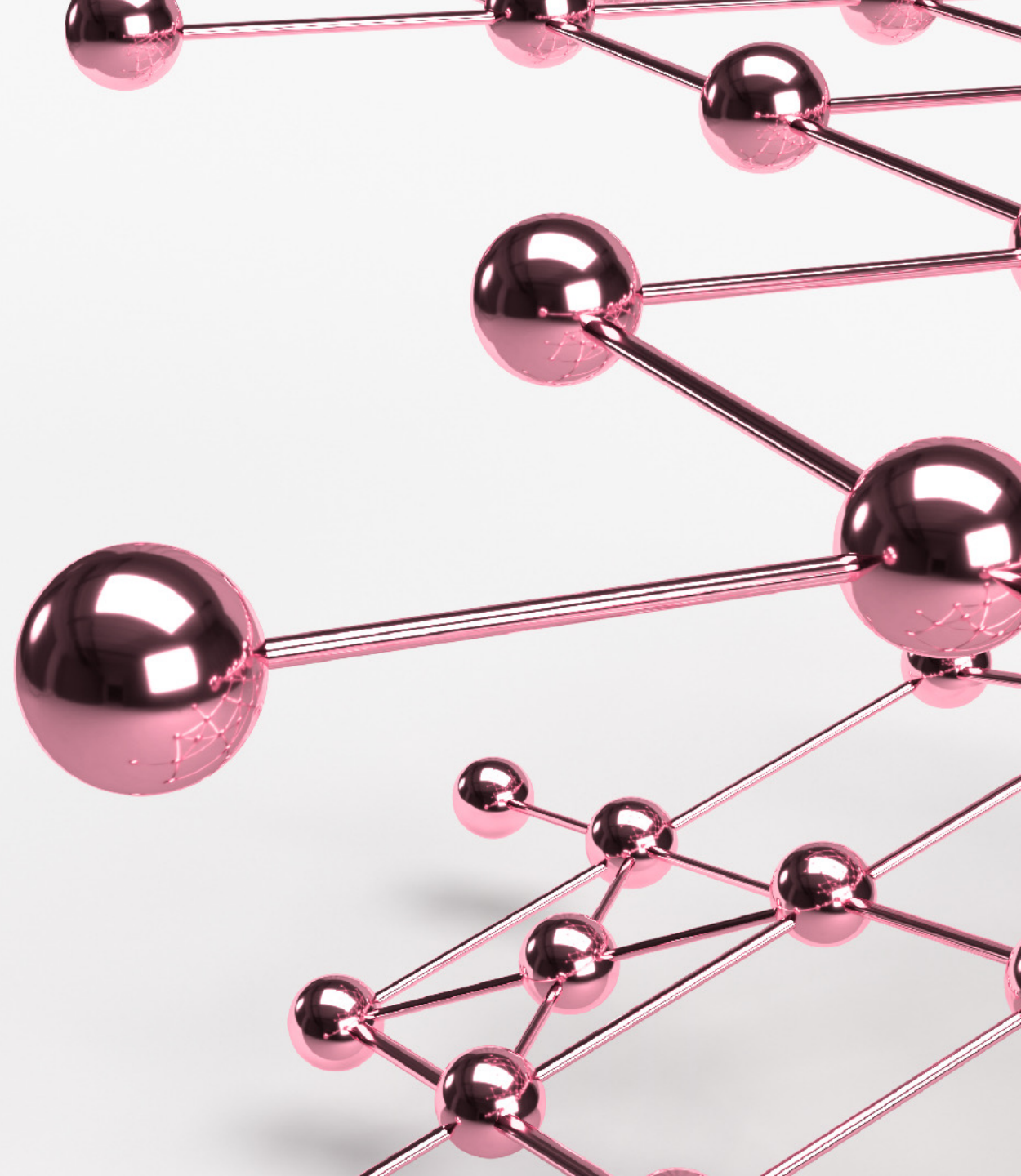




TOWARDS EXTREME NETWORK KPIS WITH PROGRAMMABILITY IN 6G

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Sándor Laki (Faculty of Information Systems, Eötvös Loránd University)
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DESIRE6G GENERICS

> DESIRE6G <

SLOGAN: DEEP PROGRAMMABILITY & SECURE DISTRIBUTED INTELLIGENCE FOR REAL-TIME END-TO-END 6G NETWORKS

Project coordination:
University of Amsterdam

Technical coordination:
Ericsson Hungary

Duration:
01/01/2023 - 31/12/2025

Total Cost:
6.227.919€



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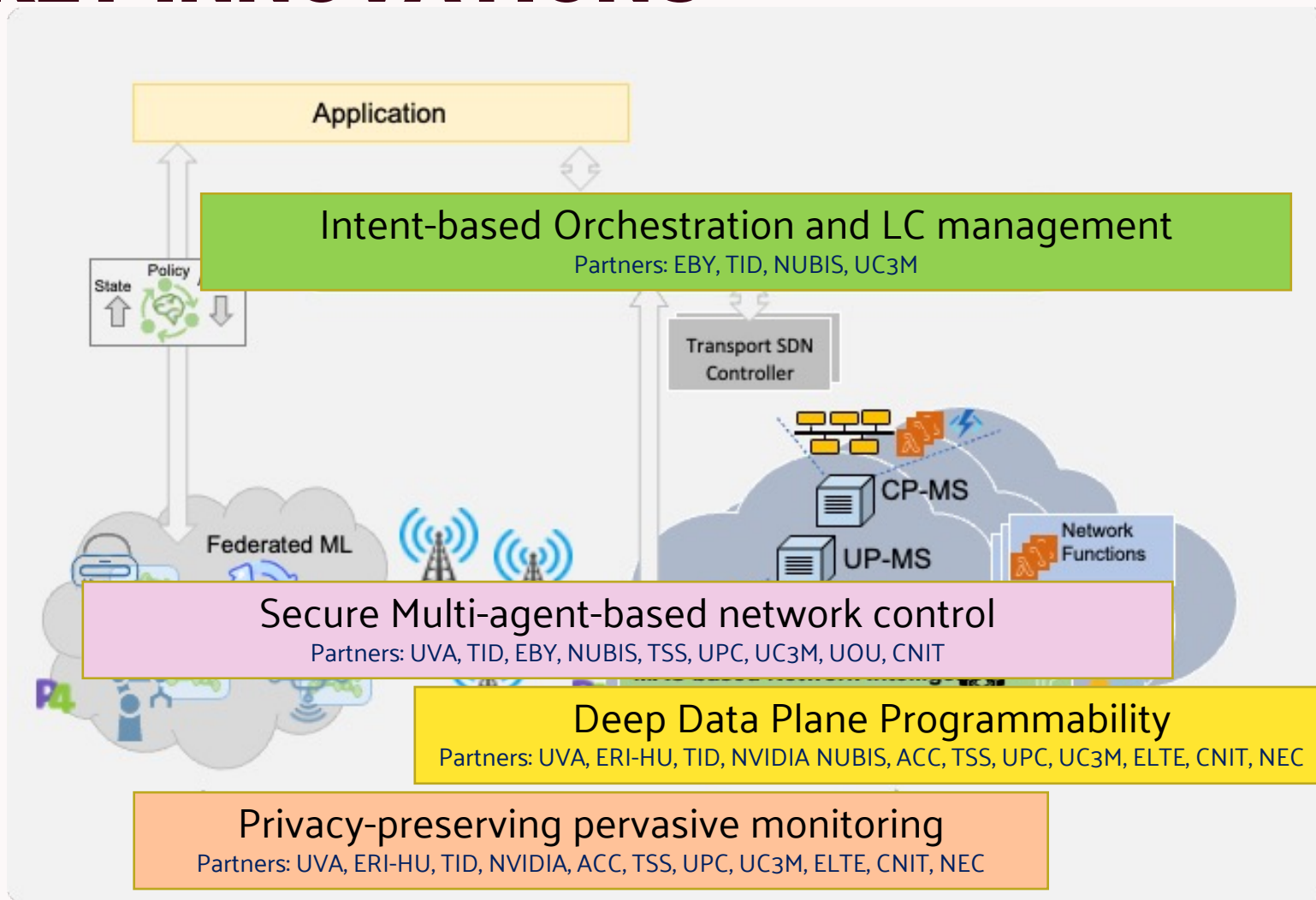
WHY DESIRE6G?

What is the difference between D6G and the other 6G projects?

We study

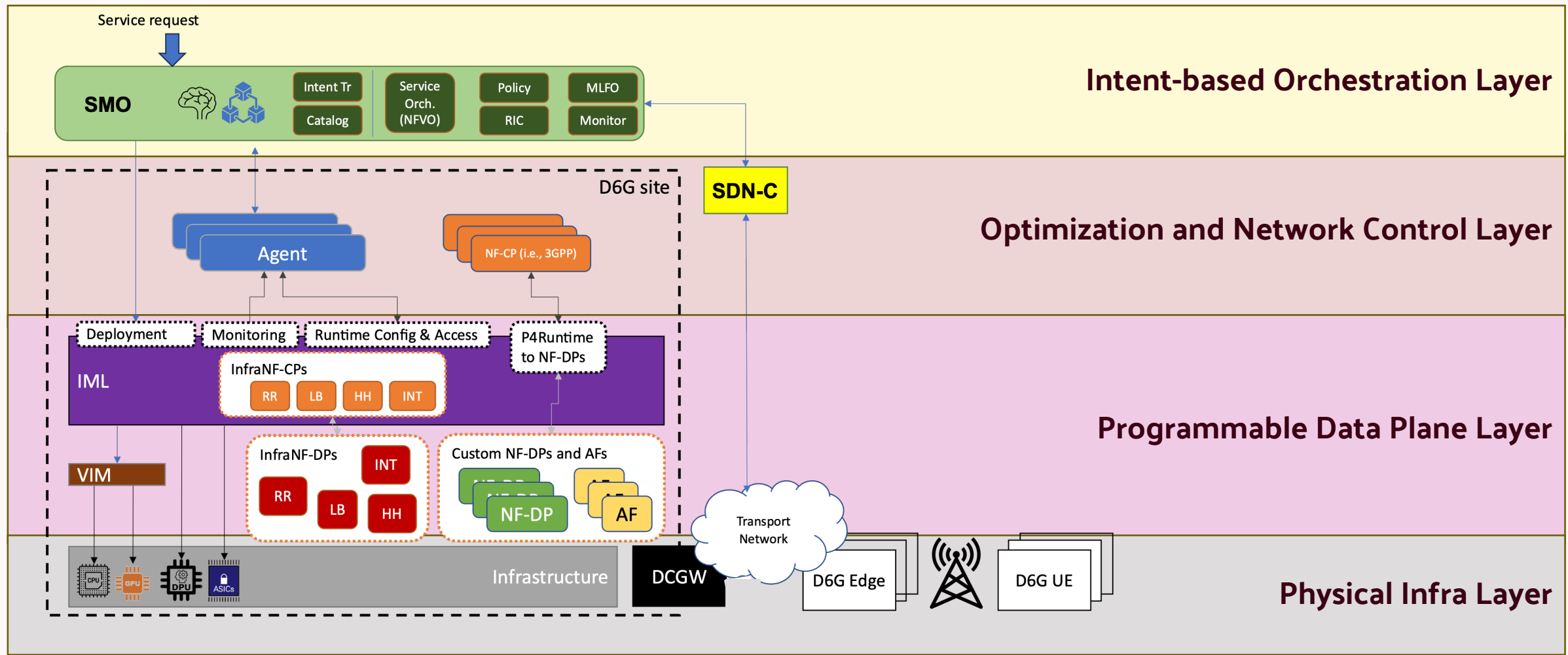
- How end-to-end network programmability helps in solving really challenging use cases / KPIs (such as below ms latency) in a multi-service network – study the flexibility / performance trade-off
- How to solve the complexity problem of centralized control and optimization with a distributed agent-based system
- And how can we put this together as simply as possible with other innovative methods, like AI-driven telemetry, blockchain-based federation and a DLT-backed software security framework
- So D6G has a **bottom-up** view and focuses on proof of concept **demos** to validate the value proposition

D6G KEY INNOVATIONS

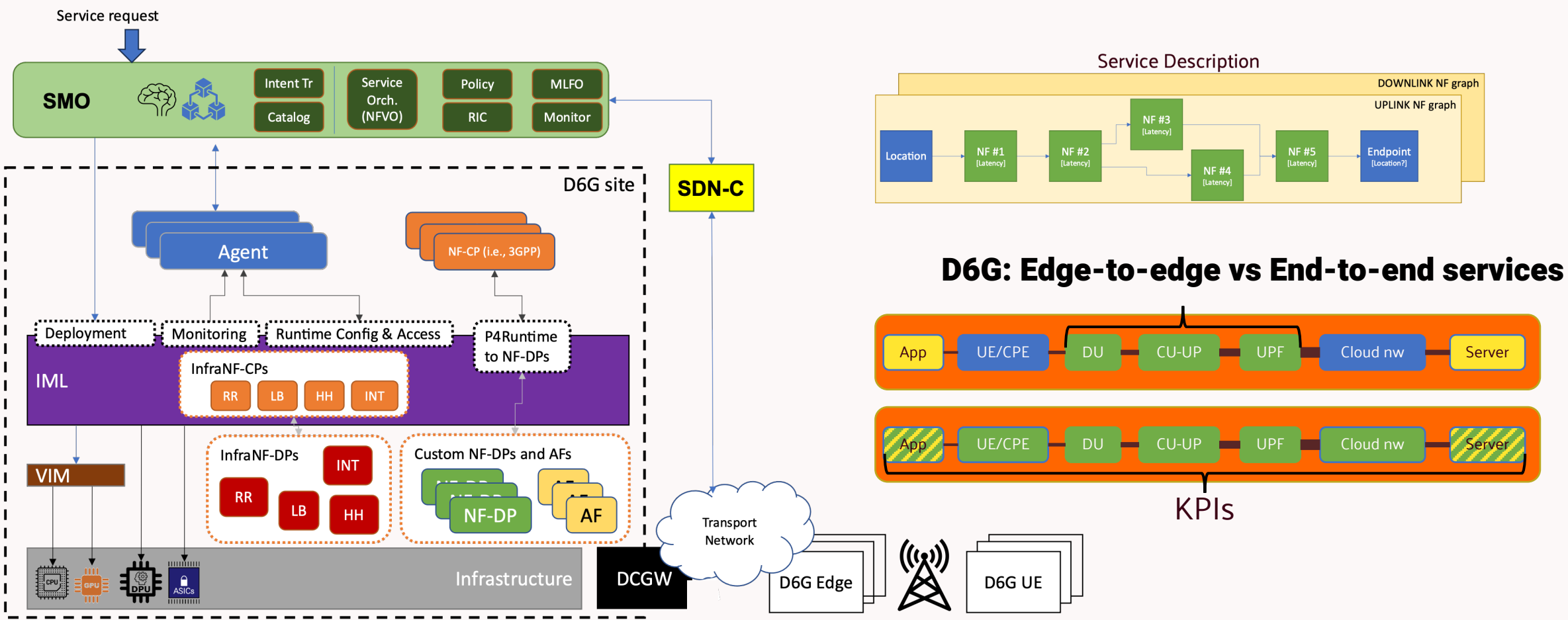


Innovation
Intelligent Applications
End-to-end and per-domain intent-based orchestration
Lightweight blockchain-based federation
xURLLC services
Serverless Architecture
RAN-Core Convergence
Cloud-to-edge continuum
Secure Distributed Intelligence
E2E Data Plane Programmability
Multi HW acceleration
E2E Telemetry

D6G ARCHITECTURE AND LAYERS



D6G ARCHITECTURE AND SERVICES





ARCHITECTURE DETAILS

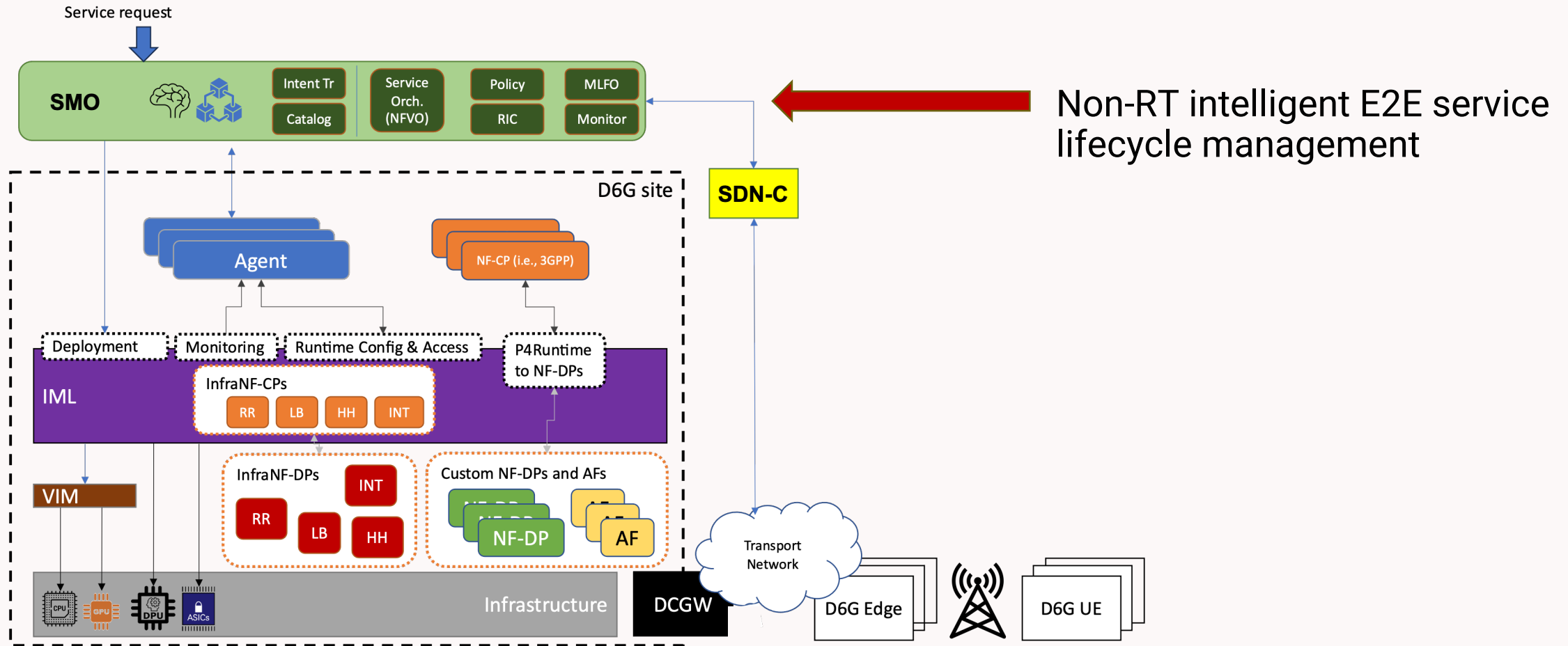


DESIRE6G has received funding from the Smart Networks and Services Joint Undertaking (SNS JU) under the European Union's Horizon Europe research and innovation programme under Grant Agreement No 101096466.

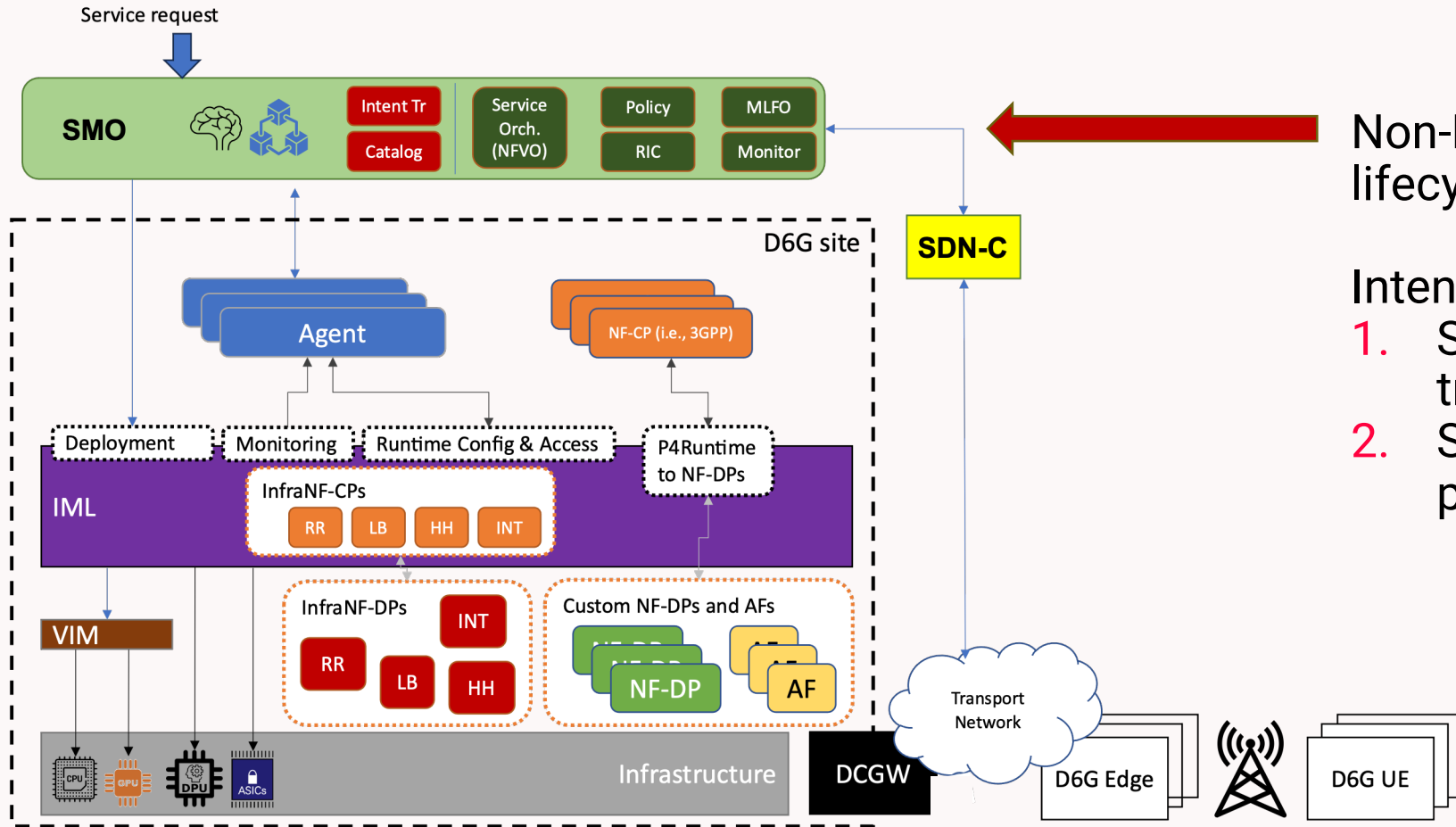


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SERVICE MGMT & ORCHESTRATION



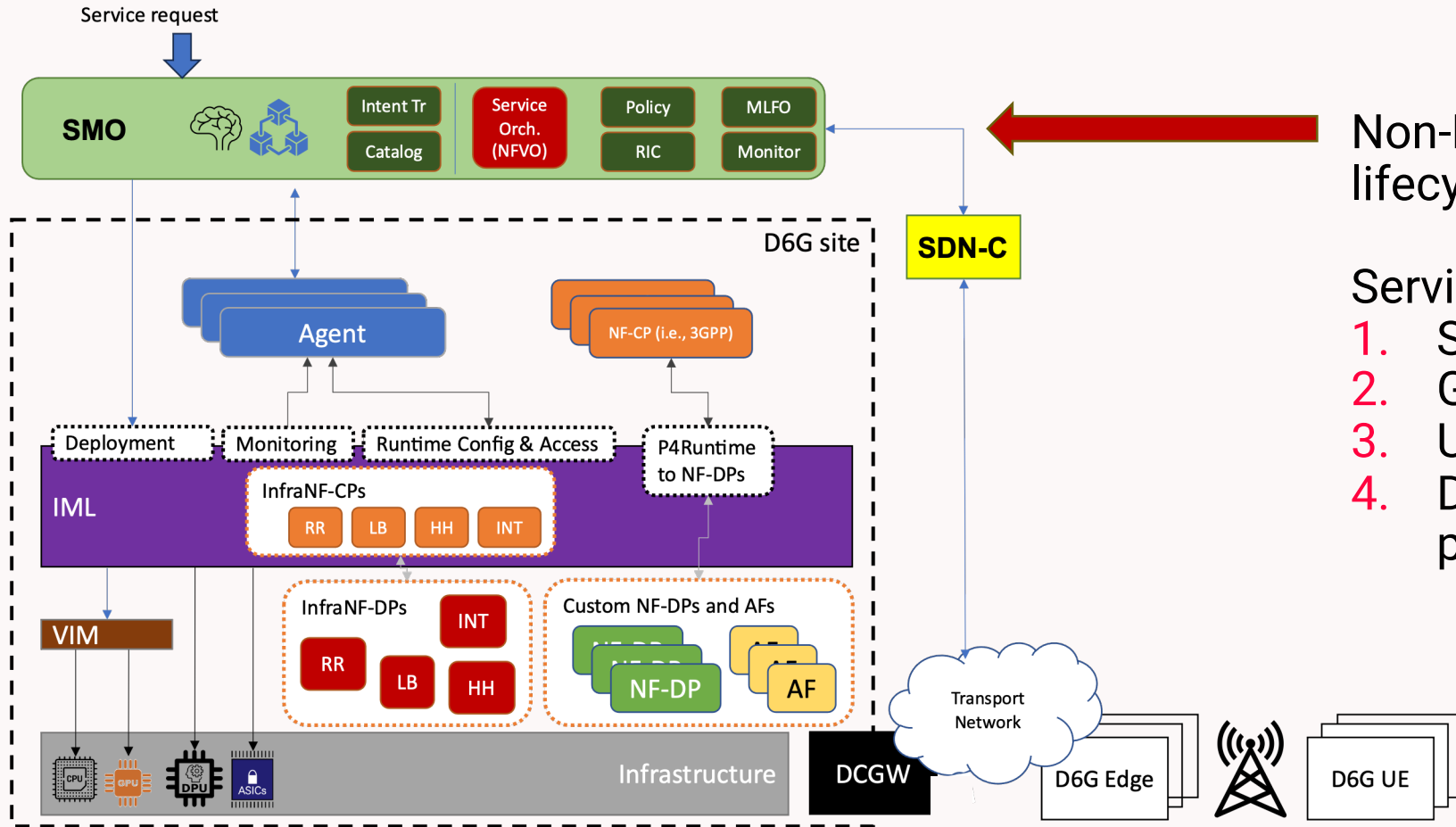
SERVICE MGMT & ORCHESTRATION



Non-RT intelligent E2E service lifecycle management

- Intent-based service creation:
1. SLAs and further intents are translated into service config
 2. Service descriptions are populated into the catalog

SERVICE MGMT & ORCHESTRATION

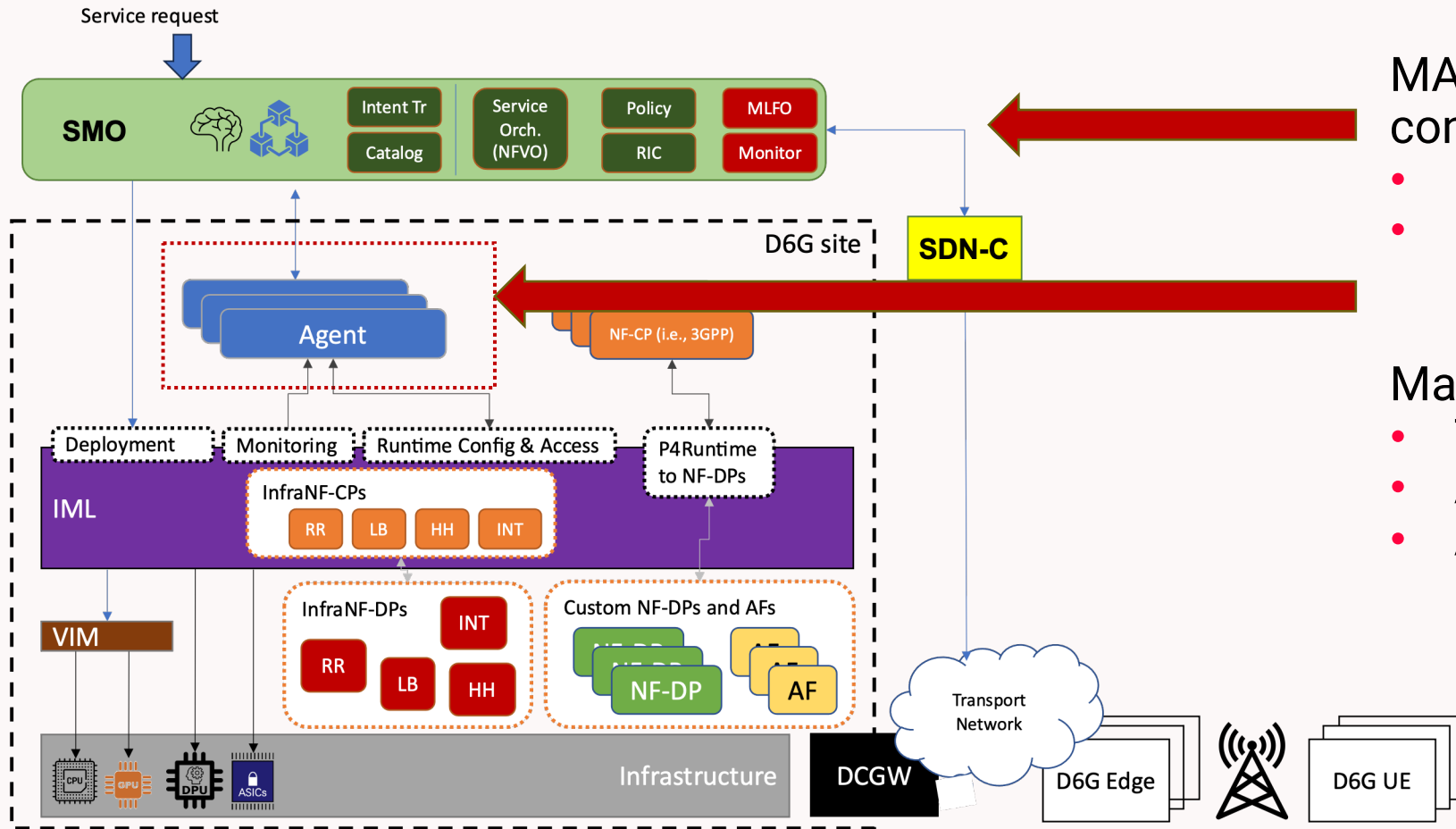


Non-RT intelligent E2E service lifecycle management

Service orchestration:

1. Service graph creation
2. Graph splitting (multi-site)
3. Usually static
4. Dynamic orchestration is possible on new requests too

MULTI-AGENT SYSTEM



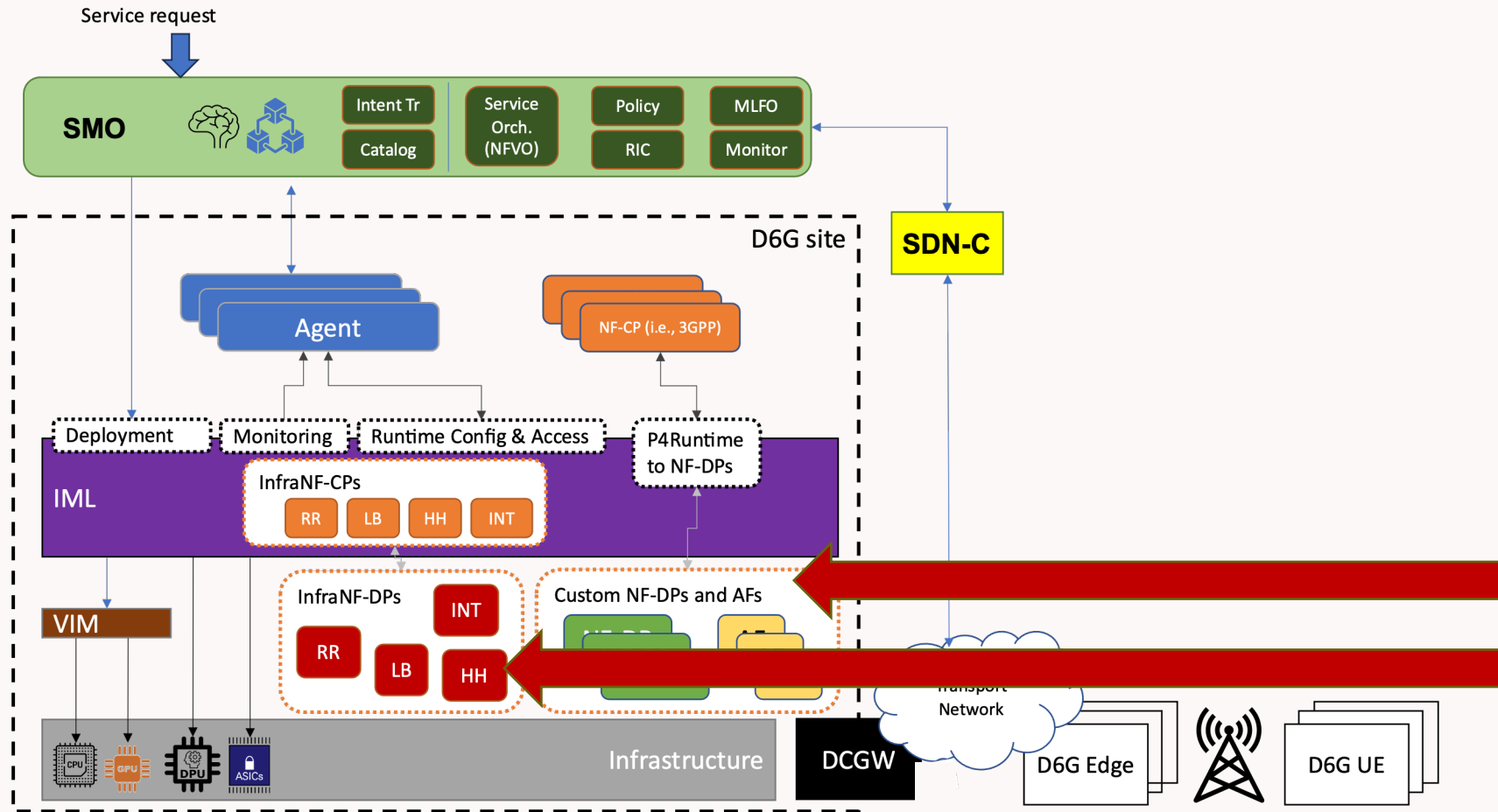
MAS enables NRT distributed control with

- local (near real-time) and
- central (orchestration - MLFO, monitor) components

Main tasks:

- Telemetry collection
- AI-driven decision making
- Actuation / reconfiguration

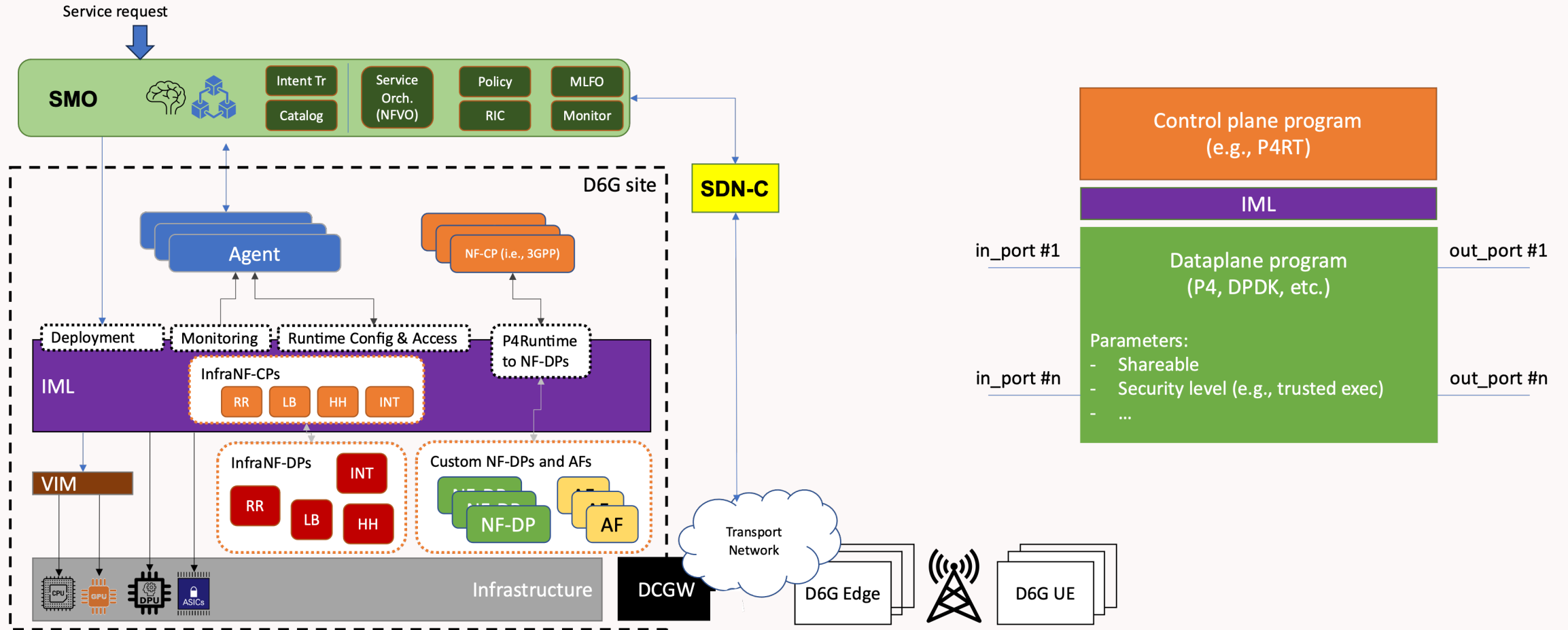
PROGRAMMABLE DATA PLANE



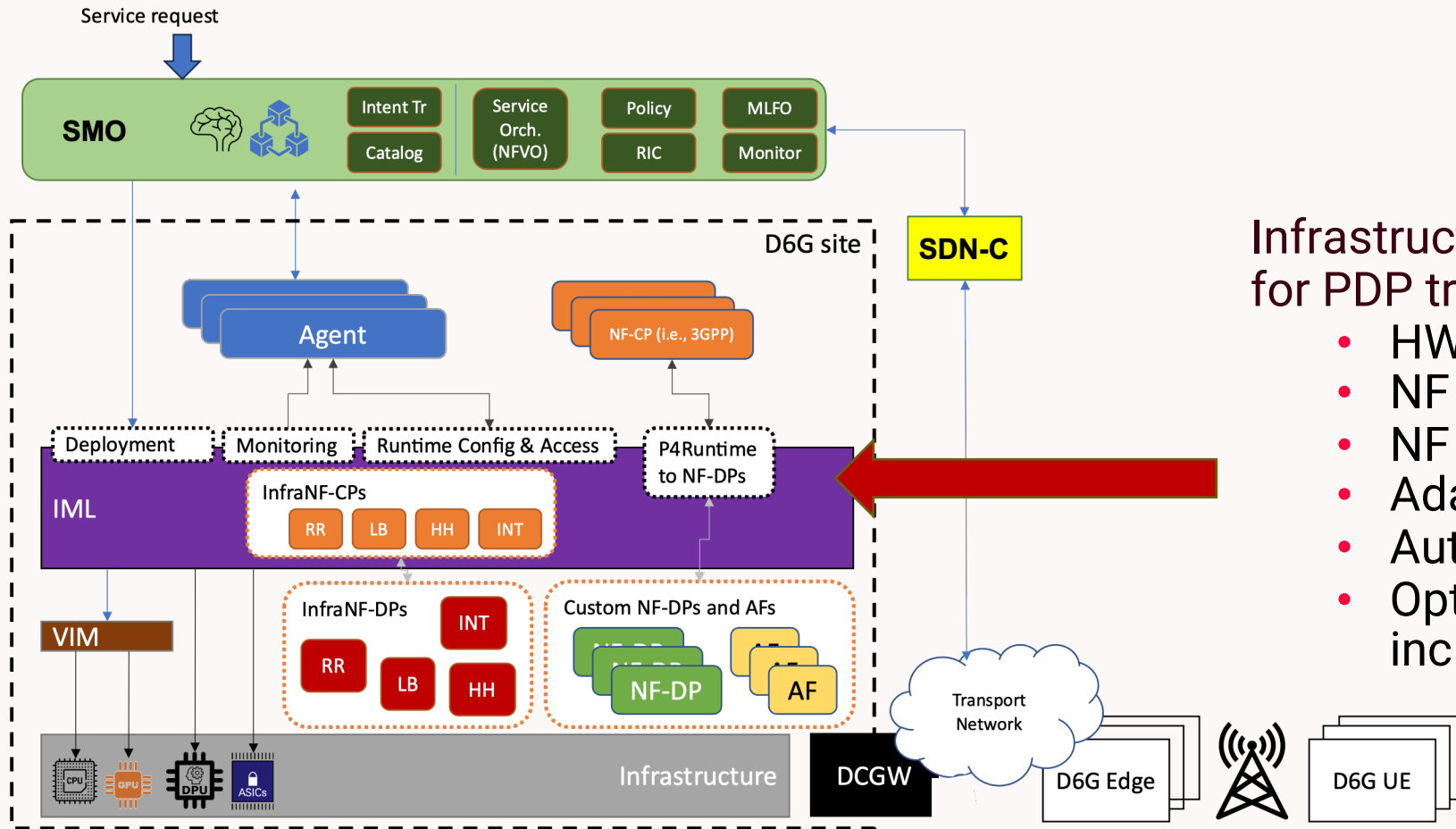
E2E programmable data plane

- Flexible, customized packet processing operations and protocol support
- Transparent hardware acceleration
- (In band) Network Telemetry

PDP: TRANSPARENCY IN DATA PLANE



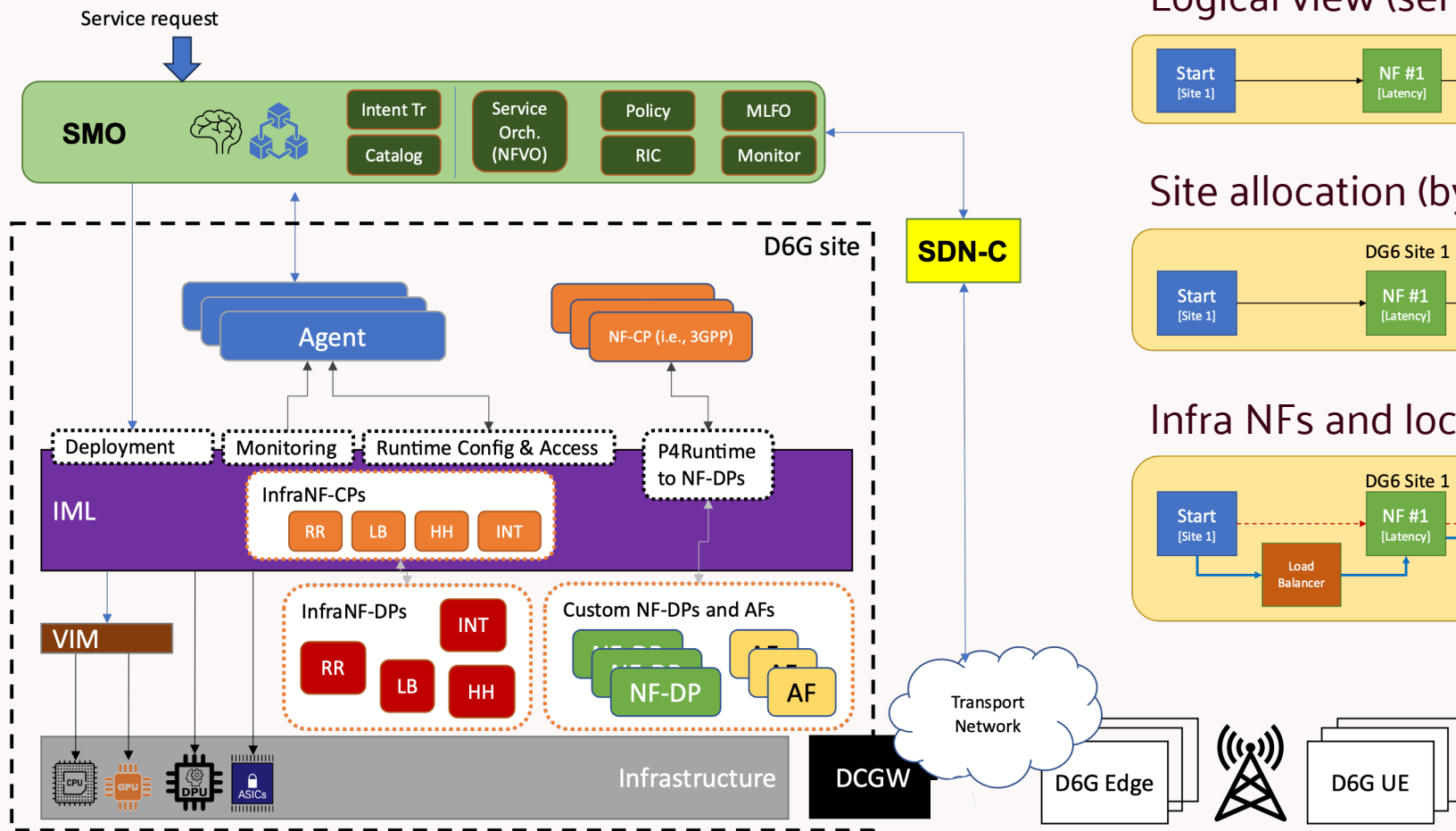
INFRASTRUCTURE MANAGEMENT LAYER



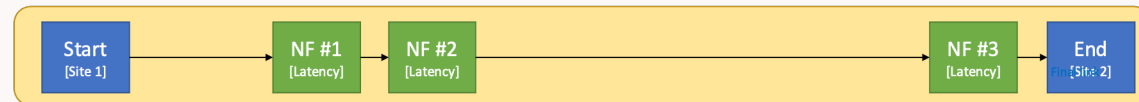
Infrastructure Management Layer: the key for PDP transparency

- HW-offload in CP-agnostic way
- NF aggregation with CP separation
- NF disaggregation
- Adaptation to non-PDP domains
- Automatic heavy-hitter offload
- Optimal routing between NF-DPs, including collocation optimization:

SERVICE DEPLOYMENT



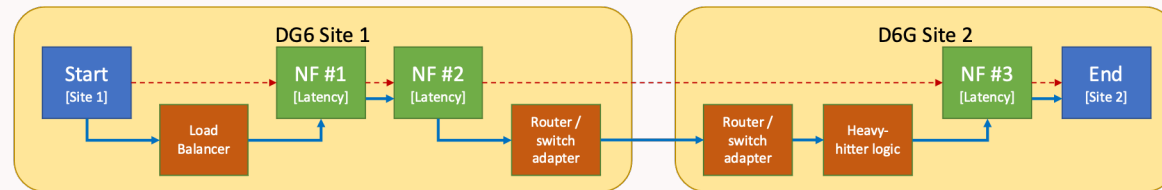
Logical view (service creation time)



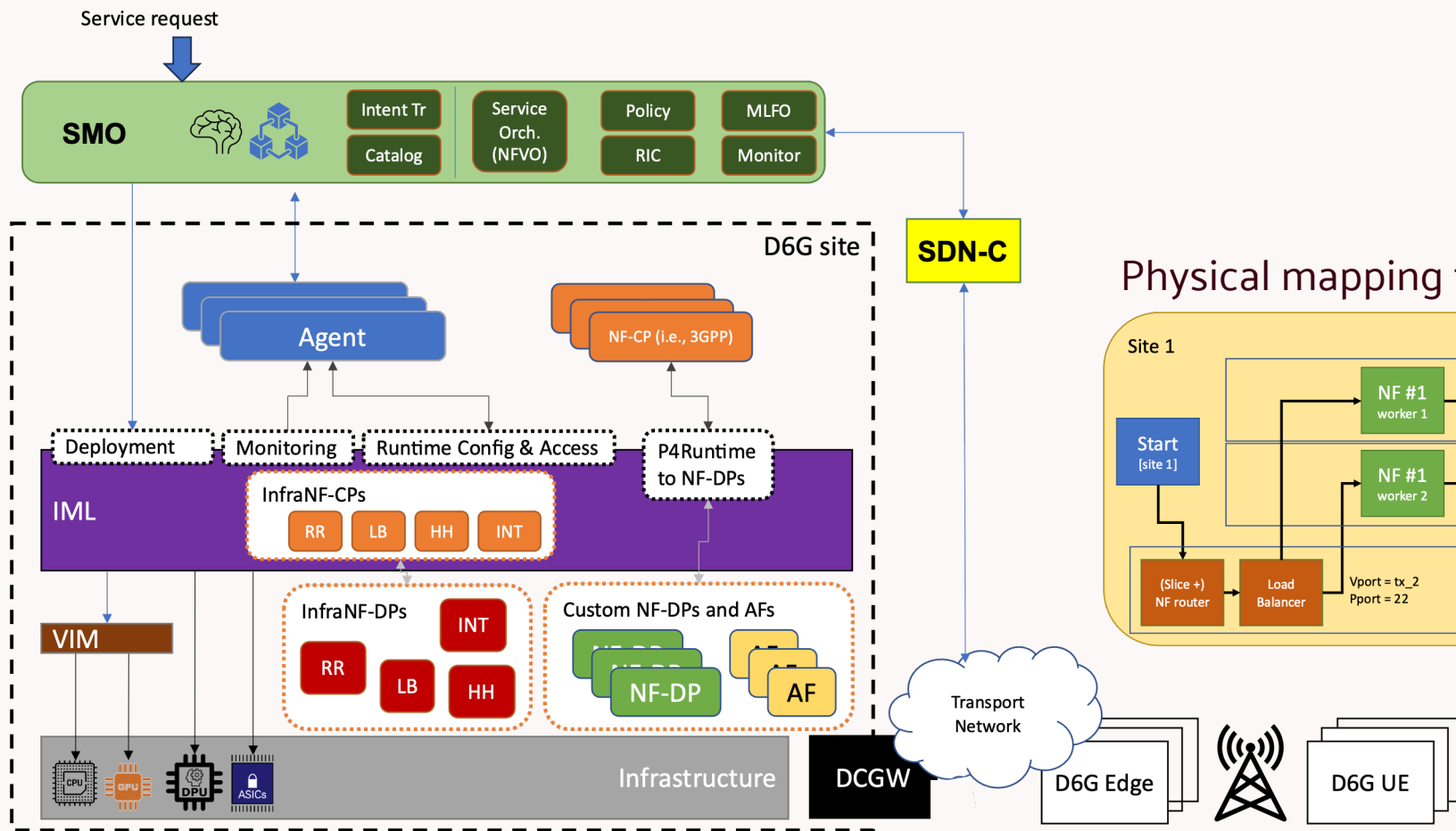
Site allocation (by SMO)



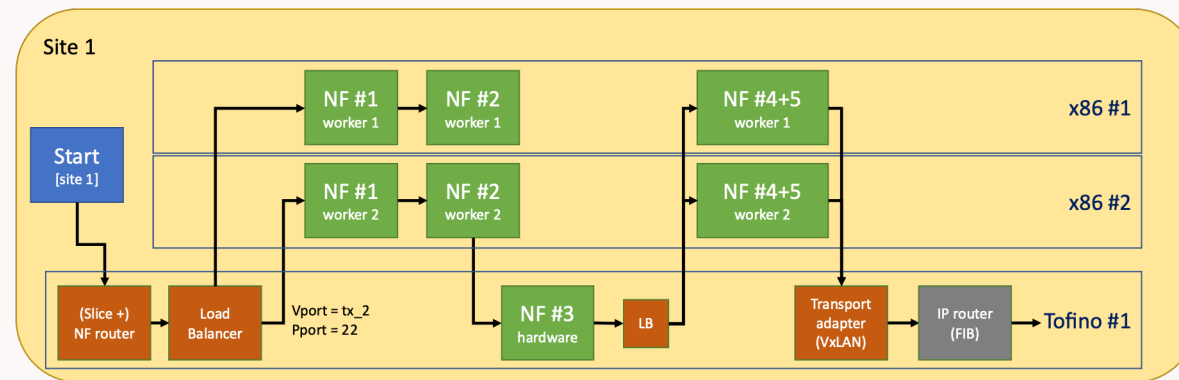
Infra NFs and local connections (by IML)



SERVICE DEPLOYMENT



Physical mapping to local resources (IML & VIM)





TOWARDS A UNIFIED CLOUD-NATIVE DATA PLANE



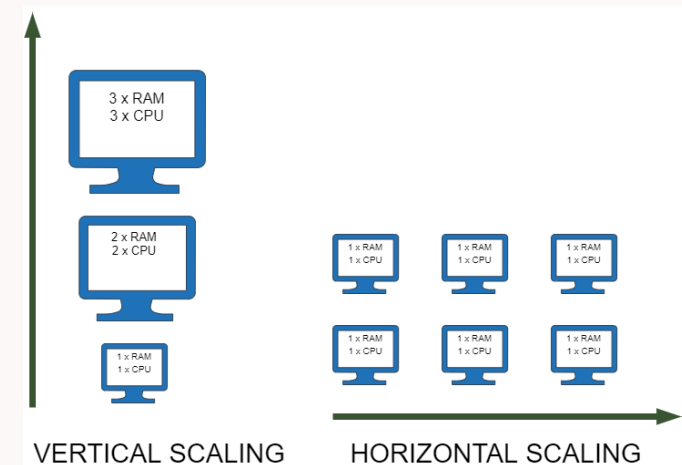
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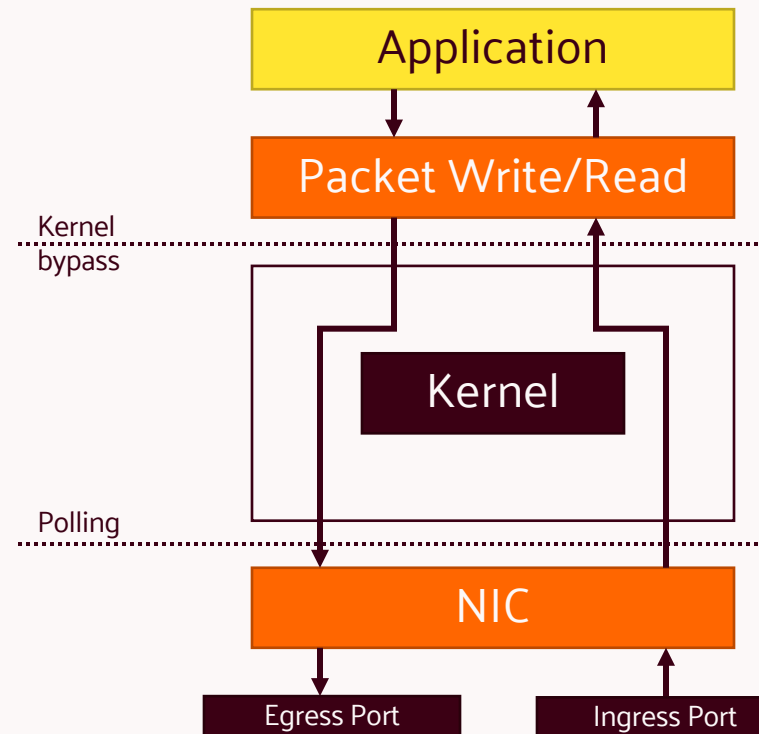
SOFTWARIZATION TREND IN PACKET CORE NETWORKS

- Delivering new functionalities
 - Timely and customized way
- Softwarized packet core
 - Packet processing in software
 - Running on commodity servers
- High flexibility and good scalability
 - Software instances can be scaled up or down
 - Network Function Virtualization

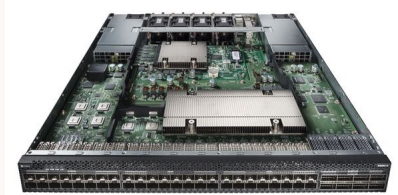
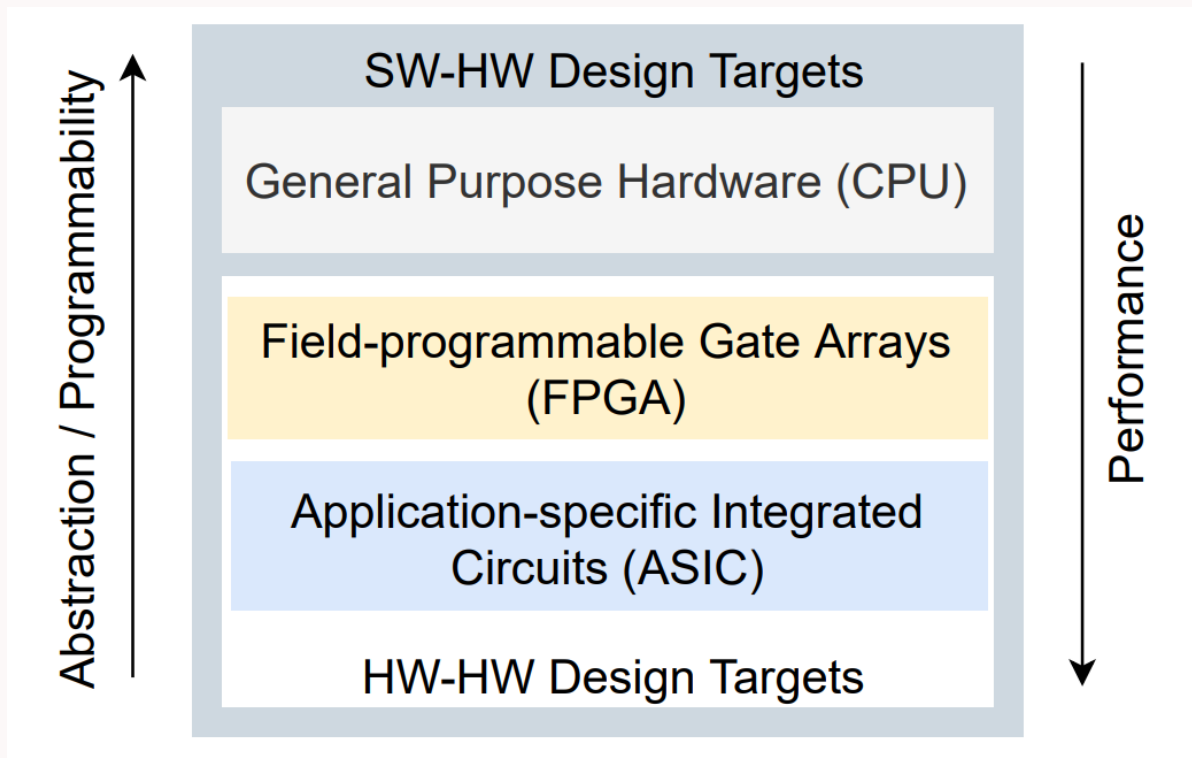


DRAWBACKS

- Unpredictable latency and problems with low latency guarantees
 - Commodity hardware not designed for packet processing
- Throughput limits
 - Several bottlenecks: PCIe speed, cache misses, memory access, etc.
- Kernel-bypass techniques
 - High performance packet processing
 - Needed for good throughput
 - Fully utilized CPU cores
 - Constantly polling NICs
- High energy consumption
 - W/pps
 - Increasing OPEX

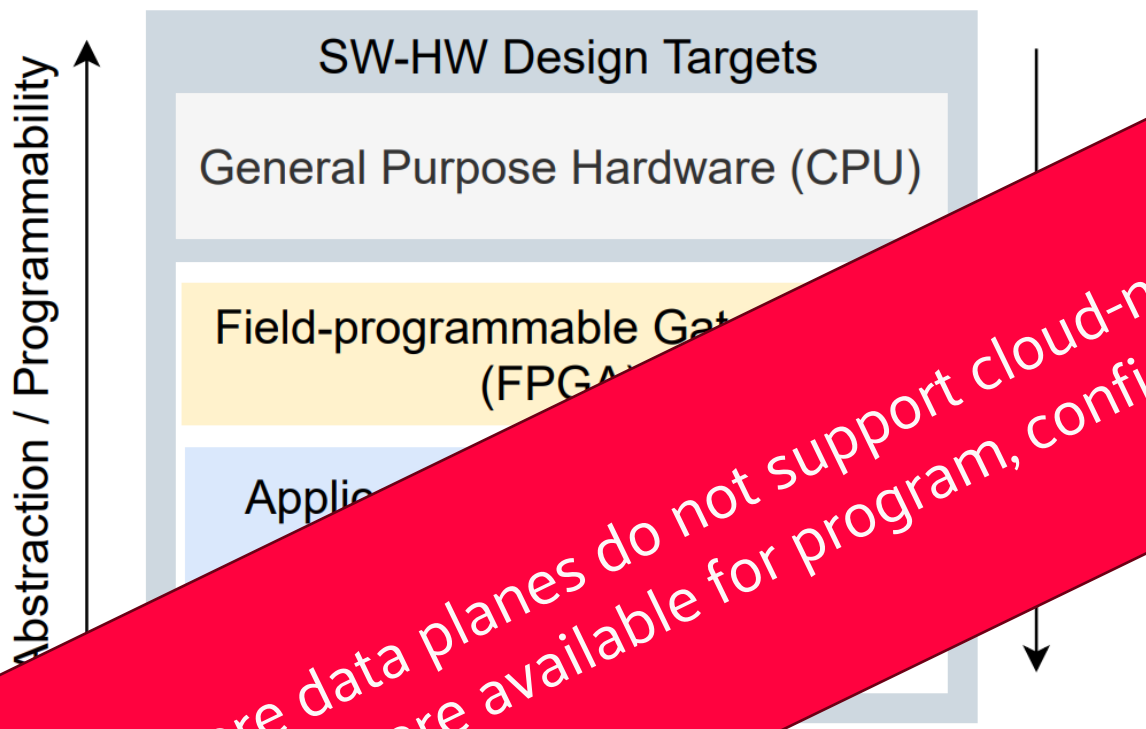


PROGRAMMABLE NETWORK DEVICES AS NF(V) BACKENDS



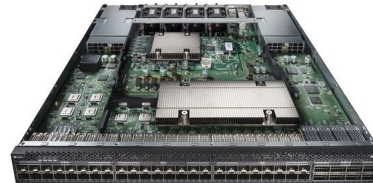
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PROGRAMMABLE NETWORK DEVICES AS NF(V) BACKENDS

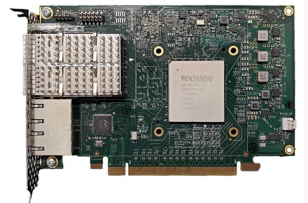


Hardware data planes do not support cloud-native integration. Only low level tools and APIs are available for program, configure and deploy network functions.

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SHARED INFRASTRUCTURE

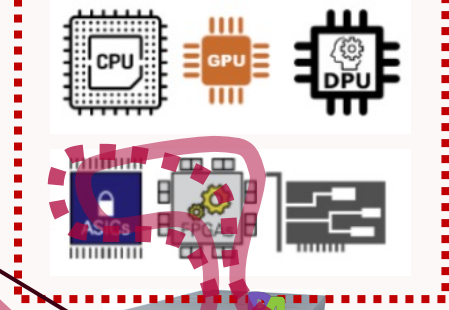
UE with high throughput demand



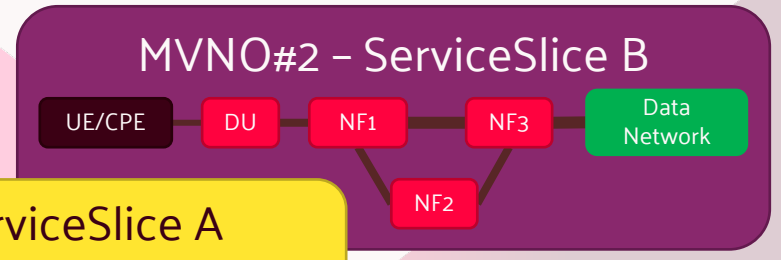
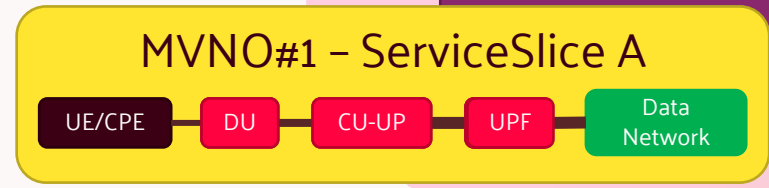
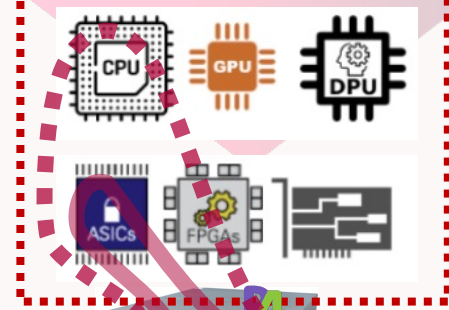
UE with low throughput demand



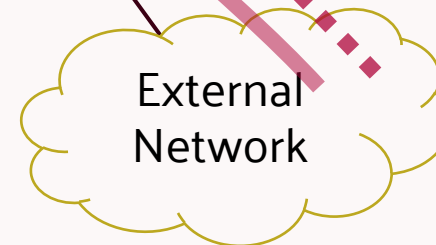
EDGE



CORE



- Network services are defined at **high abstraction level**.
- Network function implementations are **not node specific**.
- The D6G data plane hides the implementation details - introducing a **cloud-native approach for packet processing**.

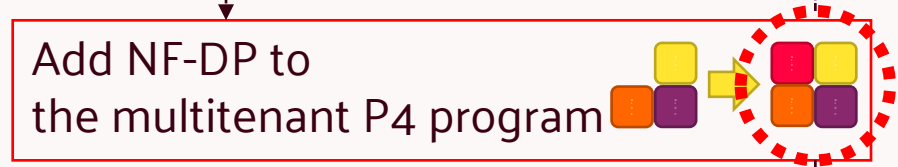


IML: A CLOUD-NATIVE DATA PLANE MANAGER

- Infrastructure Management Layer (IML)
 - A **cloud-native data plane manager**
- Provides a **simple logical view** of the data plane to control planes
- Ensures **service/slice requirements**
- Hides the underlying **implementation and optimization** details
 - Load balancing
 - Heavy hitter handling
 - Auto-scaling
 - HW offloading/acceleration
 - HW multitenancy

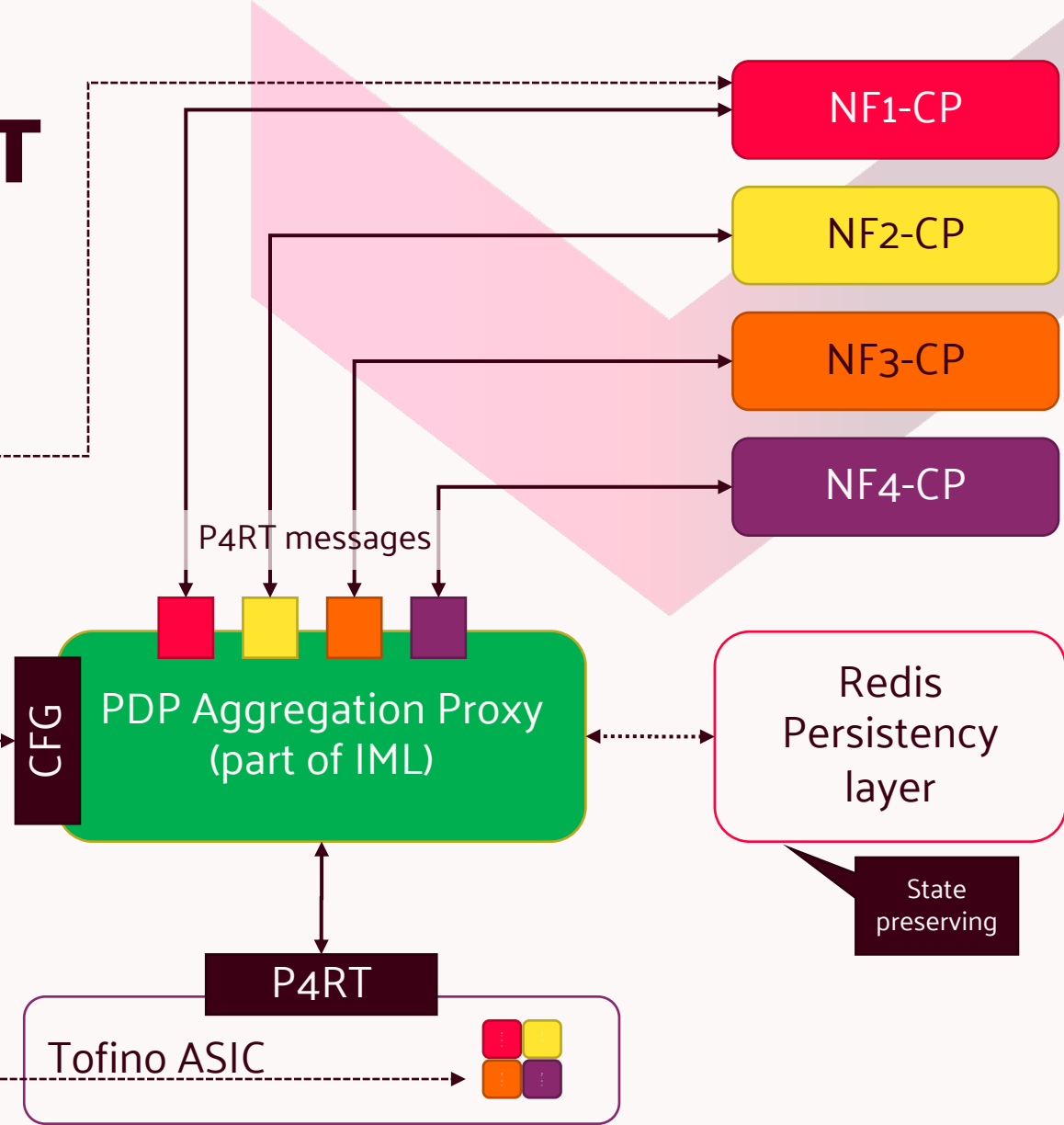
MULTITENANCY SUPPORT ON P4 TARGETS

New NF1 in NF Repository

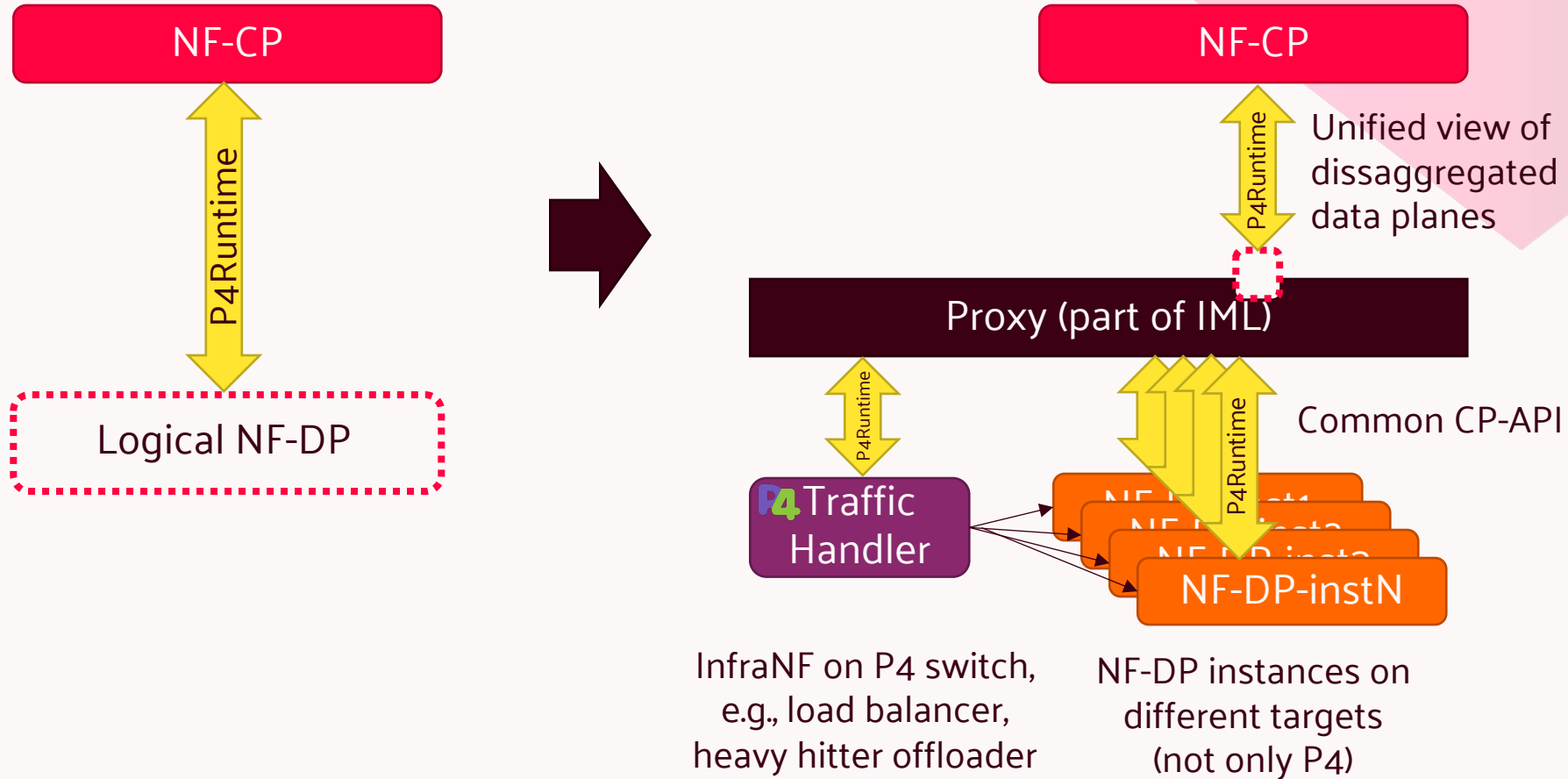


Goals:

- Shared P4 ASIC resources
- Resource/Traffic isolation (Aggregated P4 program)
- Security isolation (PDP Aggregation Proxy)



SEAMLESS LOAD BALANCING/OPTIMIZATION

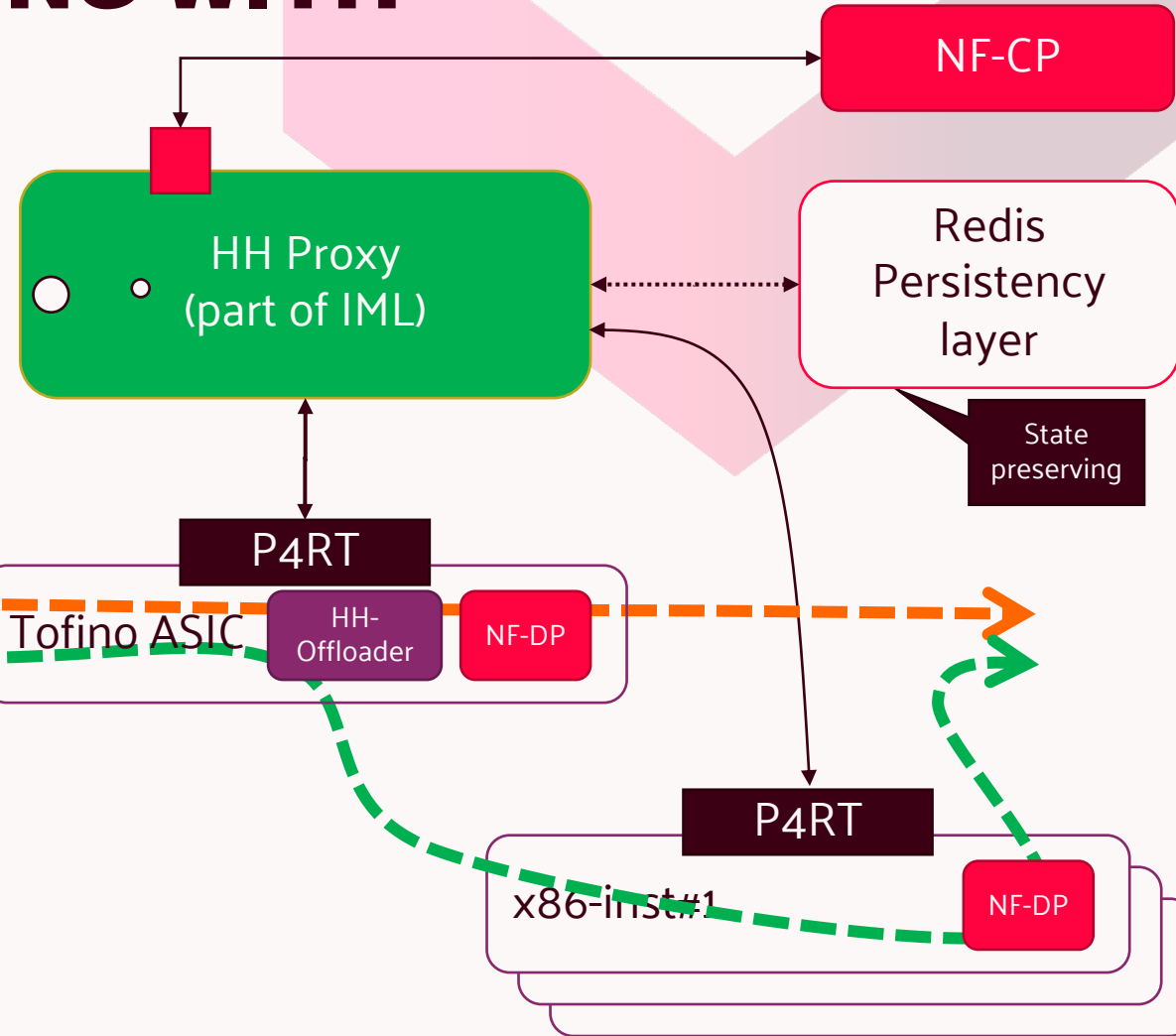


HEAVY HITTER OFFLOADING WITH HYBRID HARDWARE

Moving states from one target to another

HH User

Non-HH User



Goals:

- Heavy hitters with high throughput demand
 - Served by dedicated HW like Tofino ASIC
- Non-heavy hitters not requiring dedicated high-speed HW
- Run-time optimization needed



RUNTIME SIMPLIFICATIONS FOR 6G?

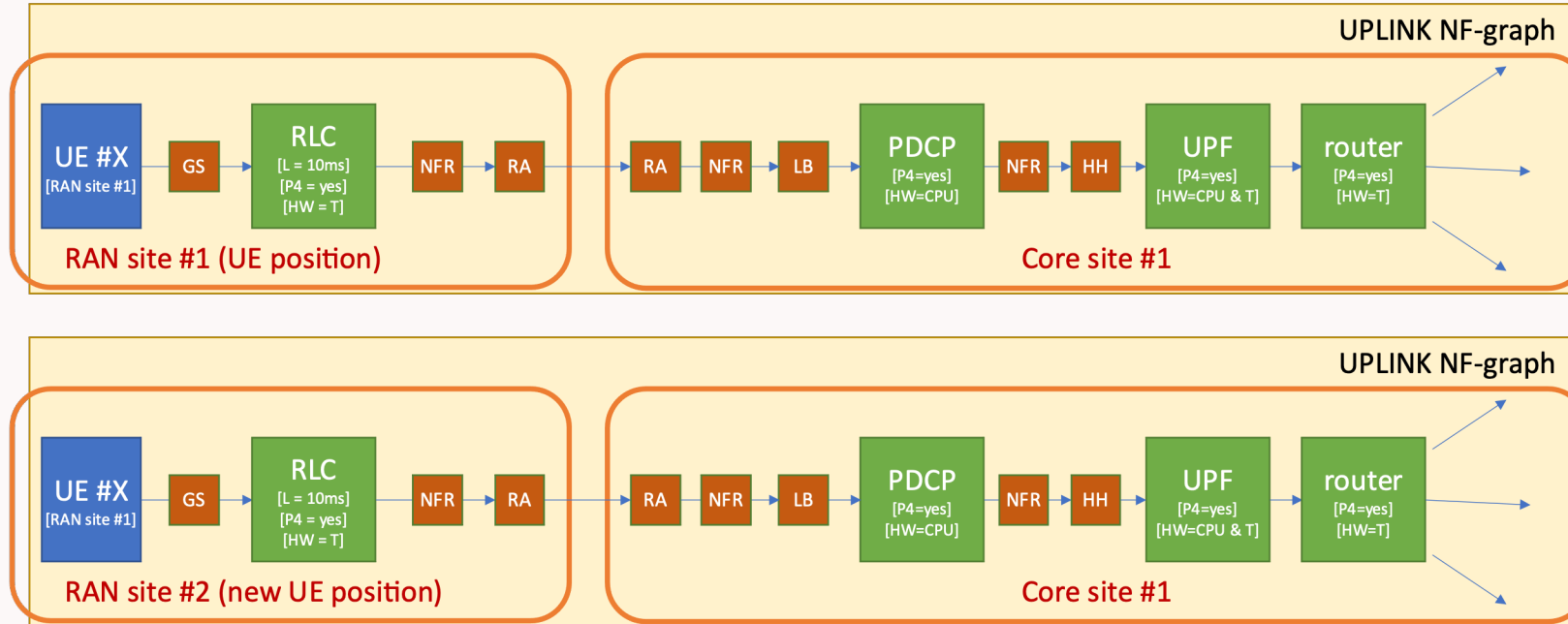


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ONE EXAMPLE: HANDOVERS



UE moves to RAN site #2: RAN sub-graph has to “follow” ← can be independent from service logic

- Uplink is usually non-critical
- Downlink: either site-site routing learns new UE position (preferred)
 - ... or it is set via CP

TAKE-AWAY

**Simplicity and high-performance: they are not necessarily enemies!
In 6G we'll need both.**

We answer the following questions:

- How to have cloud-native-like behavior also for user plane (PDP, IML)
 - Transparent acceleration
 - Automatic load balancing and heavy-hitter handling
 - These mechanisms are independent from the business logic / NF-CP
- How to maintain performance KPIs dynamically (MAS)
 - On-demand in-network telemetry
 - Multi-agent-based service optimizers
- How to offer simplicity towards users (SMO)
 - Intent-based, simple external APIs
 - Translation logic to create internal, more complex structures



THANKS!

Gergely Pongracz

email: gergely.pongracz@ericsson.com



DESIRE6G has received funding from the Smart Networks and Services Joint Undertaking (SNS JU) under the European Union's Horizon Europe research and innovation programme under Grant Agreement No 101096466. Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Commission. Neither the European Union nor the granting authority can be held responsible for them.