Network slicing: industrialization of network customization?

Christian Destré, Orange Labs Networks

Orange Expert
Future
networks

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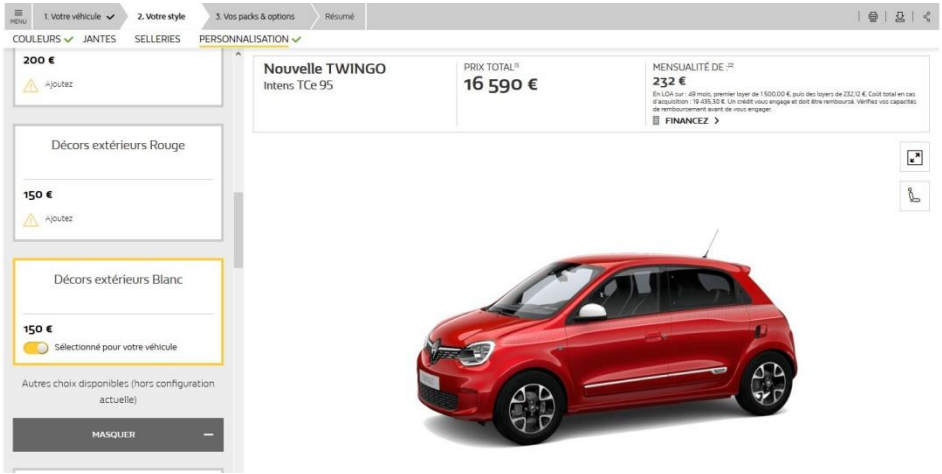
To enable mass customization



Few possible versions
Options to be added after factory production
Very few customization at factory level

Many versions (engines, interior & exterior design)
Increased customization done at factory level
Web portal to make the choice

Global trend for all industries

Network Slicing as
the network customization industrialization

Network slicing maturity is not there…yet.

- **Multiple definition of network slicing**
  - Standards: NGMN, 3GPP, GSMA…
- **It embeds lot of expectations and buzz**
  - 5G verticals relation to network slicing: business opportunities to match with technical/business realities
- **It is related to the incremental evolution of existing network technologies**
  - From 2-3-4G to 5G (Radio & Core)
  - Network transport evolution (SDN…)
- **It reminds "older" and underlying issues**
  - Multidomain network management and automation/orchestration
- **It is easy to be lost when not having a clear understanding about the slicing needs**
  - Technology is creating the need (or the opposite?)

Where are we today? Where are we going to?

OUTLINE

1. Towards network slicing: Network customization needs, existing implementations and on-going evolution

2. Automation is key to slicing: the orchestration journey

Towards network slicing: Network customization needs and related journey

We can related network customization needs to:

- **Location**
  - Connecting specific end points at given locations
  - Having full geo. coverage with mobility support
  - …
- **Network quality**
  - Throughput
  - Latency
  - Reliability
  - Security
  - …

- **Business market evolution (with their actors)**
  - B2C
  - B2B(2C)…
  - …
- **Cost**
  - Lower Marginal cost
  - New Pricing model (pay per use)
  - …
- **Agility/Flexibility**
  - Faster to deliver
  - Easy to order/change/adapt
  - …
- **…**

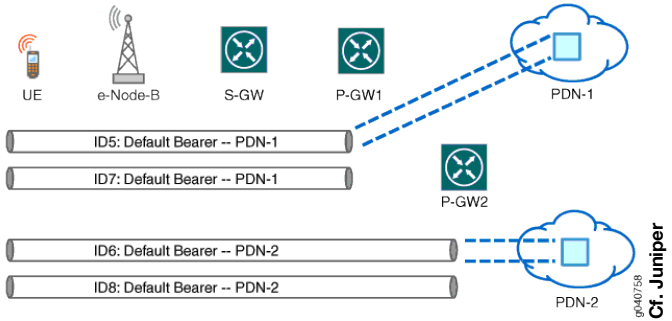
Both business and technical needs

Technological evolution is on-going:
On-demand VPN, SDWAN
Evolved Packet System (LTE+EPC)…

Example with EPS system: provide customization capabilities

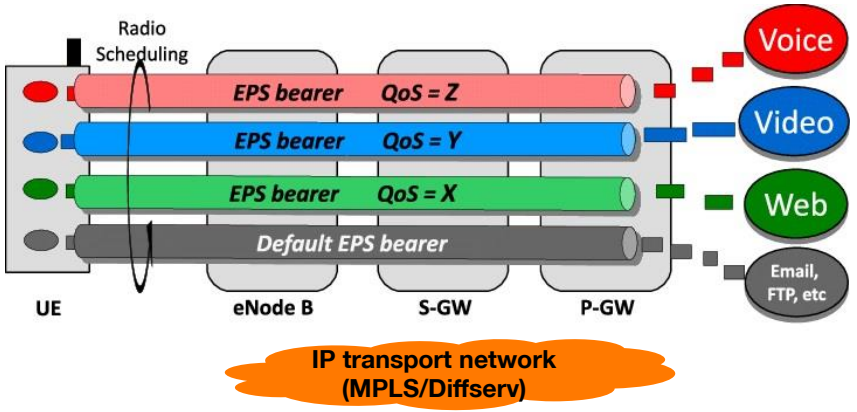
Capability to support virtual private networks:

- **Support of bearers (tunnels) to connect to Packet Data Networks (PDN)**



Capability to support various QoS:

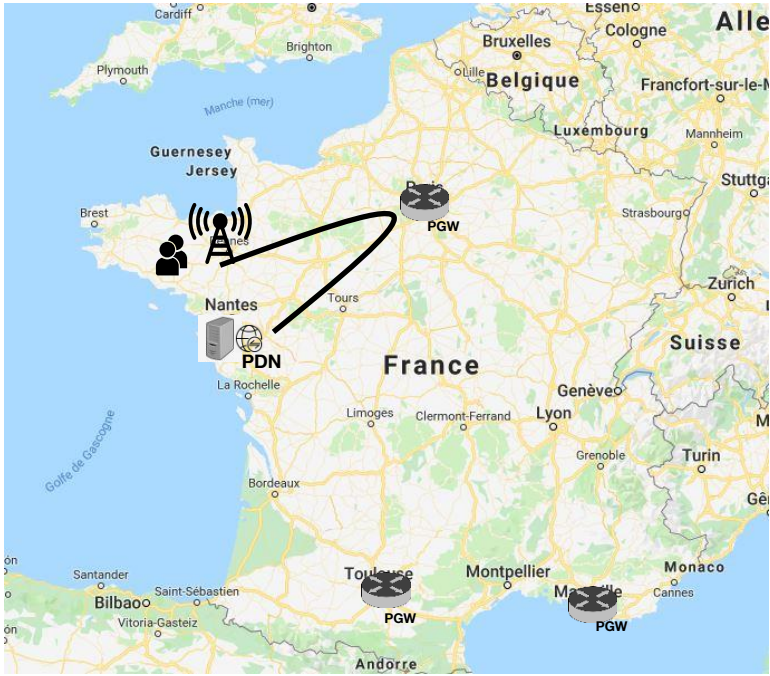
- **EPS bearer with related QoS Class Identifiers**
- **Possible mapping with underlying MPLS/Diffserv at transport network level**



Example with EPS system: limitations

Static deployment

- **Partly distributed deployment of physical/virtualised network functions (e.g. MME, PGW)**
  - Sharing EPC network for several purposes leading to traffic engineering complexity (tromboning, latency optimization)
- **EPS on top of transport network to be configured**
- **Dedicated EPC deployment for specific purposes**
  - To support specific configuration of related network functions
    - E.g. Professional Mobile Radio



With EPS it is possible to industrially provide customized network connection to users with some limitations (related to geographical distribution and automation)

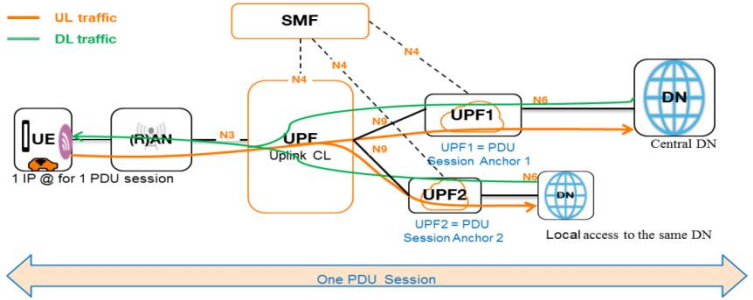
On-going evolutions for higher level of customization

Virtualisation

- **Enabling automated Lifecycle management operations of Virtualised Network Functions relying on IaaS**
- **Network (connectivity) virtualisation and automation (SDN)**

Introduction of 5G

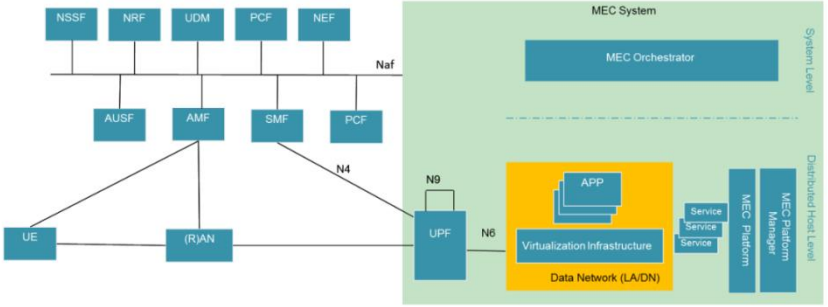
- **Wireless fiber**
- **Service Based Architecture for core control plane functions**
- **Introducing UPF for core user plane**
  - E.g. Uplink Classifier enabling **local** access to Data Network
- **Network Slicing concept at radio & core levels**



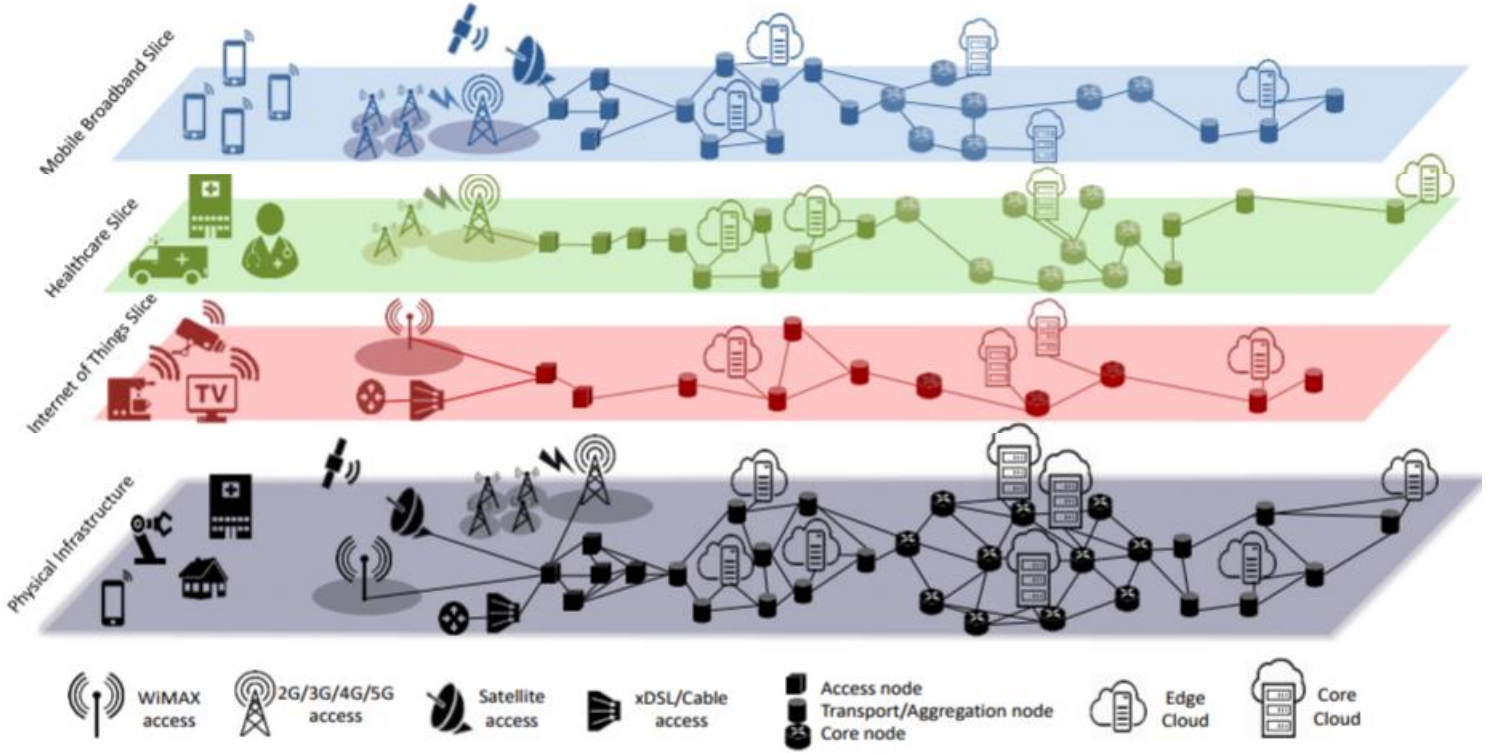
Mobile Edge Computing

- **Capability to host application at the edge**
  - Telecom Operator own application
  - User application

More flexibility for geographical distribution with local access to platform answering the need for latency/customization



Network slicing global view



How to manage the slice lifecycle management on top of underlying technology , with automation?

Network slicing requiring automation: the orchestration journey

The journey of Network slicing

Today: static 4G/5G pre-slicing
+ 5G radio, EPS, IaaS, MEC

Tomorrow: static/semi-dynamic 5G slicing
+ 5G Core, Preconfigured slices, SDN for WAN

Target: Dynamic 5G slicing
+ Network Slice as a Service, Telco-Cloud Native Infra.

Automation/orchestration is a key enabler

What to be orchestrated in the context of 5G 1/2

Some high level hypothesis regarding the 5G services:

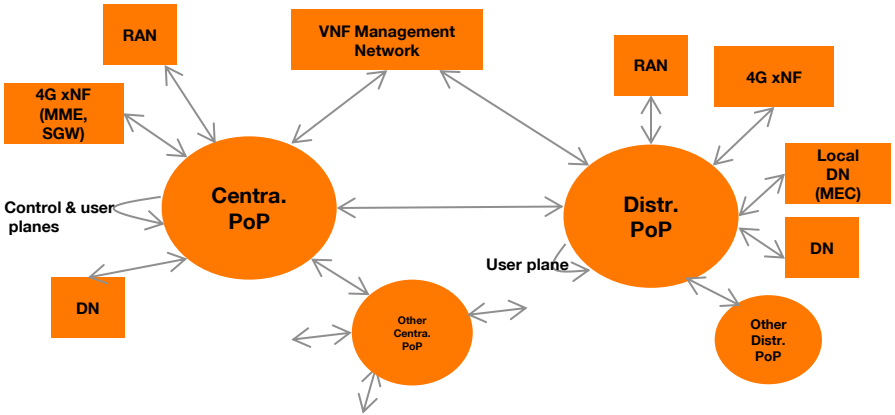
- **eMBB services: similar (and virtualised) geographical deployment to 4G/EPC services for broadband with increased throughput and increased traffic dynamicity (to support local events)**
  - MultiPoP deployment with centralized and distributed PoPs
  - Support for UPF with close CDN interconnection, static use of Mobile Edge Computing platform
  - Interworking with 4G that implies to consider connection with both 5GC and EPC networks
- **URLLC services:**
  - Reliability: specific RAN configuration + specific network connectivity (dual connectivity, redundancy up to transport networks)
  - Latency: deployment with local PoP, dynamic use of Mobile Edge Computing platforms with PoP local data networks

What to be orchestrated in the context of 5G 2/2

From IaaS/WAN point of view, we need to deploy all VNFs and set the required connectivity

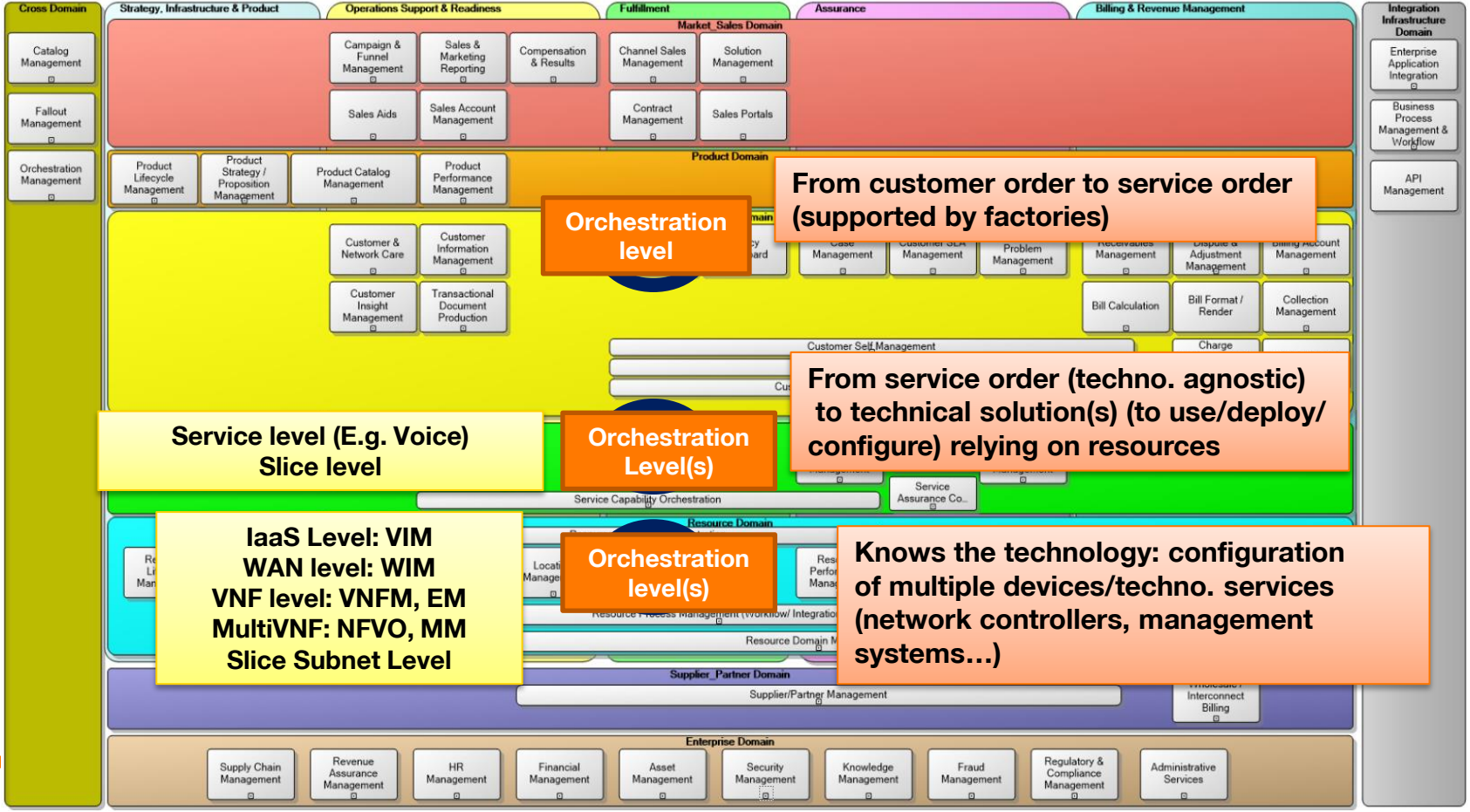
Illustration of a 5G deployment using basic hypothesis with geographical distribution for present day:

- **eMBB deployment using 2 types of IaaS PoPs: centralized, distributed**
  - 2-3 Centralized PoPs: one PoP per region and it comprises all control and user plane VNFs
  - 3-4 Distributed PoPs: each PoP contains user plane VNFs (covering UPF & PGW-U functions) with connection to local CDN/MEC
- **URLLC deployment using 3 types of IaaS PoPs: centralized, distributed and local**
  - Adding higher number of local PoPs containing user plane VNFs (UPF) with access to local Mobile Edge Computing
- **Illustration of flow matrix to be deployed related to 5G VNF**



Reality: Multiple levels of orchestration (example for delivery process)

TMF TAM



Several orchestration levels to consider 1/5

Orchestration at IaaS and WAN level	Present situation
Orchestration/VIM per PoP	First iterations are deployed Challenge to support carrier grade user plane performance on multi-purpose infrastructure Facing security requirements (regulation) On-going technology evolution of related software stack (Openstack -> Kubernetes with telco design…)
Orchestration at Network transport/WAN level/WIM for the interVIM/PoP network management	Network management with legacy technology not fully automated 5G E2E slicing SLA would justify for more automation (e.g. WAN-SDN controller) New technology to support URLLC slices to be considered (FlexE, Segment Routing…) Orchestration on top of multiple WAN/IaaS controllers instances to be considered such as ONAP (still to be proven as not implemented yet)

Several orchestration levels to consider 2/5

Orchestration at VNF level	Present situation
VNFM for VNF virtualised resource lifecycle management	Usually provided by VNF vendor for complex VNF, with integrated Element Management Could be partially supported with opensource tool such as HEAT Complexity related to the VNF software design not being cloud native Generic VNFM still a target (ONAP?)
Element Management for VNF application management (FCAPS)	Usually provided by VNF vendor for complex VNF It has the knowledge on how to configure application Used by operations for managing the Network Function (e.g. backup/restore, log …) Present approach is to have model based configuration (e.g. YANG) with open API/protocol at VNF level and monitoring with open interface ONAP solution could cover all the needs, but requires vendor adoption with related implementation

Several orchestration levels to consider 3/5

Orchestration at MultiVNF level (5G RAN and 5G Core levels)	Present situation
NFVO (on top of VIMs and WIM/Network transport/WAN orchestration and VNF levels)	Tightly related to the network operator business (integration of IaaS, WAN with resource orchestration) Requires a specific product: opensource (e.g. OSM) and proprietary products exist: difficult choice as Should be integrated with MultiVNF Management (e.g. ONAP) ONAP still to implement NFVO logic
MultiVNF Management (FCAPS)	Can be provided by a same VNF vendor for complex VNF (in addition to Element Management) If not provided, logic to be coded that requires a platform for supporting FCAPS (ONAP as candidate but to be assessed)

Several orchestration levels to consider 4/5

Orchestration at Network slicing level	Present situation
5G Network slice management	3GPP release 16 with introduction of Slice Management Functions On top of previous levels No implementation yet
Network Slice as a Service	Still not clear the user side of the slice management Question about the management tooling sharing between operator and user

Several orchestration levels to consider 5/5

Orchestration at CI/CD level	Present situation
CI/CD for all levels	Managing testing, integration with all the releases of VNF/IaaS/Service/Slice… is a challenge (transformation with RACI evolution, technological choices and evolution) Starting with IaaS & VNF levels

Orchestration at MEC level	Present situation
MEC application management	MEC application could be owned by users MEC orchestration vs other level? (MEC application as VNF not owned by the operator?)

Enabling slicing is to implement/enable all the underlying levels:
The journey is just beginning (for us)

Implementation considerations 1/2

For each level, implementation is required

- **No magic in orchestration: we have to code somewhere, to tell the machine what to do**
  - Using models is not enough, we need algorithms/engines and related implementation to benefit from modeling
    - e.g. TOSCA requiring orchestration engines, BPMN requiring coded tasks, Controllers to know the logic about what they have to do
- **Many of the orchestration levels are tightly related:**
  - Definition of interfaces and reliable APIs (divide and conquer)
  - BUT common design and elements to consider (inventory, communication bus, closed loop operation at several levels, how would it be operated?)
  - Overall CI/CD to consider: every element will evolve and thus it should be designed accordingly

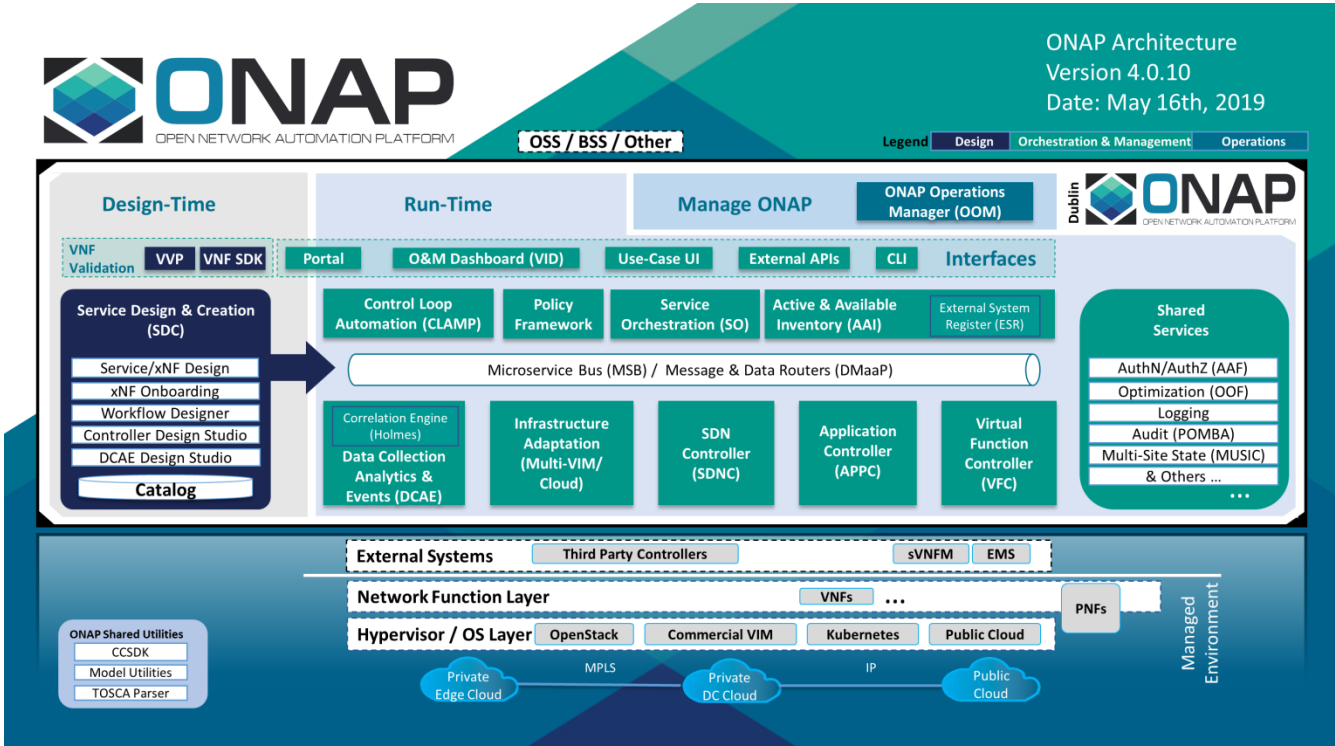
Implementation considerations 2/2

ONAP platform is appealing for implementation but:

- Facing centralized management vs distributed networking
- Are we creating a management “monster” or is it mandatory to support our overall transformation?

One instance for all?

- **VNF management**
- **MultiVNF management**
- **Service management**
- **Slice management**
- **…?**



Conclusions

Slicing is related to the industrialization of network customization

- It is part of a journey that already started long time ago
- Business slicing needs are not fully stated yet
- Existing technologies can support some of the existing needs (pre-slicing)

Orchestration/automation is critical to slicing

- Relies on many levels that are still at early stage or not fully implemented or need to be strengthened
- It should cope with operational requirements (RACI, security, CI/CD, FCAPS)

Slice as a Service and user slice management capabilities to be identified

thanks