Chips for 6G: What could we expect at least 5 years ahead?

Mohand Achouche

EF ECS 2022, Amsterdam
25-11-2022
## What is 6G?

### What the crowd-sourced crystal ball tells us?

<table>
<thead>
<tr>
<th>Technology</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>AI-based networking</td>
<td>51%</td>
</tr>
<tr>
<td>Cloud-native architecture</td>
<td>24%</td>
</tr>
<tr>
<td>Satellite</td>
<td>13%</td>
</tr>
<tr>
<td>New spectrum radio</td>
<td>12%</td>
</tr>
<tr>
<td>Digital-physical fusion</td>
<td>25%</td>
</tr>
<tr>
<td>Autonomous vehicles</td>
<td>25%</td>
</tr>
<tr>
<td>Co-bots &amp; AI agents</td>
<td>23%</td>
</tr>
</tbody>
</table>

**What will be the defining new application for the 6G Era?**

- Immersive experience/XR 27%
- Digital-physical fusion 25%
- Autonomous vehicles 25%
- Co-bots & AI agents 23%

782 votes

**What do you think will be the most important KPI for 6G networks?**

- Security and trust 34%
- Latency & reliability 29%
- Energy Efficiency 20%
- Throughput & capacity 17%

3,119 votes

**What will be the defining new technologies for 6G?**

- AI-based networking 51%
- Cloud-native architecture 24%
- Satellite 13%
- New spectrum radio 12%

3,126 votes

---

**New experiences...**

...over native-AI networks

**...which are safe and trustful**

Nokia Bell Labs 6G vision, since 2019:

- Digital-physical fusion will liberate human potential in the 6G Era
- Powered by native-AI networks and applications
- In a (quantum) safe and trusted way
Bringing future to live
Six key technology areas for the 6G essential infrastructure

- Security and trust
- New spectrum technologies
- AI native air Interface
- Cognitive, automated and specialized architectures
- Network as a sensor
- Extreme connectivity
Wireless/Optical convergence in the context of 6G
The architectural view of future networks in 2030
6G new spectrum technologies
Band options for a new generation

6G peak capacity layers and high precision sensing

Localized high capacity & FWA

6G capacity expansion layer

Basic capacity layers, NTN & URLLC

Basic coverage & IoT

6G coverage expansion layer

6G Sub-THz
W-band (92-114.25 GHz), D-band (130-174.8 GHz)

5G, 6G mmWave
24-52 GHz (licensed)
57-71 GHz (unlicensed)

5G, 6G
2.5-7.1 GHz (licensed/shared/unlicensed)
1.5, 1.8, 2.1, 2.3, 2.6 GHz (licensed/shared)

4G, 5G, refarming to 6G
600, 700, 800, 900 MHz (licensed)

4G, 5G, refarming to 6G
600, 700, 800, 900 MHz (licensed)

4G, 5G, refarming to 6G
600, 700, 800, 900 MHz (licensed)

6G
<1.5 GHz (licensed/shared)

>3000m Rural
1000m Urban
300m Dense urban
100m Hot spot
30m Local area
<10m Short range
6G new spectrum technologies

... And there is still exciting research in wireless

Analog and Mixed Signal Circuits

- Analog circuits do not follow Moore’s scaling laws for size, DC power or performance.
- The analog industry has seen strong consolidation and a trend towards higher integration of functions especially in consumer applications.
- Use of III-V technologies (GaN, GaAs and InP) enables higher frequency operation, lower noise and higher output power and efficiency for PA’s.
- Future trend is monolithic or wafer-scale integration of III-V devices with scaled CMOS (InP & GaN on Si) enabling optimal analog-digital SoC’s.

Radio-on-glass module 130-170 GHz

*2022 RFIC Symposium

256-element D-Band array

*2022 ISSCC
Solving the Extreme Connectivity equation

Flexibility and Low Power

Processor-based approach - ASIPs

- Programmable accelerator IP – adapting to changing standards
- Baseband functions – adapting to changing algorithms
- Scalable SoC – adapting to changing capacity needs

Enabling technologies

- Memory technologies and architecture
- Low-power digital building blocks
- Analog-mixed signal computation
6G: Access, Sensing and Intelligence at Scale
Disruptive Chips to unleash all the potential

- Consumers and home
- Enterprises
- Access Network
- Anyhaul
- Edge Cloud
- Centralized Cloud

- Baseband and radio digital IP
- PON line termination
- Machine learning
- Switching and routing
- Optics DSP
Sovereignty and Supply chain

Chips shortage revealed a fragile supply chain

The long-term success of European digital industry will depend on how Europe can secure its presence in the overall value chain

- EU’s capability to capture its strengths on digital infrastructure and industry verticals
- Catalyse research, and innovate in the microelectronics/Photonics domains
- Eventually build a full strategic value chain

However, European digital autonomy does not mean to control all elements of the entire value chain

- Focus on controlling essential parts by mastering advanced and competitive technologies including critical chips design capabilities to lower the cost and support growing the talent pipeline & skills
- Meanwhile ensuring mutual dependencies between different regions (trusted partners)