5G: THE NETWORK FOR THE NETWORKED SOCIETY

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POINT OF DEPARTURE

MUTUAL INTERDEPENDENCE

SPECTRUM IS THE LIFEBOOD OF ALL THAT IS MOBILE
QUANTITATIVE CHANGE LEADS TO QUALITATIVE CHANGE
(AND CONCOMITANT SOCIAL TRANSFORMATION)
CHANGING BEHAVIORS & EXPECTATIONS OF CONSUMERS INVITE INDUSTRIES TO TRANSFORM
Our vision
50 billion connected devices

26 billion connected devices
15 years

5 billion connected people
25 years

1 billion connected places
100 years

Connections (billion)

1900

2010

2020

Communication for all

Connections

10
20
30
40
50

1900

1900

2000

2000

2010

2010
MOBILE GENERATIONS ACROSS TIME

The foundation of mobile telephony
Mobile telephony for everyone
The foundation of mobile broadband
The evolution of mobile broadband
The Network for the Networked Society

1G
NMT, AMPS, TACS
~1980

2G
GSM
~1990

3G
WCDMA
HSPA
~2000

4G
LTE
~2010

5G
~2020

Historically, higher peak data rates, denser infrastructure and more bandwidth have been the hallmark of each mobile technology generation!

Access technologies & new air-interfaces have been the center of attention.
5G IS DIFFERENT: IT’S NETWORK PLATFORM

A common Network Platform designed to serve multiple industries and use cases, each with different requirements

Emphasis as much on network core as on access
5G: GLOBAL INITIATIVE

- NGMN
- ITU-R
- 3GPP
- GSMA

USA
5G Americas
University Research

EUROPE
Horizon 2020 -> 5GPPP
-> Metis + other

CHINA
863, 5G promotion group

JAPAN
ARIB, Testbed activities

KOREA
5G Forum, Govt push
5G ACCESS TIME PLAN

Industrial Use Case Studies & Pilots

Ericsson 5G Radio Testbed

Field Trials
5G Radio Prototype

E2E Network and Pre-commercial Trials

5G Commercial Launch

Industrial Use Case Studies & Pilots

E2E Network and Pre-commercial Trials

5G Study Item

“NR” Phase 1

“NR” Phase 2

ITU

3GPP

IMT-2020

Requirements

Proposals

Specifications

5G Commercial Launch

2015

2016

2017

2018

2019

2020
AGENDA

➢ WHY 5G: SOME NUMBERS, TRENDS & REQUIREMENTS
➢ NETWORK AS A PLATFORM & ITS CORE COMPONENTS
➢ 5G RADIO COMPONENTS
➢ 5G & FIVE AREAS OF EXTREME IMPORTANCE
➢ SUMMING UP:
WHY 5G? SOME NUMBERS, TRENDS & REQUIREMENTS
Technology and society stand in a symbiotic relationship. They feed off of each other in a kind of feedback loop in which they push each other to ever higher planes.
WHAT IS CHANGING? IN NUMBERS

What to expect by 2020

11x
growth in smartphone traffic

80%
of mobile data traffic will be from smartphones

60%
Mobile data traffic that will be driven by video

more people will watch streamed on-demand video than linear TV

9.2B
mobile subscriptions worldwide

85%
of all subscriptions will be for mobile broadband

70%
Of the world will have mobile broadband coverage

> 90%
global pop will have a mobile phone, 3.7 Bn LTE subscriptions
WHY DO THESE NUMBERS MATTER?

Because all kinds of societal goals – political, economic, developmental – are intrinsically tied to the growth of Mobile Broadband.
MOBILE BROADBAND IS THE FASTEST GROWING TECHNOLOGY IN HISTORY

Source: ITU.
EXPOENTIAL CHANGE

- Exponential performance
- Ubiquitous reach
- New economics

+ COMPUTATION
  - DATA
  - SPEED
+ PRACTICES
  - THINGS
  - PEOPLE
+ CAPABILITY
  - TRANSACTION
  - DISTRIBUTION

Mobility

Broadband

Cloud
CONSUMER BEHAVIOR EVOLUTION

- Enhanced Indoor Coverage
- Enriched TV/Media Experience
- Enhanced Security
- Higher performance, service aware Mobile Broadband
- Augmented Reality
- Enterprise Transformation
NEW CONSUMER BEHAVIORS

2.7 BILLION LIKES ON FACEBOOK

$13 MILLION CROWDFUNDING

$2.7 BILLION E-COMMERCE

3X UBER REVENUE OVER SIZE OF TAXI MARKET, IN SAN FRANCISCO

1.9 MILLION NEW SMARTPHONE SUBSCRIPTIONS PER DAY

133 MILLION HOURS YOUTUBE VIDEO WATCHED

500,000 AIRBNB STAYS PER NIGHT

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INDUSTRY TRANSFORMATION

HEALTH  EDUCATION  MEDIA  TRANSPORT  BANKING  UTILITY  RETAIL

WELLNESS  LEARNING  CULTURE  MOBILITY  TRANSACT  FUNCTION  EXCHANGE
MEDIA – A FIRST MOVER

ICT MEDIA 50%
Streaming music, on-line games, web & IP TV, web news, media apps, access etc.

MOBILITY - BROADBAND - CLOUD
NEW LOGICS / NEW ASSETS

ANY THING THAT CAN BE CONNECTED WILL BE CONNECTED, SMART AND INTERACTIVE

ANY RESOURCE THAT CAN BE SHARED WILL BE SHARED, ENRICHED AND ABUNDANT

ANY RESHAPING IDEA THAT CAN BE TRIED WILL BE TRIED AND TRIGGER CHANGE

NEW CAPABILITIES MADE POSSIBLE BY DIGITALIZATION AND MOBILIZATION
BROADBAND EXPERIENCE EVERYWHERE, ANYTIME

SMART VEHICLES, TRANSPORT & INFRASTRUCTURE

MEDIA EVERYWHERE

CRITICAL CONTROL OF REMOTE DEVICES

INTERACTION HUMAN-IOT
KEY TECHNOLOGY TRENDS

- Spectrum is the most valuable resource
- Throughput critical to Customer Experience
- ICT unlocks value & changes business rules
- Programmable & Automated Horizontal Networks
- New Media Services
- Integrated Security & Aware Consumers

TELECOM, DATACOM & MEDIACOM
ONE NETWORK – MULTIPLE INDUSTRIES

Industries are Digitalizing and Mobilizing

A common network platform with dynamic and secure Network Slices
5G PERFORMANCE REQUIREMENTS

- 1000x higher mobile data volumes
- 10-100x higher number of connected devices
- 5x lower latency
- 10-100x typical end-user data rates
- 10x longer battery life for low power devices

Source: METIS
WHAT 5G WILL PROVIDE

- Multi domain performance
- Energy Performance
- Global standard
- Foundation for efficient industries and society
- Massive machine type of communications
- Critical machine type of communications
- Mass market personalized TV
NETWORK AS A PLATFORM & ITS CORE COMPONENTS
5G: THE NETWORK AS A PLATFORM

Moving away from dedicated physical networks and resources for different applications

To a “Network Factory” where new networks and architectures are “manufactured by SW”

Physical Resources
(Access, Connectivity, Computing, Storage, ..)

Network slices

Service n

Health

Robotic communication

Media

MBB Basic

S1  NW1  f1

S2  NW2  f2

Sn  NWn  fn
Drivers of change in the core network:

- **Efficiency & Effectiveness**
  
  "Radically simplified network"

- **Speed & Agility**
  
  "Bring products to market much quicker"

- **Innovation & Superior performance**
  
  "Providing cloud services to enterprise"

And, the economies of scale and scope.
THE KEY CORE COMPONENTS

Virtualization

VNF  VNF

Software Defined Networking (SDN)

Distributed Cloud

Network Slicing

VNF  VNF

Central Data Center

Distributed Data Center

Software Defined Networking (SDN)
THE HEART OF NFV

The framework for Multivendor Cloud Ecosystem is OpenStack!

- Programmability
- Plug-ability
- Innovation and speed
- Reliable and secure
- Distributed and scalable
- Telco expertise & features
- Cost & Performance optimized HW
SDN: KEY CHARACTERISTICS

New Capabilities
API / Exposure

Split Control
& Data plane

Network Function
Virtualization Enablement

Rigid, inflexible (wireline) networks with manual provisioning, static configuration and massive TTM for new services

“Software driven” programmable, agile networks with capacity sharing, RT configuration/provisioning and on-demand service creation (without truck rolls)
The key core components/reCap

- Virtualization
- Software Defined Networking (SDN)
- Distributed Cloud
- Network Slicing
THE KEY RADIO COMPONENTS

Flexible and scalable design

Ultra-lean design

Minimize network transmissions
not directly related to user data delivery

Multi-antenna transmission

Multi-site connectivity

System control

Common system plane

Access/backhaul integration

Licensed and unlicensed spectrum

Extension to higher frequencies

1 GHz
3 GHz
10 GHz
30 GHz
100 GHz

Flexible PHY

Integrated D2D
5G KEY RADIO TECHNOLOGY AREAS

Extension to higher frequencies
Complementing lower frequencies for extreme capacity and data rates in dense areas

Spectrum flexibility
- Spectrum sharing
  - Unlicensed
  - Shared licensed
  - Network sharing
  Complementing dedicated licensed spectrum
- Duplex Flexibility

Multi-antenna technologies
For higher as well as lower frequencies
- Beam-forming for coverage
- Multi-user MIMO for capacity

Multi-site coordination
- Multi-site transmission/reception
- Multi-layer connectivity

Access/backhaul integration
Same technology for access and backhaul
Same spectrum for access and backhaul

Device-to-device communication
- Direct communication
- Device-based relaying
  - Cooperative devices

Ultra-lean design
- Minimize transmissions not related to user data
  - Separate delivery of user data and system information
- Higher data rates and enhanced energy efficiency

...
5G & FIVE AREAS OF EXTREME IMPORTANCE
Significant effort required regionally and globally for the required New Spectrum

**WIRELESS ACCESS & SPECTRUM**

**Overall 5G solution**

**Evolution of LTE**
- Backwards compatible

**Interworking**

**New radio-access technology**

**New spectrum**

**Existing spectrum**

**Overall 5G solution**

**NX**

**Spectrum flexibility**

<table>
<thead>
<tr>
<th>Flexible duplex</th>
<th>Dedicated Licensed Spectrum</th>
</tr>
</thead>
<tbody>
<tr>
<td>FDD and TDD</td>
<td>Complimented with spectrum sharing</td>
</tr>
<tr>
<td>Dynamic TDD</td>
<td>Unlicensed</td>
</tr>
<tr>
<td>Full Duplex</td>
<td>Shared licensed</td>
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</tbody>
</table>

**1 GHz**

**3 GHz**

**10 GHz**

**30 GHz**

**100 GHz**

**Evolution of LTE**

**Backwards compatible**

**Interworking**

**New radio-access technology**

**New spectrum**

**Existing spectrum**
SPECTRUM APPROACH

› Global & regional harmonization of spectrum is key
› More licensed spectrum bands to be added
› Capacity and Coverage considerations for bands eg. LTE-A vs NB-IoT
› Complement licensed (anchor) with unlicensed bands eg. LAA
› Bring 3GPP radio technology into unlicensed bands eg. MuLTEfire
› Multi access connectivity across 3GPP & Non-3GPP
› Performance (Interference, capacity, coverage etc) key driver
› Device ecosystem influences deployment
Demand
- Mobile broadband plus 25% penetration for 4k video
  3hrs per evening*
- 10Mbps with 95% probability

Met with
- Refarming < 3GHz
- 80MHz at 3.5GHz
- 500 MHz at ~10GHz
- Carrier aggregation
- Densification x4.25

Low-rise, European scenario with 10 000 subscribers/km², baseline ISD 425m, 1500 subs/site
Note: all spectrum below 2.6GHz modeled at 2.6GHz
*) 4k usage increasing from 0 to 100% from 2015 to 2025
Outdoor and indoor, Wide area and venues, Public and private

- 99% global population coverage
- Full indoor coverage
- Coordinated heterogeneous networks
- Flexible deployments; macros to picos
  stationary and moving platforms

- M2M control in factories
- 1 msec latency
- No reliance on ARQ
- Spatial and frequency diversity
**EXTREME RELIABILITY**

- **Coordination**
  - Spatial diversity
  - Multi-hop/Mesh
  - Network coding
  - D2D
  - Interference cancellation
  - Spectrum use
  - Channel coding

```
Radio link performance

E.g. BER $10^{-9}$
or Latency $<1$ms

E.g. loss $10^{-3}$
Latency $<30$ms

Industrial or Real Time

Critical Infrastructure

System Performance

Normal operation
Consumer grade

Robust operation
Extreme performance in
disasters and severe
system interference

Coordination
```
**Critical Communications**

- <5ms e2e delay
- 99.999% transmission reliability
- 500Kmph relative velocity

**Massive Communications**

- >10yrs battery lifetime
- >80% cost reduction
- 20dB better coverage

**Extreme availability**

**Scalability and flexibility**

**Intelligent Transport Systems**

**Connected Sensors**

**Autonomous Cars**

**Process Control**

**Logistics Tracking**

**Energy Meters**
IoT SECURITY

› Layered identification
› Communication security
› Security policy

› IoT Ecosystem interaction
  - Processors, OS’s, Platforms, Device types, Communication/Security Protocols, APIs, Interoperability
5G: SUMMING UP
5G Network Evolution to Meet Expectations

Management & Orchestration

Radio Access

Applications

Cloud Infrastructure

IP Infrastructure

Sustainability

Scope for 5G

Security
Global efforts for a global standard in 2020

Open platform for industry eco-system to leverage

Challenging 5G system requirements

Builds on LTE and previous experiences

AND, NEW SPECTRUM WILL BE KEY
5G PARTNERING ANNOUNCED WITH 21 OPERATORS. OVER 50 ECOSYSTEM PARTNERS

DRIVER OF GLOBAL STANDARDIZATION INITIATIVES: METIS I+II AND INDUSTRY ALIGNMENT

15 INDUSTRY PILOTS FOR DIGITALIZATION OF INDUSTRIES

5G TECHNOLOGY FIRSTS: 5 GBPS THROUGHPUT – JUNE 2014

5G RADIO TEST BED FIELD TRIALS 2016 - DELIVERING 25 GBPS WITH BEAM FORMING AND MIMO

5G TECHNOLOGIES ARE ALREADY IMPROVING 4G NETWORKS

5G READY CORE TEST BED: NETWORK SLICING IN TRIAL
“A VISION IS NOT JUST A PICTURE OF WHAT COULD BE; IT IS AN APPEAL TO OUR BETTER SELVES, A CALL TO BECOME SOMETHING MORE.”
THE FUTURE DOESN’T JUST HAPPEN

PEOPLE HAVE TO BELIEVE IN IT
AND WORK TO MAKE IT HAPPEN

IT’S TIME TO LIGHT UP AFRICA