White Paper V4.0

A European View on 5G Architecture and Beyond

Chapter 5- Automated Management & Orchestration Architecture

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Ch5 Automated Management & Orchestration (MANO) Architecture

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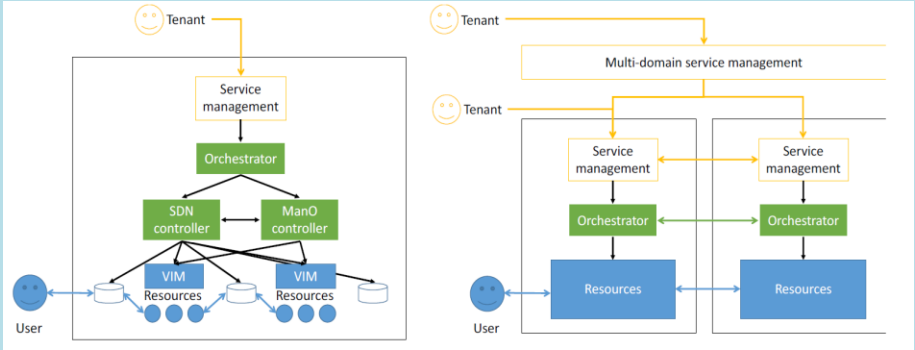
Presenting an overview of **Architecture Extensions** and **New Concepts for the Evolution of MANO Architecture for 5G and beyond networks**, leveraging on the design of previous 5GPPP Architecture white paper (Version 3.0)



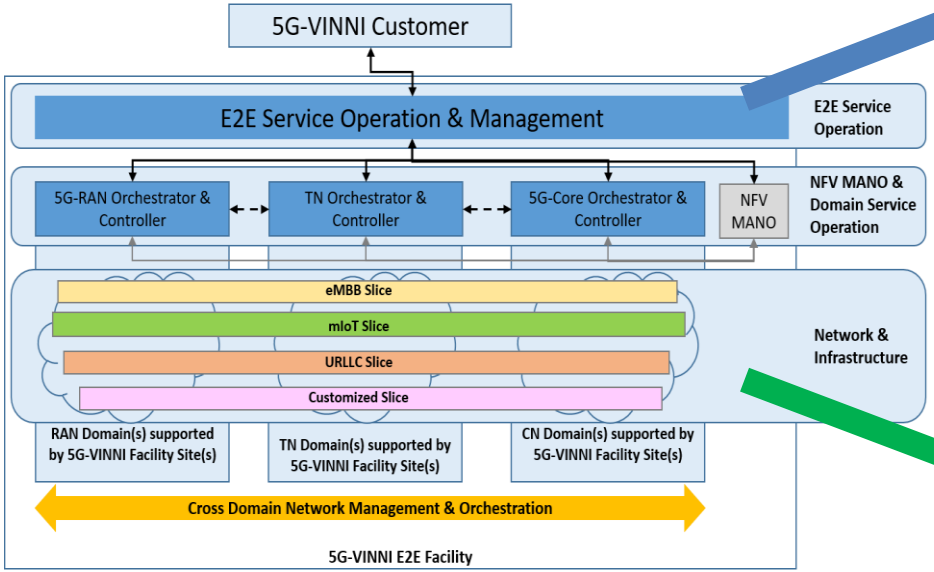
5GPPP consensus MANO architecture defined in the previous 5GPPP Arch white paper version 3.0

Architecture Extensions in Version 4.0

- Enhanced Slice Management
- Service and Network Automation adopting closed-loop design and AI integration
- Cloudification for 5G
- Enhanced monitoring and data management framework
- Evolution of MANO arch design towards (micro-)service based management concepts

Enhanced Slice Management

- Automated Slice Ordering & Lifecycle Management



Slice Ordering

1) Offer a set of pre-existing Slice types
2) Allow design of new slice templates that can be service specific or customized
3) Offer differing levels of 'capability exposure', enabling vertical experiments to be integrated to differing levels

Lifecycle Management

- Preparation phase to generate a suitable Service Blueprint
- Commissioning phase where a network slice instance is deployed
- Operation phase where is Network slice is in use
- Decommissioning phase where the network slice instance is withdrawn from service

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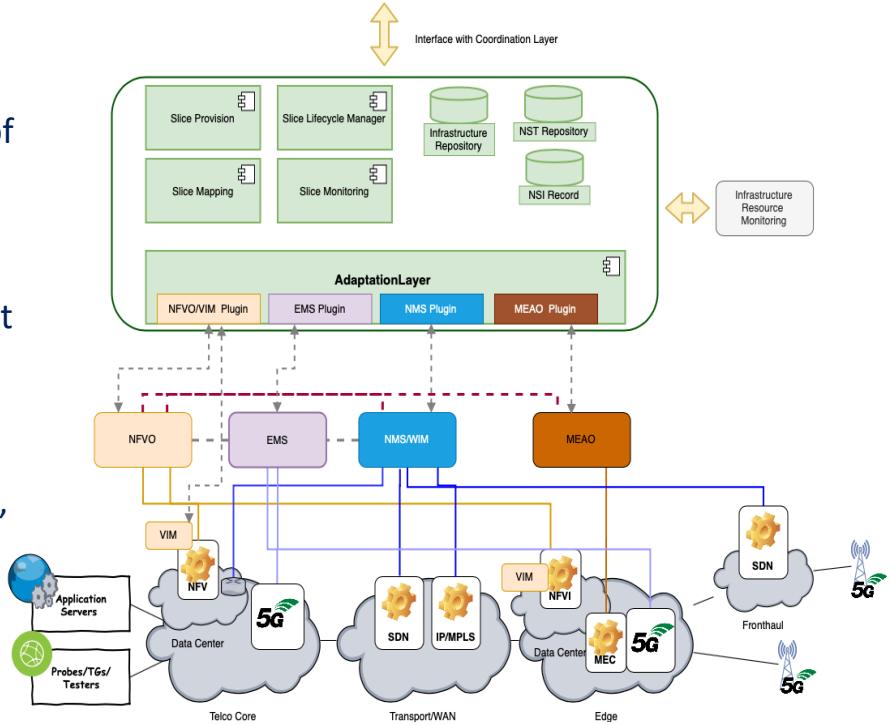
Enhanced Slice Management

- Modular Architecture
  - Slice Manager coordinates network resources of the virtualised functions and services, managing the lifecycle of multiple virtual networks on top of a common infrastructure.
  - The design of Slice Manager is based on a highly modular architecture, built as a collection of micro-services (running on docker containers).
  - This way offers great simplicity in building and maintaining applications, allows flexibility and scalability, while containerized approach makes applications independent of underlying system.

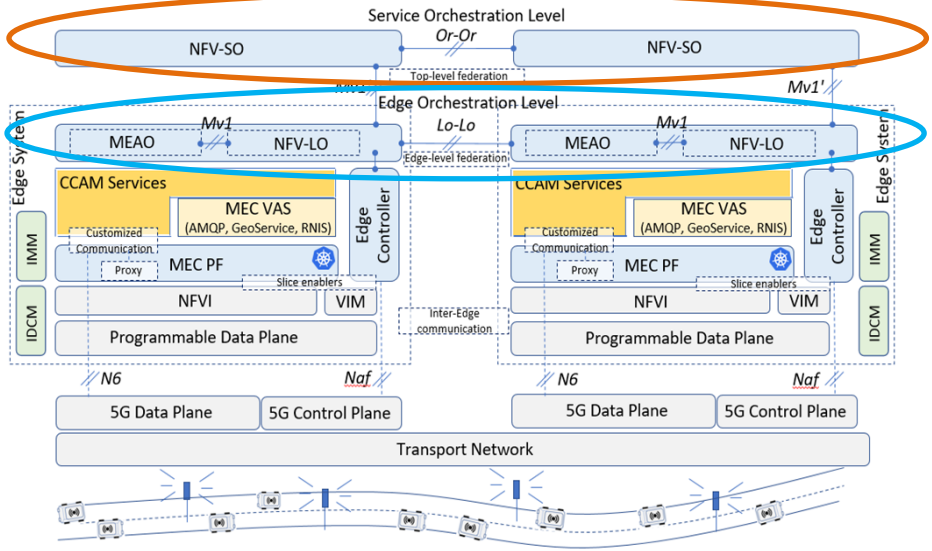
Slice Manager Architecture



Enhanced Slice Management

- Orchestration hierarchy
  - Hierarchical and distributed edge orchestration architecture design offers management and orchestration of decentralized services (e.g. automotive) running at the network edges.
  - 5G edge network orchestration platform offers two tiers of orchestration/federation over multiple reference points.
    - Service level between NFV Service Orchestrator (NFV-SO)
    - Edge level between NFV Local Orchestrator (NFV-LO)

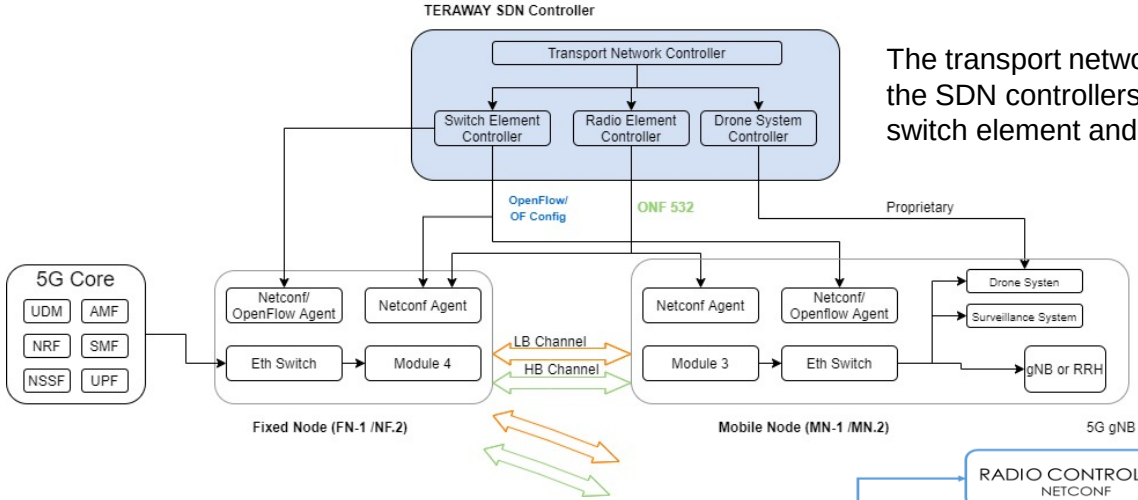
5G Edge Orchestration System



Enhanced Slice Management

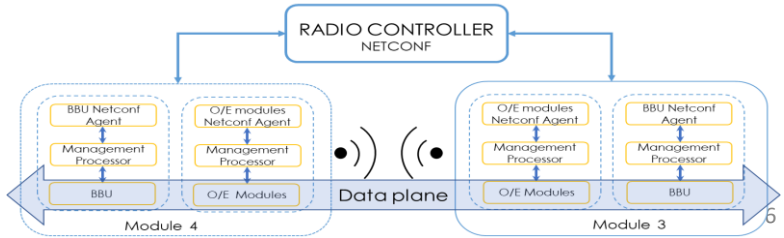
Integration of transport networks

- To include SDN enablers for integrating network services and resources
- To integrate transport and radio management for THz fronthaul links



The transport network controller includes the SDN controllers for managing fixed switch element and the THz radio element

The Transport controller will utilize Netconf using ONF532 data model for managing the radio module 3 and 4 to establish the THz link.



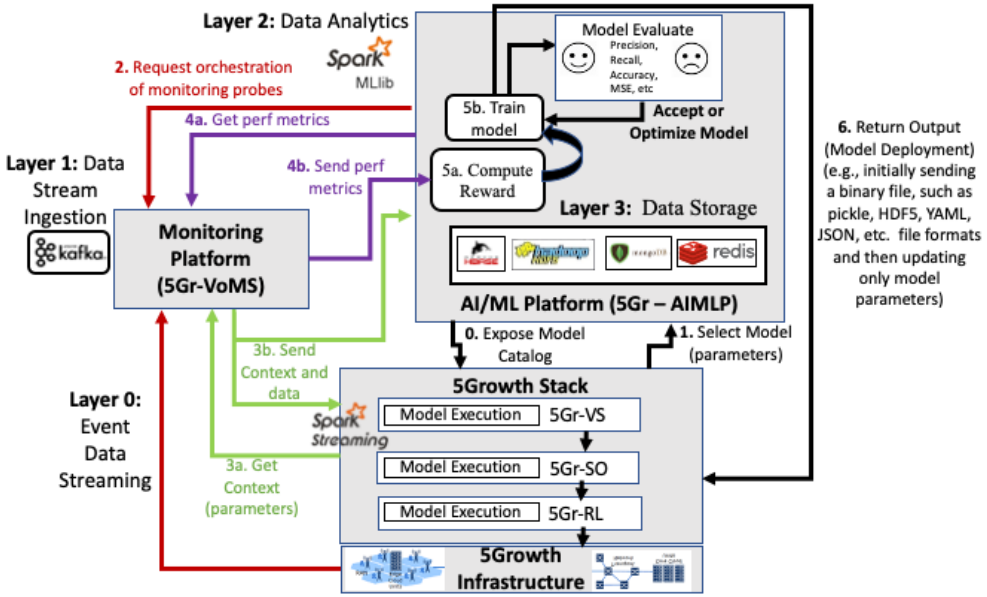
Service and Network Automation

- Closed-loop architecture design (aligned with ETSI ZSM closed-loop automation framework)

1) Collecting monitoring data from services and networks

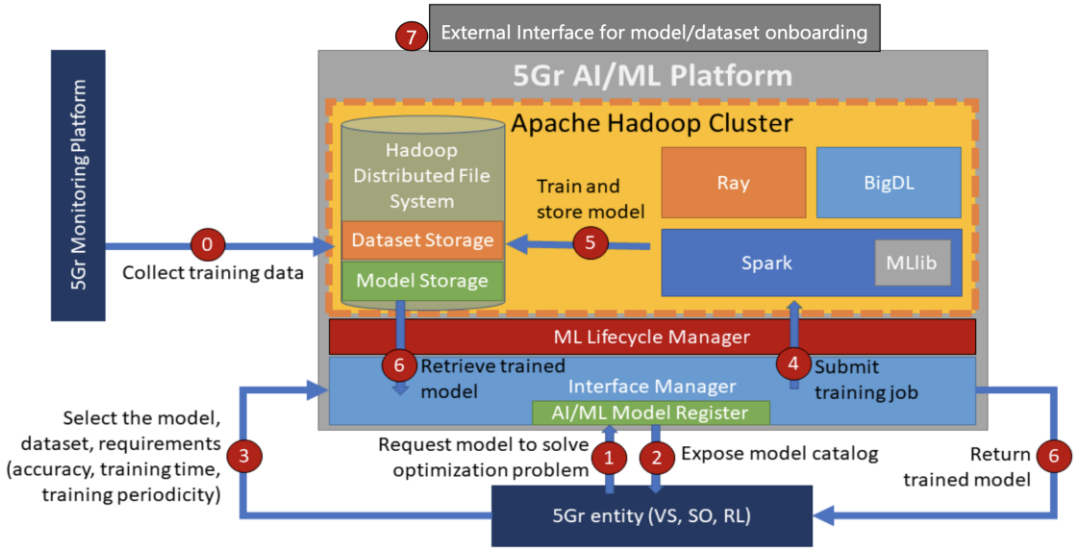
2) Performing real-time data analytics for identifying events to handle

3) Making orchestration decisions for optimization and reconfiguration of the system



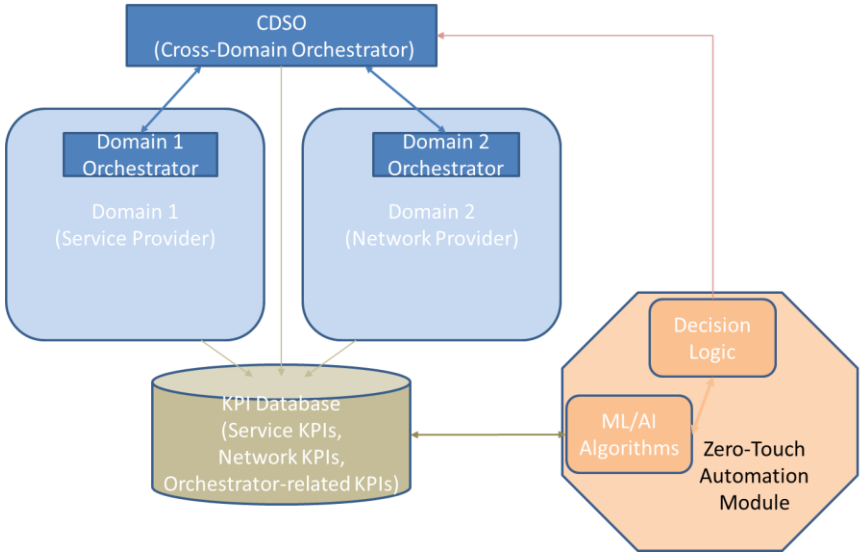
Service and Network Automation

- **AIML Integration**: Integration of an AI/ML platform (AIMLP) with the MANO stack to enable the need of using AI/ML models for fully automated service management, network orchestration, and resource control.
- AIMLP is a centralized and optimized environment for efficient training, storage, and serving of AI/ML models, **providing AI/ML as a Service (AIMLaaS)**



Service and Network Automation

- ML-based SLA assurance through flexible orchestration
  - ML methods such as cross-domain correlations and KPI prediction form the learning basis of the data analysis.
  - These ML methods are incorporated into a Zero Touch Automation block, which in turn can send recommendations to the cross-domain orchestrator.



ML methods (e.g., Pearson, Kendall) are used to predict correlations, which can give indications on which network KPIs will influence service KPIs related to the SLAs, or can indicate undesired changes between the two domains in the case when the correlation changes over time.

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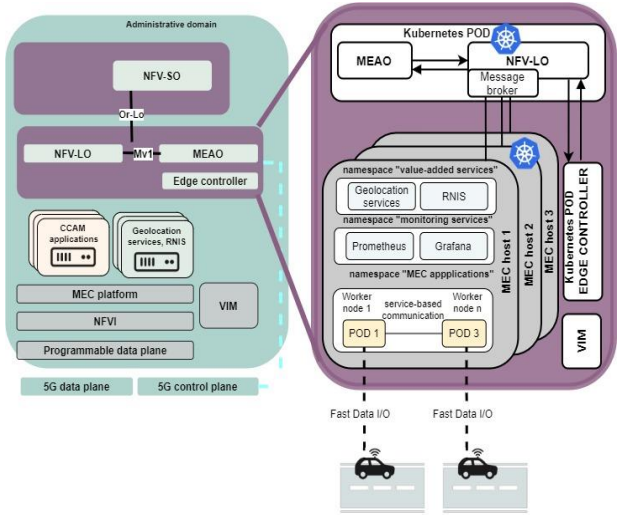
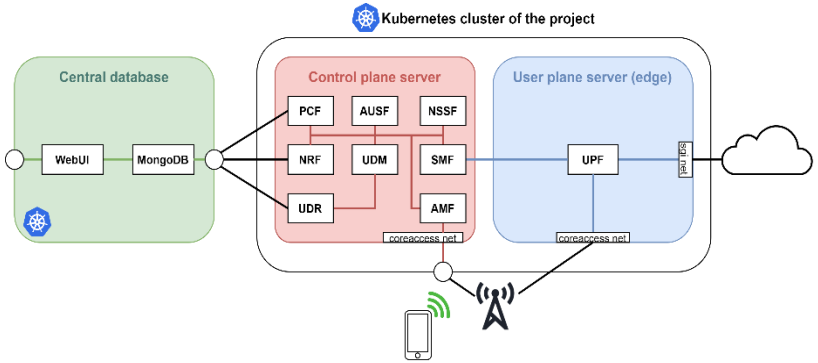
Cloudification for 5G

- VNF orchestration is being enhanced by the use of Cloud-based Network Functions (CNF) often implemented using Containers.
- There is a potential need for a dual mode NFVI, to enable VNF and CNF orchestration to co-exist, which raises new challenges for MANO to offer Container Management and Orchestration.

Exp1: Containerized edge approach on ETSI MEC

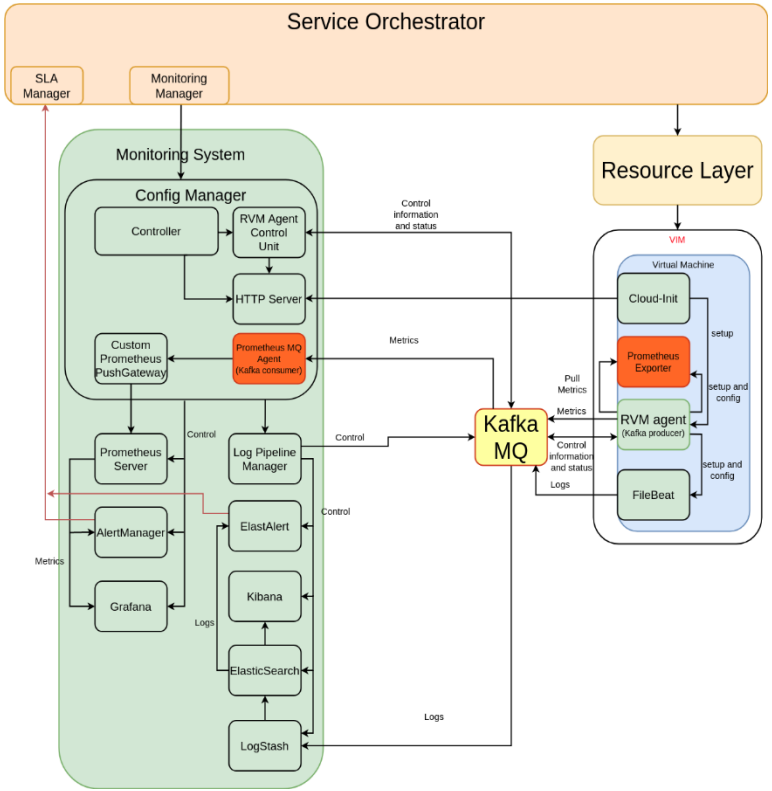


Exp2: Containerized core network approach



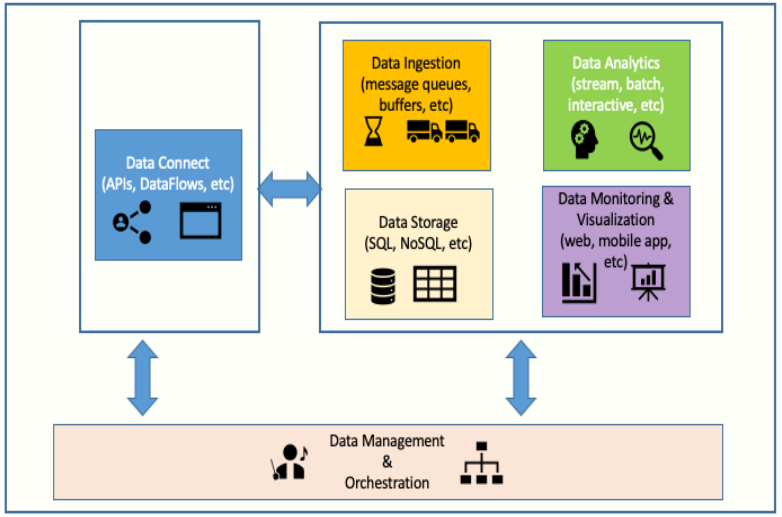
Monitoring and Data Management

- Vertical oriented monitoring
  - Integration of a Vertical-oriented Monitoring System (VoMS) with MANO stack enables monitoring of the performance of services.
  - Functionalities of VoMS:
    - Measuring service/network KPIs
    - Collecting VNF logs and metrics
    - Holding, tracking and providing metrics and logs to other orchestration components



Data Aggregation

- Data Engineering Platform
  - Enable data-driven techniques (analytics, AI, etc.) as new ways of deriving further insights from behavioural data and improving network management and orchestration, and towards increasing network self-awareness.
  - Data sources may present different means to access data of different formats, time constraints, and transported via a great variety of mechanisms, entailing different access control, confidentiality, and integrity methods.
  - ETSI ISG CIM (Context Information Management) defines a basic framework to collect different data sources and exchange of data/metadata across systems.



Data engineering platform

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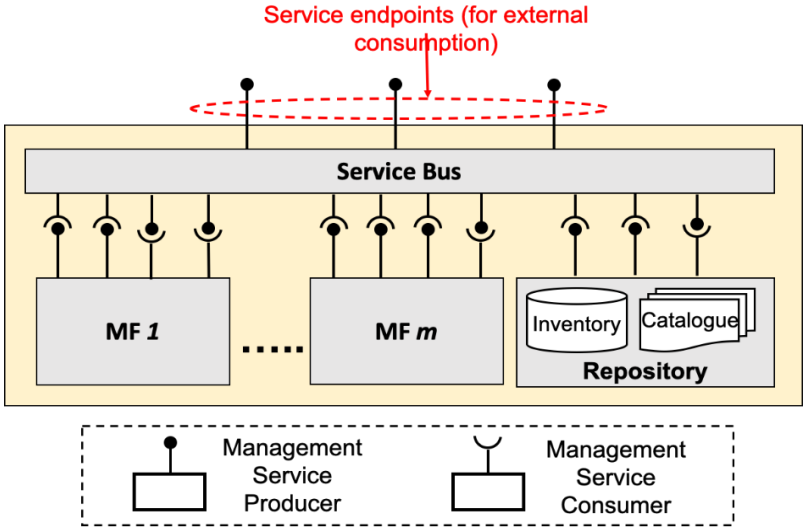
Evolution of MANO Design

- Service Based Management Architecture (SBMA)
  - It is an **emerging evolution of the MANO architecture design** that allows migrating from function blocks to management services exposing APIs based on web-based technology.
  - This change of paradigm **facilitates a rapid evolution of management and orchestration capabilities** in compliance with the innovation of the underlying network, by simply adding or updating APIs using libraries and other enablers, and hence **empowers service innovation with minimal integration effort**.
  - **Various SDOs have already captured the benefits of having a SBMA** in their architecture specifications, e.g., 3GPP SA5, ETSI ZSM, NFV start migrating towards SBMA



- **One or more Management Functions (MFs):** A MF is a management entity playing the roles of management service producer and/or management service consumer.
- **One repository**, which is a data-store that provides a single integrated catalogue and inventory for the entire SBMA
- The **service bus,** which allows interoperation and communication between the MFs taking part in the SBMA, including their interaction with the repository.

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Conclusion and Outlook

- The MANO architecture extensions aim to **enhance the network and service automation** though **enhanced network slice ordering, deployment and management E2E**.
- **AI provides an important means to assist this mission** to enable fully automated service management, network orchestration, and resource control, towards "**zero touch**".
- **In total 15 5G-PPP projects provided significant contributions** in various architecture design concepts and MANO extensions for 5G systems, providing a ground foundation for the architecture of 6G.
- **Further work and more collaborative research across 5GPPP projects are needed to** increase the consensus and promote TRL level of proposed solutions to **make these arch design concepts commercial realities**.

The 5G Infrastructure Public-Private Partnership

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