Trends in EU research for 5G Networks

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“5G is NOT 4G+1”

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5G is a totally new network technology for a totally new environment
5G Vision for 2020: Workprogramme

- 1,000 times more mobile network capacity than today
- 7 trillion wireless devices serving over 7 billion people
- 10 to 100 times more user-access capacity than today
- Energy saving: 1/10 energy consumption ratio than today
- Reducing the average service creation time cycle from 90 days to 90 minutes
- 5 times reduced End-to-End latency
- Ubiquitous 5G access including in low density areas
5G Vision 2020: Societal Objectives

• Ubiquitous access
• Very wide range of applications and services
• Low cost,
• Increased resilience and continuity
• Much higher efficiency of resources
• Robust security and privacy
• Service Areas:
  – Entertainment, health, energy, transport, education, business, government, agriculture, mining and other horizontal sectors.
• Some service instances:
  – Multi-modal interfaces, virtual presence, augmented reality, UHD+3D live broadcast, massive social networks, sensor networks, object tracking, surveillance, public-warning services, and road traffic control.
5G Vision 2020: Technical Objectives

- Peak terminal data rate $\geq 10\text{Gbps}$,
- Minimum guaranteed terminal data rate $\geq 100\text{Mbps}$
- Active terminal density $\geq 1\text{M terminals/km}^2$
- Traffic density $\geq 10\ T\text{bps/km}^2$,
- Radio latency $\leq 1\ \text{ms}$
- E2E latency within the same backhaul $\leq 10\ \text{ms}$
- Mobility support at speed $\geq 500\text{km/h}$
- Accuracy of terminal location $\leq 5\text{meter}$
- Non-quantitative reqs: software-based system architecture, SIM-less authentication, support for shared infrastructure, multi-tenancy and multi-RAT, robust security and privacy, and lawful interception capacity.
5G Vision 2020: Deployment Objectives

- Ubiquitous service availability with full capabilities
- Very-low cost service offering for very low capacity IoT terminals
- Capable of human-oriented terminals $\geq 20$ billion
- Capable of IoT terminals $\geq 1$ trillion
- Aggregate service reliability $\geq 99.9999\%$
- Complete Service Deployment time $\leq 90$ minutes

Requirements in terms of efficiency:
- Reduction of overall network management opex $\geq 20\%$.
- Reduction of network capex/traffic_unit $\geq 90\%$.
- Reduction of energy consumption $\geq 90\%$.
Making this happen:
The 5G Public-Private Partnership (PPP)

- DG CNECT from the EC, with top companies and research institutions, has launched the 5G PPP
- Research effort coordinated by the Networld 2020 European Technology Platform: networld2020.eu
- The 5G PPP is fostered, from the private side, by the 5G Infrastructure Association: 5g-ppp.eu
- Europe-wide research effort to deliver 5G technology:
  - 7 year research plan in four stages
  - 700 M€ funded by the European Commission
  - 3,500 to 7,000 M€ funded by top EU industries
Expected 5G Project Calls in H2020

• 1st call on 2014 (Phase I 2014-15): 122 MEuros
  - Large Contribution RIA (95M€), IA (25M€) and CSA (2M€)
  - Closed last November 25th, 2014
  - ~85 proposals submitted

• 2nd call on 2016 (Phase II 2016-17): 173 MEuros

• 3rd call on 2018 (Phase III 2018-19): 230 MEuros

• 4th call on 2020 (Phase IV 2020): 175 MEuros

• All of them with a mix of RIA, IA and CSA

• Most funding for large contribution

• Additionally: international joint calls with other regions
Expected Research Areas in the 5G PPP

- Wireless Networks
- Optical Networks
- Automated Network Organisation - Network Management and Automation
- Implementing Convergence Beyond the Access Last Mile
- Information Centric Networks
- Network Function Virtualisation
- Software Defined Networks
- Networks of Clouds
- Ensuring Availability, Robustness and Security
- Ensuring Efficient Hardware Implementations
Call 1: PPP Pre-structuring Model

Note: The size of the Projects boxes does not indicate the potential size or manpower of Projects.
## Call 2: possible Research Areas

| Wireless Networks | Air Interface  
|                  | Advanced Multi Antenna Transceiver techniques  
|                  | mmWave RATs  
|                  | Channel Model for 5G  
|                  | Radio Network  
|                  | Novel RAN Architectures  
|                  | Machine type Communications  
|                  | Intelligent Radio Resource Management  
|                  | Integrating satellite networks  
| Optical Networks | Programmable, elastic and high capacity optical networking  
| The software network | Novel Views on Network Architecture  
|                  | The Software Network: Interface Abstractions and Layering  
|                  | “On the fly” Virtualization and Adaptability  
| Network Management and Automation | Smart Orchestration and Use of Network Analytics and Big Data for network management  
| Effective Systems and Networks | Security Privacy and Trust  
|                          | Energy Efficient Devices and Networks  
|                          | Highly Flexible Communication Systems |
Xhaul Concept (I)

• Xhaul is an adaptive, sharable, cost-efficient 5G transport network solution integrating the fronthaul and backhaul segments of the network.
• Xhaul transport network will flexibly interconnect distributed 5G radio access and core network functions, hosted on in-network cloud nodes, through the implementation of two novel building blocks:
  – A control infrastructure using a unified, abstract network model for control plane integration (Xhaul Control Infrastructure, XCI)
  – A unified data plane encompassing innovative high-capacity transmission technologies and novel deterministic-latency switch architectures (Xhaul Packet Forwarding Element, XFE)
• Xhaul will greatly simplify network operations despite growing technological diversity.
• It will hence enable systemwide optimisation of Quality of Service (QoS) and energy usage as well as network-aware application development
Objectives for the 5G Radio Interface

- Better spectral efficiency (bps/Hz)
- Better spectral utilization (bps/Hz/m³)
- Reduced coverage differential
- Reduced latency (for specific terminals)
- Very-low cost for IoT (for specific terminals)

Source: Telefonica
Technologies for the 5G Radio Interface

- New waveforms
  - NOMA, FBMC, SCMA, Zero-tail, ...
  - Likely cost problems
- Massive MIMO
  - Hundreds of antenna-elements in the base station
  - Increasable unfeasible with mobile speed
- High-frequency bands (> 10 GHz)
- Full-duplex on the same band
Not only technology: New and Innovative Business Models

Abridged OTT/Mobile Network Operator Model/Value Chain (Tomorrow):

- Services Provider/s
  - The “Experience”
- BSS/OSS
- Infrastructure Services Provider/s
- Transport Network
- Access Network
- Device/User
  - The “Experience”

Services Provider/s

- Abstractions
- Mashups
- Intelligence

Revenue Sharing Models

Infrastructure Service Provider/s (MNO Managed Assets)

- PurePlay OTT
- Competition Partnerships
- User Experience
- MVNO Services

Mobile Device
- Network of Networks
  - “Everything as a Service”
- Access Network
- Transport Network
- Value Creation

Many questions, many challenges for building this future, this vision

Source: Interdigital Communications.
Conclusions

• 5G networks constitute an unprecedented technology revolution
• World competition among top-technology regions to arrive first!
• European effort between public and private institutions to be the winners
• Carefully drafted and well funded long term research plan
Thanks for your attention!