NETWORK SLICING IN 5G

Hans J. Einsiedler
### WHY WE NEED 5G!

**SATISFACTION OF FUTURE USE CASES**

<table>
<thead>
<tr>
<th>Broadband access everywhere</th>
<th>Broadband access in dense areas</th>
<th>Higher user mobility</th>
<th>Massive Internet of Things</th>
</tr>
</thead>
<tbody>
<tr>
<td>50+ MBPS EVERYWHERE</td>
<td>PERVERSIVE VIDEO</td>
<td>HIGH SPEED TRAIN</td>
<td>SENSOR NETWORKS</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Extreme real-time communications</th>
<th>Lifeline communications</th>
<th>Ultra-reliable communications</th>
<th>Broadcast-like services</th>
</tr>
</thead>
<tbody>
<tr>
<td>TACTILE INTERNET</td>
<td>NATURAL DISASTER</td>
<td>E-HEALTH SERVICES</td>
<td>BROADCAST SERVICES</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ERLEBEN, WAS VERBINDET.
THE MOST IMPORTANT USE CASE - THE UNKNOWN ONE!
WE CANNOT SEE INTO A CRYSTAL BALL!
Evolution of the network infrastructure from silos over monoliths towards slices.

Past:

- Telco1: POTS
- Telco2
- Telco3
- Telco4

Device platform: Devices

Present:

- Use case 1
- Use case 2
- Use case 3

Device platform: Devices

- Services 1
- Services 2
- Services 3

Network control and policy (IP based)

Access

Backbone

Future:

Use case 1 slice
Use case 2 slice
Use case 3 slice
Use case 4 slice
Use case 5 slice
Use case 6 slice

Infrastructure cloud

© CONFIG consortium

Erleben, was verbindet.
USE CASES MAPPED TO NETWORK SLICES
REQUIREMENTS WILL DEFINE THE NETWORK SLICES

RAT = Radio Access Technology; CP = Control Plane; UP = User Plane; AP = Access Point; IoT = Internet of things; D2D = Device to Device

© NGMN
Different possibilities to implement slices
End systems (terminals) are part of the slice
3GPP and ETSI expression User Equipment (UE) misleading therefore new expression needed – proposal: Service End-point Agent (SEA)
**IMPORTANT SLICE ISSUE: SERVICE END-POINT AGENT**

**END-SYSTEMS NOT SEPARATED FROM THE NETWORK**

- End-system (physical node) can be part of different slices as long as the end-system hosted different SEAs
- SEA has to be addressed through name or identifier
- ID management become very important in slicing
SLICING OFFERS INTERESTING OPPORTUNITIES (1)
ROAMING IN VISITING DOMAINS

- Local infrastructure can be extended towards other operator domains – visiting domains
- Some control and data plane functions will be moved into the visiting domain
- Legal interception control points (control and data plane) can stay in the home domain
SLICING OFFERS INTERESTING OPPORTUNITIES (2)
LOCAL BREAK-OUT

- Operator become a virtual operator in the visiting domain
- Some control functions will stay into the home domain
- All data plane function will be moved to the visiting domain
- Legal interception control plane function will stay in the home domain, data plane function will be in the visiting domain
MODULARIZATION AND CONTEXT AWARENESS IS NEEDED
TWO SUCCESS STORIES

- Modularization:
  - TR23.799 v0.8.0 is included in “Solutions for Key Issue 7: Network function granularity and interactions between them”, Section 6.7.4.

- Context awareness:
  - Key points included as text in Section 5.9 “Key Issue 9: 3GPP architecture impacts to support network capability exposure and context information awareness”.

Figure 6.7.4.1-1: Architecture Modularization Reference Model
Source: 3GPP SA2 TR.23.799 v0.8.0
WHERE ARE WE NOW?
THREE OPTIONS – WHICH IS THE RIGHT ONE?

<table>
<thead>
<tr>
<th></th>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pros</strong></td>
<td><img src="option1_pros.png" alt="Diagram" /></td>
<td><img src="option2_pros.png" alt="Diagram" /></td>
<td><img src="option3_pros.png" alt="Diagram" /></td>
</tr>
<tr>
<td>4G evolution</td>
<td>EPC functions → Fixed NW functions</td>
<td>EPC functions → 5G NW functions → Fixed NW functions</td>
<td>EPC functions → 5G NW functions → Fixed NW functions</td>
</tr>
<tr>
<td>New RAT</td>
<td>Fixed/ Wi-Fi</td>
<td>Fixed/ Wi-Fi</td>
<td>Fixed/ Wi-Fi</td>
</tr>
<tr>
<td>3 options – which is The right one?</td>
<td><strong>Pros</strong></td>
<td><strong>Cons</strong></td>
<td><strong>Cons</strong></td>
</tr>
<tr>
<td>Option 1</td>
<td>• No changes to 4G RAN</td>
<td>• Tied to the legacy paradigm for all the use cases (which may be expensive)</td>
<td>• Impact on 4G RAN to support connections to EPC functions and 5G NW functions</td>
</tr>
<tr>
<td>Option 2</td>
<td>• No need for revolutionary 5G NW functions design</td>
<td>• New design could only be utilized where there is new RAT coverage</td>
<td>• 5G NW functions/ new RAT design can be optimized to fully benefit from new technologies (like virtualization)</td>
</tr>
<tr>
<td>Option 3</td>
<td>• No changes to 4G RAN</td>
<td>• Potential signalling burden due to mobility if the new RAT does not provide seamless coverage</td>
<td>• Solves mobility issues of option 2</td>
</tr>
</tbody>
</table>

**NW** Network, **EPC** Evolved packet core, **RAN** Radio access network, **RAT** Radio access technology

© NGMN
CONCLUSION
5G WILL BE A MODULAR PLUG AND PLAY INFRASTRUCTURE

- Modular and flexible network architecture: No one-size-fits-all approach
- Virtual networks/network slices depending on use case requirements
- Context awareness will offer the possibility to optimize the infrastructure and the services
- ID management will be important not only to address the customer/end-system, it will also address the interconnection to the slice, the service execution environment
- End-systems become part of the network slice through Service End-point Agent (SEA)

Future telecommunication infrastructure will be
- modular,
- software driven,
- access agnostic,
- virtualized, and
- sliced
PARTICIPANTS AND ACKNOWLEDGEMENT
JOINED WORK OF INDUSTRY AND ACADEMIA

Current participants

http://www.5g-control-plane.eu/

Contact: Hans J. Einsiedler {hans.einsiedler@telekom.de}
THANK YOU!