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

Vertical Slicer
Service Orchestrator
Mobile Transport and Computing Platform
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
### 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
Connectivity service | sapUu - cpAs, sapAAA - cpAAA, cpAsEpc - cpEpcAs, cpAAAEPc - cpEpcAAA: L3VPN
External interconnection | sapUu: 4G
Internal interconnection | n/a (no other services, except those listed already are needed)
## Vertical Service Blueprint

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service constraints</td>
<td></td>
</tr>
</tbody>
</table>
  Number of Application servers: n/a (provided by Translator)  
  Images of virtual applications: vmAS: <<urlAS>>  
  Virtual application connection endpoints: cpAsEpc, cpAs  
  Lifecycle operations: To be defined  
  Scaling rules: Scale out: 80% load, Scale in: 60% load |
| 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 - cpAAA: 50ms |

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SST</td>
<td>n/a (see the field SLA instead)</td>
</tr>
<tr>
<td>Geographical area</td>
<td>Geographical area: &lt;&lt;Coordinates describing the plant boundary&gt;&gt;</td>
</tr>
<tr>
<td>sapAs location</td>
<td>sapAs location: &lt;&lt;MetroArea of this sap&gt;&gt;</td>
</tr>
<tr>
<td>Security</td>
<td>Security: low</td>
</tr>
<tr>
<td>Priority</td>
<td>Priority: medium</td>
</tr>
</tbody>
</table>

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15 April 2018
## Vertical Service Descriptor

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>LorryMovement_ConstructionSite_Ulm</td>
</tr>
<tr>
<td>Description</td>
<td>The position of lorries on a big construction site in Ulm are monitored</td>
</tr>
<tr>
<td>Version</td>
<td>1.1</td>
</tr>
<tr>
<td>Blueprint</td>
<td>Xyz4711_bp</td>
</tr>
<tr>
<td>Identity</td>
<td>Abc0815_vsd</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SST</td>
<td>n/a ...</td>
</tr>
<tr>
<td>Service constraints</td>
<td>Geographical area: city area of Ulm and surroundings Region_Ulm</td>
</tr>
<tr>
<td></td>
<td>sapAs location: Region_Ulm</td>
</tr>
<tr>
<td></td>
<td>Security: low</td>
</tr>
<tr>
<td></td>
<td>Priority: medium</td>
</tr>
<tr>
<td></td>
<td>...</td>
</tr>
<tr>
<td>Mgmt and control for tenant</td>
<td>Provider managed</td>
</tr>
<tr>
<td>SLA</td>
<td>sapUu: <strong>500</strong> devices with 1msg/min of <strong>200B</strong>.</td>
</tr>
<tr>
<td></td>
<td>cpAs: <strong>1Gbps</strong></td>
</tr>
<tr>
<td></td>
<td>cpAAA: <strong>10Mbps</strong></td>
</tr>
<tr>
<td></td>
<td>latency sapUu - cpAsEpc: <strong>50ms</strong></td>
</tr>
<tr>
<td></td>
<td>latency sapUu - cpAAA&amp;Epc: <strong>50ms</strong></td>
</tr>
</tbody>
</table>
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

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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