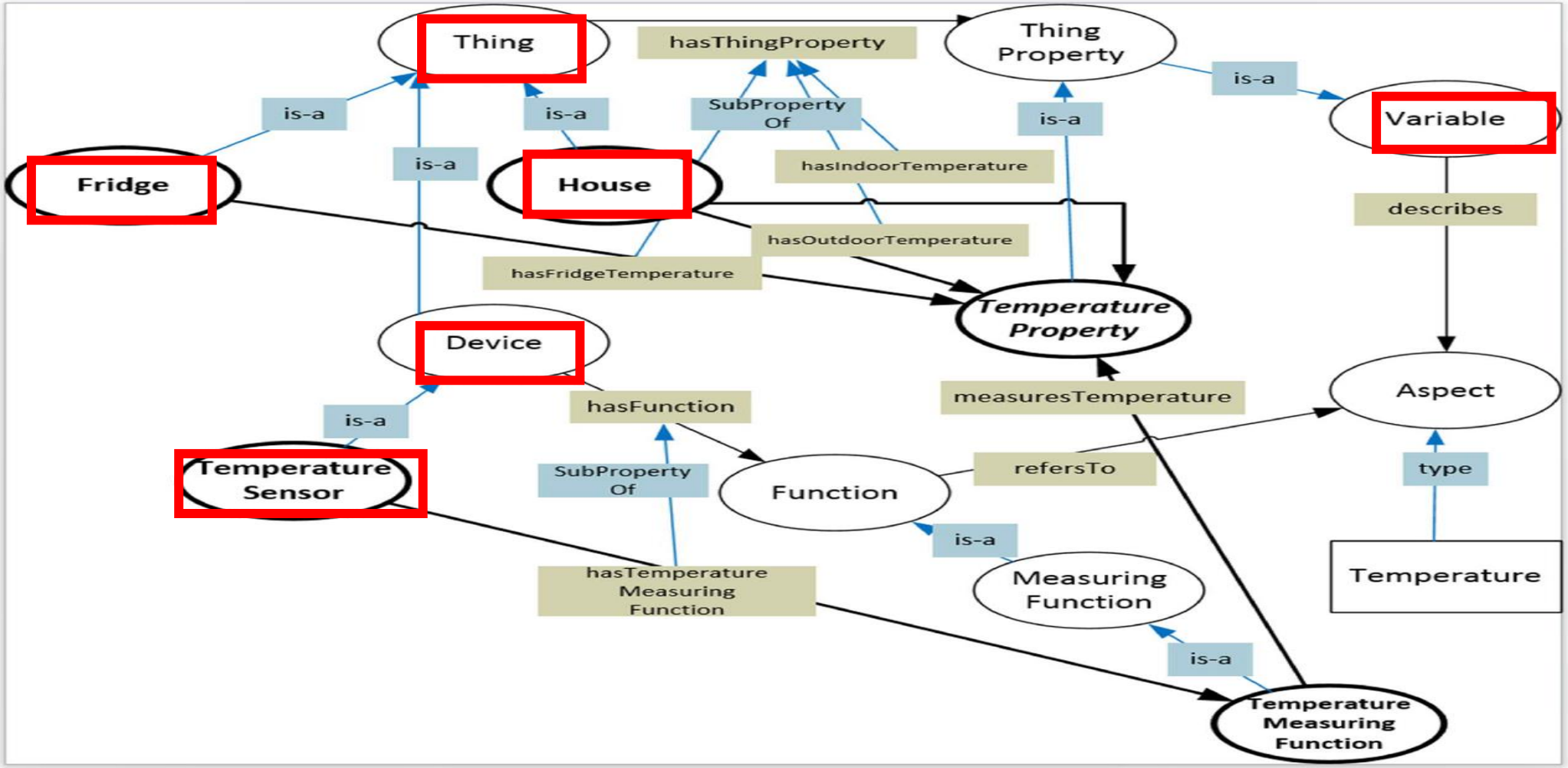
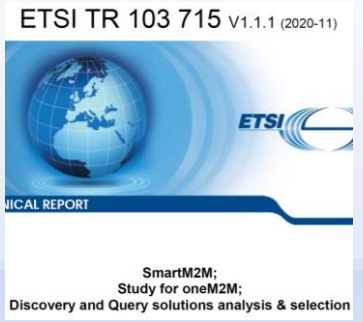
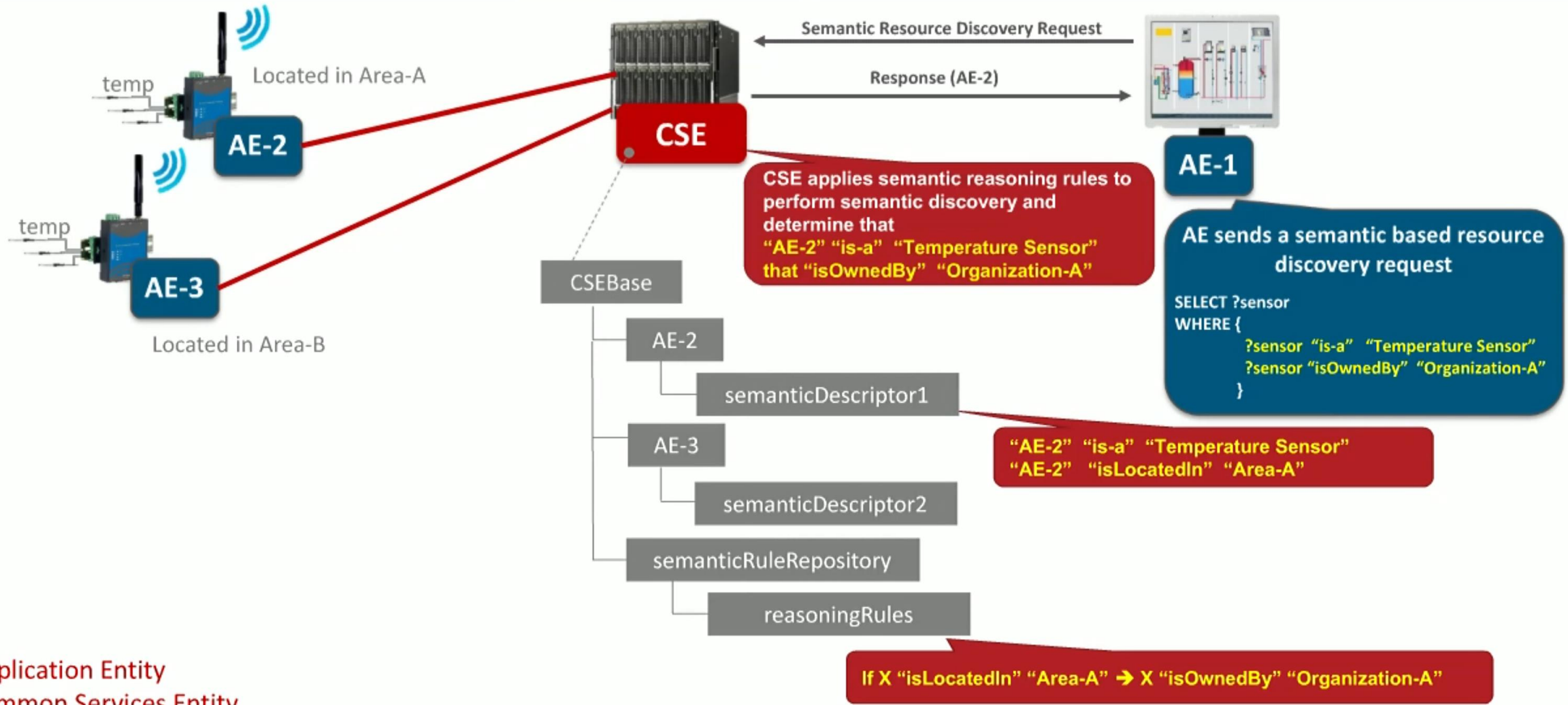


Figure 5.4.1-1: Example of mapping on the oneM2M Base Ontology



NEW
Rel-4 Feature

Semantic Reasoning



AE: Application Entity
CSE: Common Services Entity

oneM2M Semantics Support

6 Description of Classes and Properties

6.1 Classes

6.1.1 Class: Thing

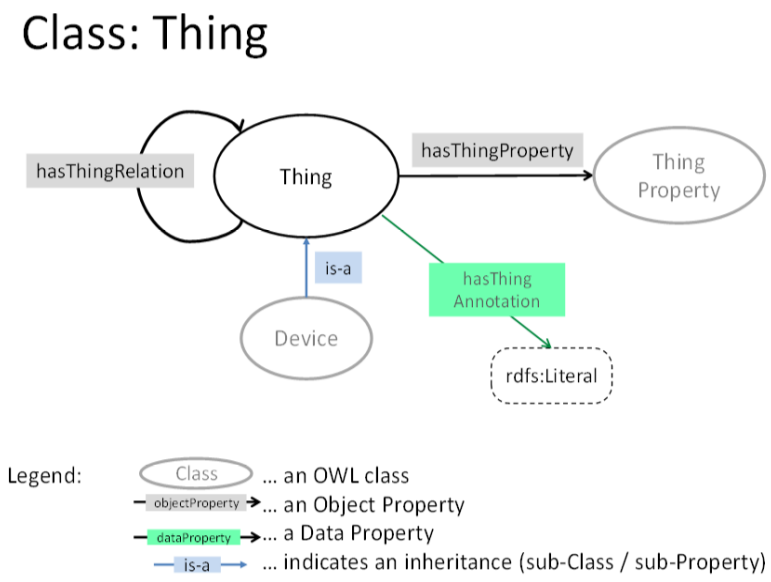


Figure 2: Thing

Description

- A **Thing** in oneM2M (Class: Thing) is an entity that can be identified in the oneM2M System.
  A Thing that is not a Device is not able to communicate electronically with its environment. However, the sub-class of Thing that ***is*** able to interact electronically is called a "Device".
  A Thing may have ThingProperties (Object Property: hasThingProperty). A Thing can have relations to other things (Object Property: hasThingRelation).
  Since a Thing that is not a Device is not able to communicate electronically it cannot influence the value of its ThingProperties or being influenced by it. Similarly a Thing cannot document its - real-world - relationships (via hasThingRelation) to other Things.

6.1.2 Class: ThingProperty

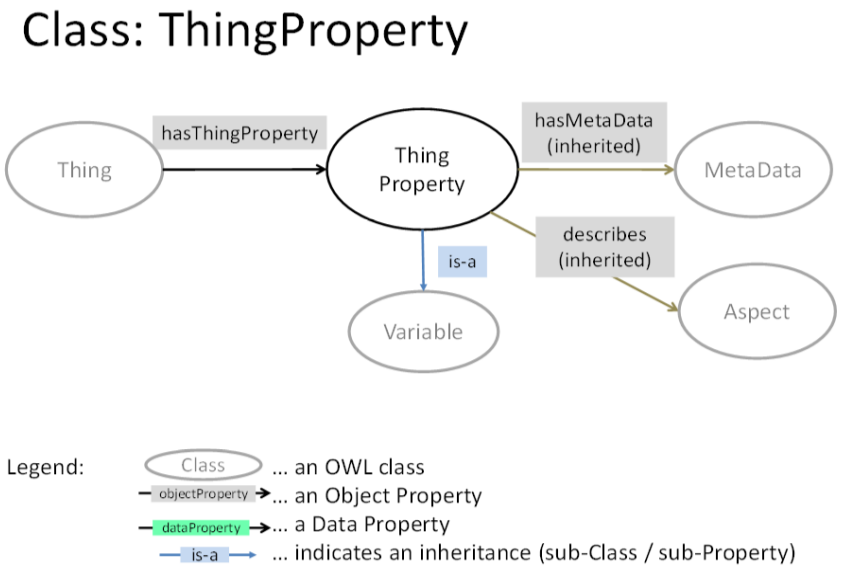


Figure 3: ThingProperty

Description

- A **ThingProperty** (Class: ThingProperty) denotes a property of a Thing. A ThingProperty can e.g. be observed or influenced by devices, or it constitutes static data about a Thing.
  E.g. the indoor temperature of the room could be a ThingProperty of a Thing "room".
  A ThingProperty of a thing can describe a certain Aspect, e.g. the indoor temperature describes the Aspect "Temperature" that could be measured by a temperature sensor.
  A ThingProperty of a Thing can have meta data.

- The class ThingProperty is a sub-class of the Variable class.

Object Properties

This Class is the domain Class of Object Property:

- describes (range Class: Aspect)
  (inherited from class: Variable)

oneM2M Semantics Support

6.1.3 Class: Aspect

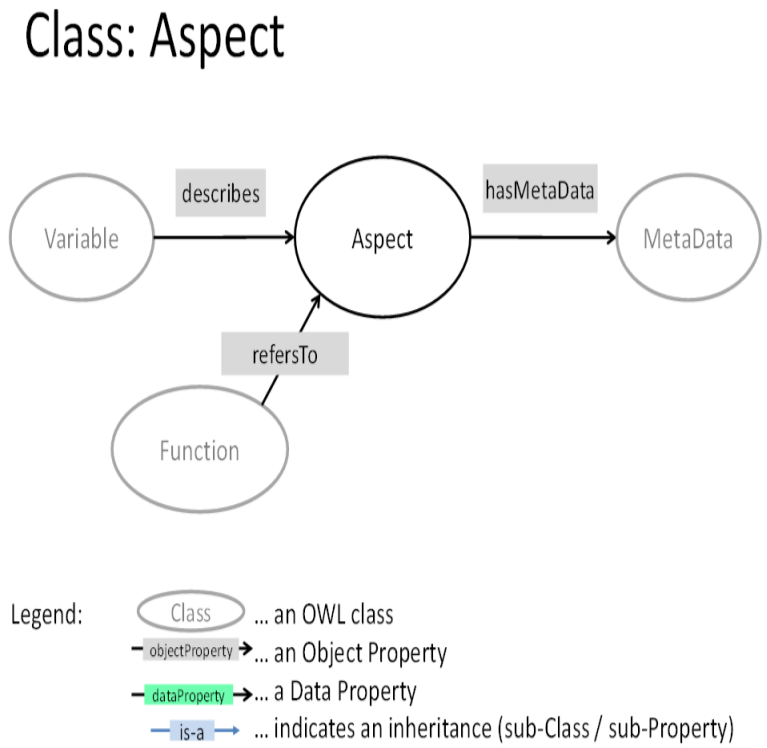


Figure 4: Aspect

Description

- An **Aspect** (Class: Aspect) describes the real-world aspect that a Function relates to. Aspect is also used to describe the quality or kind of a Variable.
  The Aspect could be a (physical or non-physical) entity or it could be a quality.

6.1.4 Class: MetaData

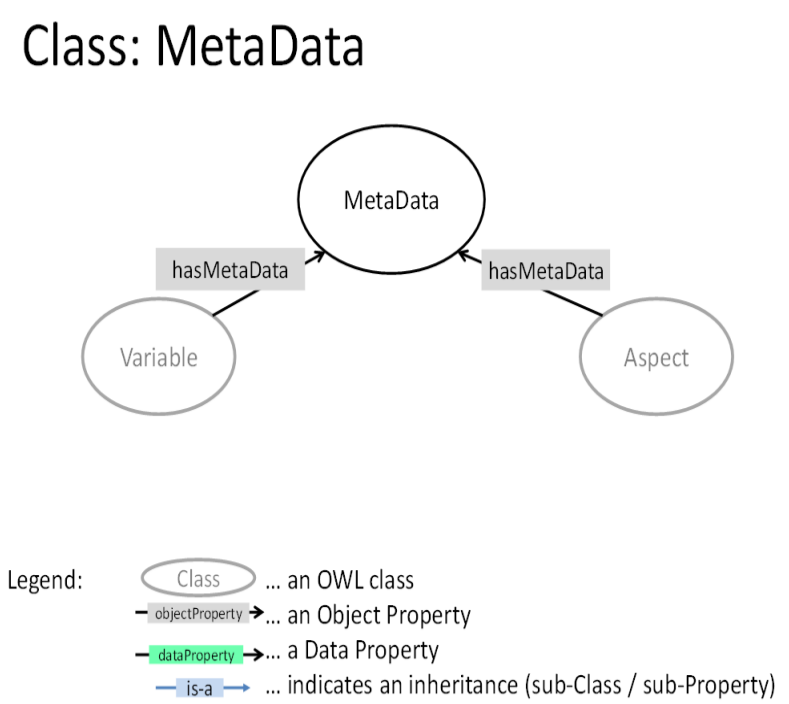


Figure 5: MetaData

Description

- **MetaData** (Class: MetaData) contain data (like units, precision-ranges …) about a Variable or about an Aspect.
  E.g. the indoor temperature could have as meta data an individual "Celsius_Scale" that specifies that the temperature needs to be understood as degrees Celsius.

Object Properties

oneM2M Semantics Support

6.1.5 Class: Device

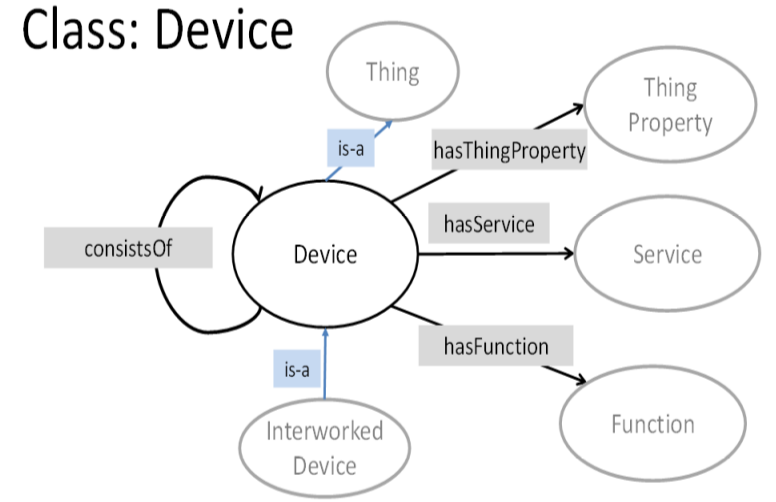


Figure 6: Device

Description

- A **Device** (Class: Device) is a Thing (a sub-class of class:Thing) that is designed to accomplish a particular task via the Functions the Device performs.
  A Device can be able to interact electronically with its environment via a network. A Device contains some logic and is producer and/or consumer of data that are exchanged via its Services with other oneM2M entities (Devices, Things) in the network. A Device may be a physical or non-physical entity.
  A Device interacts through the DataPoints and/or Operations of its Services:

6.1.6 Class: InterworkedDevice

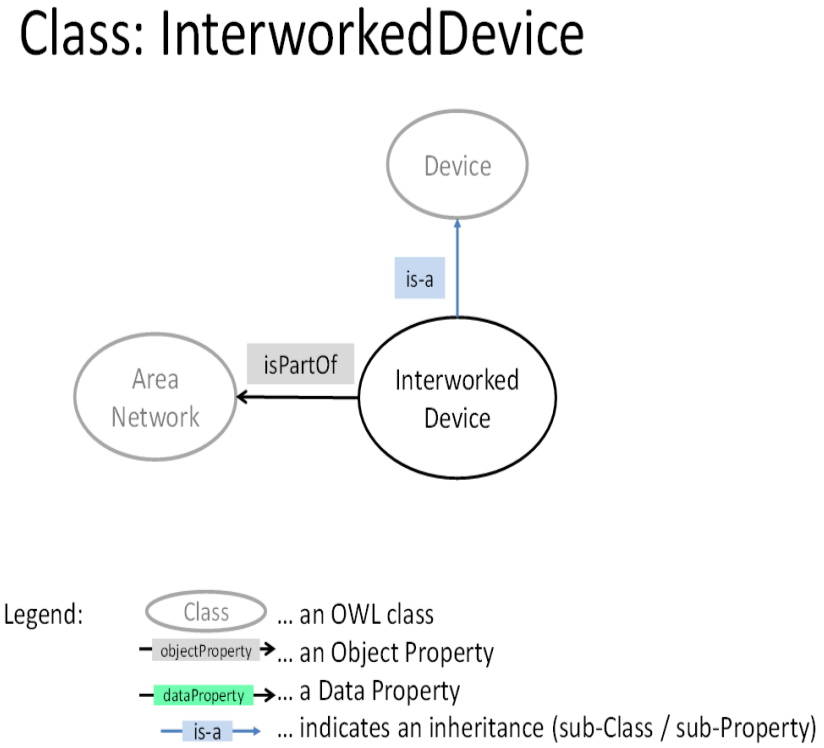


Figure 7: InterworkedDevice

Description

- An **InterworkedDevice** (Class: InterworkedDevice) is a Device - e.g. in an Area Network - that does not support oneM2M interfaces and can only be accessed from the oneM2M System by communicating with a "proxied" (virtual) device that has been created by an Interworking Proxy Entity.

oneM2M Semantics Support

6.1.7 Class: AreaNetwork

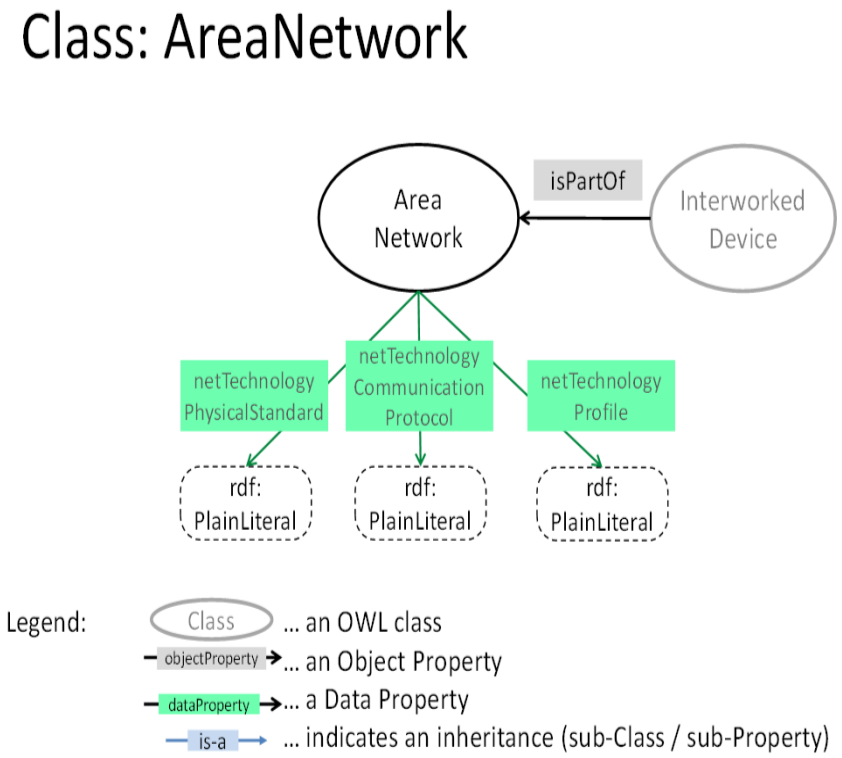


Figure 8: AreaNetwork

Description

- An **AreaNetwork** (Class: AreaNetwork) is a Network that provides data transport services between an Interworked Device and the oneM2M System. Different area Networks can use heterogeneous network technologies that may or may not support IP access.

6.1.8 Class: Service

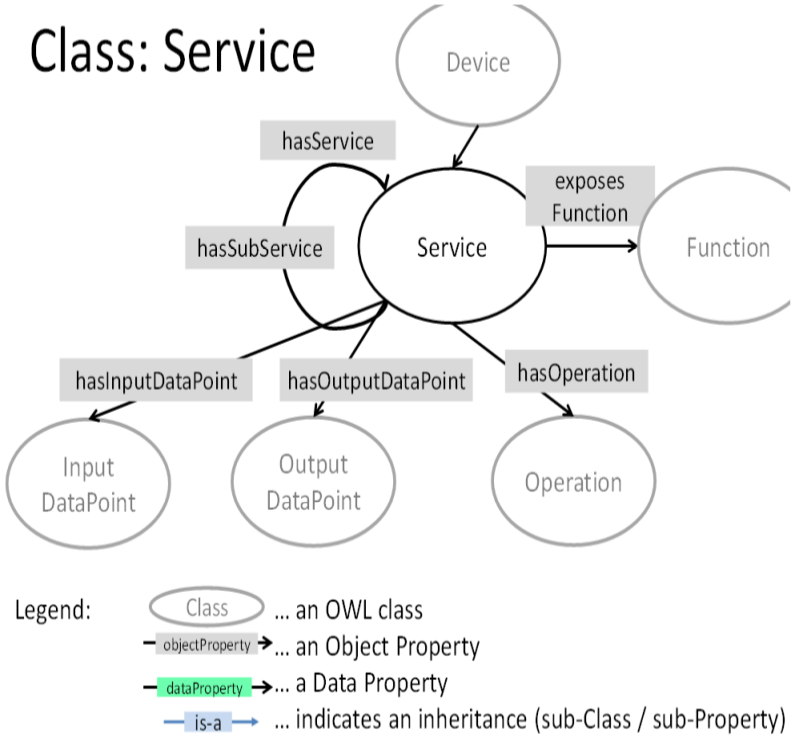


Figure 9: Service

Description

- A **Service** (Class: Service) is an electronic representation of a Function in a network. The Service exposes the Function to the network and makes it discoverable, registerable and remotely controllable in the network.
  A Service is offered by a device that wants (a certain set of) its Functions to be discoverable, registerable, remotely controllable by other devices in the network.
  A Service can expose one or more Functions and a Function can be exposed by one or more Services.

oneM2M Semantics Support

6.1.9 Class: Function

6.1.9.0 General description

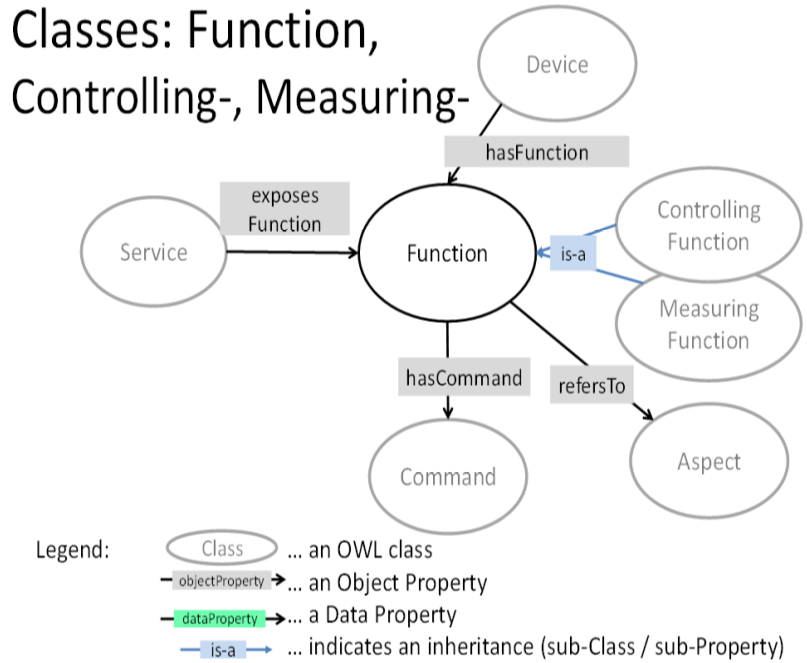


Figure 10: Function

Description

- A **Function** (Class: Function) represents a particular function necessary to accomplish the task for which a Device is designed. A device can be designed to perform more than one Function.
  The Function exhibits the - human understandable - meaning what the device "*does*".
- A Function refers to (e.g. observes or influences) some real-world aspect(s), that can be modelled as a Class: Aspect.

6.1.10 Class: Operation

6.1.10.0 General description

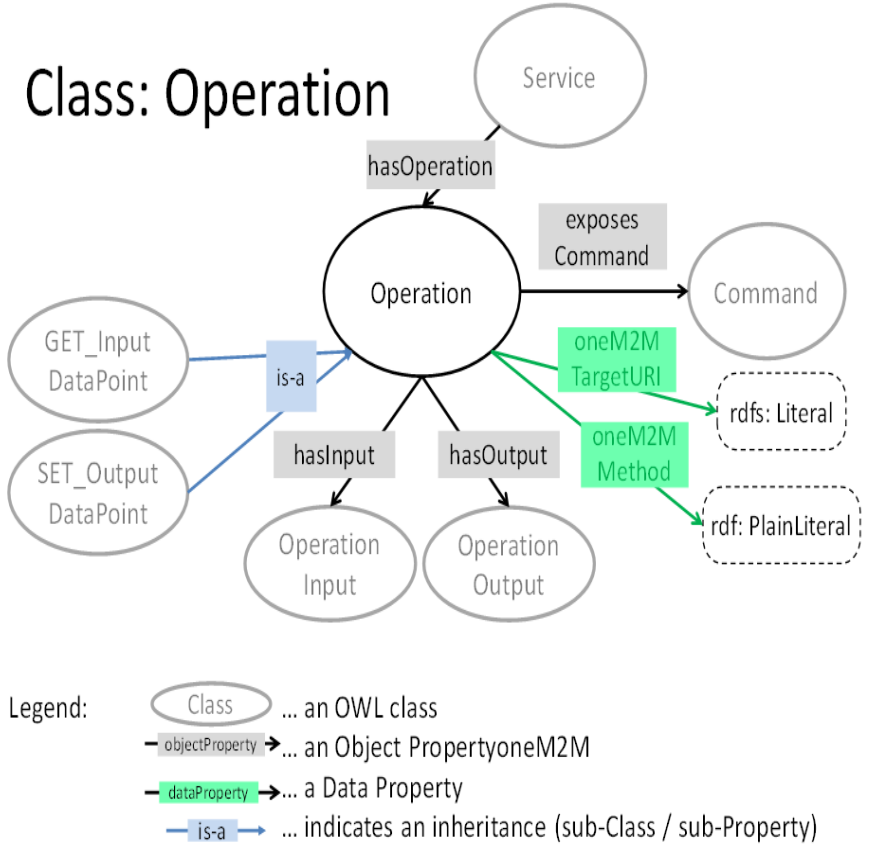


Figure 11: Operation

oneM2M Semantics Support

6.1.11 Class: Command

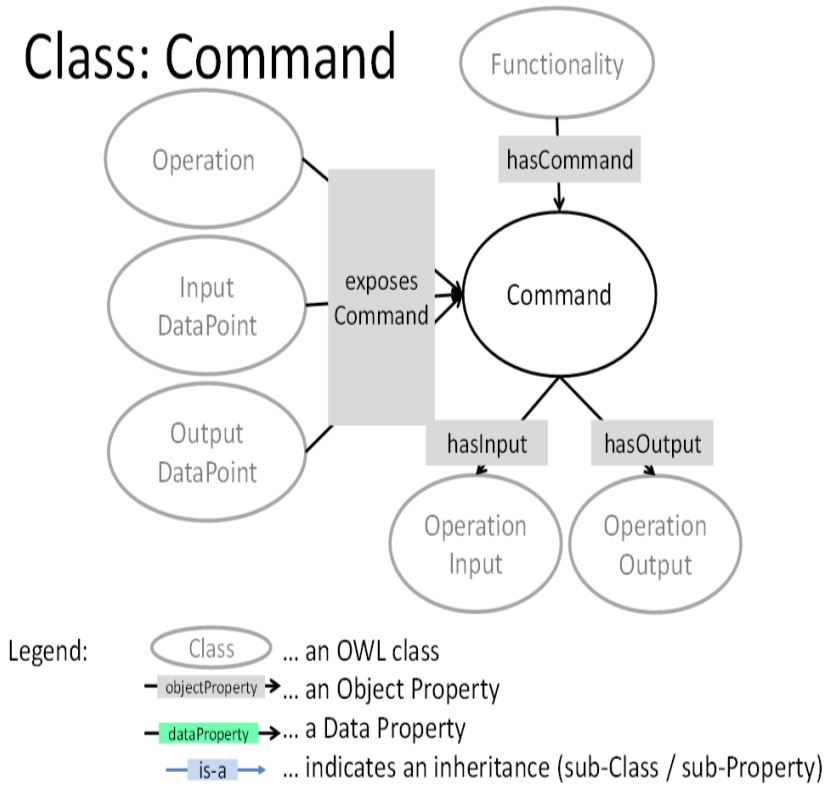


Figure 12: Command

Description

- A **Command** (Class: Command) represents an action that can be performed to support the Function. A Command is the -human understandable - name of that action that is invoked in a device or is reported by the

6.1.12 Class: OperationInput

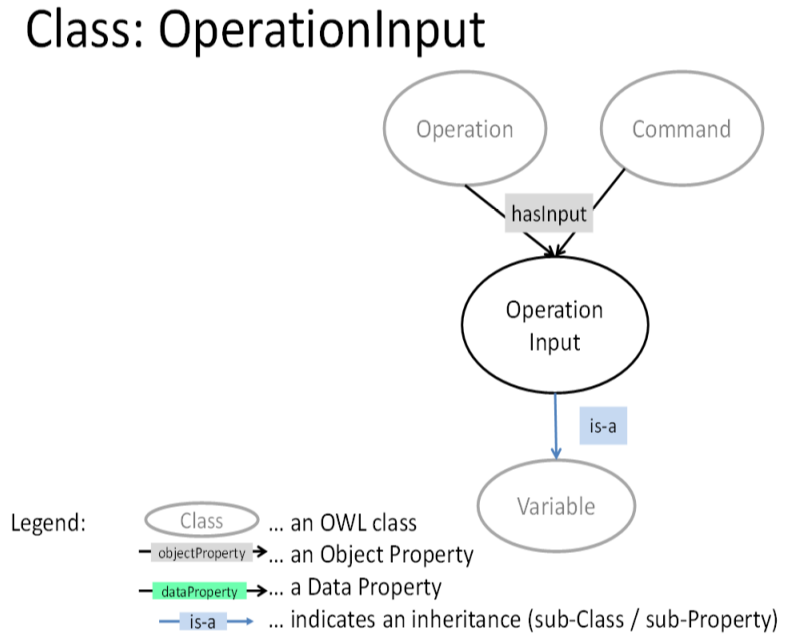


Figure 13: OperationInput

Description

- **OperationInput** (Class: OperationInput) describes an input of an Operation of a Service. OperationInput also describes the input of a Command:
  - OperationInput is transient. An instance of OperationInput is deleted when the instance of its Operation is deleted.
  - An Operation/Command may have multiple OperationInputs and/or OperationOutputs. If an instance of an Operation is invoked then the input value to that Operation shall be an instance of its OperationInput class.

oneM2M Semantics Support

6.1.16 Class: Variable

6.1.16.0 General description

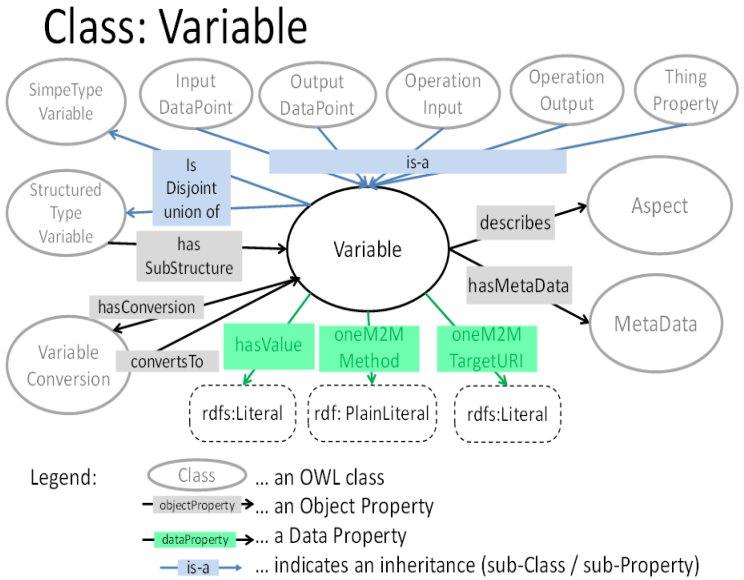


Figure 17: Variable

Description

- A **Variable** (Class: Variable) constitutes a super class to the following classes: ThingProperty, OperationInput, OperationOutput, InputDataPoint, OutputDataPoint. Additionally, class:Variable is the disjoint union of classes: SimpleTypeVariable and StructuredTypeVariable, i.e. any member of class:Variable is also member of either SimpleTypeVariable or StructuredTypeVariable.
  The members of class:Variable are entities that store some data (e.g. integers, text, etc., or structured data) that can change over time. These data of the Variable usually describe some real-world Aspects (e.g. a temperature) and can have MetaData (e.g. units, precision, etc.).

6.1.16.2 Class: StructuredTypeVariable

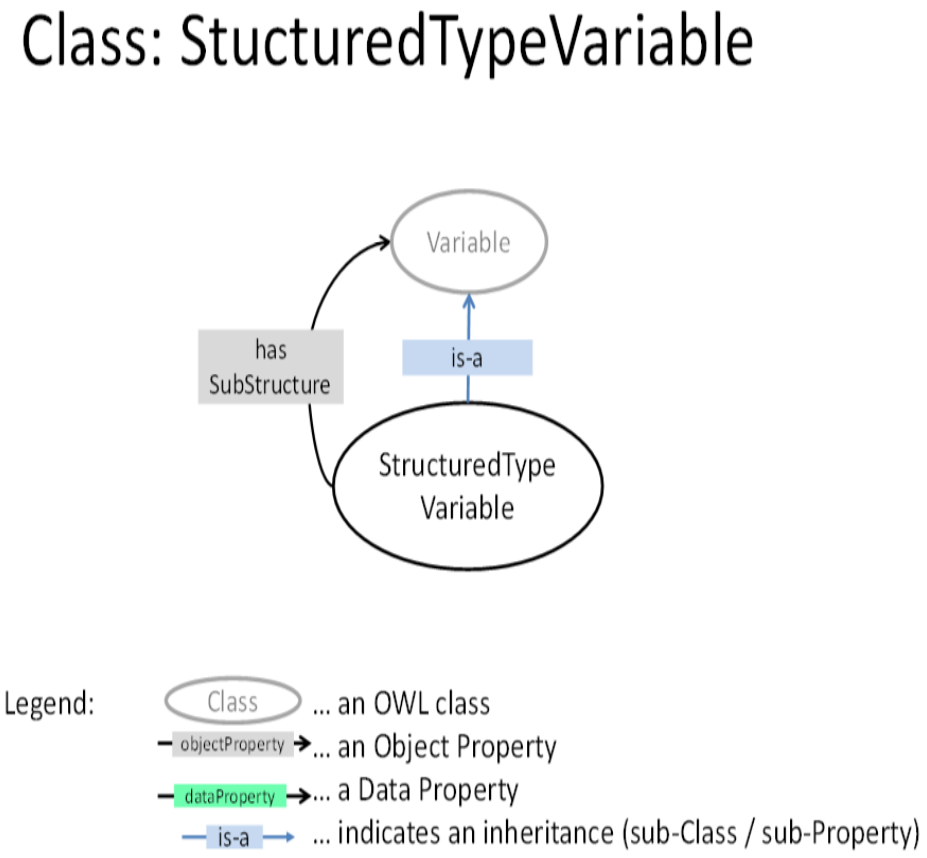
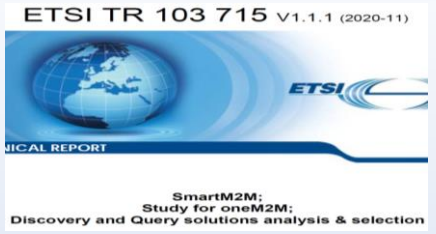


Figure 19: Variable

ETSI SmartM2M Semantic discovery in presence of a "Network" of M2M Service Providers (M2MSPs)



Advanced Semantic Discovery (ASD)

Figure 6.3.2-1 describes oneM2M as-is Semantic Discovery involving multiple CSEs.

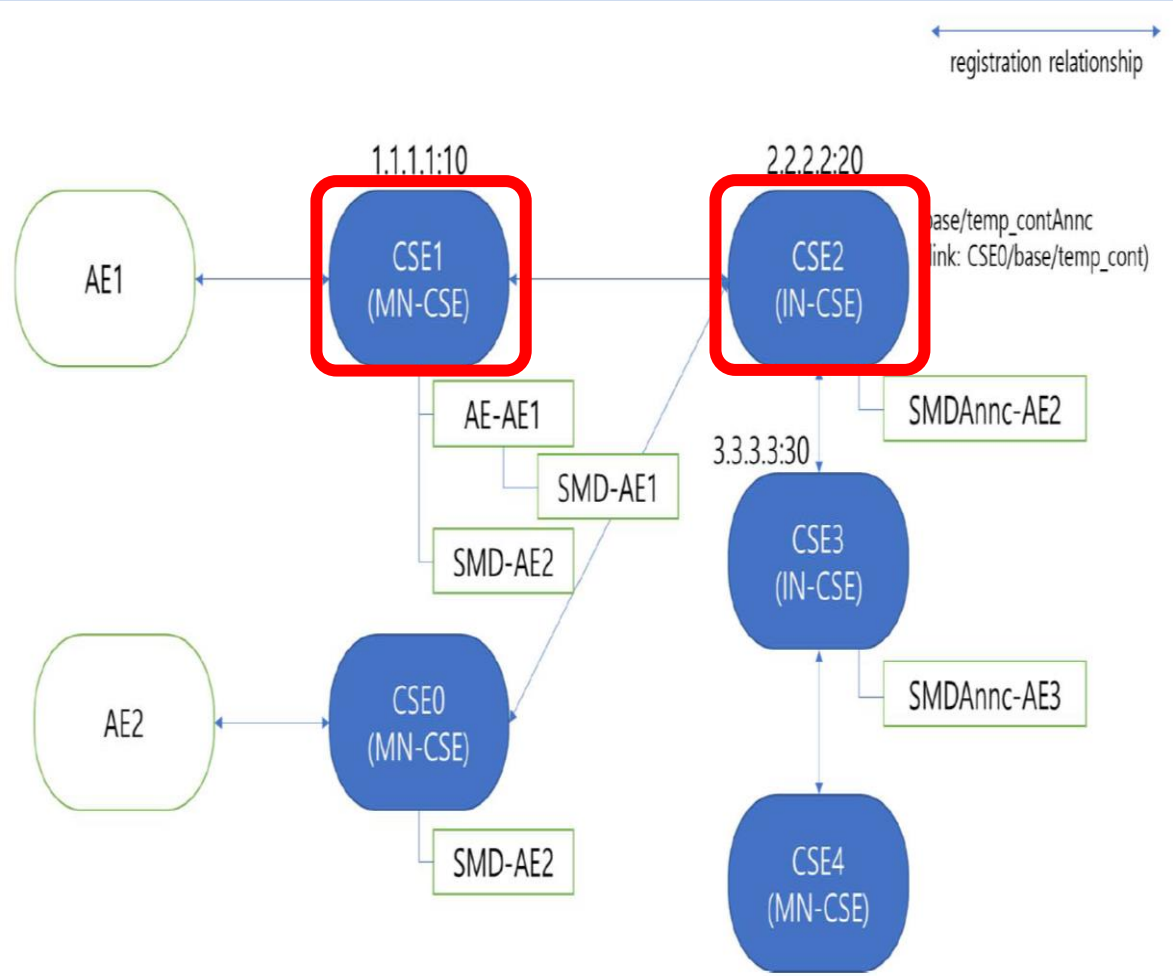


Figure 6.3.2-1: Actual oneM2M limited discovery routing in one slide

Advanced Semantic Discovery (ASD) - 1

Semantic Discovery in presence of a "Network" of M2M Service Providers (M2MSPs)

The Advanced Semantic Discovery aims to discover AEs (also called Resources) that are registered/announced to some CSEs.

The ASD could start from any AE, even these ones not belonging to the same Trusted Domain.

The ASD differs from the usual one present in oneM2M in the sense that one (or many) AE could be searched for even without knowing its identifier, but just knowing its TYPE or ONTOLOGY membership, as shown in Figure 6.3.1-1.

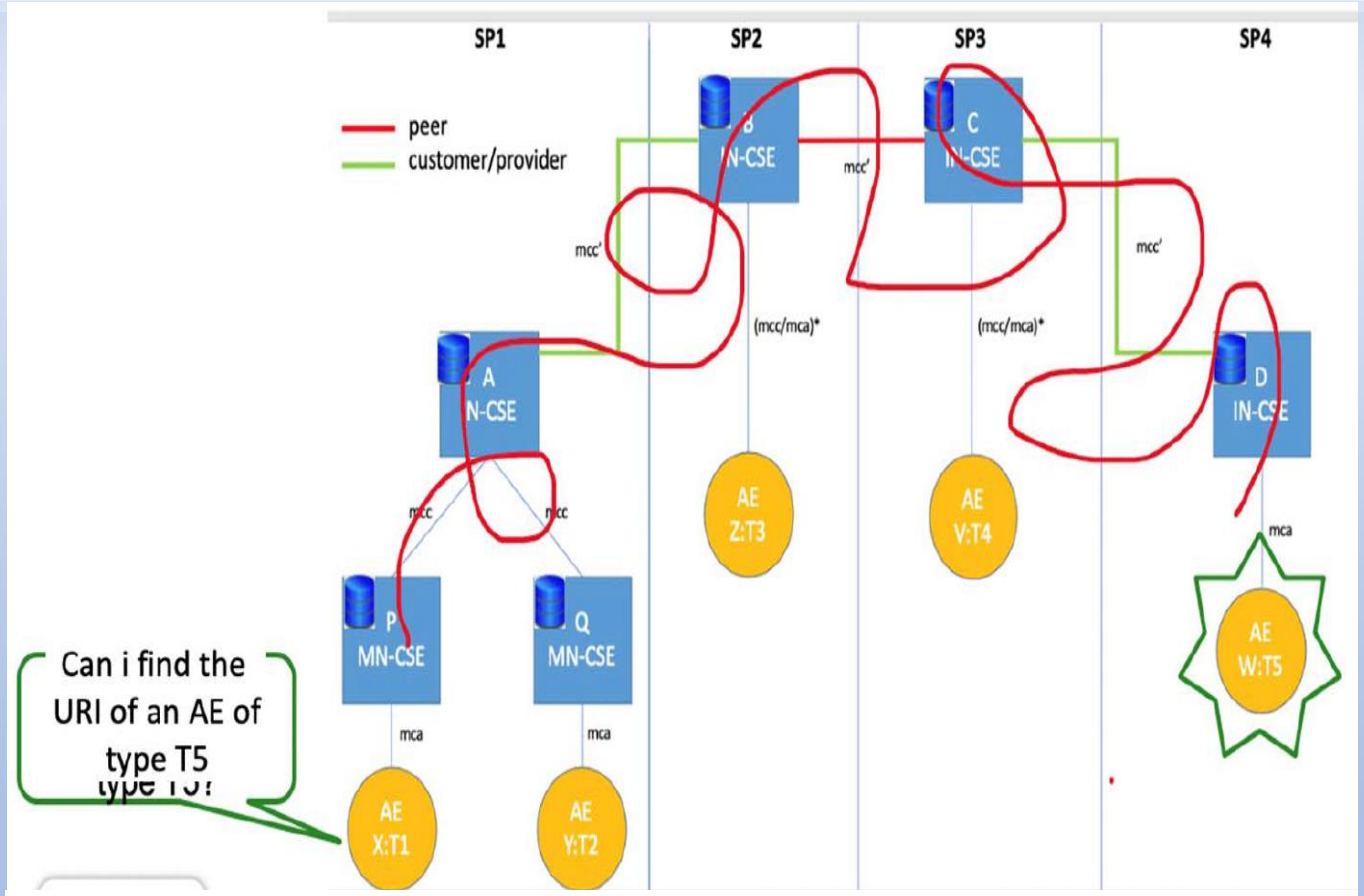


Fig. 6.3.1-1 Advanced Semantic Discovery (ASD) in one image

Semantic discovery in presence of a "Network" of M2M Service Providers (M2MSPs)

ASD within Distributed Network of CSEs belonging a single Service Provider & across different IoT Service Providers.

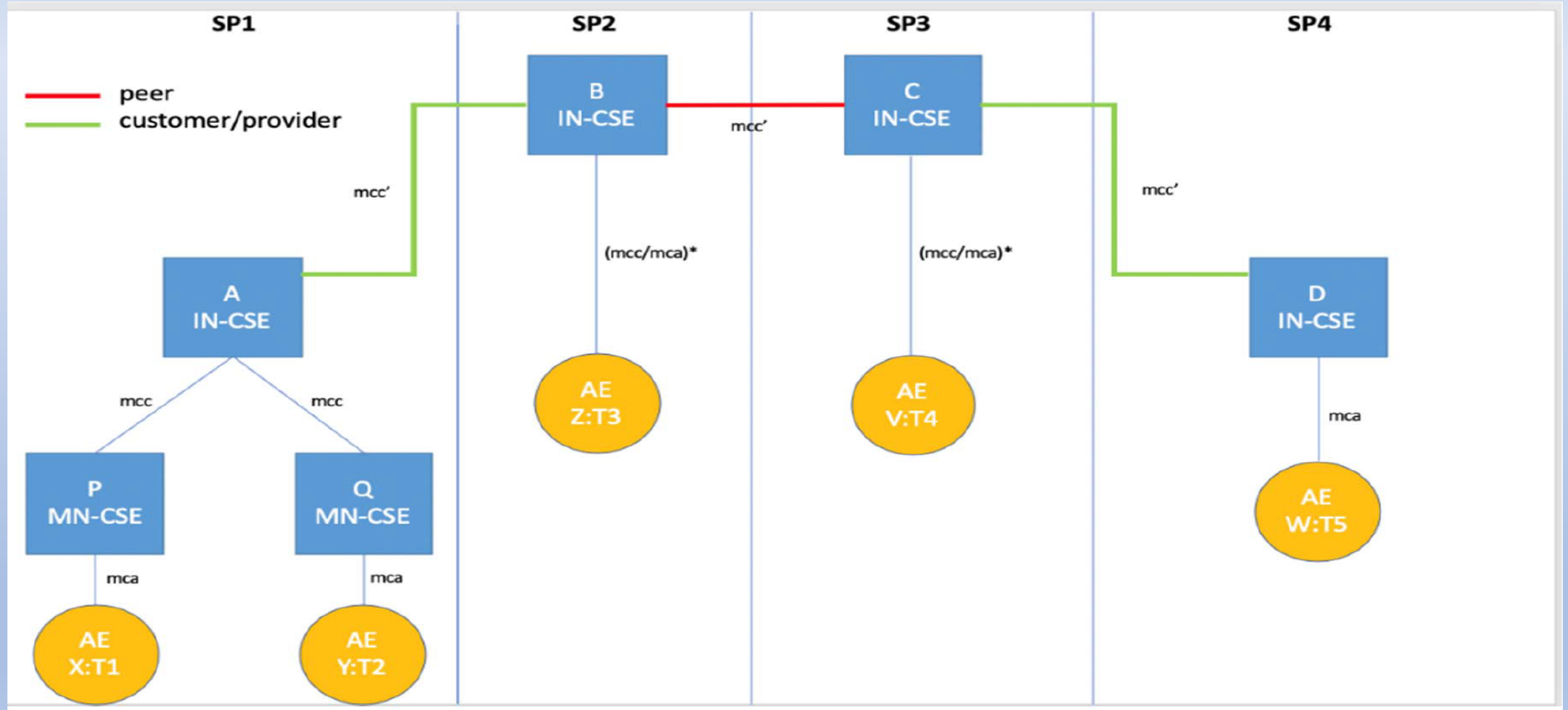
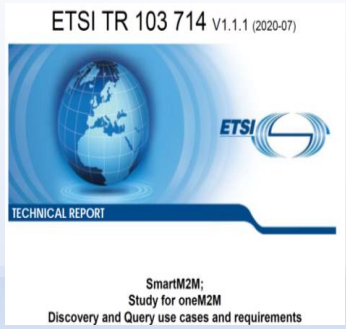


Figure 5.4-1: Pre-condition topology



5 Use Case - Semantic discovery in presence of a "network" of M2M SP

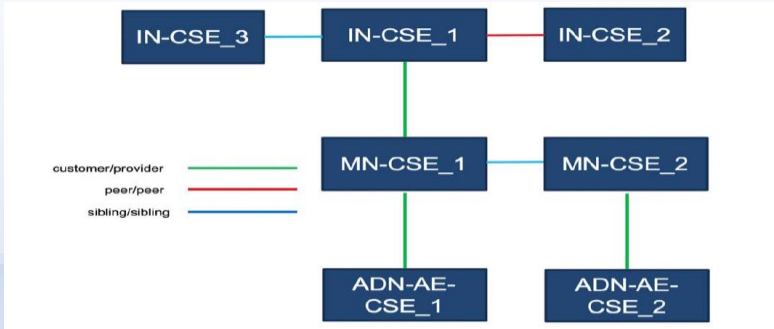


Figure 7.2.1-1: C2P and P2P and S2S CSE relationships

Table 7.2.7-1: SRT with Recommendation System

TYPE	BUCKETS[TYPE]	CSE CUSTOMERS	CSE PEERS	CSE PROVIDERS
THERMOMETER	CSE_1 ... CSE_q	(CSE_1, #cu_1) ... (CSE_x, #cu_m)	(CSE_1, #pe_1) ... (CSE_y, #pe_m)	(CSE_1, #pr_1) ... (CSE_z, #pr_m)
WATER_VALVE	CSE_1 ... CSE_r	(CSE_1, #cu_1) ... (CSE_x, #cu_n)	(CSE_1, #pe_1) ... (CSE_y, #pe_n)	(CSE_1, #pr_1) ... (CSE_z, #pr_n)
AIR_POLLUTION_STATION	CSE_1 ... CSE_s	(CSE_1, #cu_1) ... (CSE_x, #cu_p)	(CSE_1, #pe_1) ... (CSE_y, #pe_p)	(CSE_1, #pr_1) ... (CSE_z, #pr_p)

Table 7.2.6-2: Upgrading the adjacent SRT CSEs with the new y AE-THERMOMETERS

CSEcust1 TYPE	URI	CSE CUSTOMERS	CSE PEERS	CSE PROVIDERS
THERMOMETER	URI_v, URI_w	...	...	(CSE, #_+y)
CSEcust2 TYPE	**URI**	**CSE CUSTOMERS**	**CSE PEERS**	**CSE PROVIDERS**
THERMOMETER	URI_z	...	...	(CSE, #_+y)
CSEpeer TYPE	**URI**	**CSE CUSTOMERS**	**CSE PEERS**	**CSE PROVIDERS**
THERMOMETER	URI_a	...	(CSE, #_+y)	...
CSEprov TYPE	**URI**	**CSE CUSTOMERS**	**CSE PEERS**	**CSE PROVIDERS**
THERMOMETER	URI_b, URI_c, URI_d	(CSE, #_+y)	...	...

5 Use Case - Semantic discovery in presence of a "Network" of M2M Service Providers (M2MSP)

1) Advanced Semantic Discovery shall support queries written with specific Domain Ontologies, e.g. SAREF.

2) Advanced Semantic Discovery shall support semantic reasoning between the baseline oneM2M ontology and the identified domain specific ontologies, e.g. SAREF. As example, if a query is looking for a oneM2M device observing Celsius Temperature, then the Advanced Semantic Discovery would potentially return a SAREF temperature sensor.

3) Advanced Semantic Discovery shall provide Capabilities to identify Multiple Set of Targets, and a Multiplicity of Searches (e.g. by setting parameters or filters).

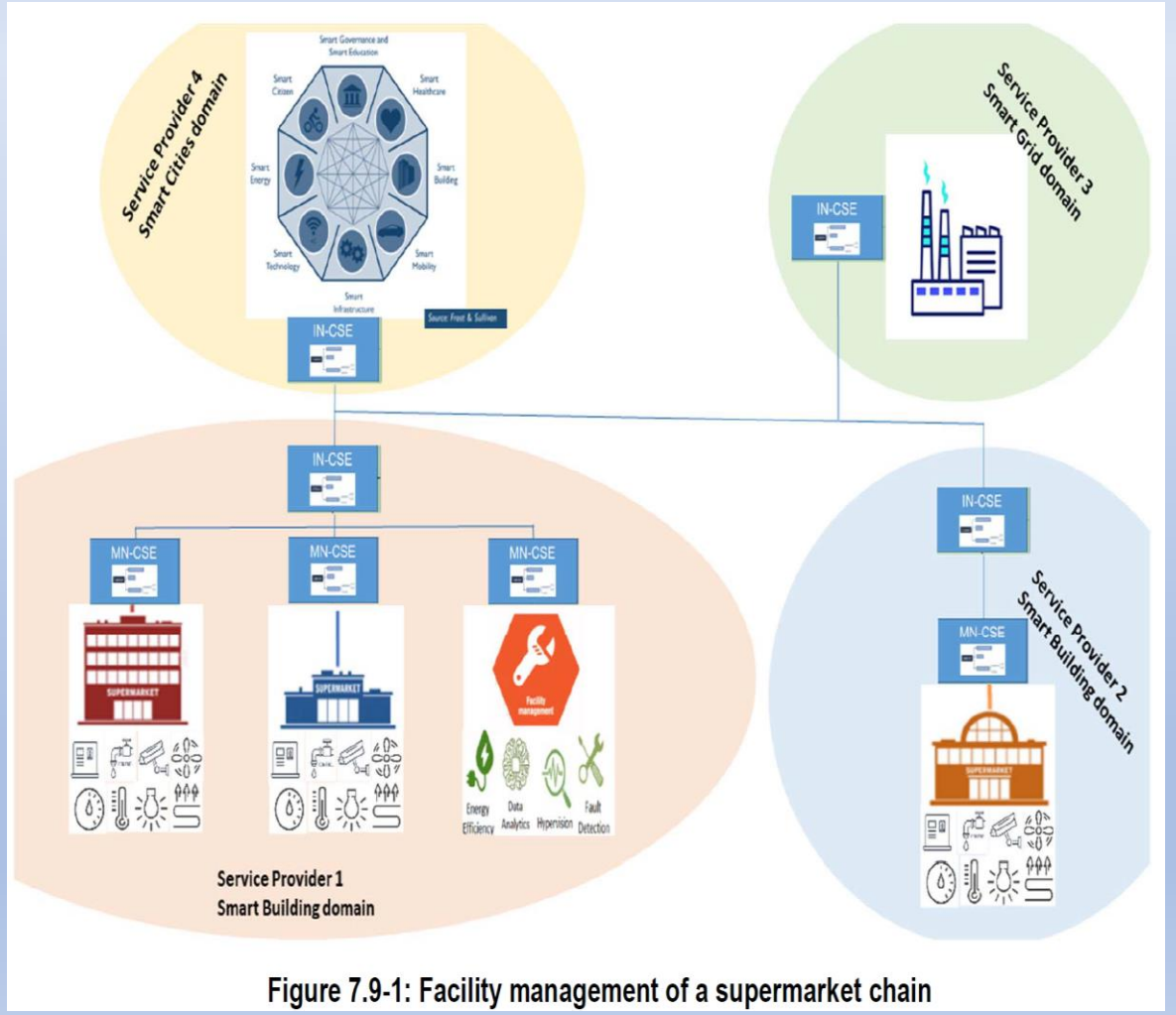


Figure 7.9-1: Facility management of a supermarket chain

5 Use Case - Semantic discovery in presence of a "network" of M2M Service Providers (M2MSP)

Use Case - Healthcare Network and Clinical Knowledge Administration

This use case looks at the Semantic Discovery Requirements through a Networking Environment between People with Disease (Patients), the Elderly, who want to live an independent life while remaining in their homes, Special Invalid People with a high risk of falling in their homes, Doctors/Care taking People, People practicing fitness exercises to improve their health, and Institutions/Organizations, who manage a Clinical Knowledge & Information Data Basis or Analyses of Patient Data.

Ageing and Living well and Epigenetics?!?!

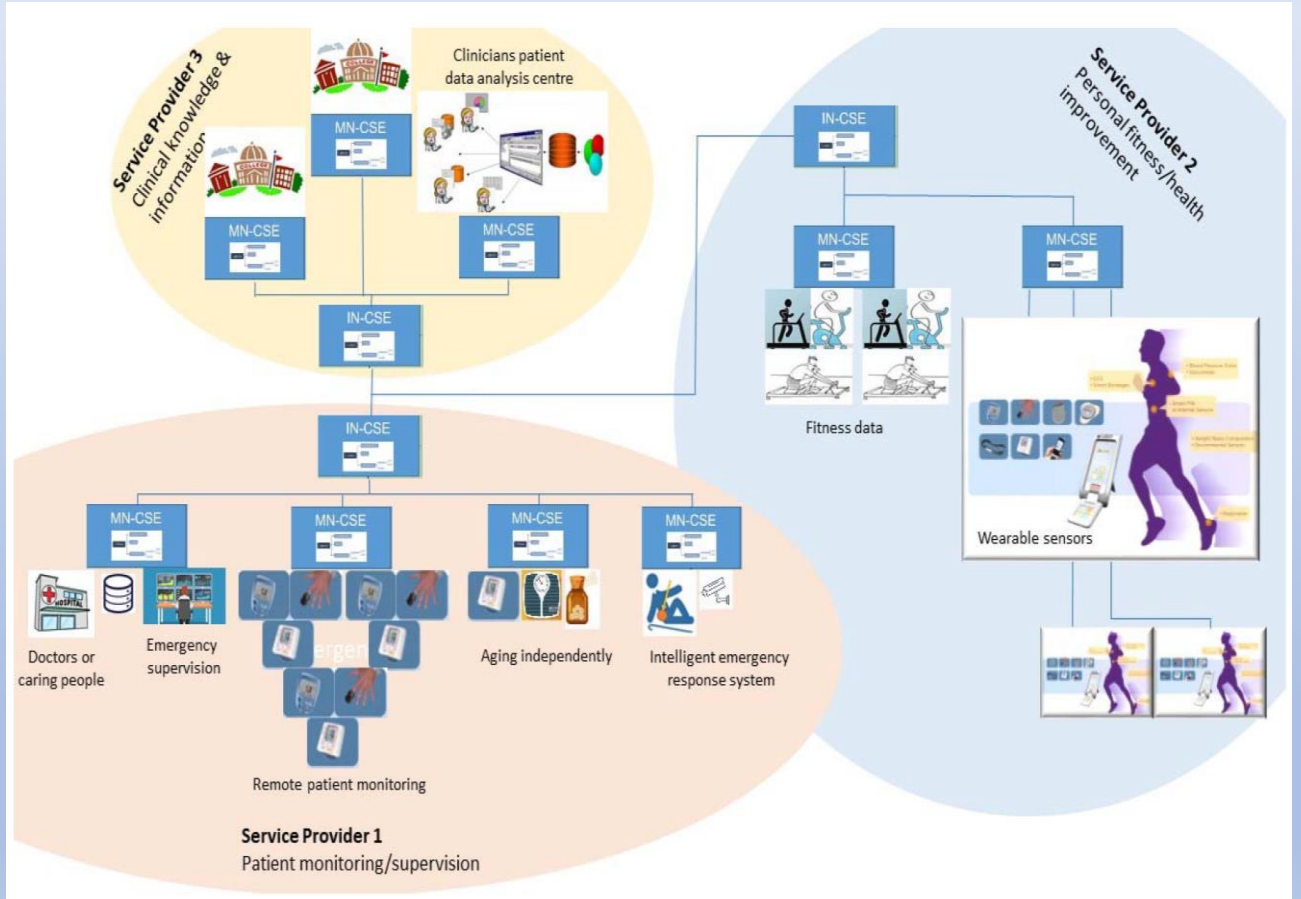


Figure 8.9-1: Healthcare network and clinical knowledge administration

oneM2M Semantic Support and Discovery - Ontology Mapping

The Ontology Mapping Task performed by

=> Create Operation or

⇒ Update Operation against an

⇒ <*ontologyMapping*> resource on a Hosting CSE.

A Retrieve operation against the same <*ontologyMapping*> resource shall be used to get the result of ontology mapping. A Delete operation against a <*ontologyMapping*> resource shall follow the basic procedure as specified in clause [1].

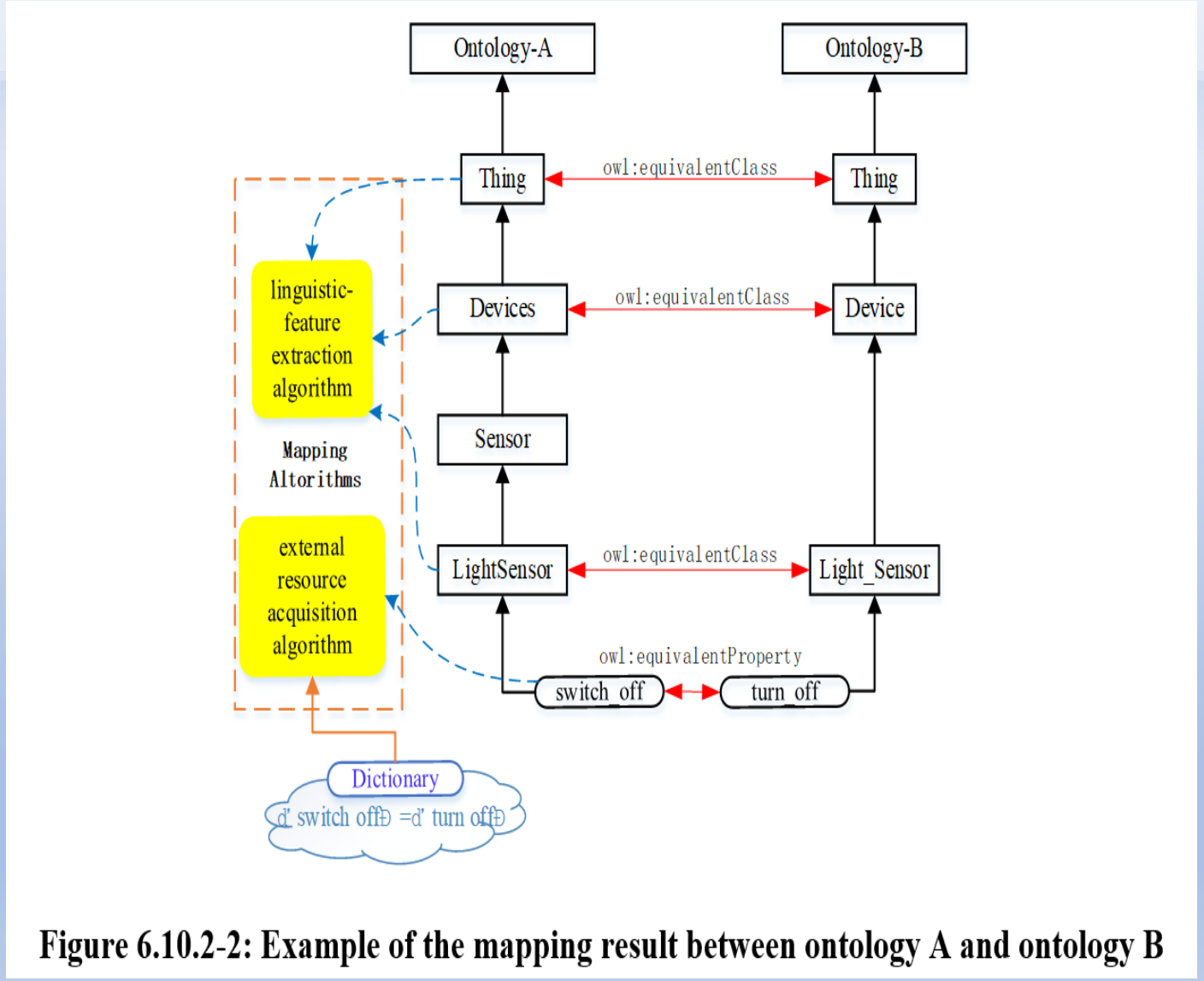


Figure 6.10.2-2: Example of the mapping result between ontology A and ontology B

ETSI CIM NGSI-LD API - Context Information Management Next Generation System Interface Linked Data API

The Goal of the ETSI ISG on Context Information Management is to issue TSs to enable multiple Organisations to develop interoperable SW implementations of a cross-cutting Context Information Management (CIM) Layer.

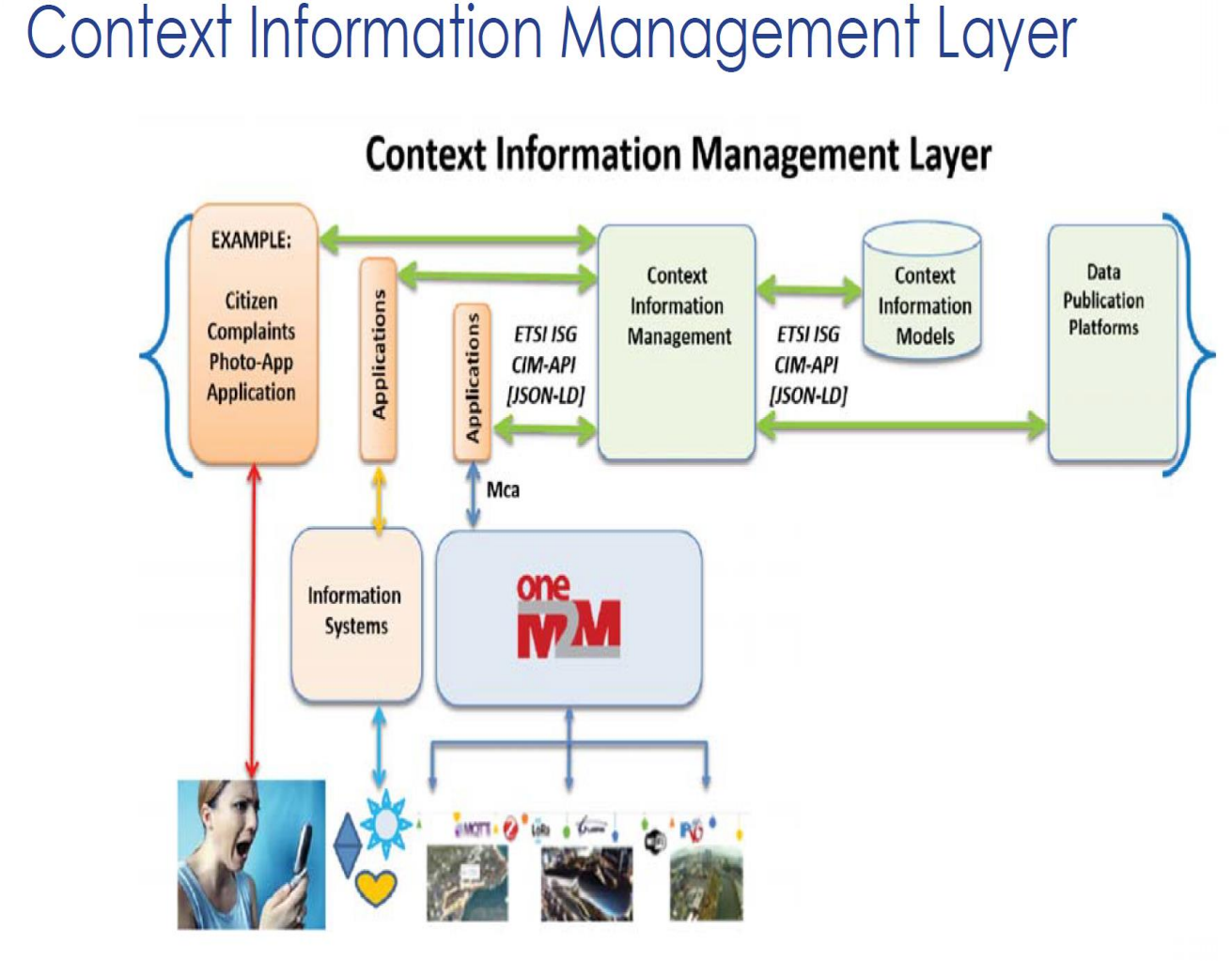
The CIM Layer should enable Applications to

- Discover,
- Access,
- Update and
- Manage

Context information from many different sources, as well as publish it through interoperable Data Publication Platforms.

Phase 1 - detect and describe the Standardization Gaps.

Phase 2 - Developing ISG CIM Group Specifications in Phase 2 will subsequently fill these gaps. It is expected that an extension of the RESTful binding of the OMA NGSI API involving expression using JSON-LD could aid interoperability, so this and potentially other extensions will be considered.



ETSI CIM NGSI-LD API - Context Information Management Next Generation System Interface Linked Data API

Context Information Management CIM - NGSI-LD API

The CIM API allows Users to:

- Provide,
- Consume
- Subscribe

> **Context Information**

Close to Real-time Access to Information coming from many different Sources (not only IoT Data Sources).

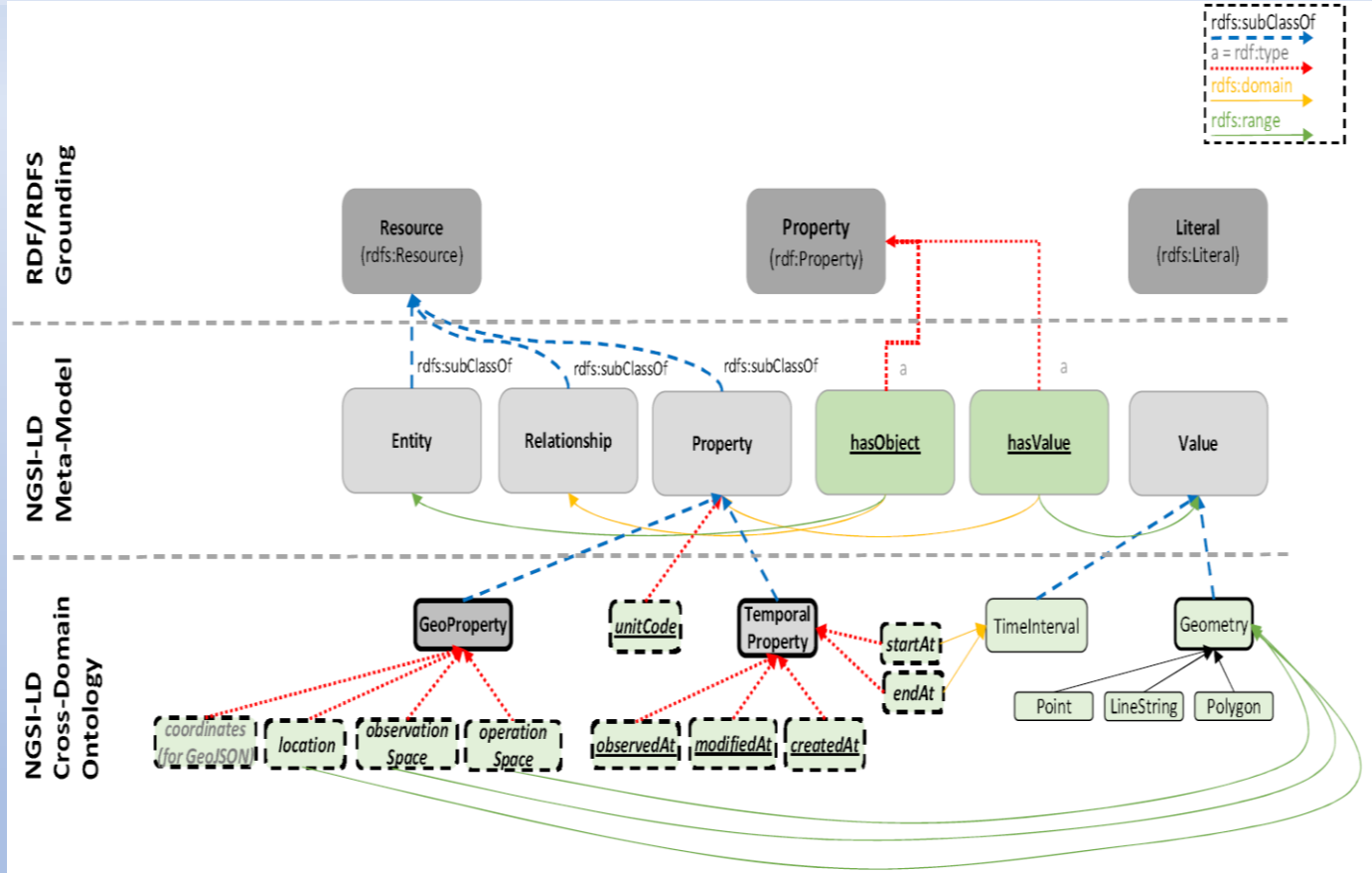


Figure 4.2.3-1: NGSI-LD Core Meta-Model plus the Cross-Domain Ontology

B.1 Mapping to oneM2M

oneM2M is a partnership project for IoT (originally defined as "machine to machine communication" in the Telecom world). OneM2M provides an OWL ontology that can be partially mapped to the ISG CIM cross-domain ontology, as illustrated in Figure B.1.

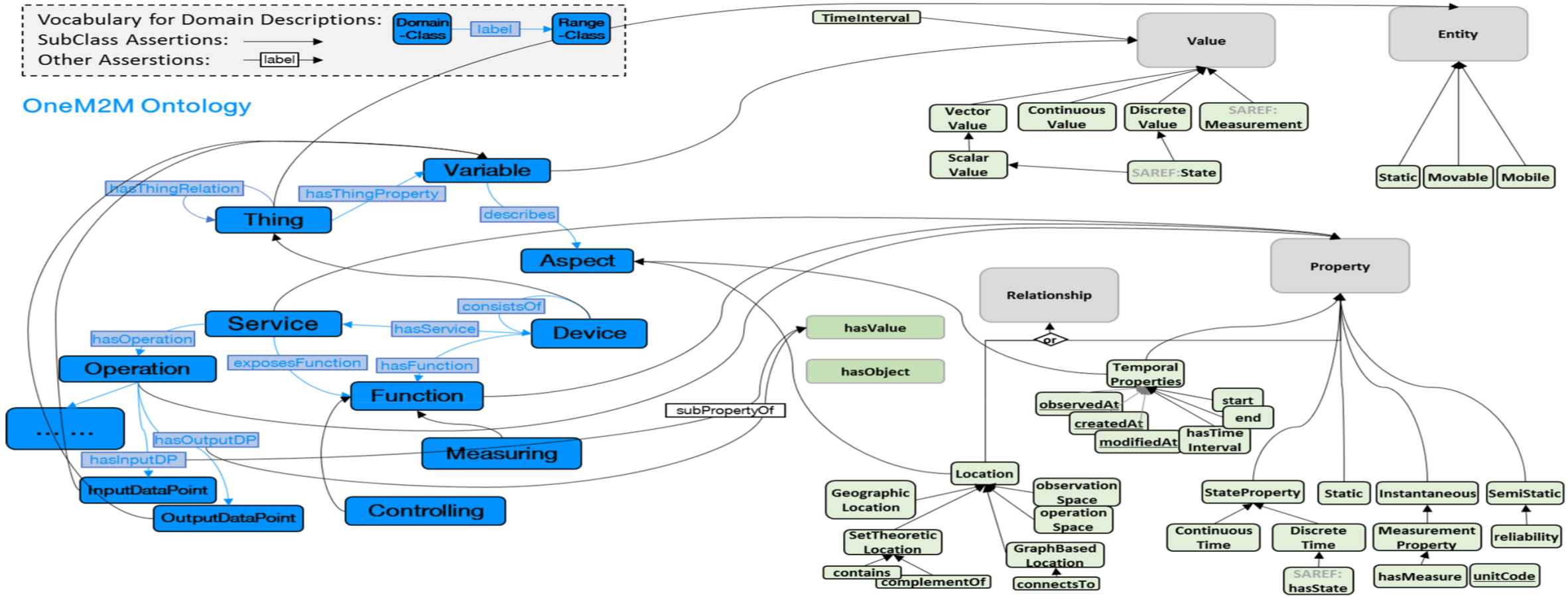


Fig. B. 1: Mapping NGSI - LD Meta - model and Cross-Domain Ontology to oneM2M Base Ontology

Mapping NGSI - LD cross domain Ontology to SAREF

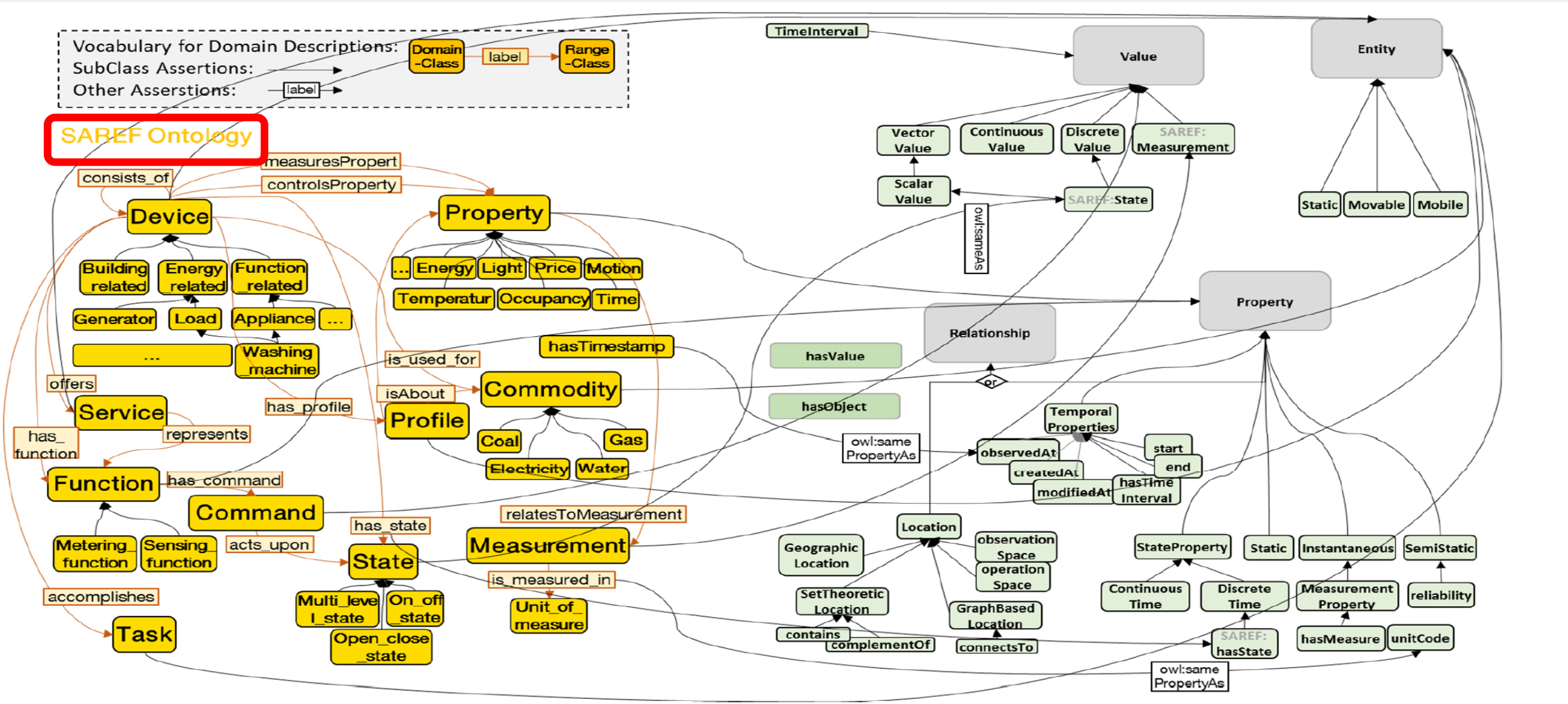


Figure B.4: Mapping NGSI-LD to SAREF

Commercial

ML Classification

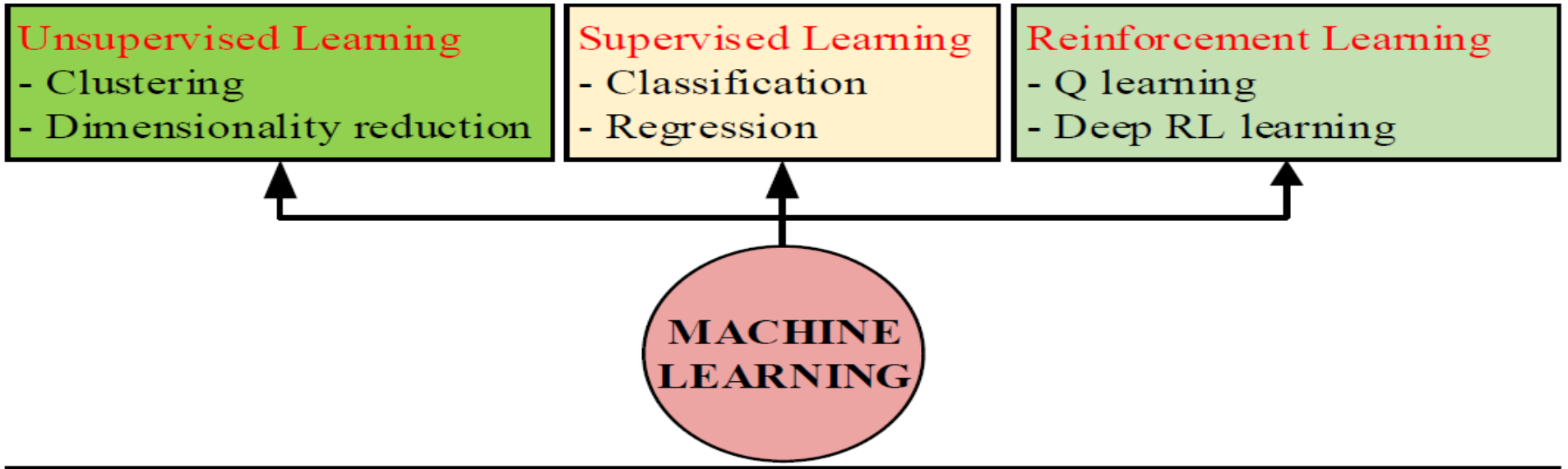
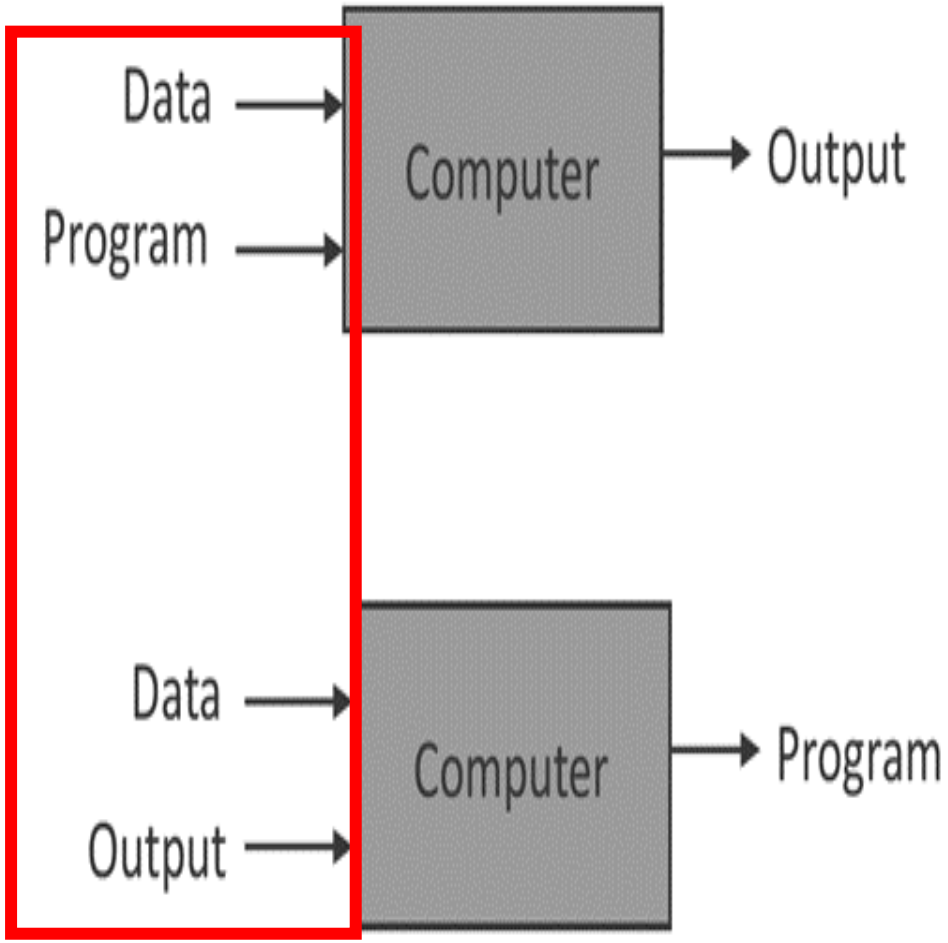
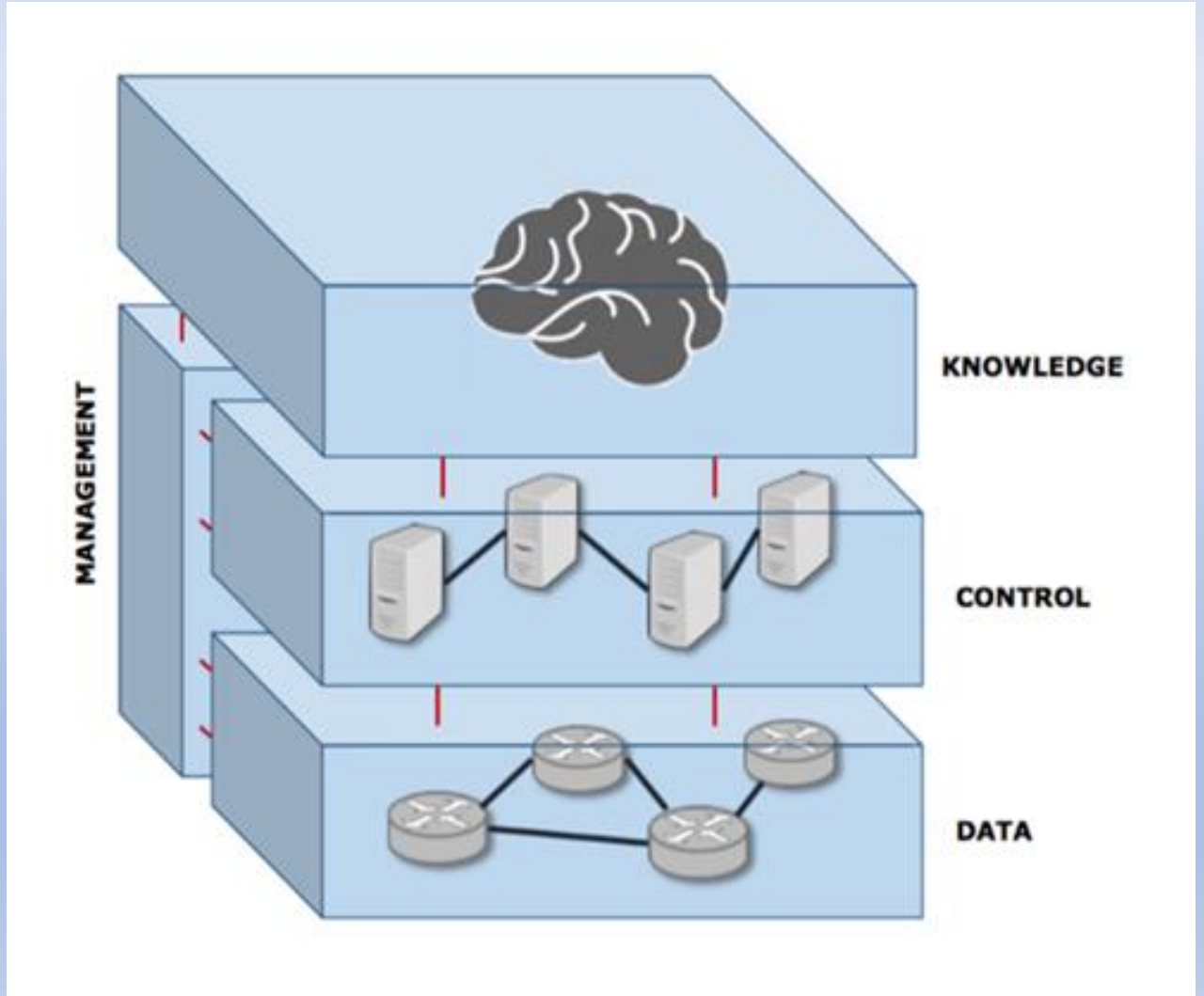


Fig. 11: Classification and applications of ML in mobile and wireless networking.

KDN – TMF


Data
Program
Computer
Output
Data
Output
Computer
Program


MANAGEMENT
KNOWLEDGE
CONTROL
DATA

Data Processing Chain Machine Learning - (ML)

The life cycle for ML can be considered to have the following Stages:

1) Data acquisition
2) Data curation
3) Model design
4) Software Build
5) Train
6) Test
7) Deployment
8) Updates

Stages 4), 5) and 6) (Build, Train, Test) can together be considered as an iterative implementation cycle.

In the ML lifecycle, the Training phase can be considered as the most critical, since it is this stage that establishes the baseline behaviour of the system.

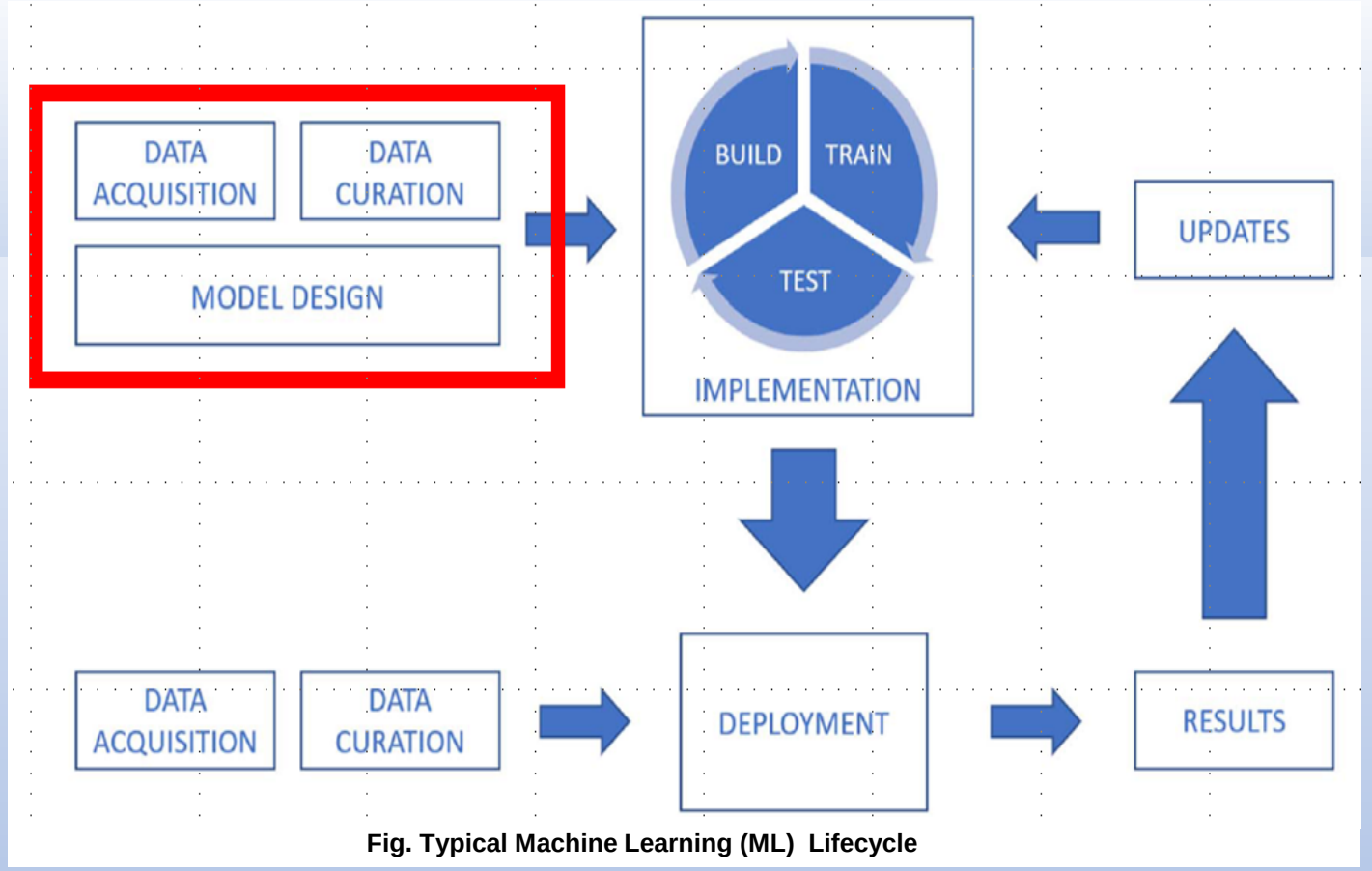
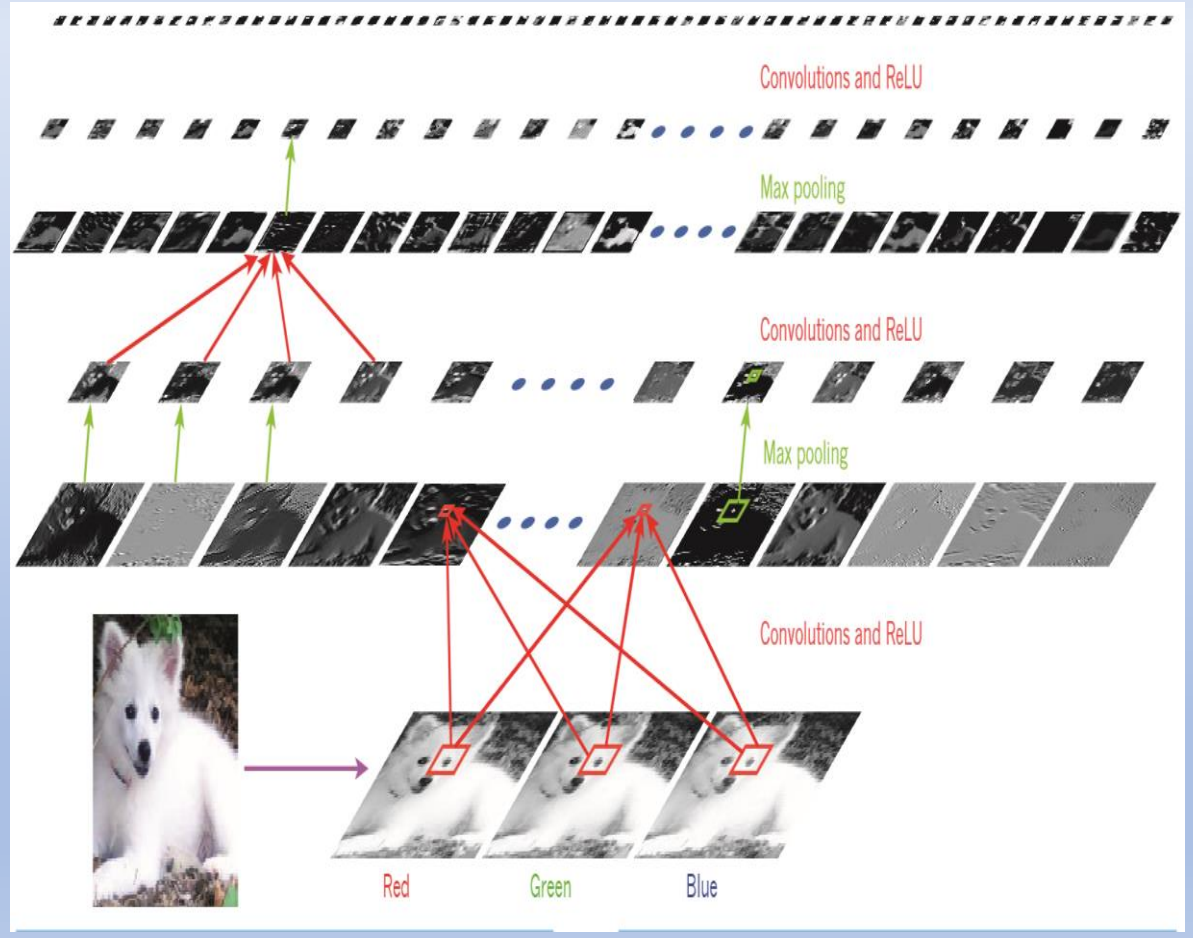
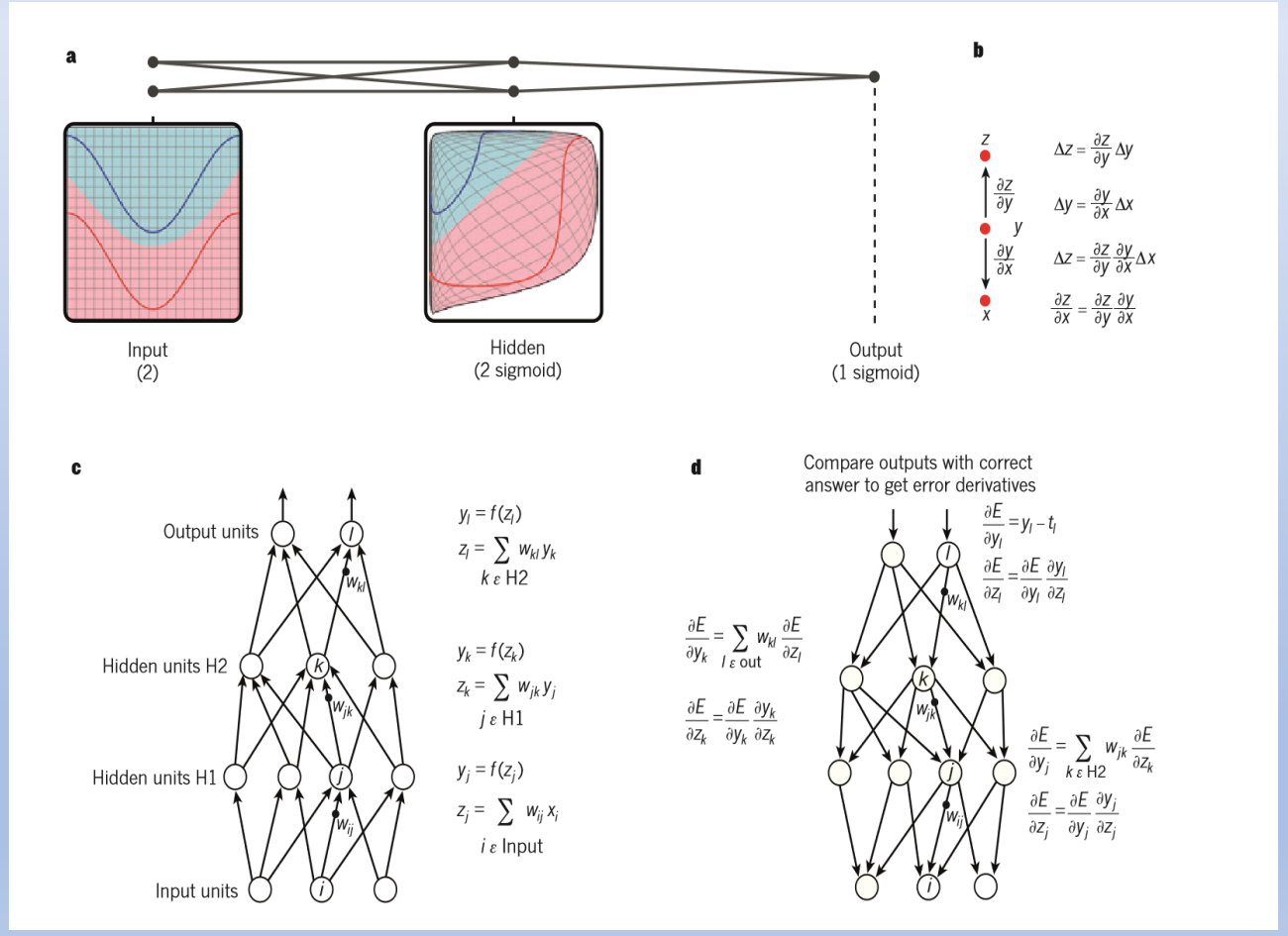


Fig. Typical Machine Learning (ML) Lifecycle

Table 1: Challenges in confidentiality, integrity and availability in the machine learning lifecycle

Clause	Lifecycle Phase	Issues
4.3.2	Data Acquisition	Integrity
4.3.3	Data Curation	Integrity
4.3.4	Model Design	Generic issues only
4.3.5	Software Build	Generic issues only
4.3.6	Train	Confidentiality, Integrity, Availability
4.3.7	Test	Availability
4.3.8	Deployment	Confidentiality, Integrity, Availability
4.3.9	Upgrades	Integrity, Availability


Convolutions and ReLU
Max pooling
Convolutions and ReLU
Max pooling
Convolutions and ReLU
Red
Green
Blue


a
Input
(2)
Hidden
(2 sigmoid)
Output
(1 sigmoid)
b
c
Output units
Hidden units H2
Hidden units H1
Input units
d
Compare outputs with correct
answer to get error derivatives

Self-Transfer Optimization Network

Deep Reinforcement Learning Framework

A DRL framework similar to the one proposed in [i.60] is considered, but modified in such a way that it learns the mapping between the network environment measurements (given as inputs) and the optimization actions/decisions (given as outputs), where the corresponding system performance metrics are mapped as rewards.

The DRL model consists of at least convolutional layers and fully connected layers, where the convolutional layers are used to capture the temporal and spatial correlations of the network environment, while the fully connected layers are used for reducing the dimension to the required dimension of the output actions. Figure 28 gives an example of the DRL model with two convolutional layers and two fully connected layers.

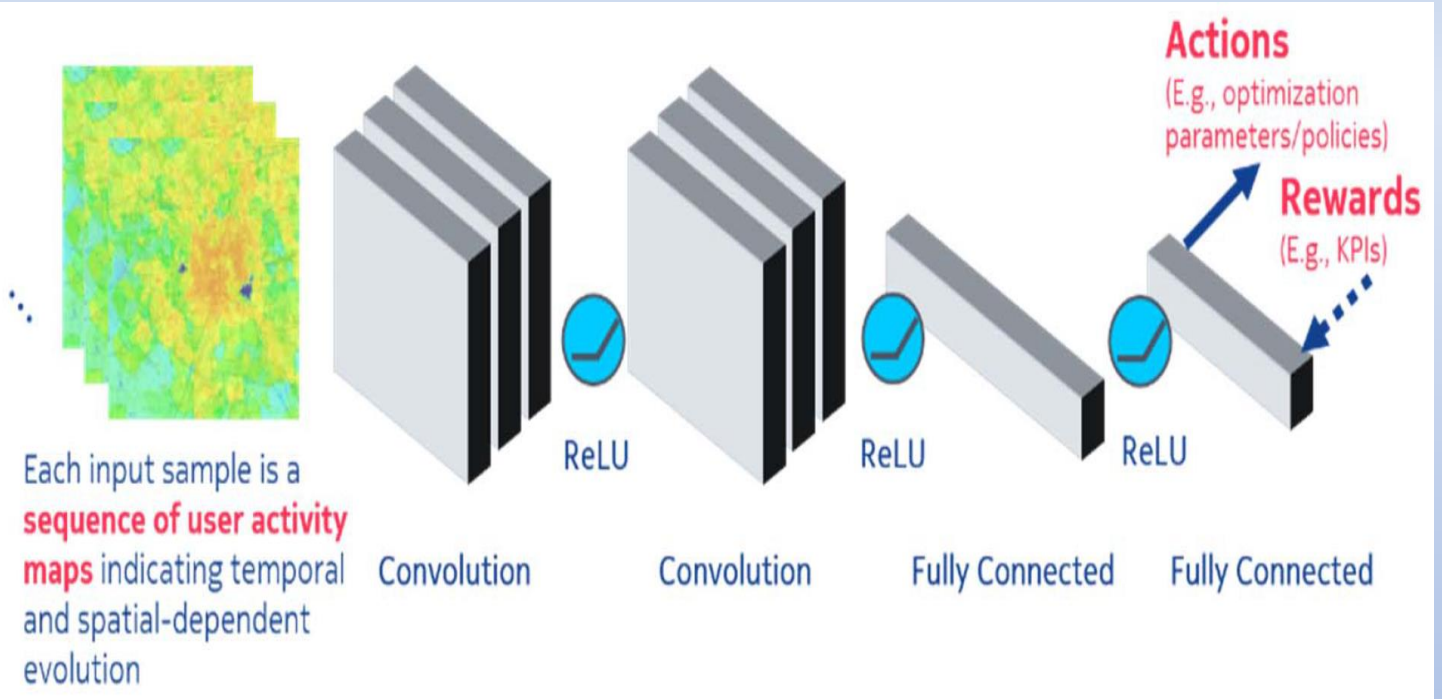
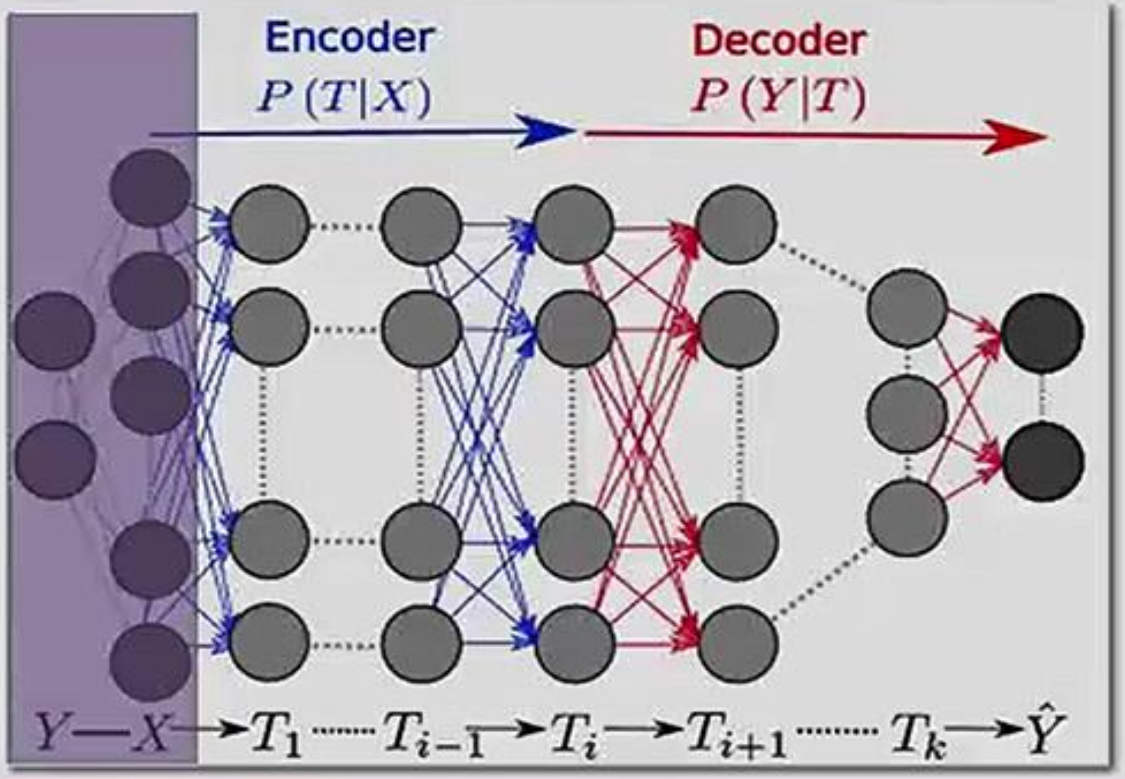


Fig 28 An example of DRL Deep Reinforced Learning Network

Each layer is characterized by its Encoder & Decoder Information



Theorem (Information Plane):

*For large typical **X**, the sample complexity of a DNN is completely determined by the encoder mutual information, **I(X;T)**, of the last hidden layer; the accuracy (generalization error) is determined by the decoder information, **I(T;Y)**, of the last hidden layer.*

The complexity of the problem shifts from the decoder to the encoder, across the layers…

ICRI-CI

ETSI ENI Architecture for Closed -Loop Network Operations & Management enabled by AI/ML Techniques

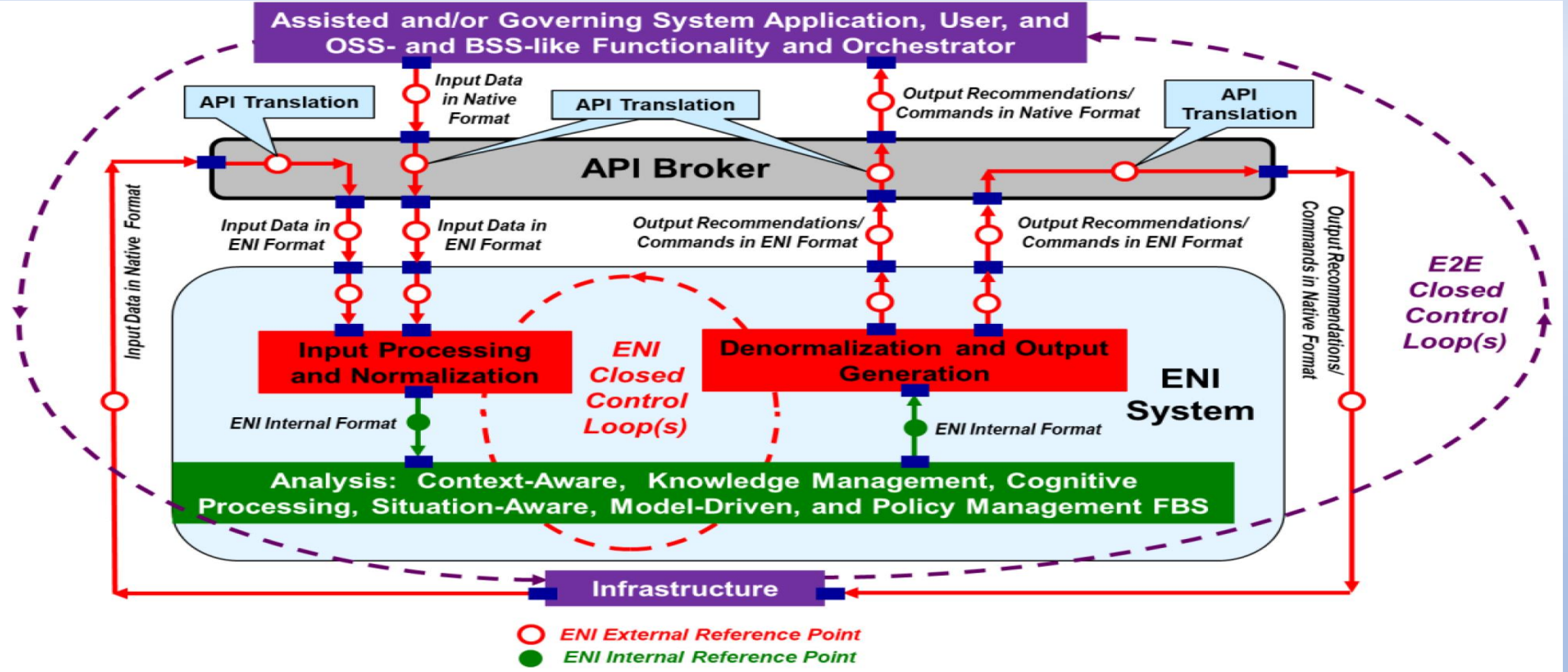
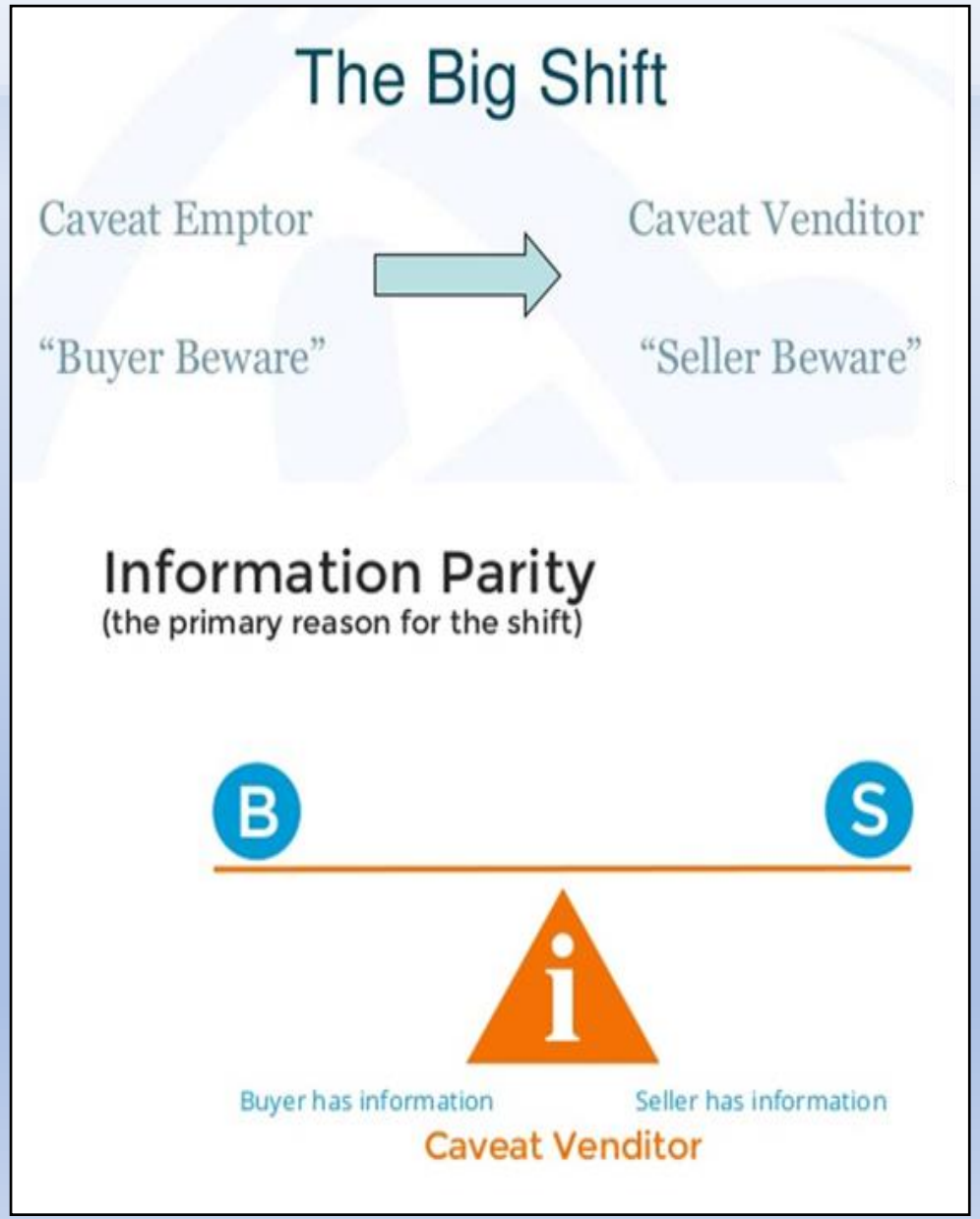


Figure 3: High-Level Functional Architecture of ENI when an API Broker is used

The Big Shift - from "Caveat Emptor" to "Caveat Venditor" - 1

THE MARKET FOR "LEMONS":
QUALITY UNCERTAINTY AND THE
MARKET MECHANISM *

GEORGE A. AKERLOF



When Information is Ubiquitous:

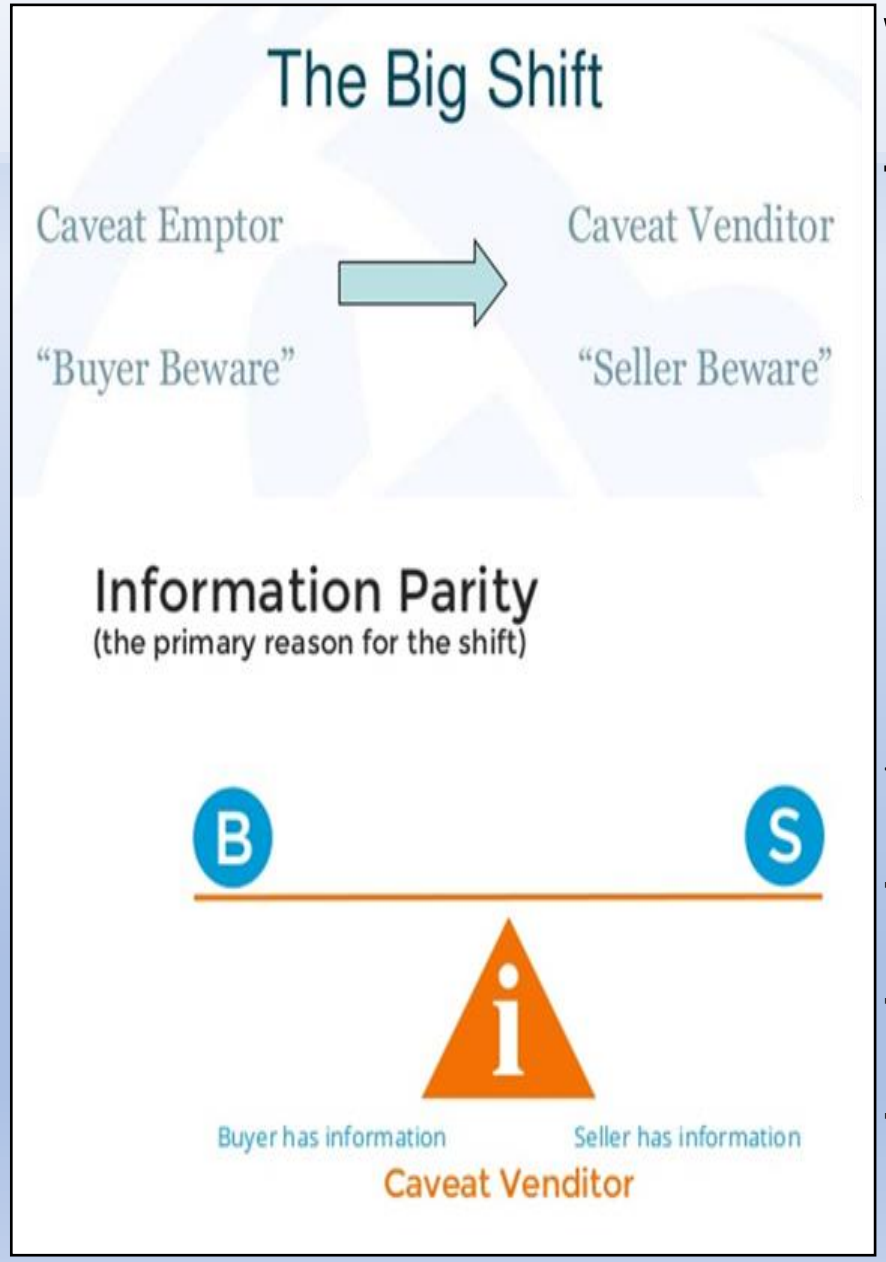
shift from **Information Inequality** to **Information Paritiy**

No longer enough

just to be able to Answer to Questions on Product/Solution/ Services

and/or present Platforms, Solutions, Services, Standards ...

The Big Shift - from "Caveat Emptor" to "Caveat Venditor" - 2



When Information is Ubiquitous

The Value of undertaking the role of "Unbiased Business Partner"

Shift in assigned importance **from "Problem - Solving" to "Problem-Identification/ Finding"**

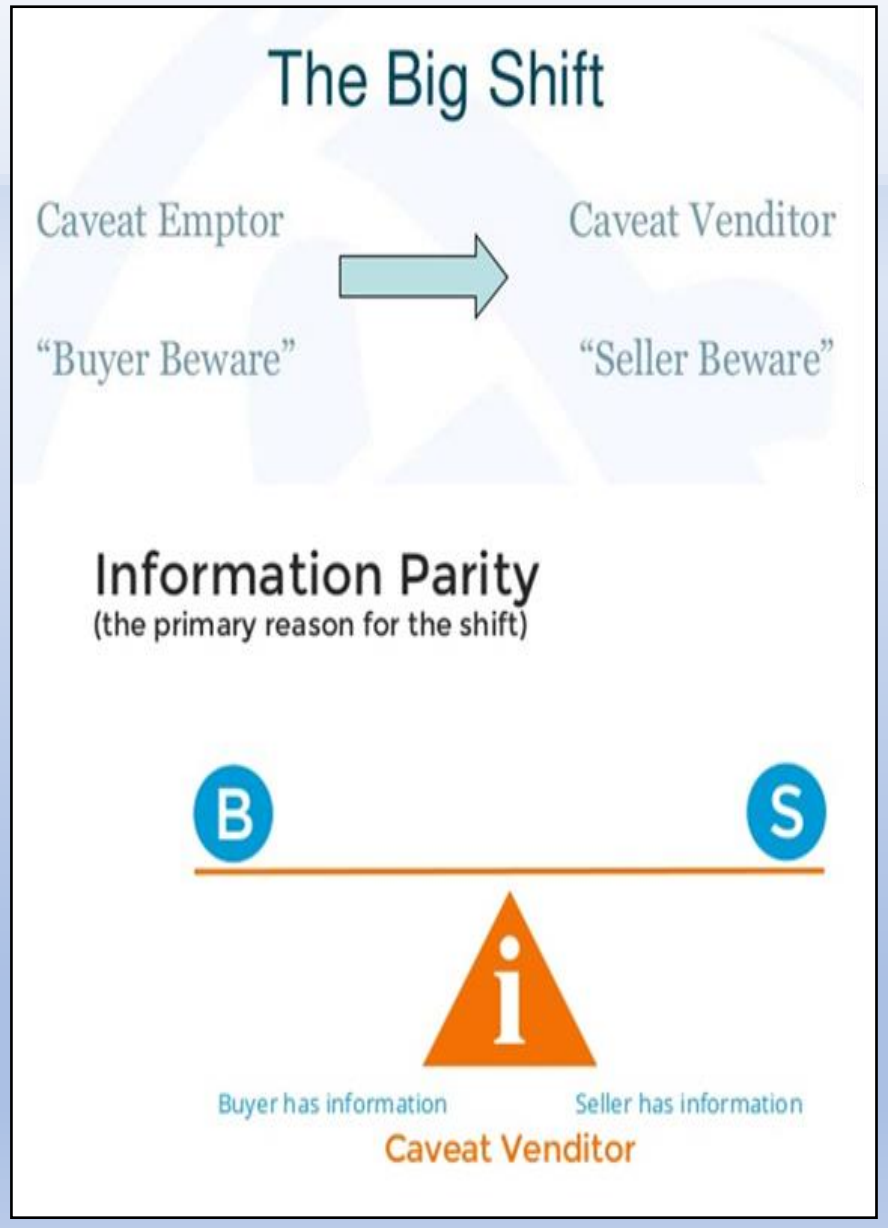
Ask the "Right Questions"
- to Identify Current Issues/Problems, curate the Vast Amount of Information &

- Ability to Hypothesize/Clarify on Future Problems, Inter-Dependencies

- Outline Future Multi-Vendor Inter- Operability & Scalability

- Ground for Personalized, Business Model and Agile Service Deployment.

The Big Shift - from "Caveat Emptor" to "Caveat Venditor" - 3



To see what the Problem is before jumping in to Resolve it

Problem Solving Approach turns upside down Two (2) "Traditional Sales Skills:

A) From "Access Information" to "Curating Information":

- Sorting - out through massive amount of Data
- Presenting the most Relevant & Clarifying Aspects

B) From "Answering Questions" to "Asking Questions" to:

Possibilities
Uncover => Surfacing Latent Issues
Unexpected problems

C) Apply "Contrast Principle" (R. Cialdini) & move from "Upselling" to "Upserving"

Most Important Question:

"Compared to What"? => Value

GAIN Model and Fallacies of Data - 2

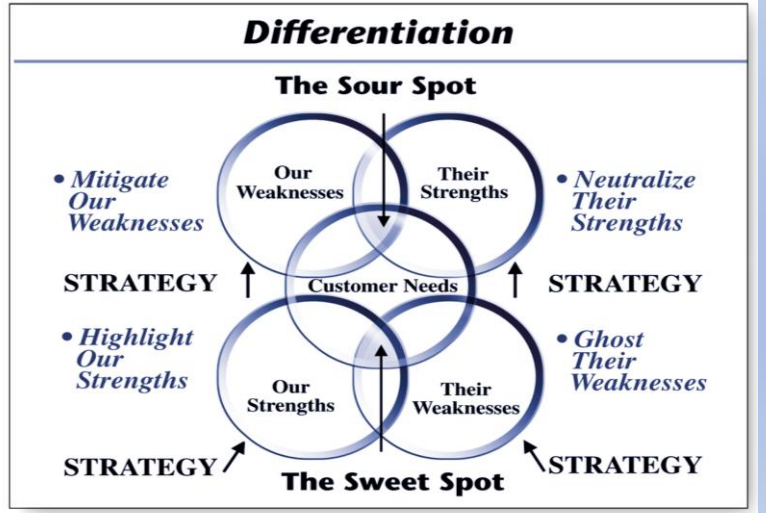
Three (3) Fallacies of Data

1. The Fallacy of Active vs Passive Data.

Growing companies start to ***generate Operations-related Data*** **(Active Data),** which can seduce with its apparent objectivity.

2. The Fallacy of Surface Growth

In consumer relationships, Corporations *focus their energies on driving growth by selling to existing Customers additional products* .



Positive (Sweet Spot) and negative (Sour Spot) differentiation exists only in the context of the customer's needs. Then Middle and Endgame strategies are implemented to grow the Sweet Spot and shrink the Sour Spot.

3. The Fallacy of Conforming/Non-Conforming Data

focus on generating data that conforms to pre - existing notions, that inherently hinders/blinds from emerging/new opportunities beyond their perspective.

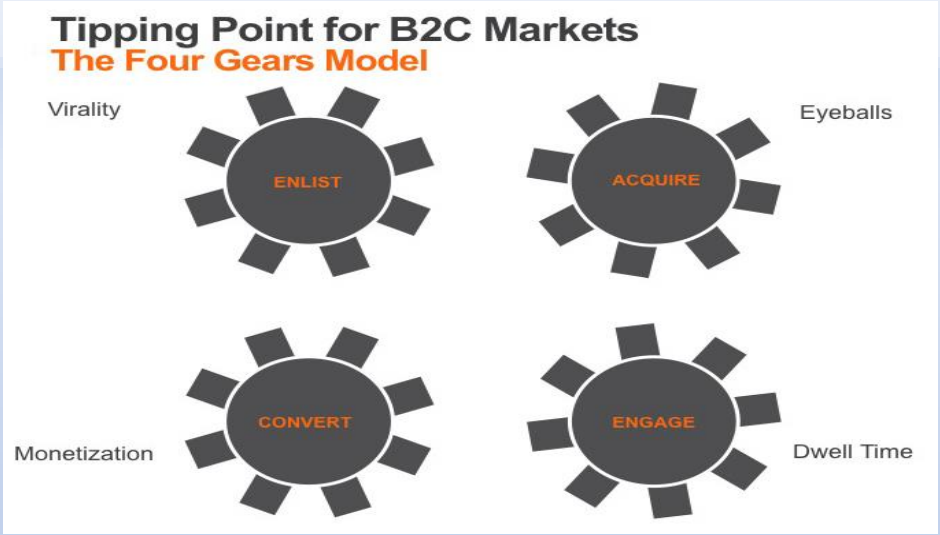
B2C/B2B Technology Adoption Phases - Business Model

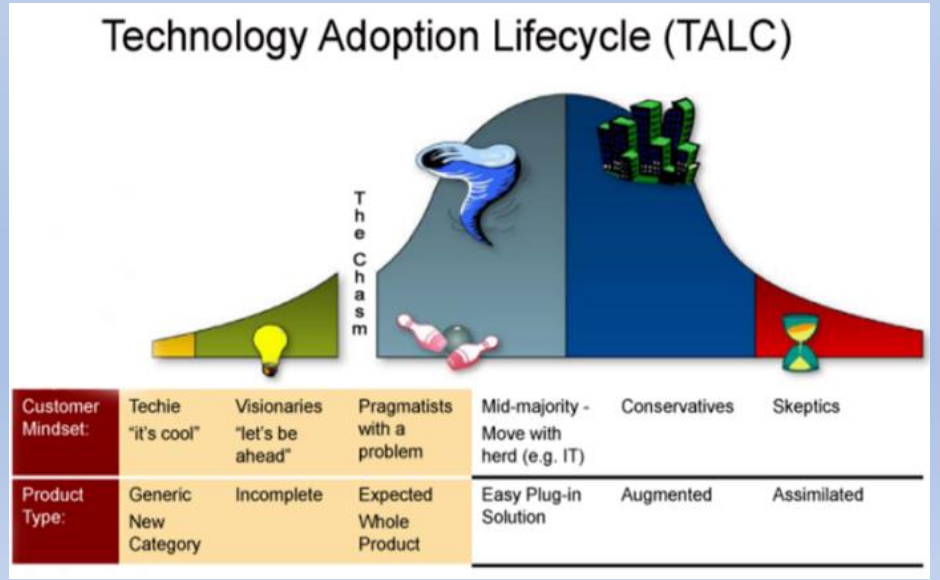
1. Engage Users

2. Develop Traffic

3. Identify the Loyal Users

4. Monetize (by charging the Loyal Users)





Summary A - Video presentations:

1. "My APIs are the best". They are proprietary, but they are the best".

2. Repeating the mistakes done in the past while deploying New Technologies without changing the Business Framework

3. "Products are Packages of Emphasis from Technologies on the rise".

Summary - B

1. How? or What/Why?

2. Package of Emphasis? or Emphasis?

3. Satisfy a Need? or Provides Progress?

within Social and Emotional Context?

Comments, Remarks, Questions?