Enabling autonomous management in NFV-MANO

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For: **ETSI perspective day in Layer123**

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Why NFV needs to support autonomous management

- Automation is a key aspect for digital transformation expected for 5G and beyond and aims to make networks more autonomous, requiring minimum to no human intervention

- As one of key 5G enabling technology, NFV supports this transformation by effectively collecting and applying NFV domain-specific data, digitizing cloud infrastructure and improving the efficiency of NS/VNF operations and maintenance.

- Unprecedented operational agility and efficiency requirements bring the need for higher degree of automation and network autonomy impacts, not only for Network Services but also down to their components (e.g., VNFs, VLs).

- ETSI NFV embraces automation features offered by the cloud native ecosystem, such as Google® Kubernetes® (HPA, VPA, etc).

- Basic automation functions (e.g., policy driven management and orchestration) are available in NFV-MANO but are not sufficient for agility and intelligence.

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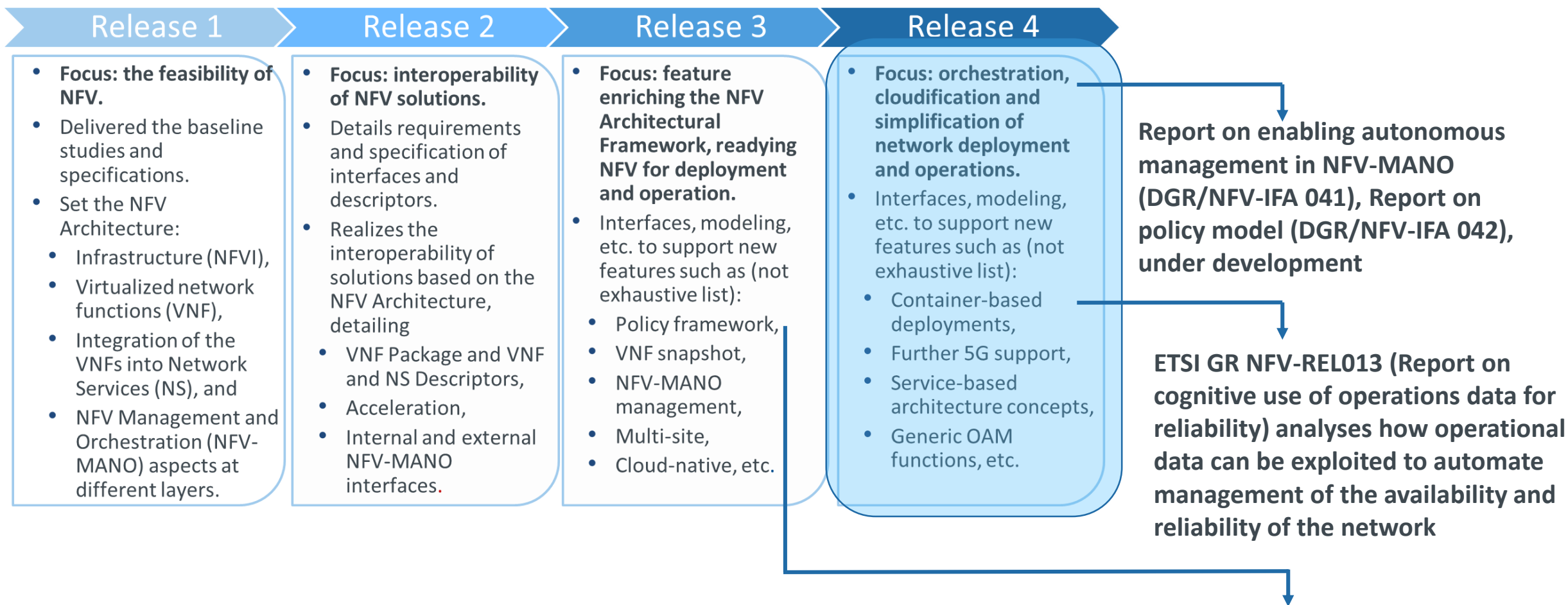(Huawei Tech, ETSI NFV-IFA WG Chairman)

Current automation mechanisms in NFV-MANO

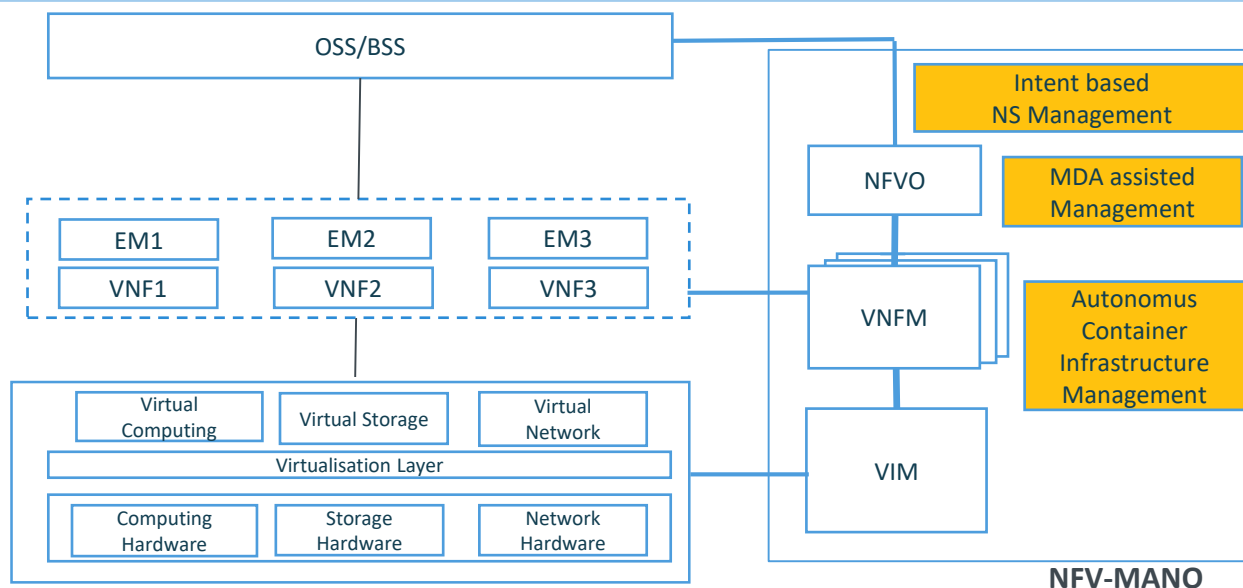NFV-MANO can make automated decisions based on

- Pre-defined lifecycle management scripts and/or auto-scaling/auto-healing rules included in, or called from, NFV descriptors (NSD, VNFD) and triggered on the occurrence of an event (e.g., an alarm, a performance threshold crossing indication, a lifecycle management event, etc.)

- Policy rules obtained through a Policy Management API (ETSI GS NFV-SOL 012)
  - ◊ Within the Release 4 timeframe, work has been started on policy modelling, with the aim to specify a policy information model and a data model to be used along with the Policy Management API.

> NFV-MANO specifications already enable "Level 3 intermediate autonomous network" according to 3GPP's classification of autonomous network level (TS 28.810)

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ETSI NFV Releases – AN related work

Release 1
- **Focus: the feasibility of NFV.**
- Delivered the baseline studies and specifications.
- Set the NFV Architecture:
  - Infrastructure (NFVI),
  - Virtualized network functions (VNF),
  - Integration of the VNFs into Network Services (NS), and
  - NFV Management and Orchestration (NFV-MANO) aspects at different layers.

Release 2
- **Focus: interoperability of NFV solutions.**
- Details requirements and specification of interfaces and descriptors.
- Realizes the interoperability of solutions based on the NFV Architecture, detailing
  - VNF Package and VNF and NS Descriptors,
  - Acceleration,
  - Internal and external NFV-MANO interfaces.

Release 3
- **Focus: feature enriching the NFV Architectural Framework, readying NFV for deployment and operation.**
- Interfaces, modeling, etc. to support new features such as (not exhaustive list):
  - Policy framework,
  - VNF snapshot,
  - NFV-MANO management,
  - Multi-site,
  - Cloud-native, etc.

Release 4
- Focus: orchestration, cloudification and simplification of network deployment and operations.
- Interfaces, modeling, etc. to support new features such as (not exhaustive list):
  - Container-based deployments,
  - Further 5G support,
  - Service-based architecture concepts,
  - Generic OAM functions, etc.

Report on enabling autonomous management in NFV-MANO (DGR/NFV-IFA 041), Report on policy model (DGR/NFV-IFA 042), under development

ETSI GR NFV-REL013 (Report on cognitive use of operations data for reliability) analyses how operational data can be exploited to automate management of the availability and reliability of the network

Policy management APIs, specified in ETSI GS NFV-SOL 012

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Enable autonomous management in NFV-MANO

Autonomous Networks (AN) areas studied in ETSI GR NFV-IFA 041:
- Intent-based management for Network Services
- Management Data Analytics (MDA) assisted management
- Autonomous container infrastructure management
- Enablement to participate in hierarchical closed loop automation within OSS

Close coordination with AN related work done in other SDOs such as TMF, ETSI ISG ZSM, ETSI ISG ENI and 3GPP SA5.

AN areas analyzed in the ETSI GR NFV-IFA041 study address:
- **Simplified interactions, separation of concerns**
  - using intents as information model
  - requests for analytics reports on NFV-MANO data

- **Fast response to changes via automated actions and decision making**
  - Use of management data analytics
  - NFV-MANO ML model training for NSs
  - Leveraging automation features offered by cloud native ecosystems such as Google® Kubernetes®

- **Reliable closed-loop decision making**
  - NFVO use of MDA for NFV-MANO improvements and optimizations
  - NFV-MANO analytics consumed by upper OSS management functions within the wider OSS management scope (e.g., network slice optimizations, etc)
  - use of intents

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Closed Loop Automation (CLA) enabled by NFV-MANO
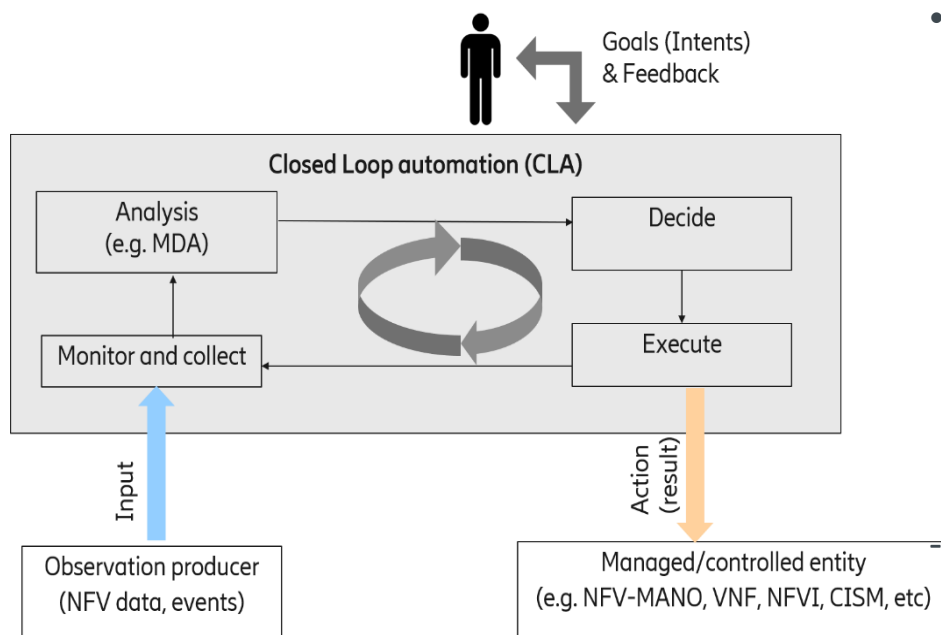
- NFV-MANO enables CLA in support of the ultimate zero-touch (ZT) management goal for autonomous networks:

  - some level of human intervention still expected (e.g., goals and expectations setting/updating, etc)

  - high level of automation expected via the machine-to-machine interactions,
    - increased system autonomy with ability to continuously monitor behaviour & performance, to determine any needed actions when the system goals are not fulfilled

NFV-MANO enables CLA:

- within NFV-MANO, via the new intent management and MDA, augmenting the decision capabilities of the closed loops

- by leveraging native capabilities for autonomous container infrastructure management, embedded in the CISM (Container Infrastructure Service Management, such as Google® Kubernetes®)

- across management layers within OSS and with BSS, enabling realizations of hierarchical CLAs across different management domains

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Intent based NS management

- Simplified information exchange with NFV-MANO consumers (e.g., other OSS/BSS management functions) Separation of concerns, consumers do not need to have a deep knowledge of NFV-MANO data models, just communicate their expectations and goals to NFV-MANO
- Intents used in the information model between management layers in closed management loops

- **Use cases**
- Current focus on NS management related use cases, simplified by introducing intents
- Examples analysed: Intent based NS instantiation, Intent based NS scaling, Intent based NS termination

- **Key issues of use case study**
- Positioning of intent in NFV-MANO layering architecture
- Intent management and policy management
- Defining intent management operations
- Designing intent information model

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Management Data Analytics assisted management

- The MDA is equipped with AI/ML models which help to provide intelligent analysis results related to a NFV domain specific subject and to improve the CLA decisions made by NFV-MANO.

- **Use cases**
- NS alarm incident analysis
- NS health analysis
- NS resource utilization analysis
- Cross administrative domain MDA

- **Key issues of use case study**
- MDA role in NFV-MANO, a domain specific logical function
- MDA basic processes: ML model training and data analysis, NFVO involved
- Input information collection: reuse subscription/notification operation mechanisms
- Input information set: PM/FM data, runtime NFV object instance info in the domain, analytics report of nested NS from the same or different domain
- Output analytics result: asynchronous operations, encapsulate result information in abstracted IEs

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Autonomous container infrastructure management

- Leverage CISM available functions from opensource de-facto standards such as CNCF Kubernetes into NFV-MANO, for fulfilling small closed-loop automation in cloud infrastructure management.

- **Use cases**
- Auto-scaling of the MCIO (K8S Pod)
- Auto-repairing CIS cluster nodes (K8S cluster nodes)
- Auto-upgrading CIS cluster nodes

- **Key issues of use case study**
- MCIO policy configuration
- Desired state of the MCIO
- Namespace quota
- CISM and VNFM relationship in autonomous management

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Potential enhancement to NFV-MANO architecture
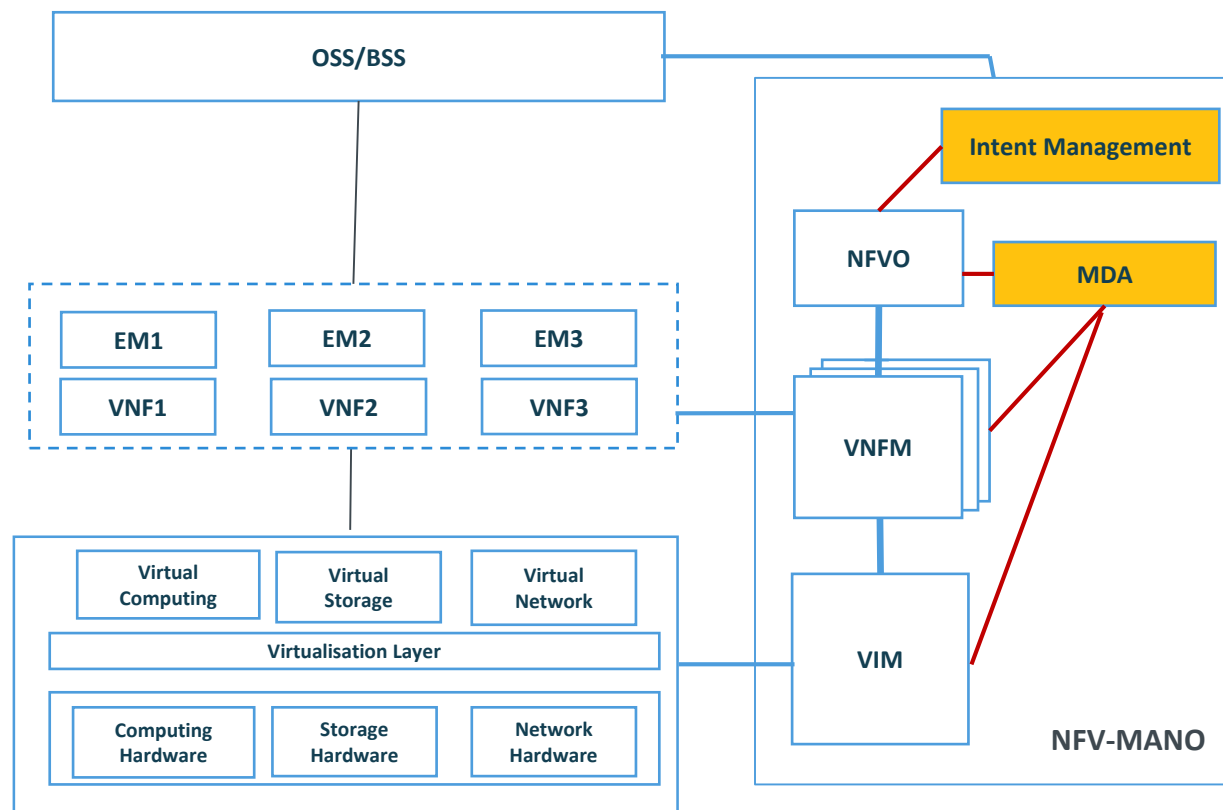
- Two new NFV-MANO functional enhancements will be introduced in NFV-MANO: Intent Management and MDA.

- Interfaces exposed by Intent Management and MDA functionality to their northbound consumers, to be defined in normative stage.

- The existing NFV-MANO functional entities (e.g., the NFVO, VNFM, VIM, CISM) are enhanced with requirements in either consuming or producing interfaces related Intent Management and to MDA.

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