



Aalto University
School of Electrical
Engineering

5G and Net Neutrality

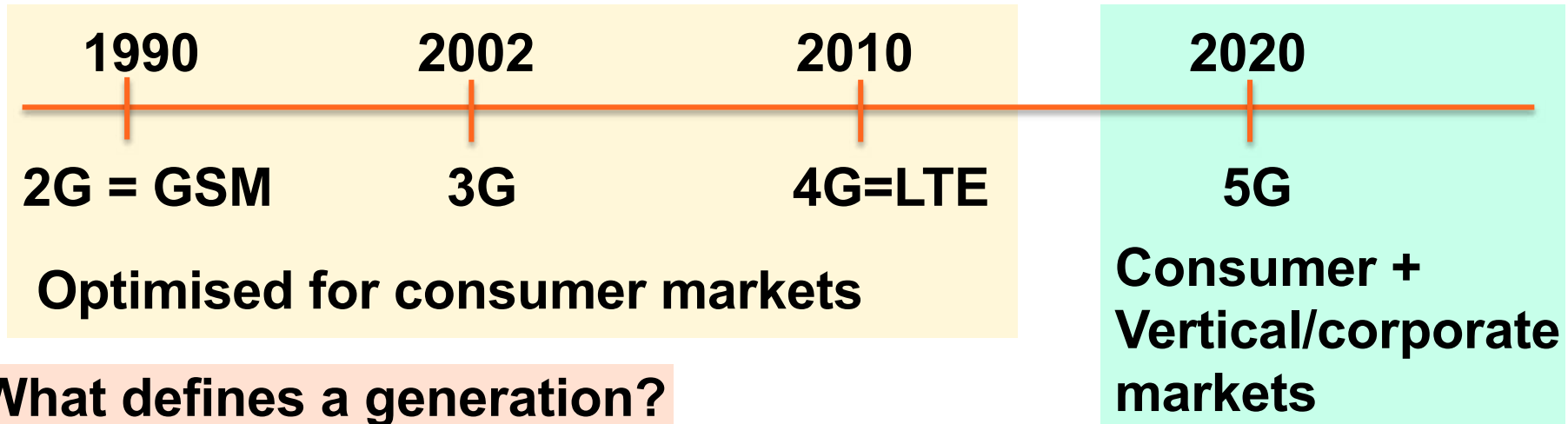
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Agenda

- **What is 5G and when**
- **How is it different from 4G**
- **Networking principles – how are they different from Internet principles**
- **Issues in Regulation: Net neutrality**
- **Impact on Industry structure**

Mobile generations timeline



What defines a generation?

- A generation is a marketing campaign
- New frequencies → new devices (+ new basestations)
- A leap in bandwidth and features
- A leap in what a user can do with it

Has helped to speed up technology development and adoption!

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5G capabilities will appear in releases



- **eMBB – enhanced mobile broadband**
 - Either non-standalone = depends on 4G or
 - Standalone = does not depend on earlier generations
- **URLLC – Ultra high reliability and low latency for vertical/corporate markets → specialised/private/public networks**
- **Slicing for tailoring to use case**

When is latency important?

- **4G latency over the air interface is from tens of milliseconds to about 100ms**
 - OK for most Internet use
 - Net gamers do not like it and will take slower ADSL any day
 - Can not do virtual/augmented reality → user becomes dizzy
 - Haptic control interfaces e.g. for remote driving – will work poorly
 - Cannot use 4G in a control loop in industry e.g. in Smart Grid protection from short circuits needs assured latency well below 100ms → now forced to use fiber → expensive

Why is higher bitrate important?

- **Building mobile network capacity in cities is less expensive and more users can be served, networks are less congested**
- **You can download your morning newspaper faster**
- **We can afford to move to higher resolution in Video**
- **New services like VR/xR will benefit**

But, *highest* peak rate is rarely important

4G devices are mostly able to consume about 10 Mbit/s on average

Internet

vs

5G

- **Best effort**
 - **User identification:**
 - FB and Google know everyone but the receiver may not know the sender
 - Messy: lots of user accounts and passwords
 - **Security**
 - Lots of hacking
 - Devices have no security certification
- **Network is tailored to a use case**
 - **User ID: SIM cards, authentication → user is always known.**
 - Mobile network will not work otherwise
 - **Security**
 - Quite decent

Why is 5G tailoring network to use case?

- **Providing high reliability+high bandwidth at the same time is way too expensive**
 - Reliable radio is needed for industrial use cases
- **There is also a tradeoff between low delay and high bandwidth**

Internet regulation in EU says

”all packets must be treated the same way irrespective of sender, Receiver, device, application etc.” = Net Neutrality

Conflict between Internet regulation and 5G principles

- **5G network SW is virtualised + the network is not only about transmission of packets, it has a compute element**
 - Virtualised + compute element == network uses cloud technology
 - According to NN, if owned by MNO, cloud is part of the network
 - →compute element can execute ***one program only***
 - *If caching → OK for www traffic but bad for e.g. voice + the same caching is not suitable for gaming and normal www traffic*
 - *NN law is a hindrance of best use of 5G compute elements, creates uncertainty and slows down investments*

Why is solving this dilemma important?

- **Achieving low latency requires local compute capability, NN law pushes this function to global players like AWS, FB, etc**
- **Ultra high bandwidth use will be very expensive and will need very high BW connection to the Internet unless the local compute element can be used to optimise the services**
- **5G will be used for critical infrastructure → physical safety will depend on high level of security. We could use the cloud capability in MNO network to improve security dramatically but are not allowed to do so because of NN**
- **Business reasons...**

Boundary between digital and physical worlds in the new battleground

- **Consumer goods manufacturers and cloud providers want to connect everything to the Internet → data about use and users**
 - Who owns the data?
- **Who builds/manages it and who can hack it?**
 - Self driving cars will collide, containers etc drop to ground in harbours, turbines are set to break mode, electricity grid is messed up and electricity distribution stops → national security
- **My advice: do not connect everything to Internet. Layers of fencing for security are needed. The consumer should own the data and have tools to manage its sharing.**

Impact of NN regulation on industry structure

- **EU style NN is great for**
 - Facebook, Google, Amazon Web Services – all de-facto global monopolies and none are European
- **NN regulation ties the hands of European MNOs in the battle with the cloud industry**
 - This hampers also the respective vendors like Nokia, Ericsson
- **Huawei does not suffer from this: China does not care about NN, so they can make all possible use of "compute" in 5G**

How to solve this dilemma of virtualization?

- **Option 1: if compute capacity in 5G network is sold to subscriber, the subscriber is would be allowed to use it any way they like**
- **Option 2: if compute capacity is sold to cloud service provider (Over the top provider), they can use it to execute any program**
- **Option 3: MNOs could use to execute programs with special regulation to be written for this purpose**

Thank You
(Questions? )

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