Network Slices for Vertical Industries

The First Workshop on Control and Management of Vertical Slicing Including the Edge and Fog Systems (COMPASS)

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Overview

- Motivation
- 5G-TRANSFORMER system
- Vertical service descriptions
- Translation to network slices
- Arbitration
- Summary

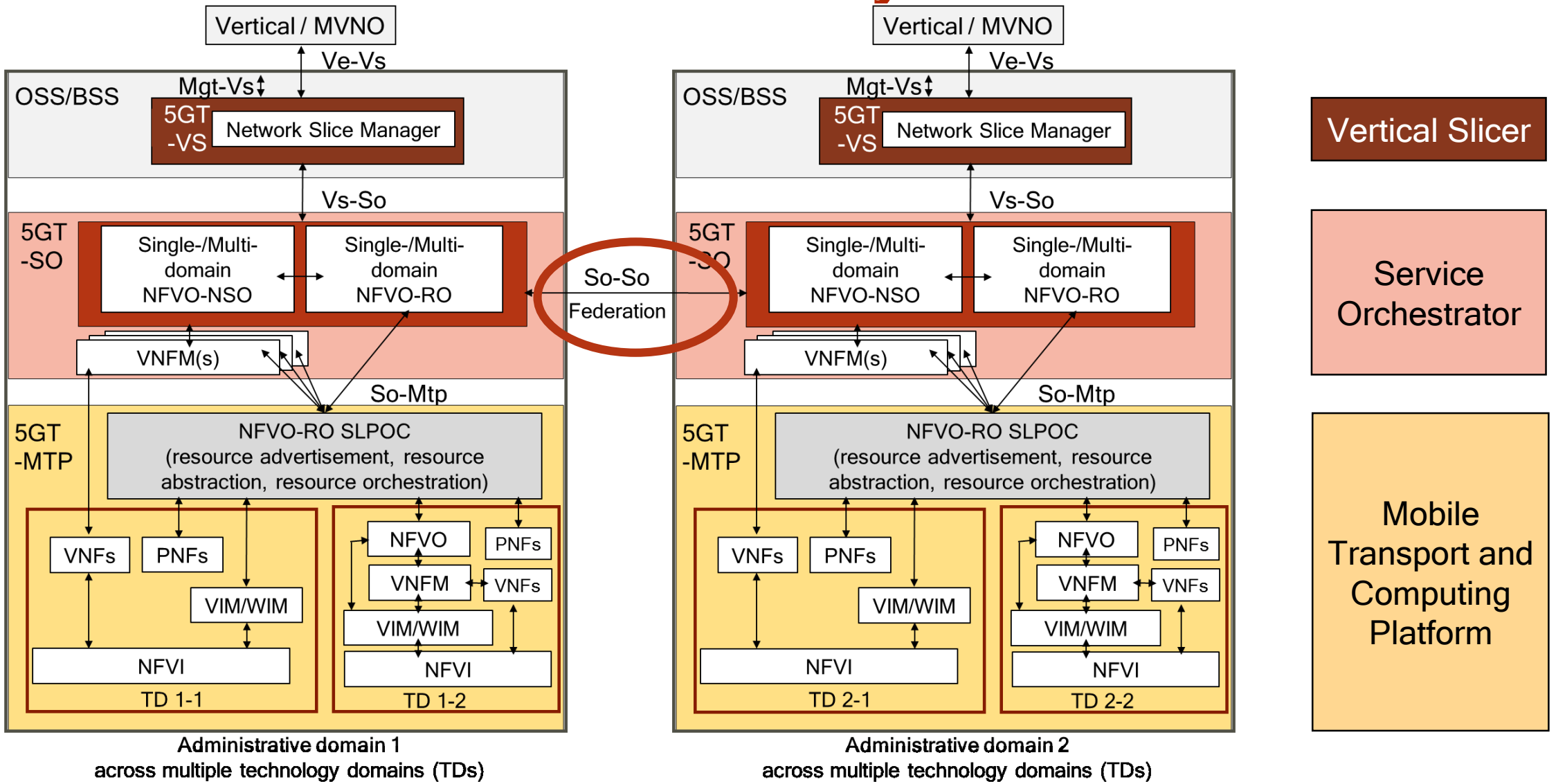
Motivation

- 5G networks provide different service types
  - eMBB enhanced mobile broadBand
  - mIoT massive IoT
  - URLLC ultra-reliable low-latency communication
- Different service types require different deployments
  - Create several logical networks on common physical infrastructure
  - ➔ network slices
- (eMBB), mIoT, and URLLC enable the creation of new services
  - Provided by vertical industries (automotive, eHealth, smart city, …)
  - Hundreds, thousands, … of service instances
  - Communication service extended with applications provided by verticals
  - ➔ vertical service

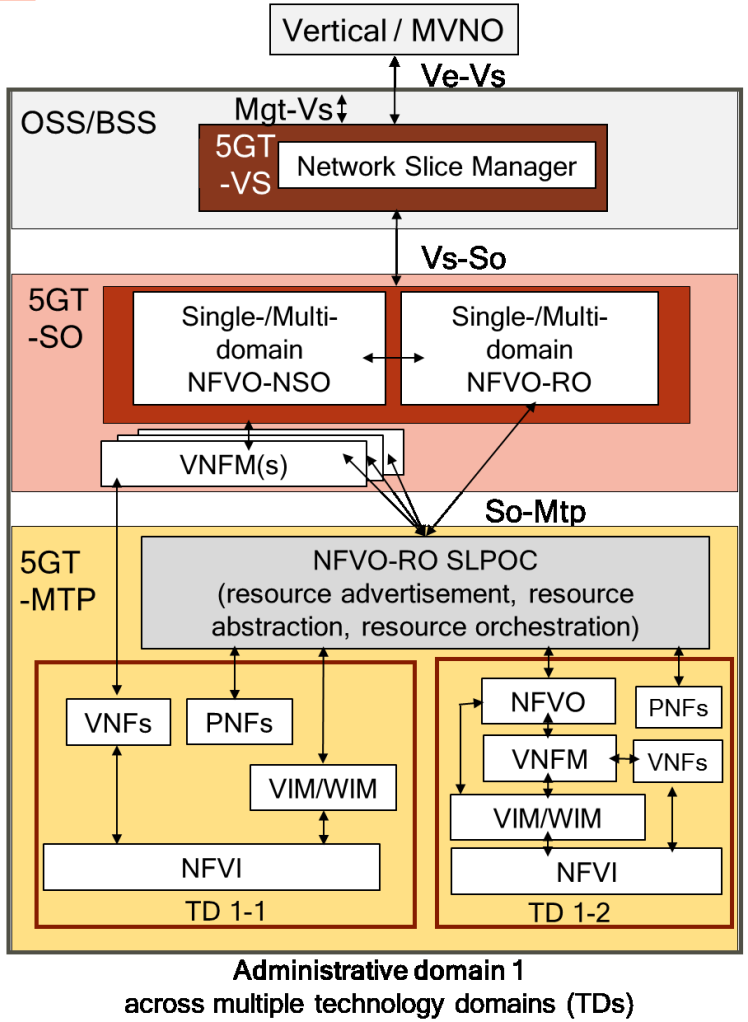
Motivation (contd.)

- Verticals are experts in their application domain
  - Assumption: less knowledgeable in creating and orchestrating network slice for their specific service
  - Intersection collision avoidance (automotive), onsite live experience (entertainment), emergency response in case of heart attack (eHealth), control of production plant (eIndustry), …
- Create a platform that allows verticals to focus on the service to be provided
  - Creation and orchestration of network slices handled by the platform

5G-TRANSFORMER system architecture



5G-TRANSFORMER Components



Vertical Slicer

- Common entry for all verticals
- Definition of vertical services and SLAs
- Mapping to network slices,
- Arbitration

Service Orchestrator

- End-to-end orchestration of network slices
- Federation

Mobile Transport and Computing Platform

- Orchestration of resources
- Manages network, compute, storage infrastructure
- Infrastructures: cloud/MEC datacenter, 5G AN/CN, …
- Provides different abstractions

Vertical Service Descriptions

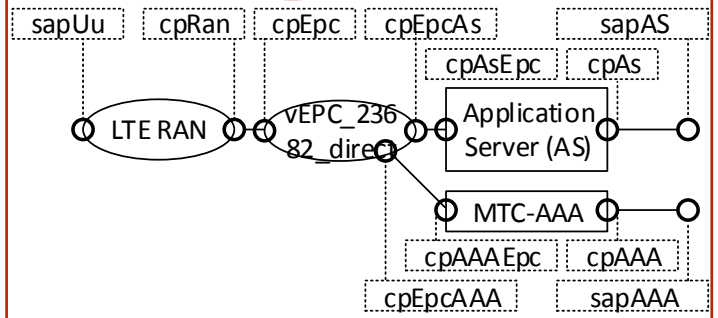
- Vertical Service Blueprint
  - Incomplete description of a vertical service
    - Required latency, throughput, …
    - Coverage area
    - VM image of vertical application
  - Created by 5G-TRANSFORMER service provider
- Vertical Service Descriptor
  - Complete description of vertical service
  - Multiple instances of same vertical service possible
- Network Service Descriptor (ETSI NFV)
  - n:m relation to vertical service instances
  - Used as network slice template
  - Passed to 5GT-SO

Missing information provided by vertical

VSD/NSD Translator, Arbitrator

Vertical Service Blueprint

Field	Description
Name	LTE Sensor Monitoring
Description	… reference architecture in 3GPP 23.682, indirect mode. … application server and AAA server are provided by the vertical.
Version	1.0
Identity	Xyz4711_bp
Parameters	<**coverageArea**, Coordinates, “LTE coverage area”, Service Constraints/Geographical area> <**sapLocation**, Coordinate, “Location of SAP”, Service Constraints/sapAS Location> <**deviceAmount**, Int, “amount of sensors”, SLA/sapUu> <**msgRate**, Int, “sensor msg rate”, SLA/sapUu> <**msgSize**, …>, <**aggregatedBw**, …> <**asVM**, URL, “location of AS VM”, functional component/as/image”> <**aaaVM**, …>

Field	Description
Atomic functional components involved	vEPC_23682_indirect, 4GRAN, MTC-AAA, AS
Service sequence	
Connectivity service	sapAS - cpAs, sapAAA - cpAAA, cpAsEpc – cpEpcAs, cpAAAEpc - cpEpcAAA: L3VPN sapUu: 4G
External interconnection	sapAS, sapAAA, sapUu
Internal interconnection	n/a (no other services, except those listed already are needed)

Vertical Service Blueprint

Field	Description
SST	n/a (see the field SLA instead)
Service constraints	Geographical area: **<<Coordinates describing the plant boundary>>** sapAs location: **<<MetroArea of this sap>>** Security: low Priority: medium …
Mgmt and control for tenant	Provider managed
SLA	sapUu: **<<N>>** devices with **<<rate>>**msg/min of **<<size>>**B. cpAs: **<<bwAs>>**bps cpAAA: 10Mbps latency sapUu – cpAsEpc: 50ms latency sapUu – cpAAAEpc: 50ms

Field	Description
Number of Application servers.	n/a (provided by Translator)
Images of virtual applications.	vmAS: **<<urlAS>>**
Virtual application connection end points	cpAsEpc, cpAs
Lifecycle operations	To be defined
Scaling rules	Scale out: 80% load, Scale in: 60% load

Vertical Service Descriptor

Field	Description
Name	LorryMovement_ConstructionSite_Ulm
Description	The position of lorries on a big construction site in Ulm are monitored
Version	1.1
Blueprint	Xyz4711_bp
Identity	Abc0815_vsd

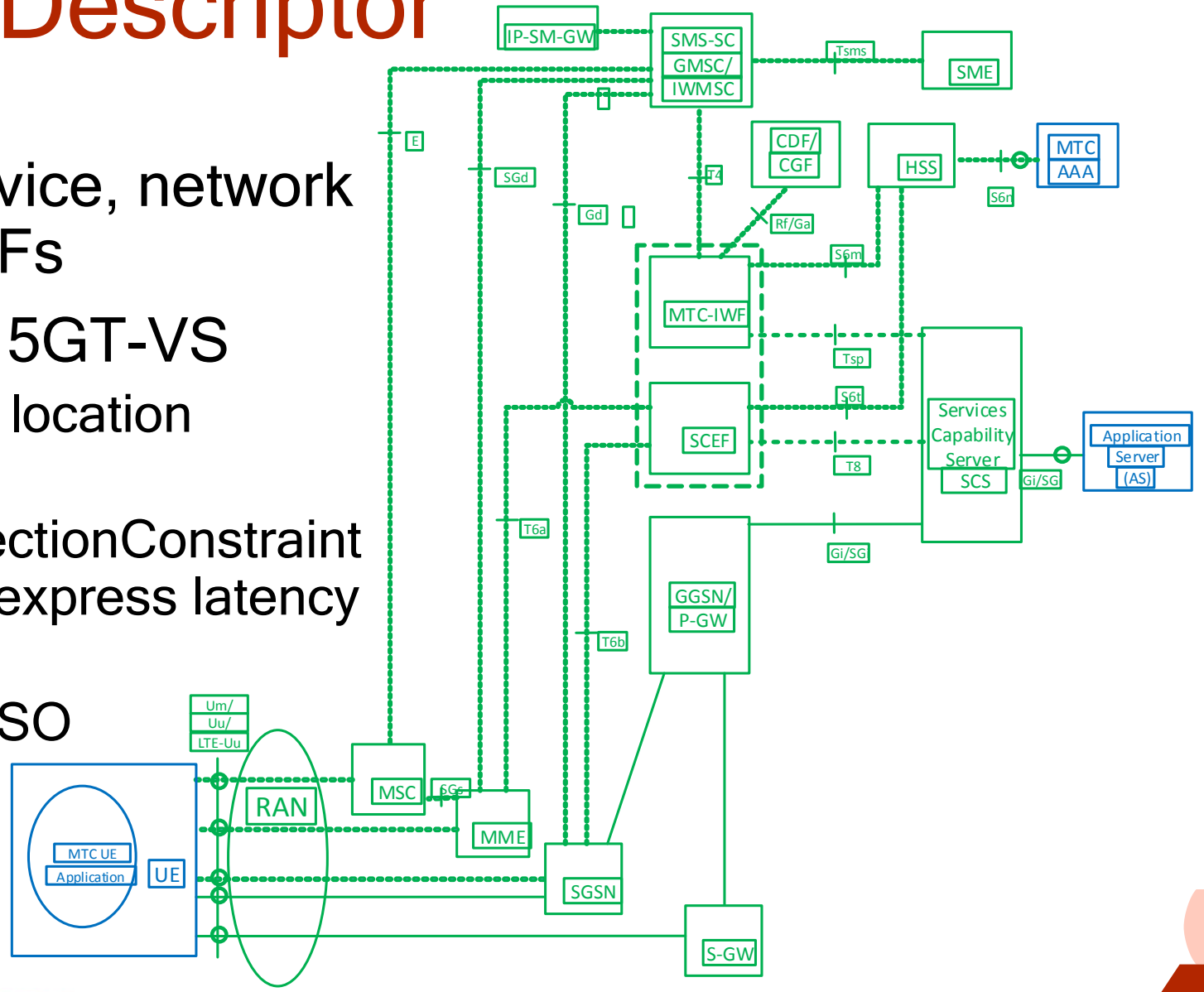
Field	Description
SST	n/a …
Service constraints	Geographical area: **city area of Ulm and surroundings** sapAs location: **Region_Ulm** Security: low Priority: medium …
Mgmt and control for tenant	Provider managed
SLA	sapUu: **500** devices with **1**msg/min of **200**B. cpAs: **1G**bps cpAAA: 10Mbps latency sapUu – cpAsEpc: 50ms latency sapUu – cpAAAEpc: 50ms

Translator/Arbitrator

- Map vertical service to network slice
- NFV NSD used as network slice template
  - Structural information in VSD is similar to NSDs
  - Cardinalities, availability, …
- Additional decisions to take (Arbitrator)
  - Map to existing network slice or create new one?
    - Isolation requirement
    - Sensor monitoring example: security: low
    - ➔several instances in same NSI, even of different verticals
  - Map (composed) vertical service to one or to several network slices?
    - Same or different lifecycle of parent/child VSDs?
    - Isolation requirements
    - Describe connectivity among network slice instances

Network Service Descriptor

- Even for simple vertical service, network slice may contain many VNFs
- No placement decisions by 5GT-VS
  - Enhance SAP definition with location information
  - Enhance pointToPointConnectionConstraint with endpoint information to express latency constraint along path
  - Placement decision by 5GT-SO



Arbitration

- Resources are limited
  - Bandwidth, storage, processing capacity, …
  - Some vertical services might not get all the resources they need
  - Provide resources to high-priority vertical services, accept KPI degradation for low-priority ones
- Vertical and provider agree on resource budget
  - Assign priorities to vertical service instances
  - Assign resources to high-priority services of the vertical
  - Arbitrator encodes this assignment in deployment flavours of NSDs
  - Arbitrator may modify NSD computed by Translator
  - Reassignment when vertical services are instantiated or terminated
- 5GT-SO scales vertical services within the limits of deployment flavours
  - Unaware of priorities

Arbitration (contd.)

- Storage/memory
  - Assign according priority
- Processing/bandwidth
  - Focus on **service latency**
    - Processing time in VNFs
    - Network travel time
  - Service latency depends on future placement by 5GT-SO
- Extend NSD with deployment flavours for best and worst case
- At vertical service instantiation
  - Default DF: worst case
  - Optional DF: best case

- Best case deployment flavour
  - VNFs deployed to **same server**, **zero network travel time**
  - Sufficient logical cores, such that processing time satisfies latency requirement
- Worst case deployment flavour
  - VNFs deployed to **different servers**, **non-zero network travel time**
  - Sufficient logical cores and bandwidth, such that processing plus network travel time satisfies latency requirement

Summary and Outlook

- Different descriptions and main components of the 5GT-VS have been presented
  - Vertical service blueprints and descriptors, network service descriptors
  - Translator, Arbitrator
- PoC implementation about to start
  - Evaluate algorithms
- Complement catalogue of blueprints with possibility to compose vertical services from building blocks