

# 3GPP SA5 introduction on Autonomous Networks

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- 3GPP SA5 ToR
- Rel-16 5G management specifications
- 5G Service based Management architecture(SBMA)
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- Conclusions

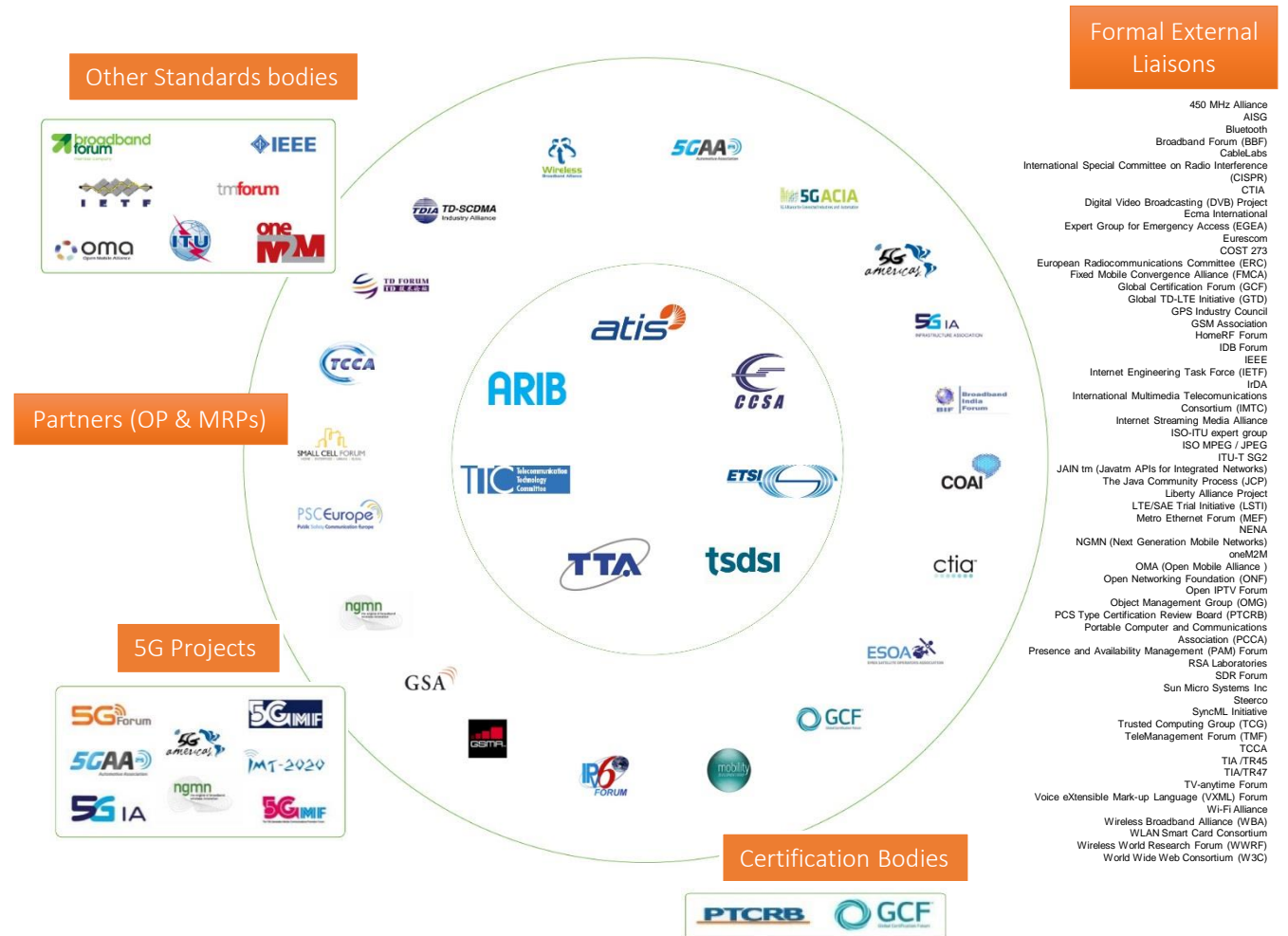
# 3GPP standards eco-system



Participation in 3GPP is made possible by companies and organizations becoming members of one of the 3GPP **Organizational Partners**, the seven Standards Developing Organizations (SDOs) - from China, Europe, India, Japan, Korea and the United States.

Specific inputs, in the form of market requirements may also come in to the Project via any of the twenty **Market Representation Partners** in 3GPP. These organizations have all signed up to the 3GPP Project scope and objectives.

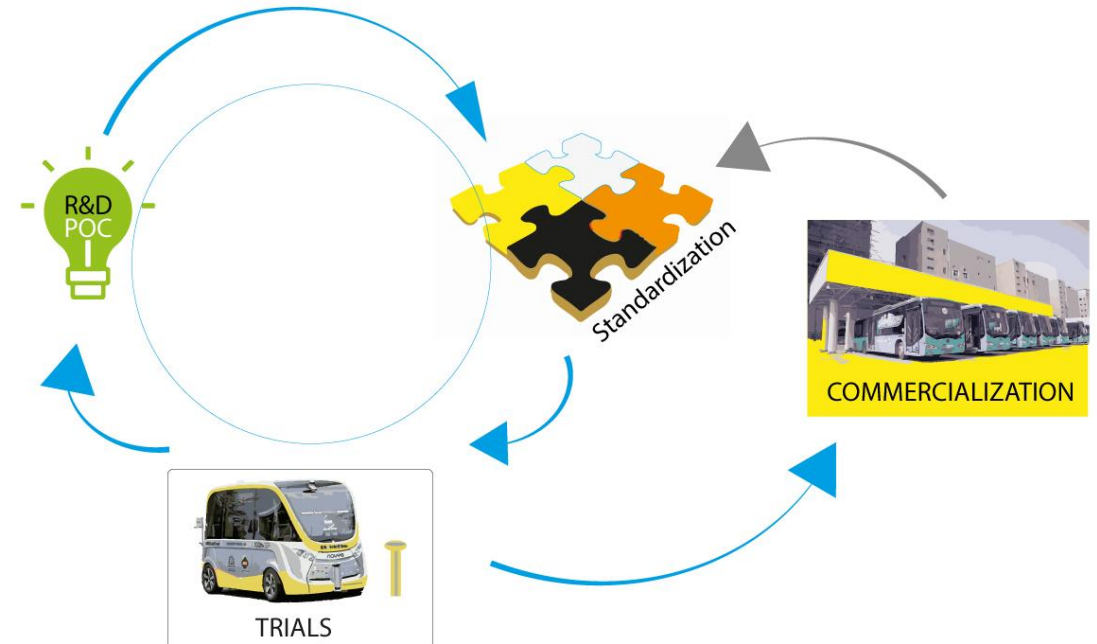
There is also a lot of external cooperation with other standards bodies and a broad variety of other groups, by way of formal Liaisons.



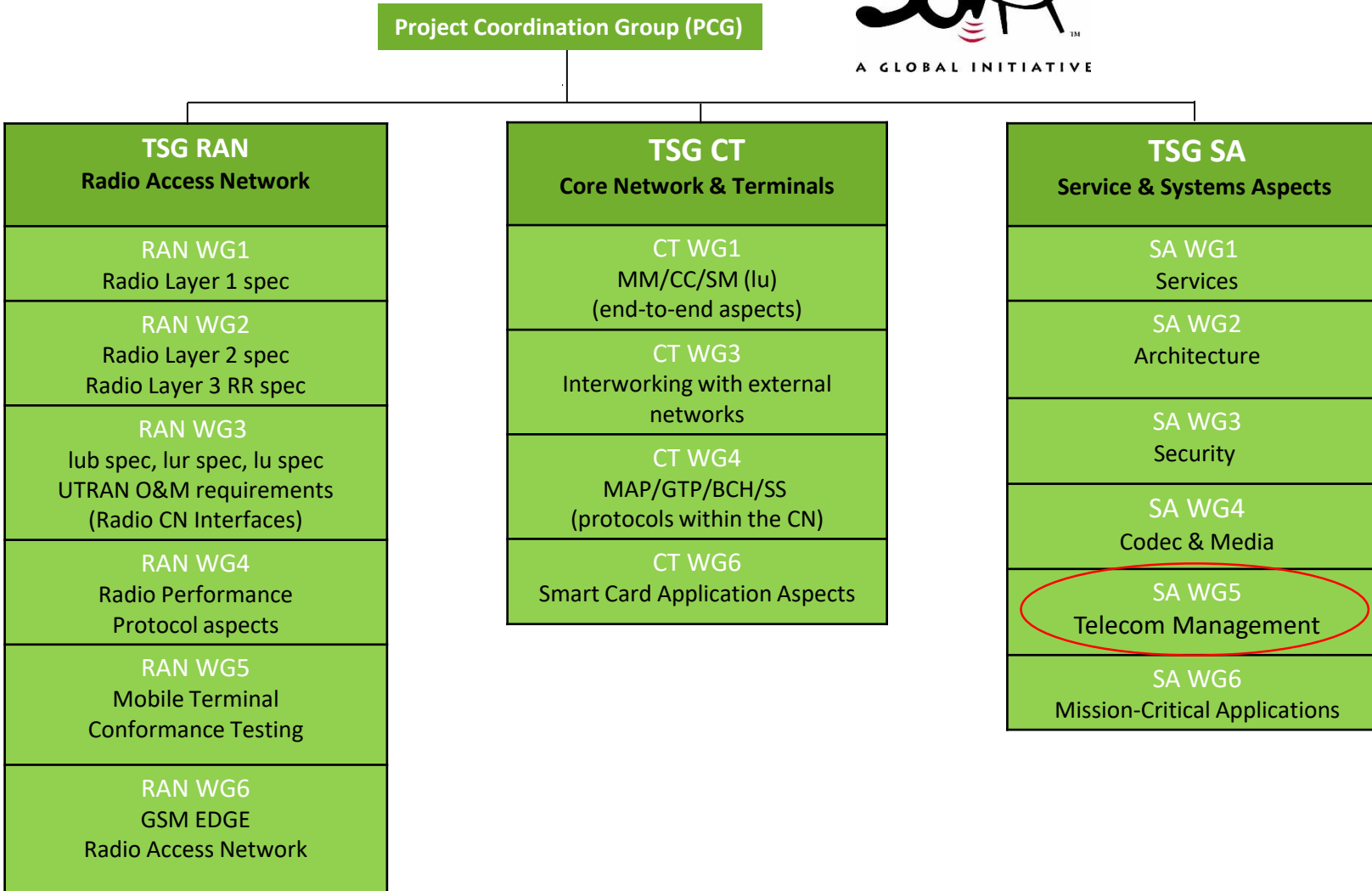
# The role of 3GPP



- 3GPP is part of the invention, proof of concept, **standardization**, trials, commercialization ...cycle
- Its role is to specify and maintain a complete system description for mobile telecommunications
- The system description is characterized by a number of standardized interfaces, not a description of standardized deployment
- This standardization approach enables an interoperable, multi-vendor approach to deployment and generates mass market economies of scale, without stifling innovation



# 3GPP organization

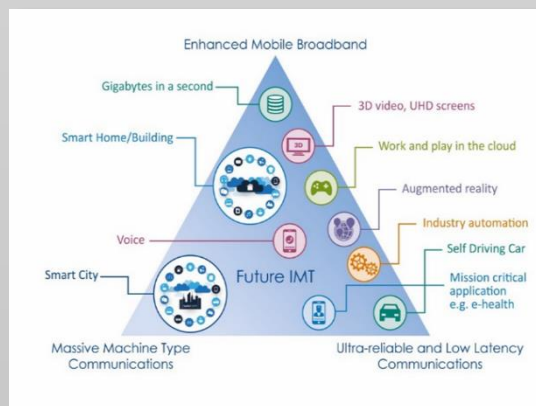


- 3GPP SA5 is responsible for management, orchestration and charging standards for 3GPP networks
- Coordinates with all 3GPP working groups
- Communicates with other SDOs and industry fora

# Bring the work in to the group



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## Use Cases

- Higher Data Rates
- Higher User Mobility
- Highly variable data rates
- Diverse Deployments
- Improved Coverage

## Overall Goals

- Enable new business
- Greater Efficiency (lower cost per bit for capital investment, operations & energy)
- Flexibility (not one-size fits all system)



## 3GPP Specifications and Reports:

Requirements	21 series
Service aspects ("stage 1")	22 series
Technical realization ("stage 2")	23 series
Signalling protocols ("stage 3") - user equipment to network	24 series
Radio aspects	25 series
CODECs	26 series
Data	27 series
Signalling protocols ("stage 3") -(RSS-CN) and OAM&P and Charging (overflow from 32.- range)	28 series
Signalling protocols ("stage 3") - intra-fixed-network	29 series
Programme management	30 series
Subscriber Identity Module (SIM / USIM), IC Cards. Test specs.	31 series
OAM&P and Charging	32 series
Security aspects	33 series
UE and (U)SIM test specifications	34 series
Security algorithms	35 series
LTE (Evolved UTRA), LTE-Advanced, LTE-Advanced Pro radio technology	36 series
Multiple radio access technology aspects	37 series
Radio technology beyond LTE	38 series

## Overview

- TSG SA WG5 is responsible for Telecom Management of the 3GPP network. This includes aspects such as operation, orchestration, assurance, fulfillment, automation and charging. Both functional and service perspectives are covered.
- TSG SA WG5 specifies requirements, stage 2 and stage 3 solutions. The solutions include architecture, service definitions and data definitions. Management services includes services towards vertical industries. Charging service is used for billing or other analytics as well as customer care.
- TSG SA WG5 also specifies design principles, guidelines and methodology for management, orchestration and assurance.

## Scope of Responsibilities

- TSG SA WG5 is responsible for all specification work pertinent to Telecom Management. Important areas where TSG SA WG5 is actively involved and developing specifications with **full support of automation** are:
  - Telecom management architecture framework.
  - Service Management, Network Management, Element Management (which includes management of Network Elements and Network Functions) and Charging Management.

# 3GPP SA5 ToR introduction-2



- 📶 Management aspects of energy efficiency.
- 📶 Exposure of management services to entities external to the network operator, e.g. verticals.
- 📶 Data collection for Telecom Management. Examples of data being collected: alarms, performance measurements, KPIs, QoE, trace, MDT data and charging data.
- 📶 Services and functions which support orchestration, assurance and analytics. Examples are (but not limited to):
  - 📶 Life Cycle Management (LCM), Fault Management, Configuration Management, Accounting Management, Performance Management and Security Management (FCAPS).
  - 📶 Management of autonomous networks, Self-Organizing Networks (SON), Intent driven management, Closed and open loop assurance and Data analytics.
  - 📶 Network Resource Models (NRMs), operations and notifications.
- 📶 3GPP Management support for edge components deployed at MNO premises.
- 📶 TSG SA WG5 is committed to engage in charging and management aspects of supporting new services for public and non-public networks.
- 📶 TSG SA WG5 coordinates with other 3GPP WGs and all relevant Standards Developing Organizations (SDOs), industry fora and Market Representation Partners (MRPs) in the specification work pertinent to Telecom Management.

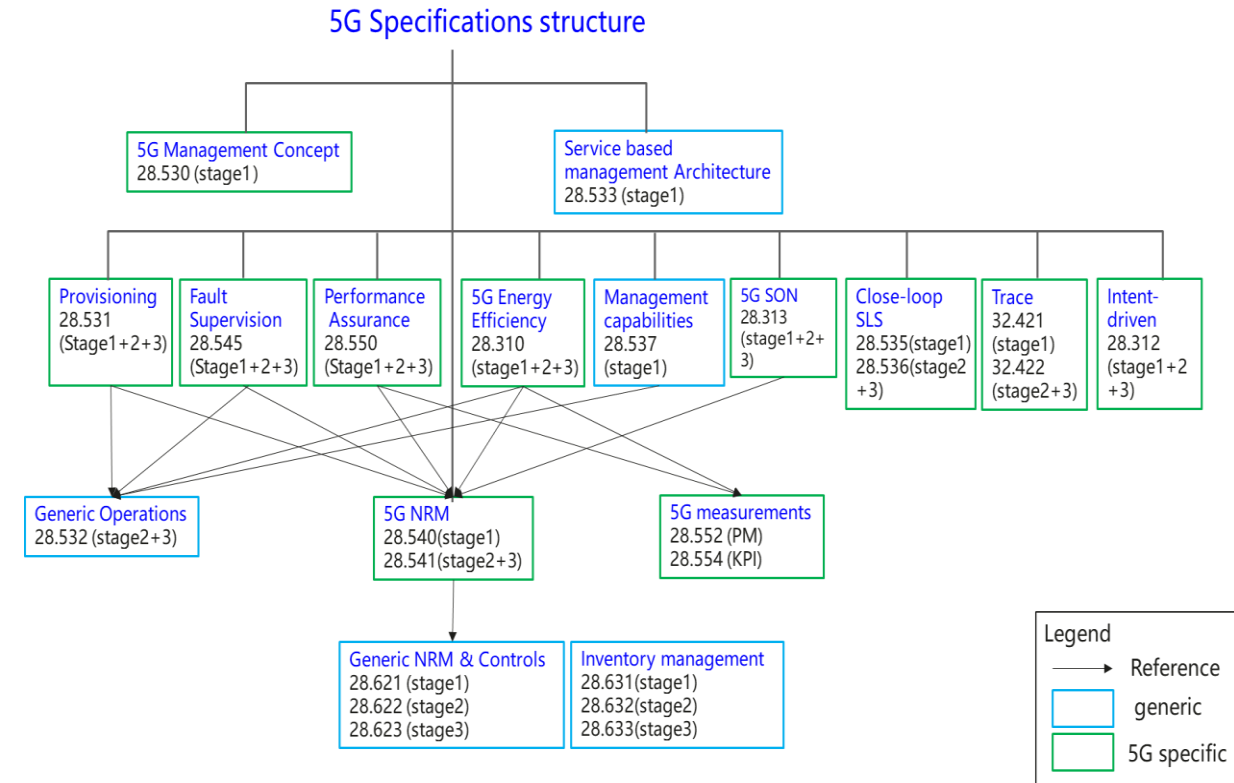
3GPP SA5 ToR URI: <https://www.3gpp.org/specifications-groups/sa-plenary/sa5-telecom-management>



# 3GPP SA5 5G specifications (TS 32.103)



1	Network and service management concept specification	TS 28.530[42]
2	Network management service based management architecture specifications	TS 28.533[43]
3	Network and Network slicing management related specifications	
3.1	Network and Network slicing provisioning	TS 28.531[44],TS 28.532[45],TS 28.540[46],TS 28.541[47]
3.2	Network and Network slicing fault supervision	TS 28.545[48],TS 28.532[45]
3.3	Network and Network slicing performance assurance	TS 28.550[49],TS 28.532[45],TS 28.540[46],TS 28.541[47],TS 28.552[50], TS 28.554[51]
3.4	NRM	TS 28.540[46],TS 28.541[47]
4	Energy efficiency related specifications	TS 28.310[52],TS 28.532[45],TS 28.552[50],TS 28.554[51]
5	ONAP-3GPP integration	TS 28.532[45]
6	Trace and MDT management	TS 32.421[37],TS 32.422[54]
7	5G SON management	TS 28.313[53],TS 28.541[47]
8	SLA management	TS 28.540[46],TS 28.541[47]
9	5G management capabilities (Heart beat)	TS 28.537[54],TS 28.532[45]
10	Close-loop SLS	TS 28.535[55], TS 28.536[56]
11	Management service discovery	TS 28.530[42],TS 28.533[43]
12	Management of tenant information	TS 28.530[42], TS 28.531[44],TS 28.533[43],TS 28.550[49],TS 28.552[50],TS 28.541[47]



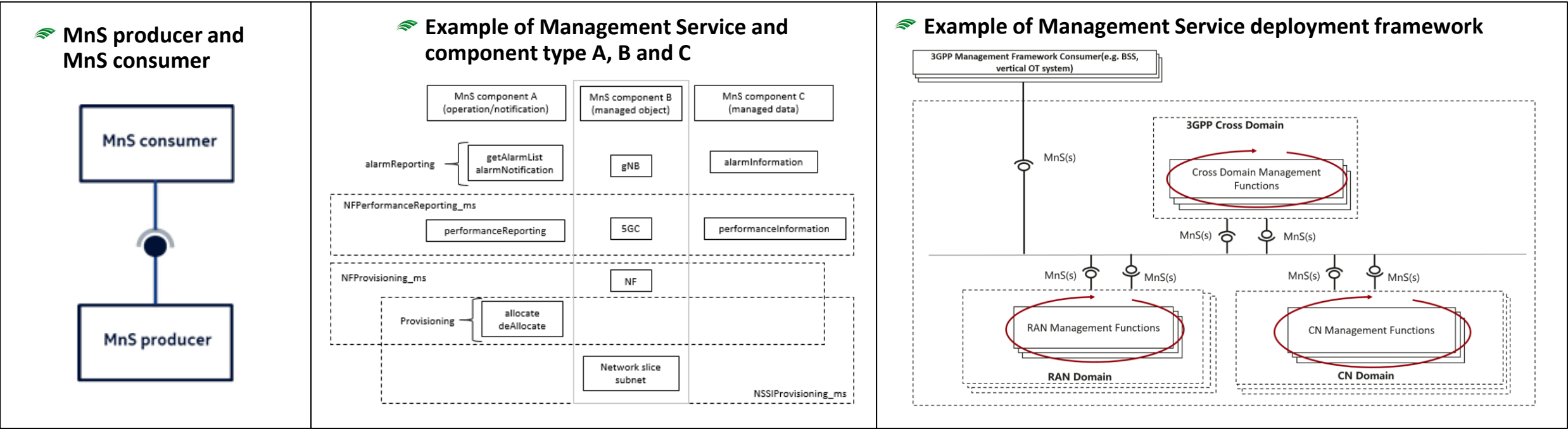
# Service Based Management architecture(TS 28.533)



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The fundamental building block of the Service Based Management Architecture (SBMA) is the Management Service (MnS). A MnS is a set of offered capabilities for management and orchestration of networks and services. An MnS producer offers its services via a standardized service interface composed of individually specified MnS components (i.e. MnS component type A, B,C ).

A Management Function (MnF) is a logical entity playing the roles of MnS consumer and/or MnS producer



# Autonomous network related topics in LTE and 5G



## LTE

- 3GPP SA5 has been engaged in autonomous network relevant topics for LTE network. Self-Organizing Network (SON) for E-UTRAN including SON concepts and requirements, Self-configuration, Automatic neighbour relation (ANR), self-optimization and self-healing were standardized since 3GPP Rel-8 (in 2008).
  - Centralised SON: SON solution where SON algorithms are executed in the OAM system. Centralised SON has two variants:
    - NM-Centralised SON: SON solution where SON algorithms are executed at the Network Management level.
    - EM-Centralised SON: SON solution where SON algorithms are executed at the Element Management level.
  - Distributed SON: SON solution where SON algorithms are executed at the Network Element level.
  - Hybrid SON: SON solution where SON algorithms are executed at two or more of the following levels: NE or EM or NM.

## 5G

- Autonomous Network Level
- Closed loop communication service assurance
- Intent driven management service for mobile networks
- Management Data Analytics Service
- Self-Organizing Networks (SON) for 5G networks
- Network Slicing

# Autonomous Network Level Study - Introduction



- In 3GPP Release 16, 3GPP SA5 has studied on concept, use case, requirements and solutions for levels of autonomous network (Corresponding contents have been captured in TR 28.810).
  - 3GPP TR 28.810: “Study on concept, requirements and solutions for levels of autonomous network”
- In 3GPP Release 17, 3GPP SA5 has started a new work item on normative work for levels of autonomous network (Corresponding contents will be captured in TS 28.100).
  - 3GPP TS 28.100: “Management and orchestration; Levels of autonomous network”

# Autonomous Network Level Study (TR 28.810) - Concepts



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## Concept of network autonomy

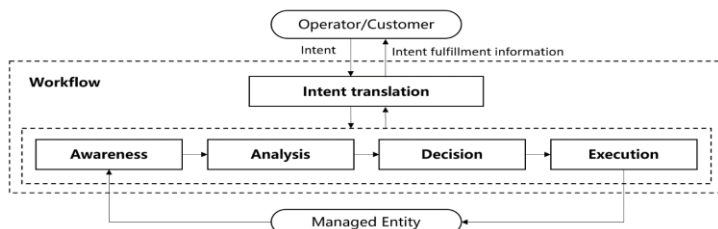
Network autonomy describes the telecom system (including management system and network) capability which is able to be governed by itself with minimal to no human intervention. Some features discussed in 3GPP are related to network autonomy. Following are some examples:

- Self-Organizing Network (SON)
- Management data analytics
- Intent driven management
- Close loop SLS assurance

## Potential dimensions for classification of network autonomy

### Workflow

- **Intent translation:** The group of tasks which translate network or service intent from operator or customer into detailed management operations which may affect one or more of the following groups of tasks (i.e. awareness, analysis, decision, execution) and translate the detailed network and service information to intent fulfillment information (e.g. the intent is satisfied or not)..
- **Awareness:** The group of tasks which monitor network information (including network performance, network anomaly, network event, etc).
- **Analysis:** The group of tasks which analyse the collected information (e.g. information about network status, network issues and so on) or based on the historical data to further predict the future change trend of the above network status, and make recommendation for decision.
- **Decision:** The group of tasks which decide the necessary management operation for execution, e.g. network configuration or adjustment.
- **Execution:** The group of tasks which execute the management operations.



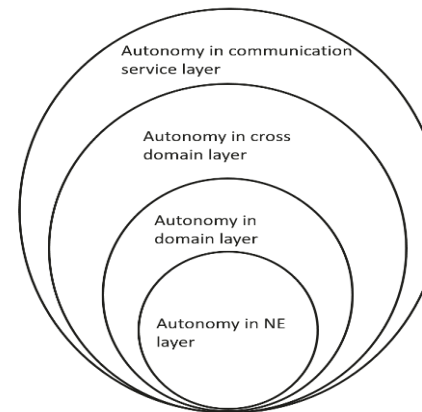
## Concept of network autonomy level

Network autonomy level describes the level of application of autonomy capabilities in the network management workflow. The participation of the human and telecom system in the network management workflow are important factors to evaluate the network autonomy level. For each network autonomy level, which tasks can be performed by telecom system, which tasks can be performed by human, and which tasks can be performed by cooperation of human and telecom system needs to be clarified. For example, in the highest autonomy level, all tasks are performed by telecom system.

### Management scope

Potential scopes of network autonomy:

- Autonomy in NE layer, which means the autonomy mechanism is executed in the NE.
- Autonomy in domain layer, which means the autonomy mechanism is executed in the MnF(s) in domain.
- Autonomy in cross domain layer, which means the autonomy mechanism is executed in the MnF(s) in cross domain.
- Autonomy in communication service layer, how to execute the autonomy mechanism in communication service layer is FFS.



### Scenarios

The network autonomy can be implemented for different scenarios, the complexity of network autonomy depends on the detailed scenarios it applied. Also it will be more challenge for the telecom system to achieve the network autonomy for full scenarios than for certain scenarios. For example, autonomy applicability of network deployment will be more challenge for outdoor combine indoor scenario than only outdoor scenario.

# Autonomous Network Level Study (TR 28.810) - Classification



## Framework approach for classification of autonomous network level

**Level 0 manual operating network:** No categorization of the tasks is accomplished by telecom system itself.

**Level 1 assisted operating network:** A part of the execution and awareness tasks are accomplished automatically by telecom system itself based on human defined rules. At this level, telecom system can assist human to improve the execution and awareness efficiency.

**Level 2 preliminary autonomous network:** All the execution tasks are accomplished automatically by telecom system itself. A part of the awareness and analysis tasks are accomplished automatically by telecom system itself based on human defined policies. At this level, telecom system can assist human to achieve the close loop based on human defined policies.

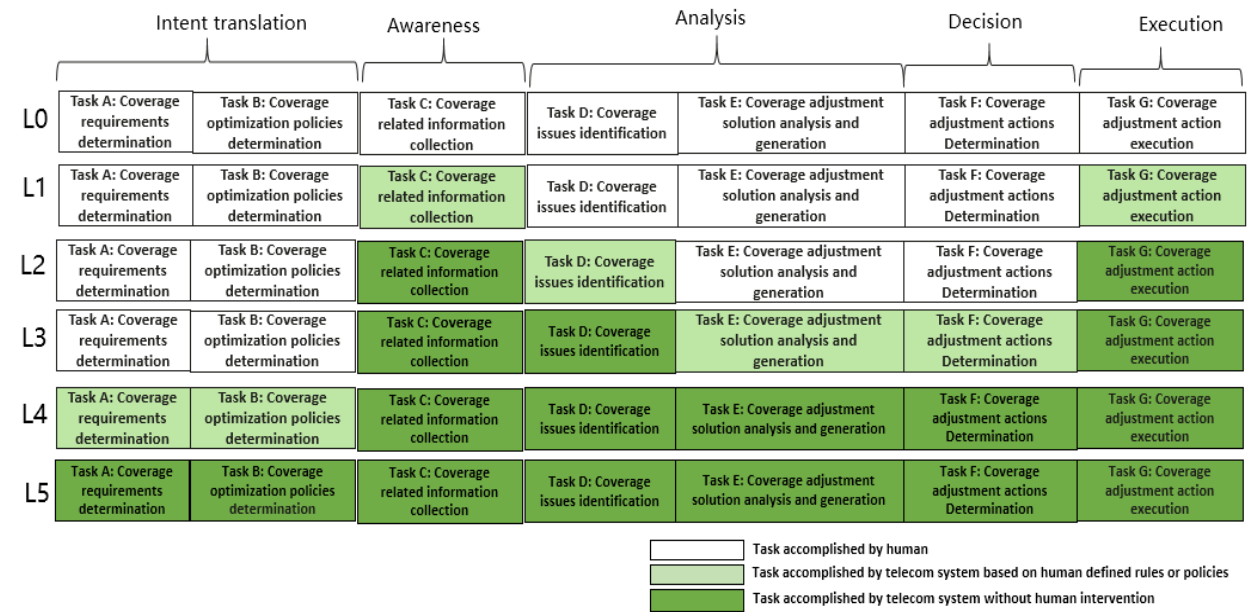
**Level 3 intermediate autonomous network:** All the execution and awareness tasks are accomplished automatically by telecom system itself. A part of the analysis and decision tasks are accomplished automatically by telecom system itself based on human defined policies. At this level, the telecom system can achieve the close loop automation based on the human defined close loop automation policies.

**Level 4 advanced autonomous network:** All the execution, awareness, analysis and decision tasks are accomplished automatically by telecom system itself. And intent translation tasks can be partly accomplished automatically by telecom system itself based on human defined intent translation policies. At this level, telecom system can achieve the intent driven close loop automation based on human defined intent translation policies, which means the telecom system can translate the intent to the detailed close loop automation and translate the detailed network and service information to intent fulfilment information (e.g. the intent is satisfied or not) based on human defined intent translation policies.

**Level 5 fully autonomous network:** The entire network autonomy workflow is accomplished automatically by telecom system without human intervention. At this level, telecom system can achieve the whole network autonomy.

Network autonomy level		Task categories				
		Execution	Awareness	Analysis	Decision	Intent translation
L0	Manual operating network	Human	Human	Human	Human	Human
L1	Assisted operating network	Human & Telecom system	Human & Telecom system	Human	Human	Human
L2	Preliminary autonomous network	Telecom system	Human & Telecom system	Human & Telecom system	Human	Human
L3	Intermediate autonomous network	Telecom system	Telecom system	Human & Telecom system	Human & Telecom system	Human
L4	Advanced autonomous network	Telecom system	Telecom system	Telecom system	Telecom system	Human & Telecom system
L5	Full autonomous network	Telecom system	Telecom system	Telecom system	Telecom system	Telecom system

Note 1: Human reviewed decision have the highest authority in each level if there is any conflict between human reviewed decision and telecom system generated decision.  
 Note 2: The present of above five task categories does not reflect the workflow sequence.



# Autonomous Network Level Workitem (TS 28.100)



**The following definition has been captured:**

- 📶 **Autonomous Network:** telecommunication system (including management system and network) with autonomy capabilities which is able to be governed by itself with minimal to no human intervention.
- 📶 **Autonomous Network Level:** describes the level of autonomy capabilities in the autonomous network.

Note: The content of this slide is under discussion in the draft TS 28.100.

# Closed loop communication service assurance- Introduction

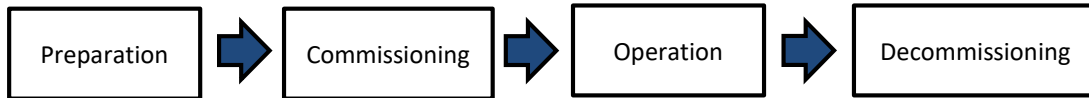


- In 3GPP Release 16, 3GPP SA5 has specified the concept for open control loops and closed control loops, as well as use cases, requirements and a model for closed loop communication service assurance (Corresponding contents have been captured in TS 28.535 and TS 28.536).
- In 3GPP Release 17, 3GPP SA5 has started a new work item on enhanced closed loop SLS assurance.
  - TS 28.535: “Management and orchestration; Management services for communication service assurance; Requirements”
  - TS 28.536: “Management and orchestration; Management services for communication service assurance; Stage 2 and stage 3”

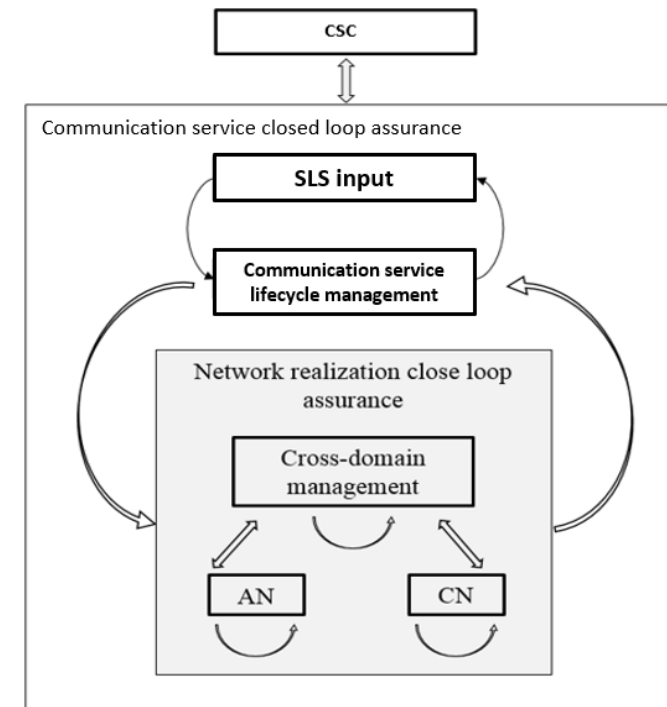


# Closed loop communication service assurance (TS 28.535)

- Communication service assurance applies to different phases in the life of communication services these lifecycle phases are; preparation, commissioning, operation and decommissioning.

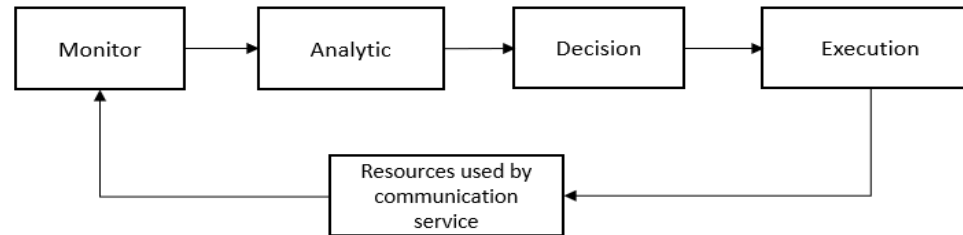


- For communication service assurance one can identify two interactions of management control loops:
  - Between the CSC and the CSP: In this case, the CSC provides the requirements for an assured communication service to the CSP, the CSP provides the corresponding communication service, the CSP also provides feedback to the CSC. The CSP adjusts the resources used by a communication service or the CSC adjusts the SLS continuously to achieve the assured requirements.
  - Between the CSP and the NSP: the communication service provided by CSP requires the network capabilities. For example, the CSP requires a certain network latency. The NSP management system adjusts the network or CSP adjusts the latency requirement continuously to satisfy the latency requirement.

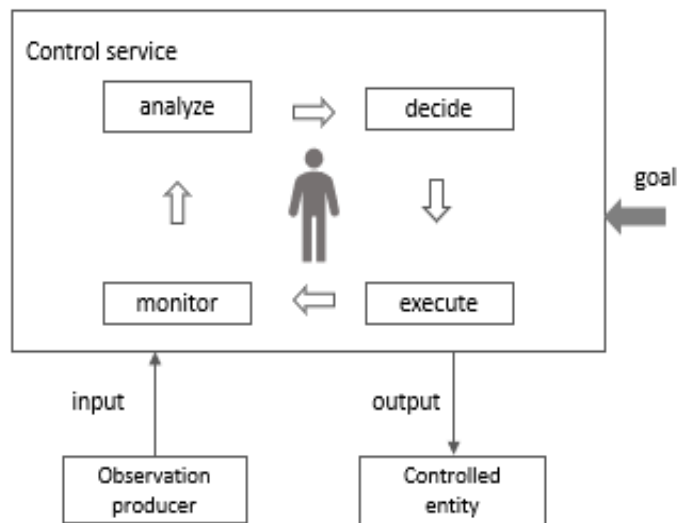


# Closed loop communication service assurance (TS 28.535)

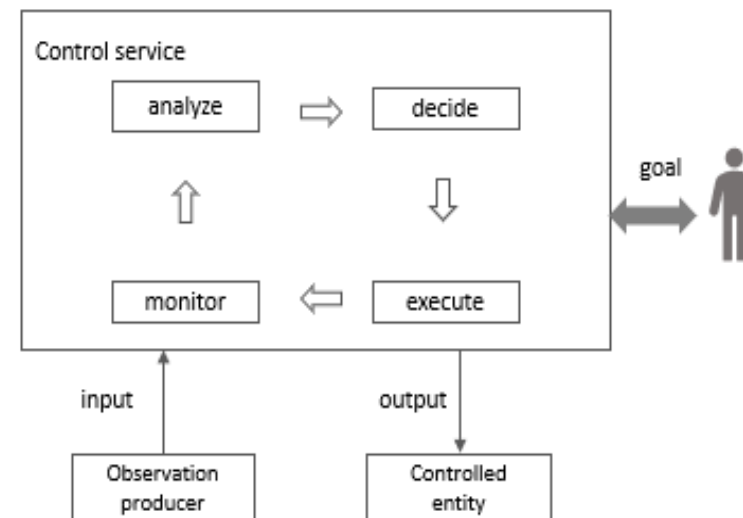
Overall process of communication service assurance using a management control loop



A control loop can be an open control loop in which case a human operator or other management entity intervenes inside the loop. A control loop can be closed and operates without human operator or other management entity involvement inside the loop other than possibly the initial configuration of the measurement producer and configuration of control loop.



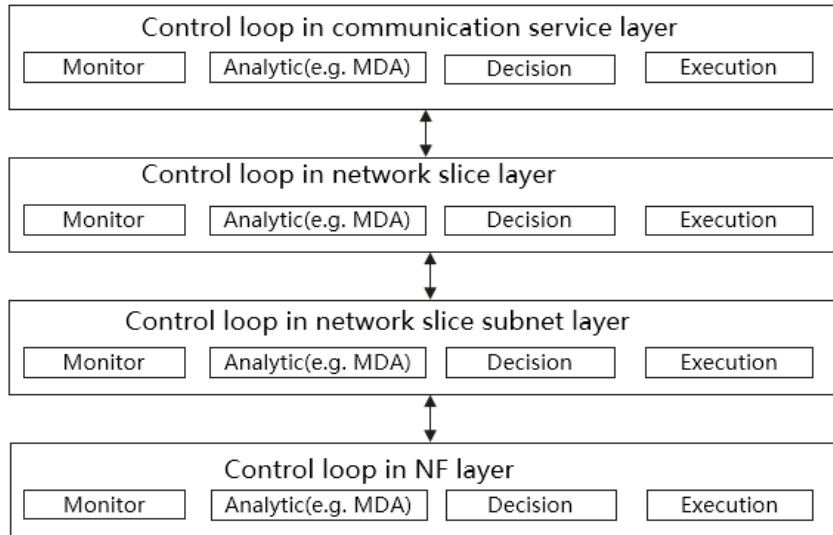
Open control loops



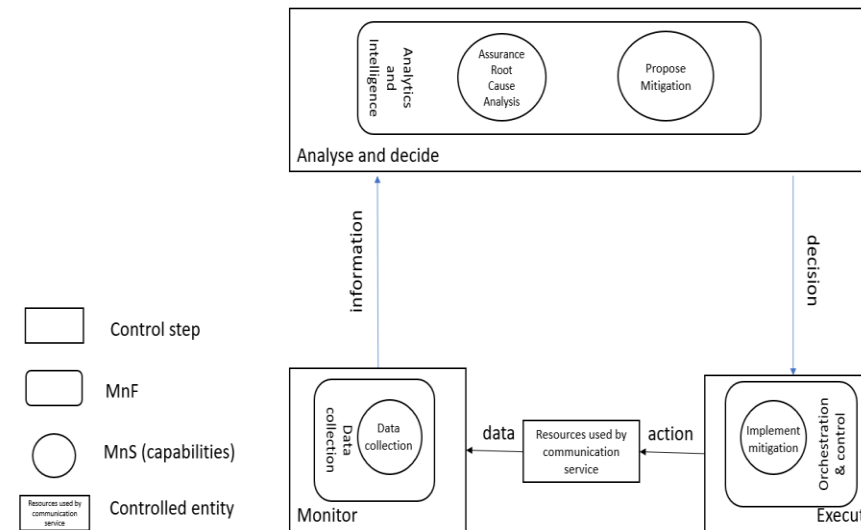
Closed control loops

# Closed loop communication service assurance (TS 28.536)

- Control loop deployed in different layers



- Communication service assurance relies on a set of management services that together provide the CSP with the capability to assure the communication service as per agreement with a CSC (e.g. enterprise).

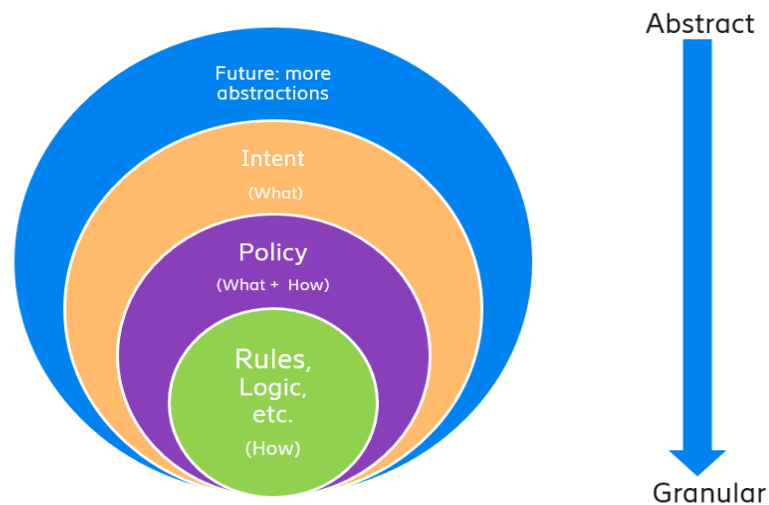


- In 3GPP Release 17, 3GPP SA5 has studied on concept, scenarios and solutions for intent driven management, which enable to simplify the management interfaces (Corresponding contents have been captured in TR 28.812). And the normative work for intent driven management has been started in 3GPP SA5 (Corresponding contents will be captured in TS 28.312).
  - 3GPP TR 28.812: “Telecommunication management; Study on scenarios for Intent driven management services for mobile networks”
  - 3GPP TS 28.312: ” Management and orchestration; Intent driven management services for mobile networks”

# Intent driven management for mobile networks Study (TR 28.812) - Concepts

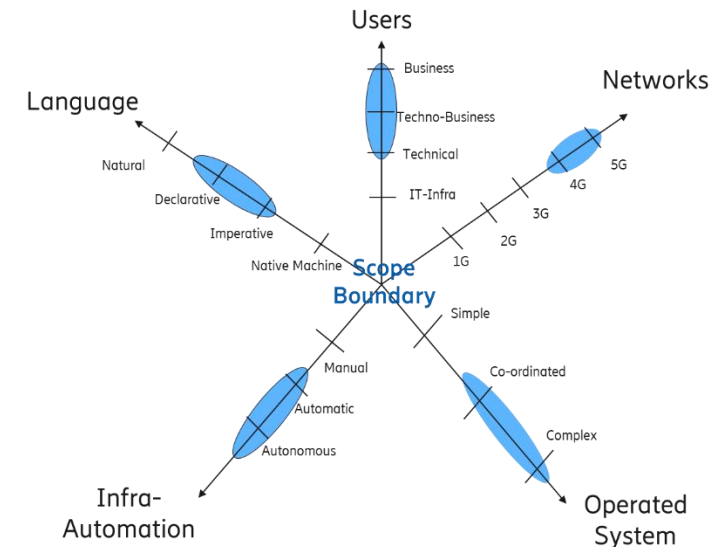
## Intent driven management vs policy driven management

- A policy is a function that governs the choices in behaviour of a system. It specifies the action(s) to be taken when specified condition(s) occur. More focus on “How” and less on “What” covering domain specific issues/aspects.
- An intent defines to what position (in what state) we want as specific entity to be. More focus on “What”.



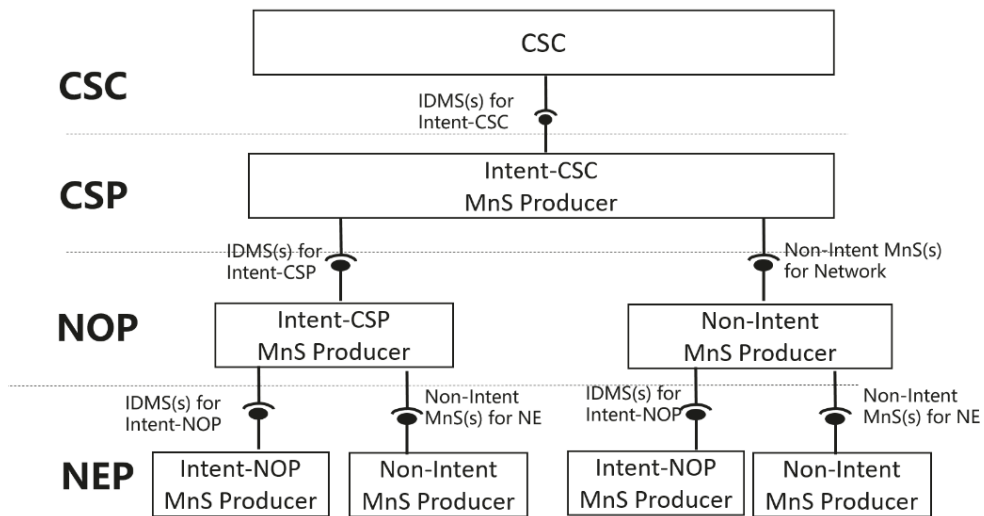
## Dimensions of intent driven framework

- Users
- Network
- Operated system
- Language
- Infra-Automation



# Intent driven management for mobile networks Study (TR 28.812) - Scenarios

## Potential way to satisfy intent-CSC



## Intent driven management scenarios

- ▲ 5 Scenarios for Intent driven management services for mobile network
  - ▲ 5.1 Scenarios related to Intent-CSC
    - ▷ 5.1.1 Service deployment
    - ▷ 5.1.2 Intent driven service creation
    - ▷ 5.1.3 Intent driven Communication Service deployment at the edge
  - ▲ 5.2 Scenarios related to Intent-CSP
    - ▷ 5.2.1 Network provisioning
    - ▷ 5.2.2 NSI resource utilization optimization
    - ▷ 5.2.3 Intent driven NSI resource capacity planning scenario
    - ▷ 5.2.4 Intent driven NSI performance assurance scenario
  - ▲ 5.3 Scenarios related to Intent-NOP
    - ▷ 5.3.1 Cell Re-home
    - ▷ 5.3.2 Area load balance
    - ▷ 5.3.3 Instant Cell Updating
    - ▷ 5.3.4 Instant Cell Deletion
    - ▷ 5.3.5 Intent driven network optimization scenario
    - ▷ 5.3.6 Capacity Management
    - ▷ 5.3.7 Intent driven NF deployment
    - ▷ 5.3.8 Intent driven NF capacity changing
    - ▷ 5.3.9 Intent driven management for area based deployment scenario
    - ▷ 5.3.10 Intent driven coverage optimization scenario

# Intent driven management for mobile networks (TS 28.312)



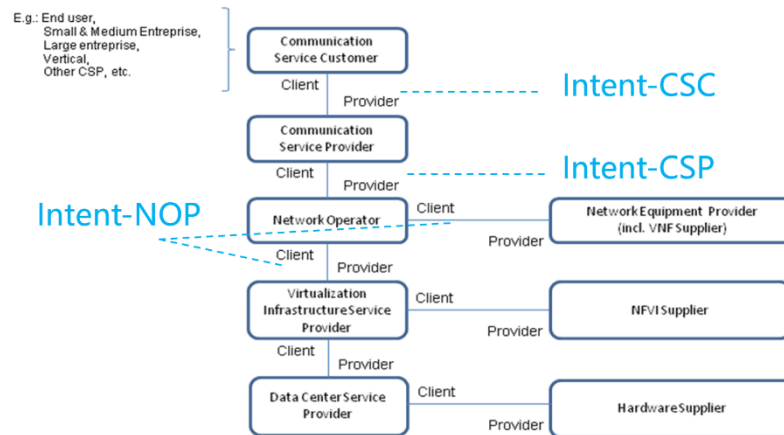
🌿 **Intent Definition:** A desire to reach a certain state for a specific service or network management workflow.

## 🌿 Intent categorizes based on user types

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

## 🌿 Intent categorizes based on management scenario types

- 🌿 Intent for network and service design/planning
- 🌿 Intent for network and service deployment
- 🌿 Intent for network and service maintenance
- 🌿 Intent for network and service optimization/assurance



Note: The content of this slide is under discussion in the draft TS 28.312.

# Management Data Analytics Service - Introduction



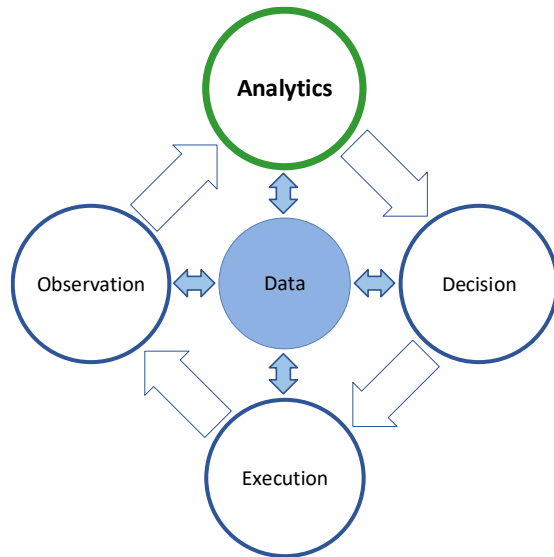
- 📶 In 3GPP Release 17, 3GPP SA5 has started the study on concept, use case, requirements and solutions for Management Data Analytics Service, which is in conjunction with AI and ML techniques, brings intelligence and automation to the network service management and orchestration (Corresponding contents will be captured in TR 28.809) .
  - 📶 3GPP TR 28.809: “Study on enhancement of management data analytics”




# Management Data Analytics Service Study (TR 28.809)

## MDA role in management loop

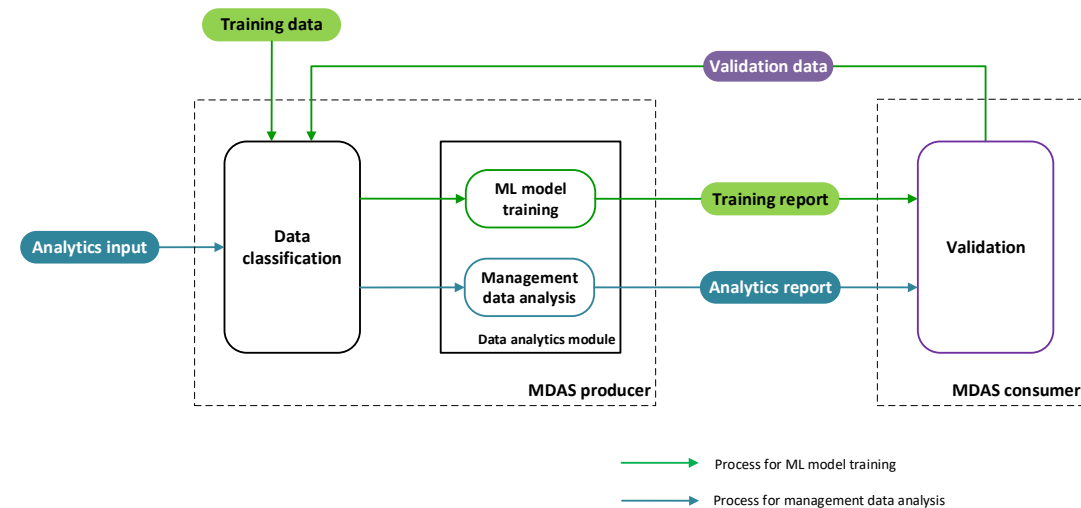
- The MDA forms a part of the management loop (which can be open loop or closed loop, see TS 32.500 [10]), and it brings intelligence and generates value by processing and analysis of management and network data, where the AI and ML techniques may be utilized.



 In scope of the present document

## MDA process

- There are two kinds of processes for MDA, the process for ML model training and the process for management data analysis.



Note: The content of this slide is under discussion in the draft TR 28.809.

## MDA Use case

### ▲ 6.1 Coverage related issues

- ▷ 6.1.1 Coverage issue analysis

### ▲ 6.2 Resource related issues

- ▷ 6.2.1 RAN user plane congestion analysis
- ▷ 6.2.2 Resource utilization analysis
- ▷ 6.2.3 Cross-slice resource optimization
- ▷ 6.2.4 NAS level congestion control optimization

### ▲ 6.3 SLS assurance related issues

- ▷ 6.3.1 E2E latency analysis
- ▷ 6.3.2 Network slice load analysis
- ▷ 6.3.3 Service experience related analysis
- ▷ 6.3.4 Network slice throughput analysis
- ▷ 6.3.5 Uplink/downlink throughput per UE in network slice analysis
- ▷ 6.3.6 KPI anomaly analysis
- ▷ 6.3.7 Jitter analysis

### ▲ 6.4 Fault management related issues

- ▷ 6.4.1 Alarm incident analysis

### ▲ 6.5 Mobility management related issues

- ▷ 6.5.1 Handover optimization
- ▷ 6.5.2 Inter-gNB Beam Selection Optimization

### ▲ 6.6 Energy efficiency related issues

- ▷ 6.6.1 MDA assisted energy saving

### ▲ 6.7 Paging performance related issues

- ▷ 6.7.1 Paging optimization

### ▲ 6.8 Software management related issues

- ▷ 6.8.1 RAN Node Software Upgrade

### ▲ 6.9 MDA assisted SON coordination

- ▷ 6.9.1 SON conflict prevention and resolution

### ▲ 6.99 MDA management aspects

- ▷ 6.99.1 ML model training for MDA

Note: The content of this slide is under discussion in the draft TR 28.809.

# SON for 5G networks - Introduction

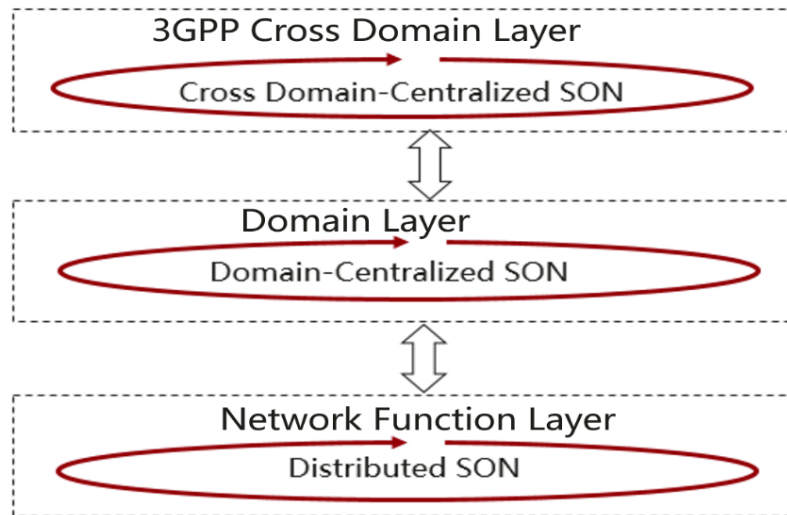


- In 3GPP Release 16, 3GPP SA5 has specified the concepts, use cases, requirements and solutions for 5G SON, including ANR management, PCI configuration, RACH optimization, MRO and Energy Saving (Corresponding contents have been captured in TS 28.313 and TS 28.541). In 3GPP Release 17, 3GPP SA5 has started new work item(s) to continue specify the use cases, requirements and solutions for the 5G SON, including, Self-establishment of 3GPP NF, Centralized Capacity and Coverage Optimization, Load Balancing Optimization, NSI resource allocation optimization, MRO enhancement and Handover Optimization enhancement.
  - 3GPP TS 28.313: “Self-Organizing Networks (SON) for 5G networks”
  - 3GPP TS 28.541: ” Management and orchestration; 5G Network Resource Model (NRM); Stage 2 and stage 3”

Figure 4.1.1-1 Overview of SON Framework

# SON for 5G networks(TS 28.313)

## Overview of SON Framework



## SON Use case

### 6.4 Use cases

#### 6.4.1 Distributed SON management

6.4.1.1 RACH Optimization (Random Access Optimisation)

6.4.1.2 MRO (Mobility Robustness Optimisation)

▷ 6.4.1.3 ANR management

▷ 6.4.1.4 PCI configuration

#### 6.4.2 Centralized SON

##### 6.4.2.1 PCI configuration

6.4.2.1.1 Initial PCI configuration

6.4.2.1.2 PCI re-configuration

##### 6.4.2.2 Use case for establishment of a new RAN NE in network

6.4.2.2.1 Use case for RAN NE plug and connect to management system

6.4.2.2.2 Use case for self-configuration of a new RAN NE

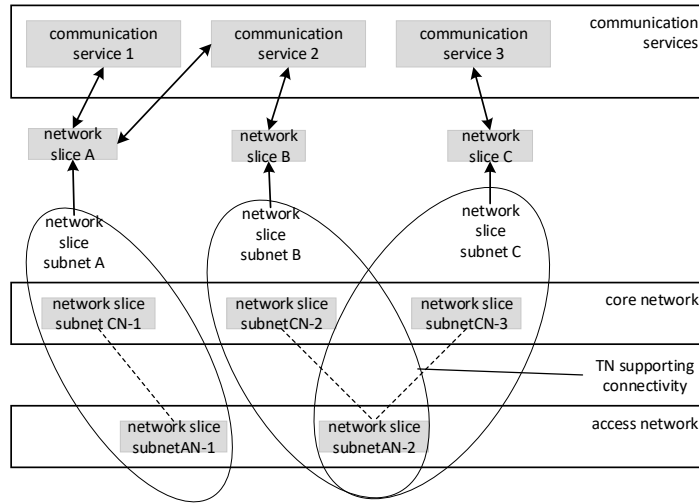
# Network Slicing - Introduction



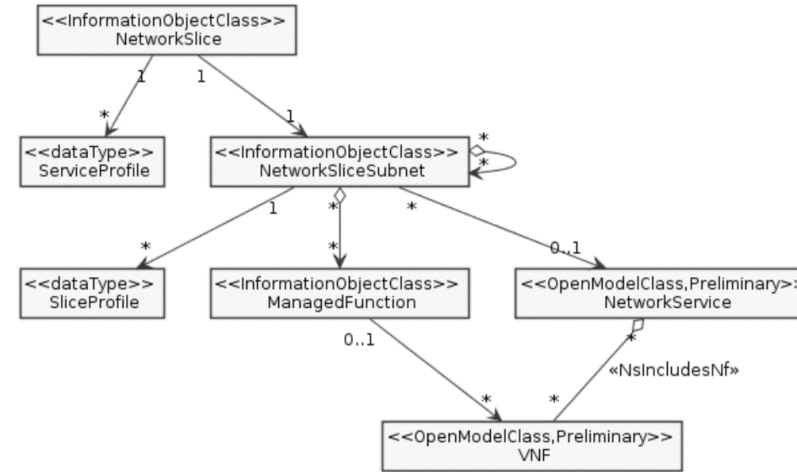
- 3GPP SA5 has worked on the network slicing topics from Release 15. In Release 16, the SLA parameters related to network slicing have been documented as Service Profile in TS 28.541. SA5 just started a Rel-17 network slice management enhancement study and 5G SLA enhancement work item.
  - TS 28.530: “Management and orchestration; Concepts, use cases and requirements”
  - TS 28.531: “Management and orchestration; Provisioning”
  - TS 28.541: “Management and orchestration; 5G Network Resource Model (NRM); Stage 2 and stage 3”
  - TS 28.545: ” Management and orchestration; Fault Supervision (FS)”
  - TS 28.550: “Management and orchestration; Performance assurance”

# Network Slicing (TS 28.530 & 28.541)

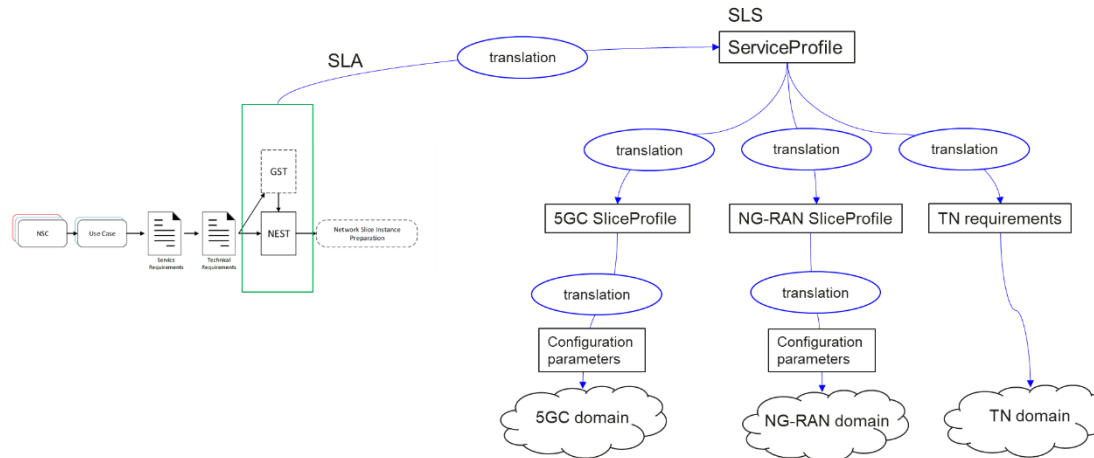
## Communication services using network slices



## Network Slicing NRM



## Relation between GSMA GST, ServiceProfile and SliceProfile



# Conclusion



- 3GPP is an industry driven standardization activity with truly global reach.
- Standardization of interfaces enables an interoperable, multi-vendor approach to deployment and generates mass market economies of scale.
- 3GPP SA5 has built up experience related to autonomous networks since 2008.
- 3GPP SA5 has already made some progress on autonomous networks and continues to deliver more features to support autonomous networks.
- 3GPP SA5 is actively involved and developing specifications with full support of automation.
- 3GPP SA5 is happy to cooperate with other SDOs on autonomous networks.

# Thank you!



For more Information:



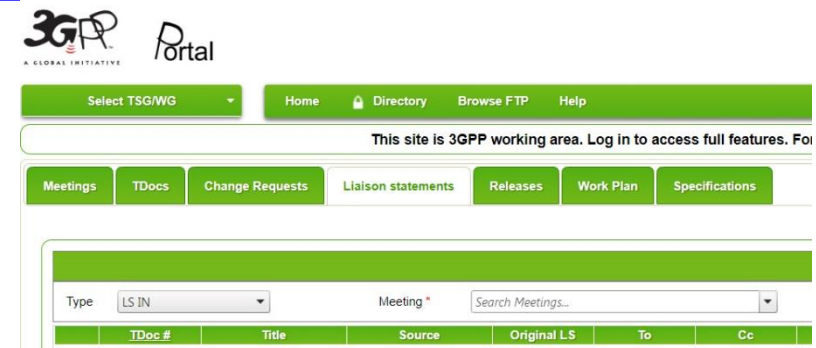
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