

ETSI ISG NFV: Advances in Telco Cloud Architecture Standardization

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June 2026

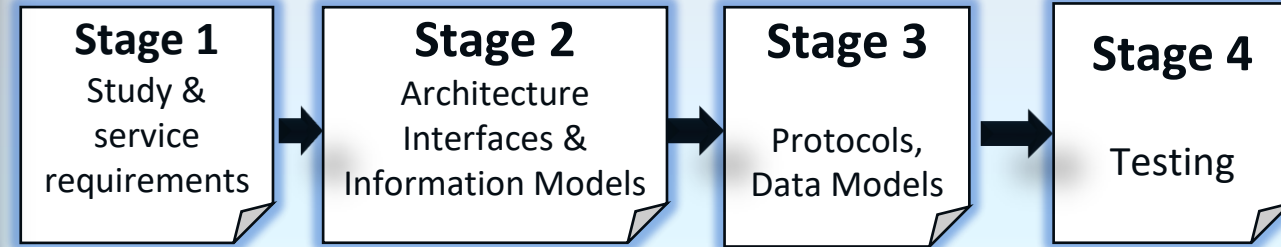


ETSI Industry Specification Group NFV

Overview

- ETSI ISG NFV for Network Functions Virtualisation is an ETSI-led industry group that defined the architectural framework and standards for virtualizing network functions on commodity hardware instead of dedicated appliances.
- It introduced key NFV concepts such as VNFs (Virtualized Network Functions), NFVI (NFV Infrastructure), and MANO (Management and Orchestration), which form the foundation of modern telecom cloud deployments.

ETSI NFV follows a staged specification approach in the development of the standards:



Working Groups

Stage 1

EVE WG

Evolution and Ecosystem

Stage 1/2

IFA WG

Interfaces and Architecture

Stage 3-4

SOL WG

Solutions & Testing

SEC WG

Security

TSC

(Technical Steering Committee)

Specifications

Deliverables are named as “ETSI GS/GR NFV[-WG] YYYY”

- NFV-EVE: produced by the EVE WG
- NFV-IFA: produced by the IFA WG
- NFV-SOL: produced by the SOL WG
- NFV-SEC: produced by the SEC WG

GS: Group Specification. It includes normative provisions.

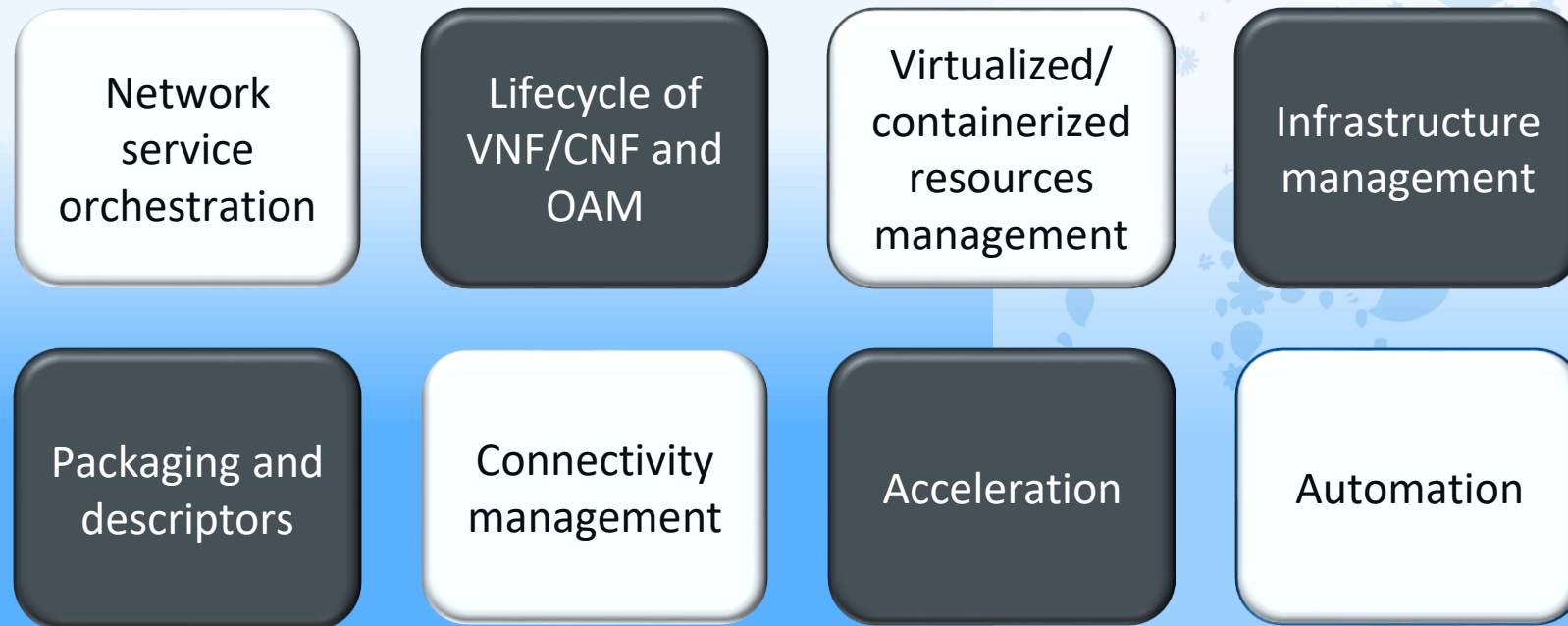
GR: Group Report. It includes informative descriptions.

YYY: A number that identifies a specific deliverable.

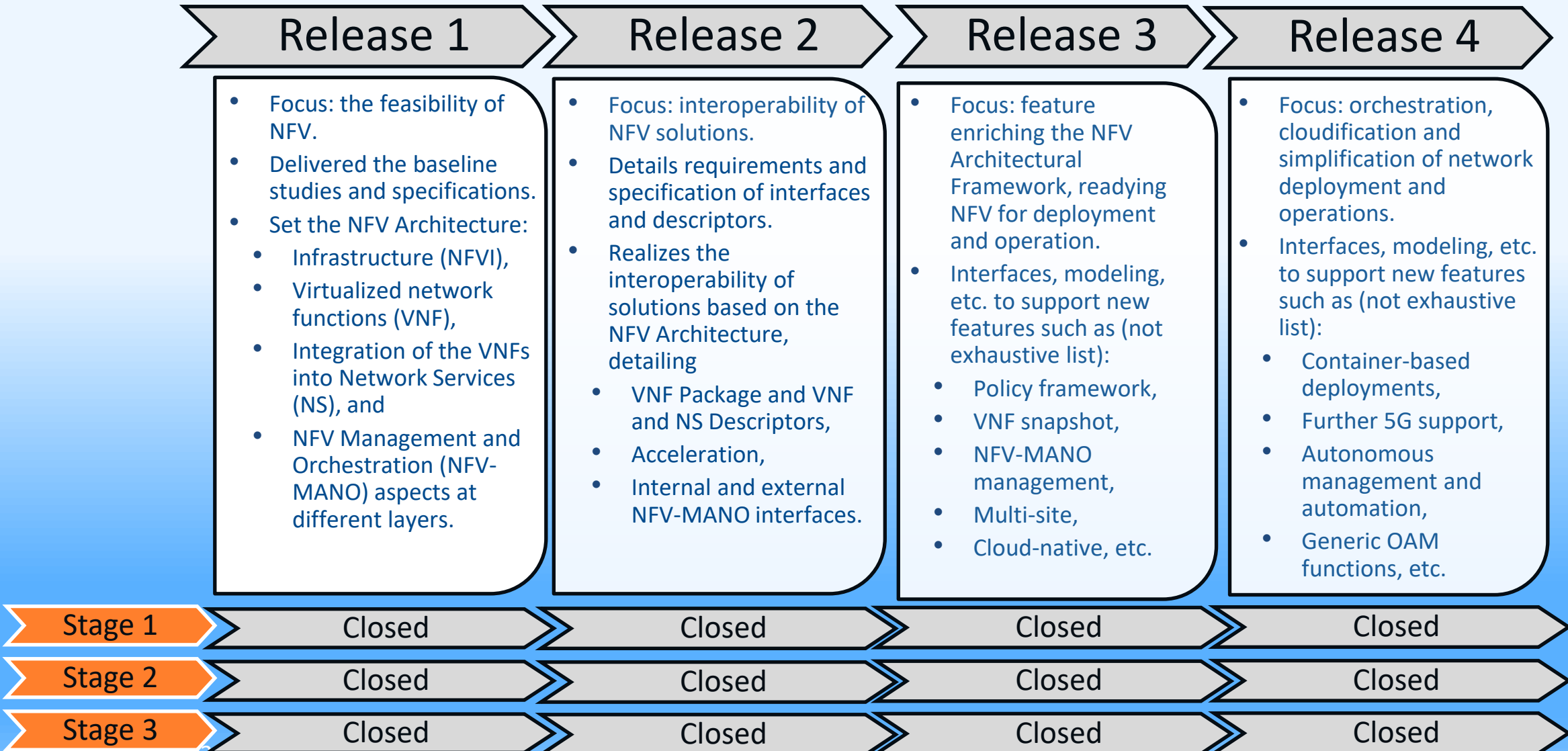
Areas and work items by ETSI NfV

From a functional perspective, ETSI NfV covers different areas between services and infrastructure for telecom networks virtualization.

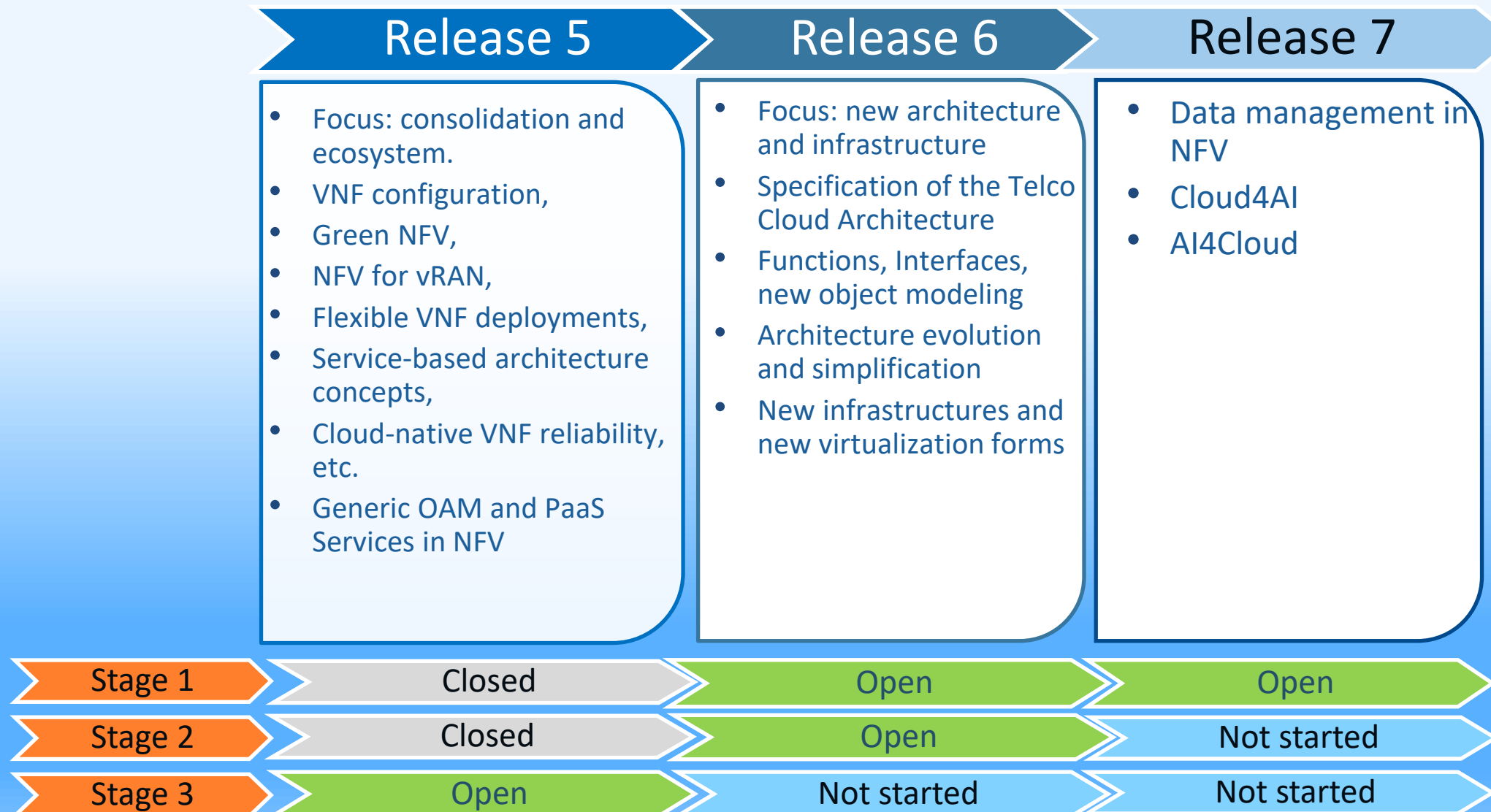
- In addition, **non-functional areas of security and reliability** are also covered with respect to the different functional areas.
- **Maturity of the work in ETSI NfV** is derived depending on the level of completeness of specification at different stages or concerning to scope of work by the ISG.



ETSI NFV Releases



ETSI NFV Releases



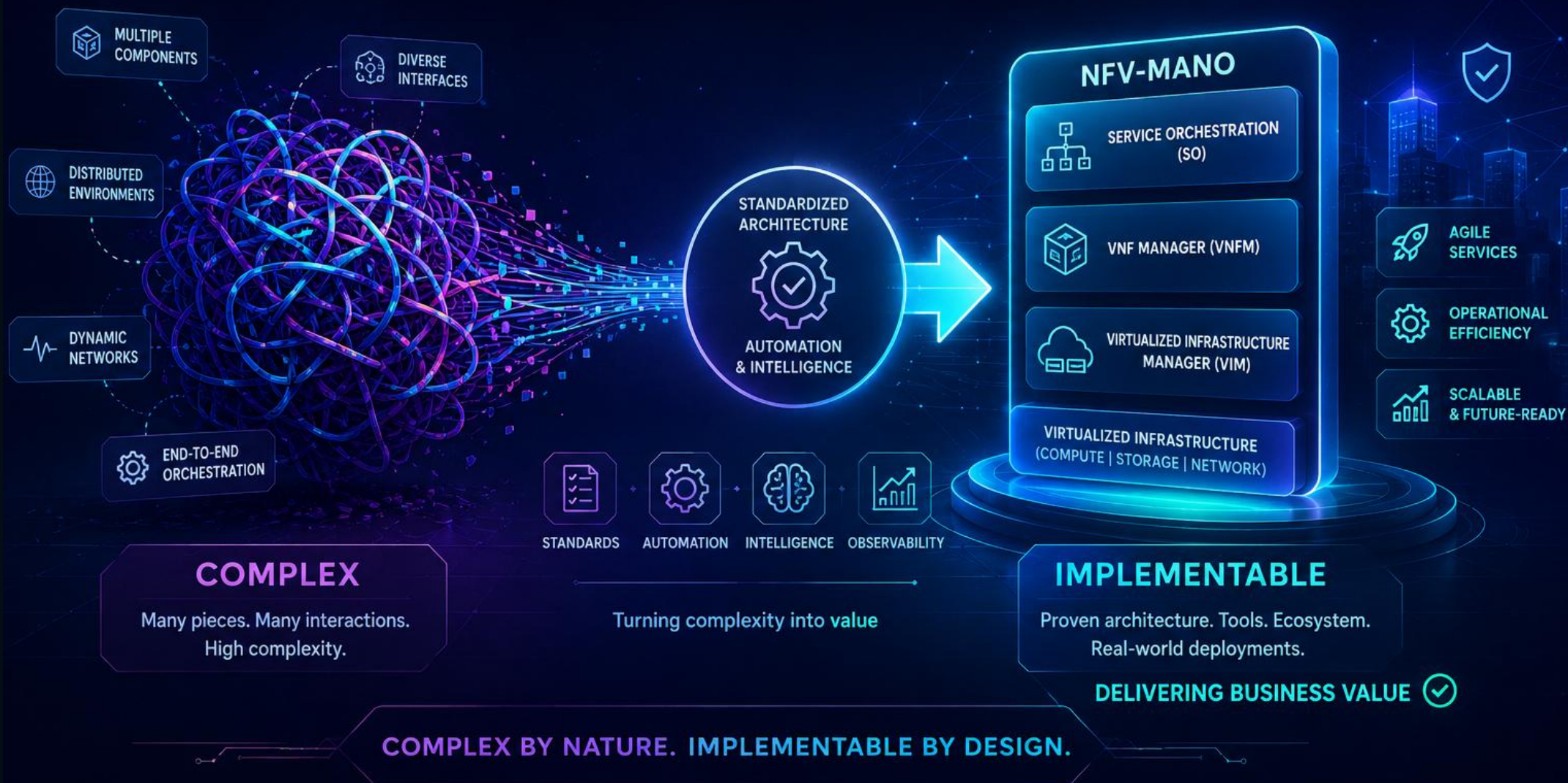
- Automation and orchestration of VNFs deployed in VMs and/or containers.
- Orchestration of network services combining VM-based and container-based VNFs.
- Automation functions (MDAF, Intent Management).
- Functions for the management of container clusters and workloads LCM (CISM, CCM).
- Functions for managing virtual and physical infrastructure resources (VIM, PIM).
- Real-time monitoring and analytics.
- Scalability and flexibility.
- Security and compliance support



<https://www.etsi.org/images/files/ETSIWhitePapers/ETSI-WP-67-The-Role-of-NFV-MANO-and-Its-Added-Value.pdf>

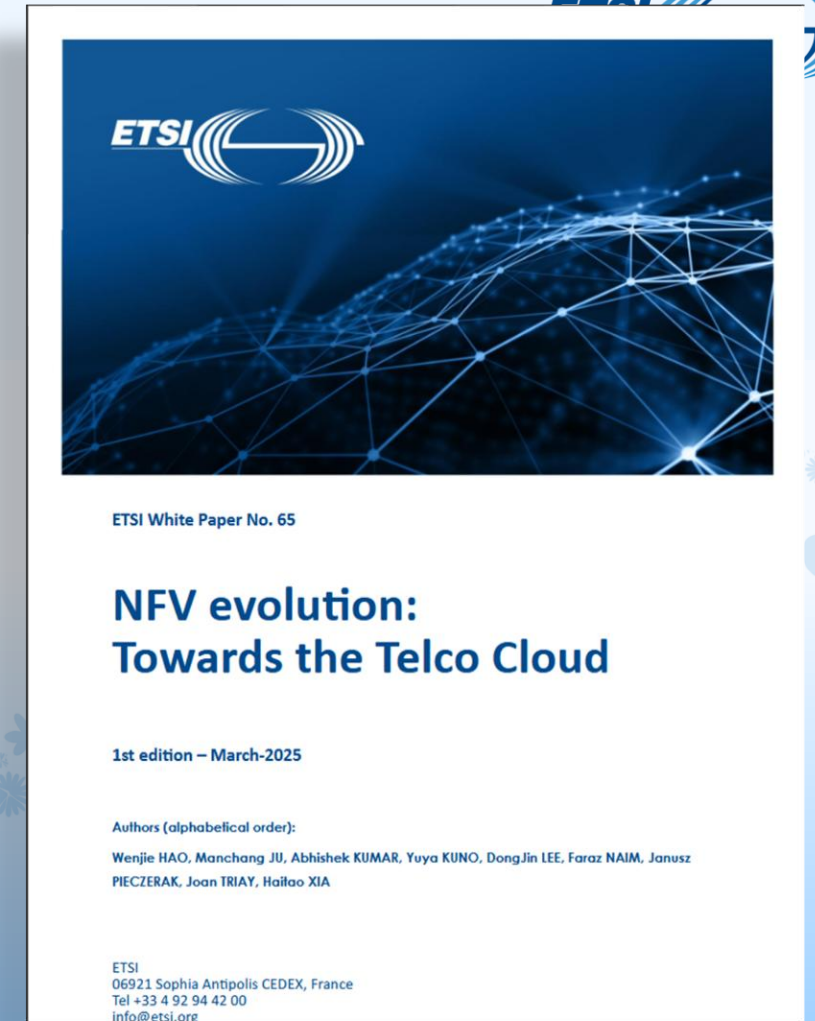
★ NFW-MANO ★

is COMPLEX but IMPLEMENTABLE



Need for an NFV evolution

- The ecosystem around NFV and Cloud has evolved
 - many new technologies based on cloud-native principles, automation and artificial intelligence (AI), offering additional paths and opportunities for NFV to grow further
- Telco Cloud management and orchestration are inherently complex.
- Different Telco Cloud stakeholders, such as operators, vendors, and application developers, have diverse requirements and varying understandings regarding management and orchestration.



See White Paper “NFV evolution: Towards the Telco Cloud”, March 2025
[https://www.etsi.org/images/files/ETSIWhitePapers/ETSI-WP-65-NFV-evolution-Towards the Telco Cloud.pdf](https://www.etsi.org/images/files/ETSIWhitePapers/ETSI-WP-65-NFV-evolution-Towards%20the%20Telco%20Cloud.pdf)

THE EVOLUTION OF NFV: ADVANCING TOWARD THE TELCO CLOUD

FROM VIRTUALIZATION TO LIMITLESS POSSIBILITIES

LEGACY NETWORKS

Hardware-Centric
Silos & Lock-in



VIRTUALIZATION

Decoupling Hardware
and Software



NFV

Network Functions
as Software



NFV-MANO

Automation, Orchestration
and Lifecycle Management



CLOUD NATIVE NETWORKS

Agile, Scalable
and Intelligent



TELCO CLOUD

OPEN | INTELLIGENT | AUTOMATED
SECURE | SCALABLE | SUSTAINABLE



FASTER INNOVATION

Rapid services.
Time to market.



GREATER AGILITY

Adapt. Scale.
Evolve.



ENHANCED RESILIENCE

Built-in reliability
and security.



SUSTAINABLE FUTURE

Optimized resources.
Lower footprint.



ONE JOURNEY. ENDLESS POSSIBILITIES.
BUILDING THE FUTURE. TOGETHER.



AUTOMATION



ORCHESTRATION



OPEN ECOSYSTEM



AI & ANALYTICS



APIs



DEVOPS

ETSI GR NFV-IFA 054 (Release 6)

Key architectural principles in NFV evolution

Simplification

- Future NFV-MANO, a more declarative system
- Architectural view hierarchy
- Simplifying open-source integration complexity
- Improved modular design
- Service-driven architecture

Evolution

- Support more new telco cloud applications than the evolved VNFs/CNFs (e.g., AI Apps) on top of the infrastructure.
- Platform services are more generic, extended, flexible to be customized to certain telco cloud applications.
- Focus more on the architectural functionality than interface.

ETSI GR NFV-IFA 054 V6.1.1 (2025-02)



**Network Functions Virtualisation (NFV) Release 6;
Architecture;
Report on architectural support for NFV evolution**

Disclaimer

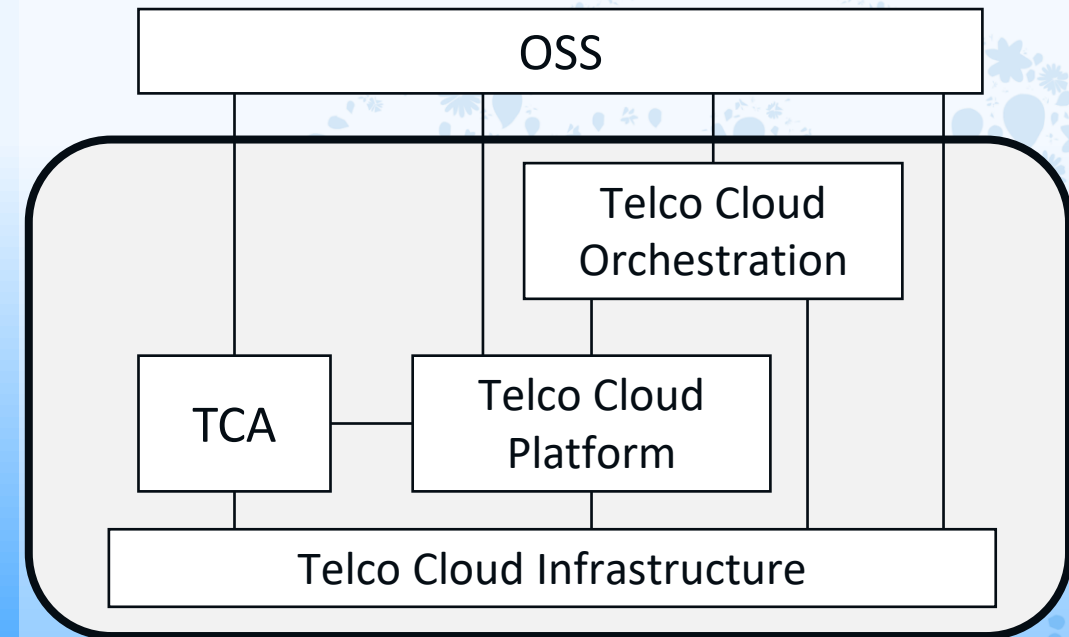
The present document has been produced and approved by the Network Functions Virtualisation (NFV) ETSI Industry Specification Group (ISG) and represents the views of those members who participated in this ISG. It does not necessarily represent the views of the entire ETSI membership.

Evolving NFV: Telco Cloud Framework

- Enhance NFV capabilities and scope in framework for declarative management, smarter orchestration, and cloud native technology/components
- Each architectural block encapsulates the full-stack of functionality
 - Telco Cloud Applications
 - Telco Cloud Orchestration and Automation
 - Telco Cloud Platform
 - Telco Cloud Infrastructure
- Architectural components expose service interfaces
 - Infrastructure services
 - Platform services
 - Orchestration services
- OSS/BSS communicates Telco Cloud with simplified declarative APIs design.

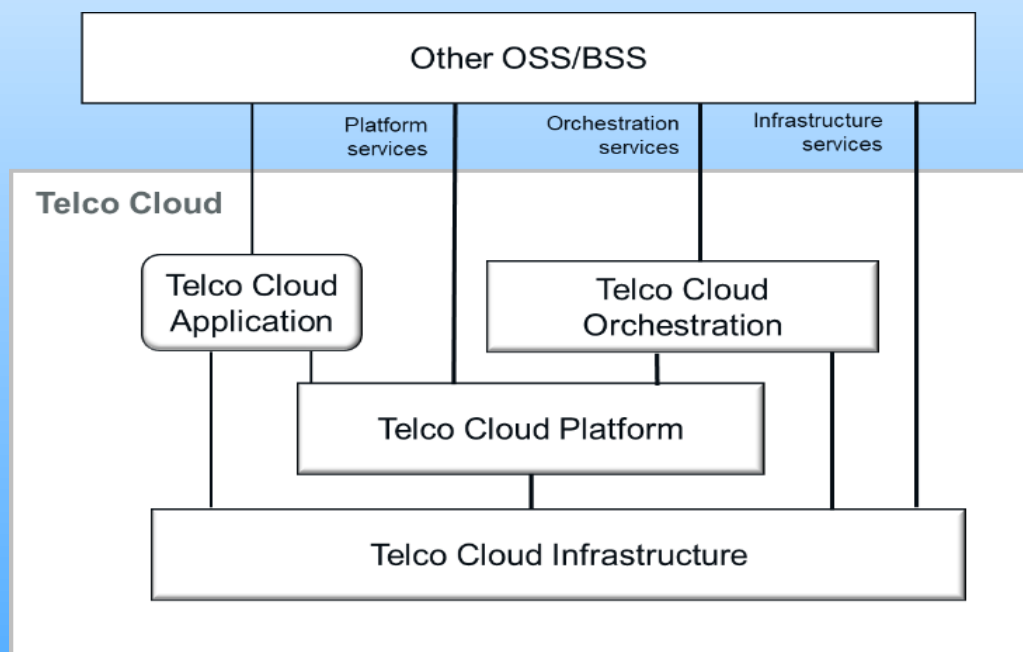
NFV Telco Cloud Architecture

Specified in NFV Release 6



NFV Telco Cloud Architecture

Declarative and smarter orchestration



Principle	Approach
Declarative management APIs	Simplifying workflows, "infrastructure/management as code," leveraging Kubernetes Resource Model based CRDs for intent expression and reconciliation.
GitOps	Applying version control best practices for integrating declarative targets, identifying configuration drifts, maintaining consistency.
Resource and service controller-based platforms	Achieving modularity and flexibility through dedicated controllers managing platform aspects.
Data as code and readable/versatile data models	Using textual data models as "new code" for versioning, testing, CI pipelines; simplifying descriptors.
Automation and intelligence	Integrating advanced tools and AI (big data, digital twin) for dynamic deployment, flexible configuration, optimization, decision-making, security.
Observability and security	Enhanced real-time insights (in-band monitoring), MBSS, AI-driven threat detection for robust protection.

ETSI GS NFV 008-1 V6.1.1 (2026-01)



**Network Functions Virtualisation (NFV) Release 6;
Architecture;
Part 1: Architectural Framework for Telco Cloud**

- Start of work: 2025-04-11
- Publication: 2026-01-12

Architectural blocks:

- Telco Cloud Infrastructure
- Telco Cloud Platform
- Telco Cloud Orchestration
- Telco Cloud Applications

ETSI GS NFV 008-2 V6.1.1 (2026-03)



**Network Functions Virtualisation (NFV) Release 6;
Architecture;
Part 2: Functional and Non-Functional Requirements for Telco
Cloud**

- Start of work: 2025-10-21
- Publication: 2026-03-20

Functional Requirements

- Telco Cloud Orchestration Functions
- Telco Cloud Platform Functions
- Telco Cloud Infrastructure Functions





Cloud Network Functions Virtualisation (NFV) Release 6; Descriptors and Packaging; Part 1: TCI descriptors

- Start of work: 2026-02-02
- Publication: 2026-09-26 (planned)

Activities

- Specify information and data models of descriptors for objects related to Telco Cloud Infrastructure, like CIS clusters based on ETSI GS NFV-IFA 036 requirements.
- Develop the structure and content of the descriptor information models.
- Develop the related data model specification for a CIS Cluster Descriptor (CCD), CIS Cluster Node Descriptor (CCND) and CIS Cluster Node Resource Descriptor (CCNRD), prominently using the CRD schema format.



Cloud Network Functions Virtualisation (NFV) Release 6; Descriptors and Packaging; Part 2: TCA descriptors

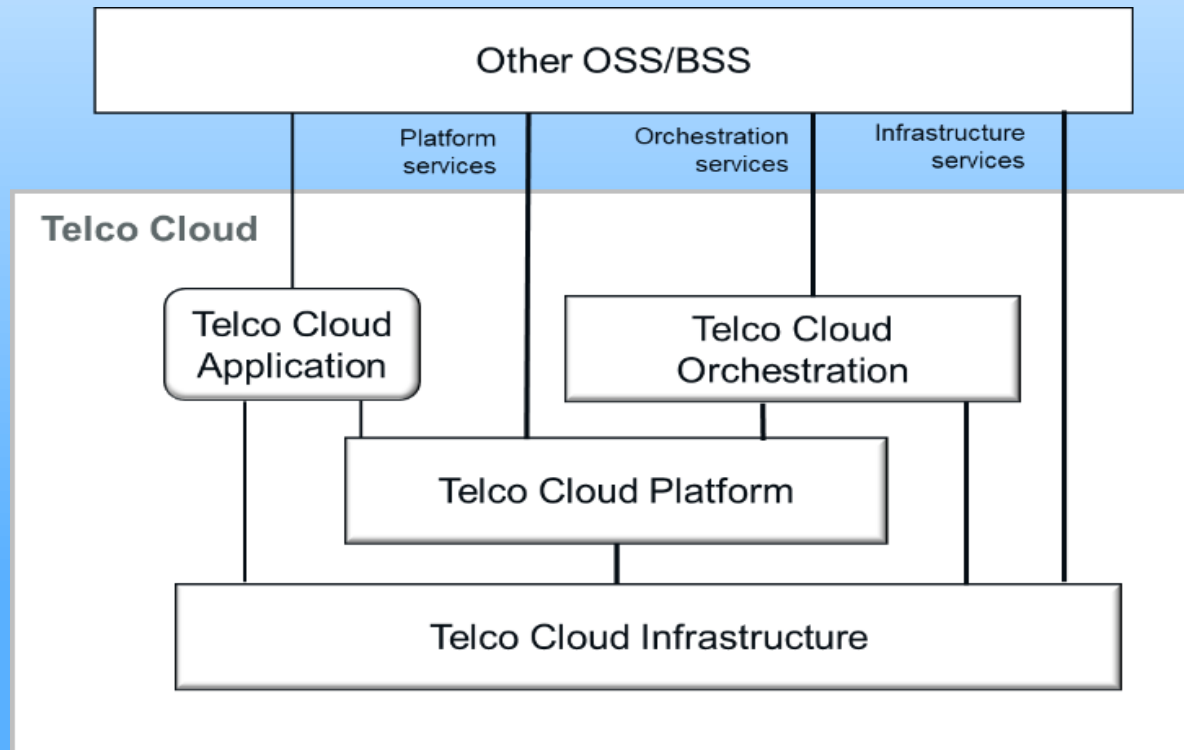
- Start of work: 2026-02-02
- Publication: 2026-09-26 (planned)

Activities

- Specify requirements, information models and data models for descriptors for Telco Cloud Applications (TCAs) and Telco Cloud Application Components (TCACs).
- Develop information and data model specification for TCAC Descriptors, prominently using the CRD schema format for the case of containerized deployments.
- Develop information and data model specification for TCAC Descriptors, prominently using the TOSCA schema format for the case of VM-based deployments.
- Formats for other deployment forms will be studied.

ETSI NFV Telco Cloud Architecture for Cloud-Native and AI-Native

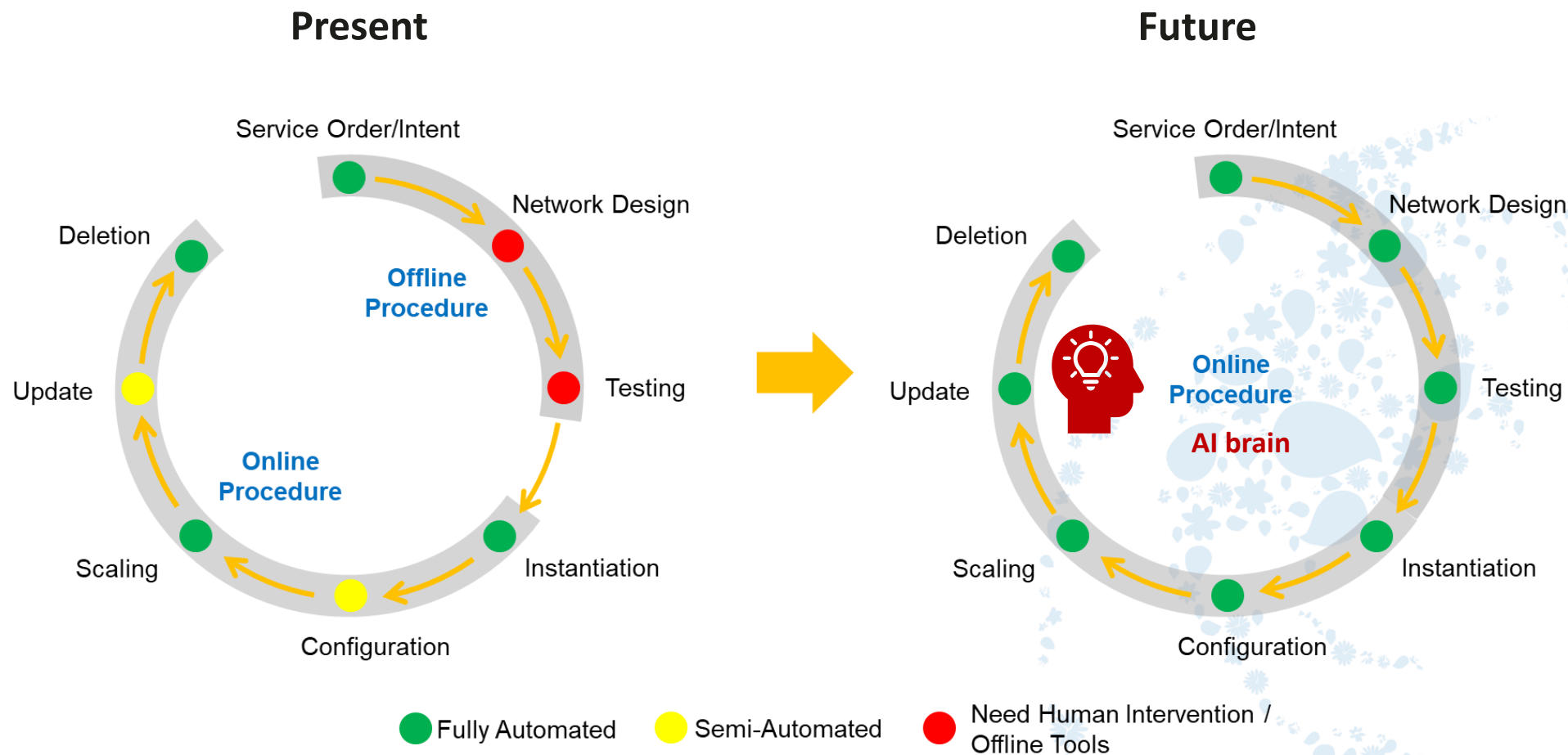
Cloud-Native and AI-Native - Building the future of Telco Cloud Architecture



Ongoing activities

1. TC Application Descriptors and Packaging
2. TC Network Management
3. TC Orchestration and Service assurance
4. **Cloud4AI** (Release 7 activity, see NFV GR EVE029, NFV GR EVE030, NFV GR EVE031)
5. AI4Cloud
6. Data management in NFV (Release 7 activity, see NFV GR EVE028)

Autonomous networking, AI-native network management and operation



The Evolution of NNFV: AI-Native Telco Cloud



TRANSFORMING NETWORKS. EMPOWERING INTELLIGENCE. DELIVERING THE FUTURE.

1. TRADITIONAL NETWORKS

Hardware-Centric
Rigid & Proprietary



PAST

2. VIRTUALIZATION ERA

Decouple Hardware
from Software



3. NFV ERA

Network Functions
as Software



4. CLOUD-NATIVE TELCO

Agile, Scalable
Cloud Infrastructure



5. INTELLIGENT TELCO CLOUD

Data-Driven
Autonomous Operations



FOUNDATIONAL ENABLERS



NFV-MANO



CLOUD NATIVE
PLATFORM



CONTAINERS &
KUBERNETES



EDGE
COMPUTING



AI/ML
PIPELINES



DATA &
ANALYTICS



API-DRIVEN
ECOSYSTEM



SECURITY
BY DESIGN



AI-NATIVE OPERATIONS

Predict. Prevent. Optimize.



AUTONOMOUS NETWORKS

Self-Configuring. Self-Healing.



ULTIMATE CUSTOMER EXPERIENCE

Intelligent. Contextual. Seamless.



SUSTAINABLE BY DESIGN

Efficient. Green. Responsible.



FROM COMPLEXITY TO INTELLIGENCE

FROM AUTOMATION TO AUTONOMY

FROM TODAY'S NETWORKS
TO TOMORROW'S POSSIBILITIES



THE JOURNEY CONTINUES. THE FUTURE IS AI-NATIVE.

AI-native Infrastructure, next phase of Telco Cloud evolution

1st edition – May 2026



AI-native Infrastructure, next phase of Telco Cloud evolution

ETSI White paper: “**AI-native Infrastructure, next
phase of Telco Cloud evolution**”

Published, May 2026

AI-native Infrastructure, next phase of Telco Cloud evolution

Motivation

- Telco Cloud evolution:
 - NFV → Cloud-Native → AI-Native
- Traditional OAM approaches are reaching their limits:
 - Multi-cloud and edge complexity
 - Massive scale and service diversity
 - Increasing operational costs
- AI transitions from an application workload to an embedded infrastructure capability

Vision & Key Outcome

AI-Native Telco Cloud = Intelligent Infrastructure

Where:

- AI models become first-class platform entities
- AI agents participate in network operations
- Infrastructure supports autonomous and intent-driven behaviour
- Move from Resource-centric cloud operations to Intelligence-centric infrastructure operations

Business Drivers and Emerging AI Services

Key Telco AI Use Cases

Intelligent Communications

- Real-time translation
- Conversational assistants
- AI-enhanced calling services

AI-Powered OAM

- Fault prediction
- Root cause analysis
- Automated remediation
- Closed-loop operations

Network Intelligence

- Experience-aware networking
- Adaptive policy enforcement
- Dynamic traffic steering

AI Ecosystem Platform

Infrastructure exposure for:

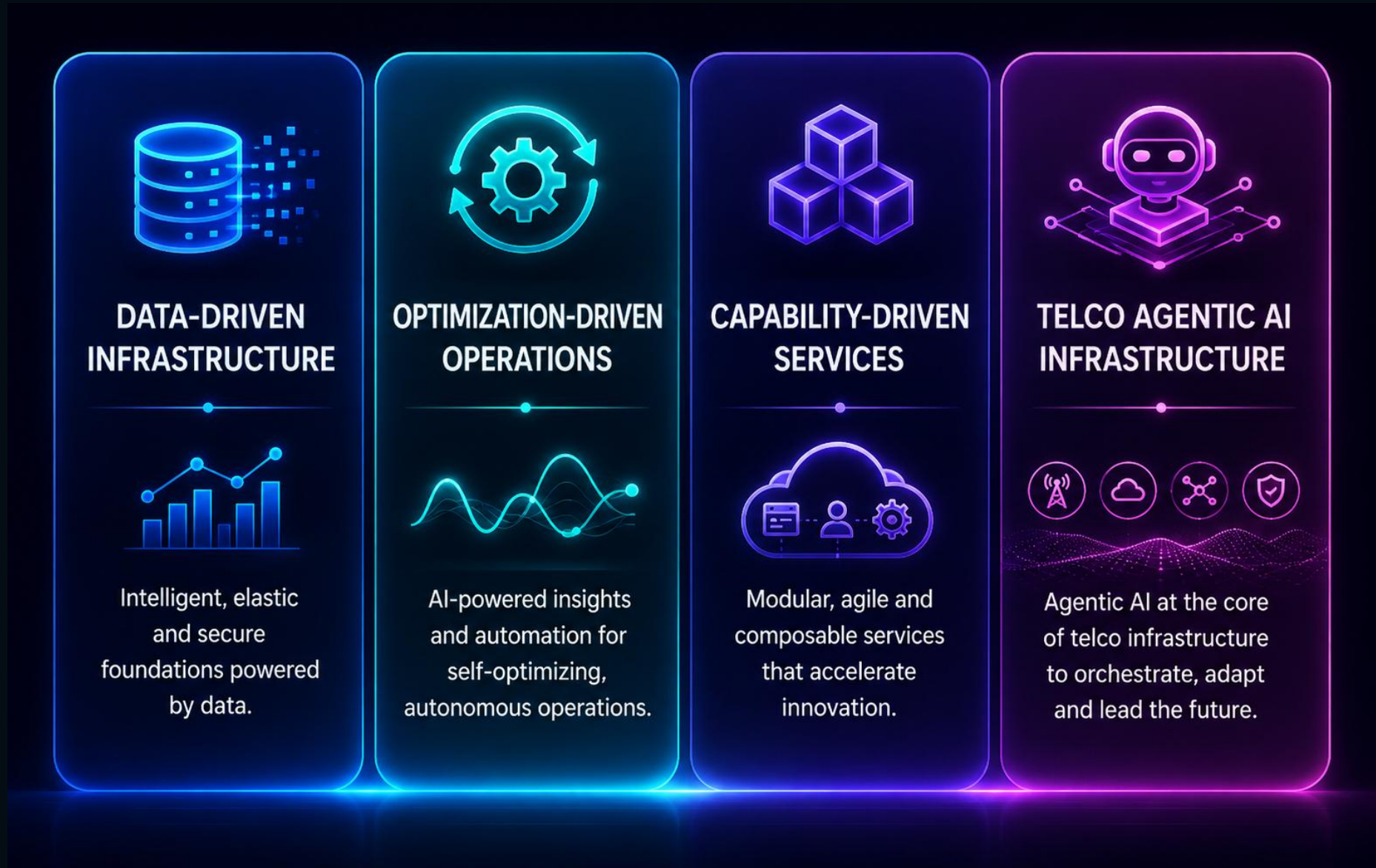
- 1) XR applications
- 2) Robotics
- 3) Multi-agent systems
- 4) Industry AI services

Business Impact

- ✓ Improved operational efficiency
- ✓ Reduced OPEX
- ✓ New AI-driven revenue streams
- ✓ Telco Cloud becomes a strategic digital asset



AI-Native Telco Cloud Architecture: Capability Pillars



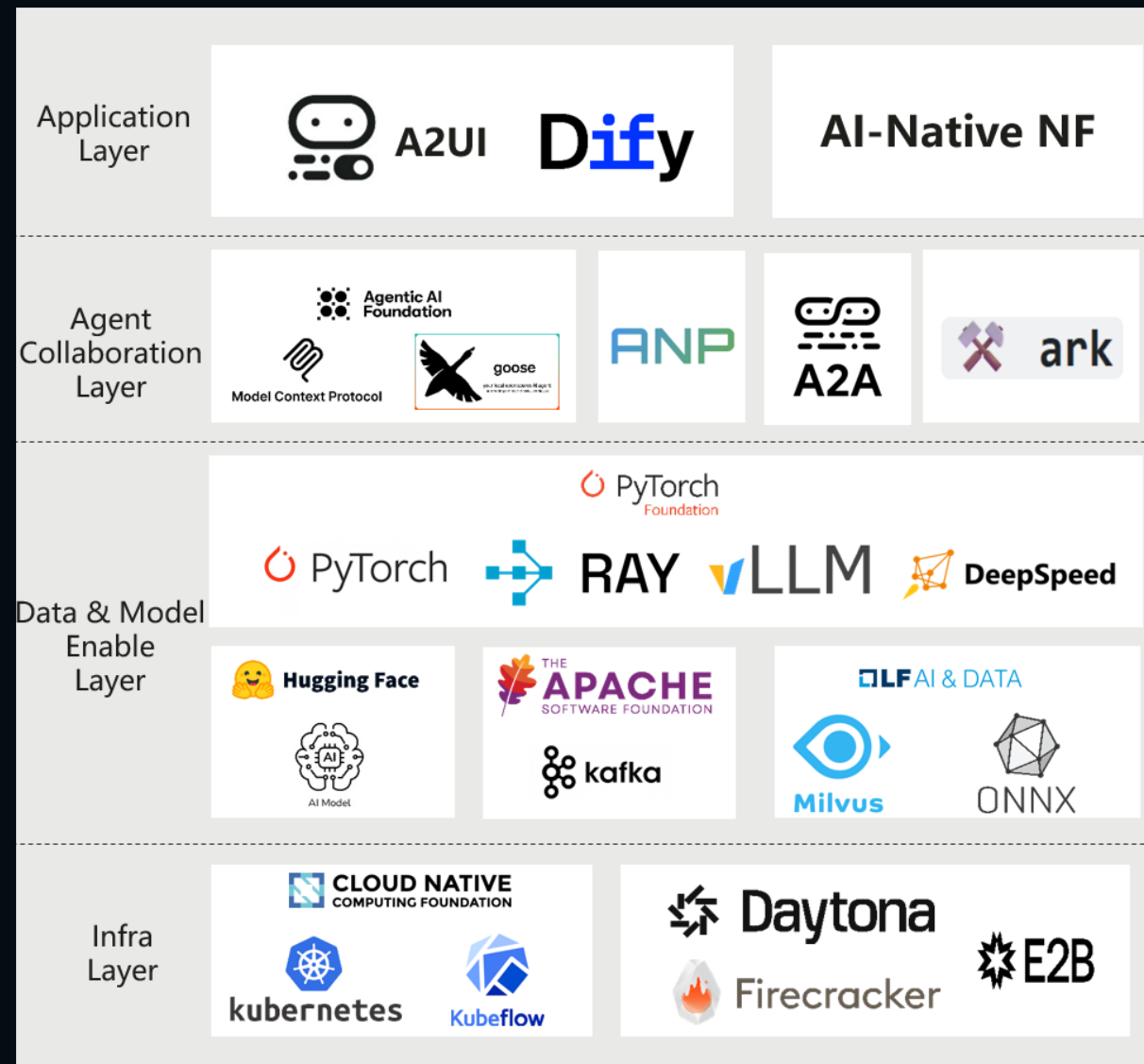
AI-Native Telco Cloud Architecture

AI-native network functions & services

Multi-agent orchestration and task execution

Model lifecycle, training, inference

Compute, storage, networking, orchestration



Technical Enablers for AI-Native Infrastructure

1. Heterogeneous Computing

- CPUs + GPUs + NPUs + XPU
- Accelerator-aware scheduling
- Resource pooling across cloud and edge

2. AI-Native Orchestration

- Intent-driven management
- Dynamic resource allocation
- Model-aware scheduling
- Multi-agent coordination

3. MaaS (Model-as-a-Service)

- Provides:
- Model lifecycle management
- High-performance inference
- Federated learning
- LLM integration

4. AI Agents

- Support:
- Perception → Reasoning → Action loops
- Autonomous OAM
- Service assurance
- Self-healing networks

5. Digital Twin Platform

- Predictive operations
- What-if simulations
- Agent training environment
- Closed-loop optimization

6. AI-Native Data Plane

- Real-time telemetry
- Data-model-agent feedback loops
- Built-in governance and trust

Challenges

Challenges

Infrastructure Complexity

- Heterogeneous accelerators
- Runtime diversity
- Multi-domain federation

Resource Management

- Model-aware scheduling
- Data locality optimization
- Distributed orchestration

Security & Trust

- AI agent governance
- Hallucination risks
- Model integrity protection
- Secure sandboxes

Sustainability

- Energy-aware orchestration
- Efficient AI models
- Accelerator utilization optimization

Next Industry Priorities



AI-NATIVE TELCO CLOUD STANDARDS

Drive interoperable,
secure and portable
AI-native cloud
standards across
the ecosystem.



AUTONOMOUS OPERATIONS FRAMEWORKS

Enable intent-driven,
self-optimizing and
self-healing operations
at scale.



HETEROGENEOUS COMPUTING GOVERNANCE

Govern diverse compute,
accelerators and cloud
environments with
policy, placement
and performance
assurance.



TRUSTED AI AND DATA GOVERNANCE

Ensure responsible AI
and data usage with
privacy, transparency,
security and
compliance by design.



ETSI + 3GPP + OPEN SOURCE COLLABORATION

Accelerate innovation
and adoption through
standards, openness
and ecosystem
collaboration.



Summary

- NFV-MANO evolves towards orchestration and management of the Telco Cloud.
- Future Telco Cloud evolves from a cloud platform into an AI-native digital infrastructure that hosts, orchestrates, and operationalizes intelligence at network scale.
- Evolution is about:
 - the design of a new reference architecture
 - supporting declarative management
 - enabling autonomous network operations and energy efficiency
 - integrating heterogeneous infrastructures for deploying diverse applications via cloud-native and AI-native philosophy.

References

Published

- NFV008-1 **Architectural framework for Telco Cloud** Available at: https://www.etsi.org/deliver/etsi_gs/NFV/001_099/00801/
- NFV008-2 **Functional and Non-Functional Requirements for Telco Cloud** Available at: https://www.etsi.org/deliver/etsi_gs/NFV/001_099/00802/

Drafts available at <https://docbox.etsi.org/ISG/NFV/Open/Drafts> :

- ETSI GS NFV009-1: Descriptors and Packaging: TCI Descriptors
- ETSI GS NFV009-2: Descriptors and Packaging: TCA Descriptors
- ETSI GS NFV010-1: Part 1: Telco Cloud Infrastructure service interfaces
- ETSI GS NFV010-2: Part 2: Telco Cloud Platform service interfaces
- ETSI GR Draft EVE029: Report on telco cloud platform services for agentic applications
- ETSI GR Draft EVE030: Report on enhancing telco cloud orchestration functionality for agentic applications
- ETSI GR Draft EVE031: Report on Telco Cloud Infrastructure support for telco AI Agents

ETSI White Paper No. 71 AI-native Infrastructure, next phase of Telco Cloud evolution

https://www.etsi.org/wp-content/uploads/ETSI-WP-71_AI-native_Infrastructure_next_phase_of_Telco_Cloud_evolution.pdf