Network Slicing: 3GPP, SDO, Carriers, Communities

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Turn physical infrastructure into multiple logical networks, one per service instance.

**NOT** a one-size fits all architecture **NOT** a Dedicated Network

One-Network, Many-Service
Different aspects of network slicing have been already prototyped both Opensource and commercials platforms

Industry is currently providing network slicing by means of
(a) Local/dedicated services enabled by MEC platform
(b) Dedicated core networks and RAN sharing

Next steps : **SO-CN** and **SO-RAN**
3GPP re-architects mobile networks

**Slicing Functions**
- NSSF
- NEF
- NRF
- PCF
- UDM
- AF

**Control Plane**
- AUSF
- AMF
- SMF

**User Plane**
- UEs
- DU
- CU
- UPF
- DN

**3GPP Mobile Network Functions**
- AMF: Access & Mobility Management Function
- AUSF: Authentication Server Function
- NRF: Network Repository Function
- UDM: Unified Data Management
- NSSF: Network slice selection function
- SMF: Session Management Function
- UPF: User Plane Function
- AF: Application Function
- PCF: Policy Control Function
- NEF: Network Exposure Function
### 3GPP re-architects mobile networks

<table>
<thead>
<tr>
<th>Feature</th>
<th>3G</th>
<th>4G</th>
<th>5G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Downlink waveform</td>
<td>CDMA</td>
<td>OFDM</td>
<td>OFDM, SCFDMA</td>
</tr>
<tr>
<td>Uplink waveform</td>
<td>CDMA</td>
<td>SCFDMA</td>
<td>OFDMA, SCFDMA</td>
</tr>
<tr>
<td>Channel coding</td>
<td>Turbo</td>
<td>Turbo</td>
<td>LDPC (data) / Polar (L1 contr.)</td>
</tr>
<tr>
<td>Beamforming</td>
<td>No</td>
<td>Only data</td>
<td>Full support</td>
</tr>
<tr>
<td>Spectrum</td>
<td>0.8 – 2.1 GHz</td>
<td>0.4 – 6 GHz</td>
<td>0.4 – 90 GHz</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>5 MHz</td>
<td>1.4 – 20 MHz</td>
<td>Up to 100 MHz (400MHz for &gt;6GHz)</td>
</tr>
<tr>
<td>Network slicing</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>QoS</td>
<td>Bearer based</td>
<td>Bearer based</td>
<td>Flow based</td>
</tr>
<tr>
<td>Small packet support</td>
<td>No</td>
<td>No</td>
<td>Connectionless</td>
</tr>
<tr>
<td>In-built cloud support</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**3GPP Mobile Network**
3GPP Mobile Network

- Safety/autonomous driving service
- URLLC (Ultra Reliable Low Latency)
- Infotainment/video streaming
- eMBB (Mobile Broadband)
- Maintenance/statistics
- mIoT, low throughput

NSSAI_1
NSSAI_2
NSSAI_3

Runtime

AMF
SMF1
SMF2
SMF3
UPF1
UPF2
UPF3
AutoPilot
Caching

UDM
NSSF
NRF
PCF

NSSAI_1
NSSAI_2
NSSAI_3
SDO, Carriers, OpenSource, Communities
Can opensource without standard?
YES

Can standard without opensource?
YES
Today standardization and open-source are becoming complementary.

Clear need for open-source for 5G to

(a) Lower the entry barrier
(b) Reduce TCO and improve accessibility and reuse
(c) Common R&D framework for innovation
Leverage **FRAND-type of License** for open-source in 5G
(a) Allow 3GPP members to contribute to open-source and still perceive royalties (e.g. OSA License)
(b) Compatible with both commercial and academic/research/prototyping use

1. Common R&D prototyping
2. Feasibility and Validation
3. Reproducibility

1. Reference implementation
2. Open-source community following 3GPP specs
3. Community representation in 3GPP
Towards RAN WhiteBOX

(1) Specifying APIs and interfaces
(2) Exploring open source NF and commodify hardware where appropriate
(3) Enabling RAN virtualization and RAN intelligence

Operator-led Alliance
XRAN + C-RAN → O-RAN

Consortium-led Alliance
OpenAirInterface

Standard and OpenSource
ORAN: xRAN+ CRAN

Carrier-led consortium: AT&T, China Mobile, Deutsche Telekom, NTT DOCOMO, Orange

Objective: push more openness into the radio access network with ORAN reference design

(a) virtualized network elements with open, standardized interfaces

(b) real-time analytics with machine learning systems and artificial intelligence
OAI: Follow 3GPP Specification

Community-led consortium: Orange, Nokia, TCL, Fujitsu, Samsung, Interdigital, …

Objective: Reference implementation and development kit for common R&D prototyping

(a) OpenSource RAN and CN code base
(b) Open APIs, e.g. FlexRAN and FlexCRAN
(c) Fully software solution (Intel and Arm-based)
(d) User and developer community
OpenSource Platforms for Agile network service delivery platforms (OpenAirInterface and Mosaic-5G.io)
Facebook and Google are quickly entering the datacenter Telco space
Value-chain of Telecom is under siege and may become very different because of this

Example: [https://telecominfraproject.com/](https://telecominfraproject.com/)
- Low-cost equipment for rural areas (openCellular)
- Federating open-source developers
Fusion of Computing, Information and Cellular technologies

(a) 5G and beyond is not only New Radio and verticals, it is also an evolution in General-Purpose computing for wireless networks

(b) More and more software technologies (NFV, SDN, MEC) and Data (mining, analytics) jointly with radio signal processing

Conclusion
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