Mobile Network Bottlenecks and future needs

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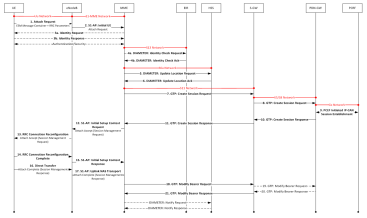
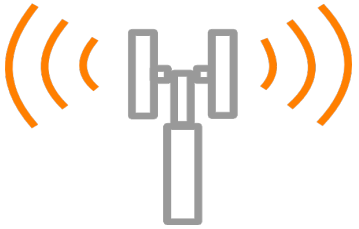
Outline

What does a mobile network do?



The Core Network



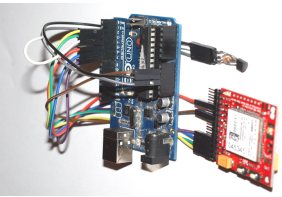
The Radio Access Network

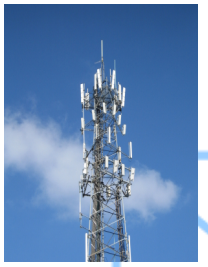
C-RAN back-of-the-envelope

Mobile Networks

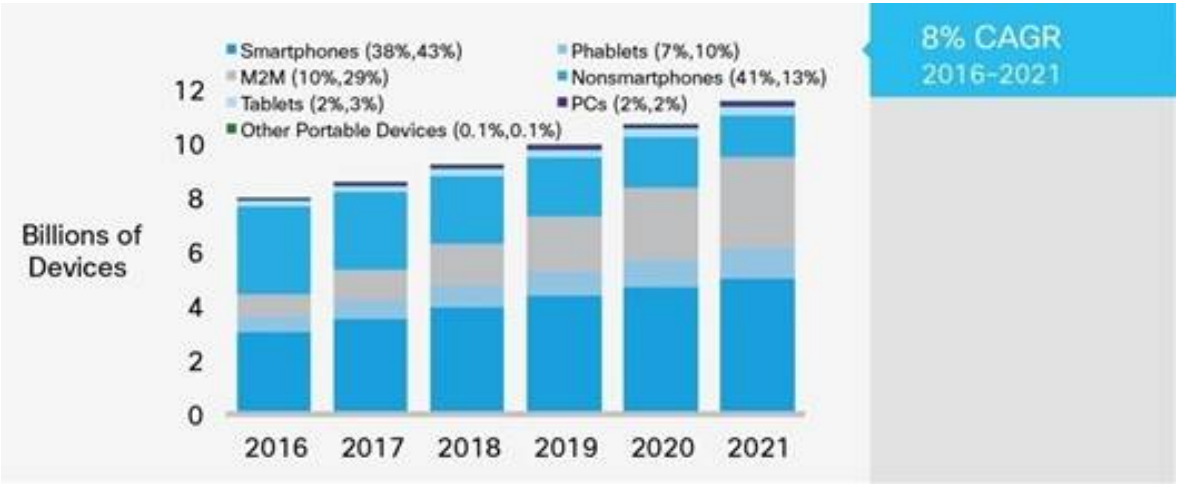
- Connect devices (UE) with a PDN (Internet) and with each other
- Provide global coverage and mobility

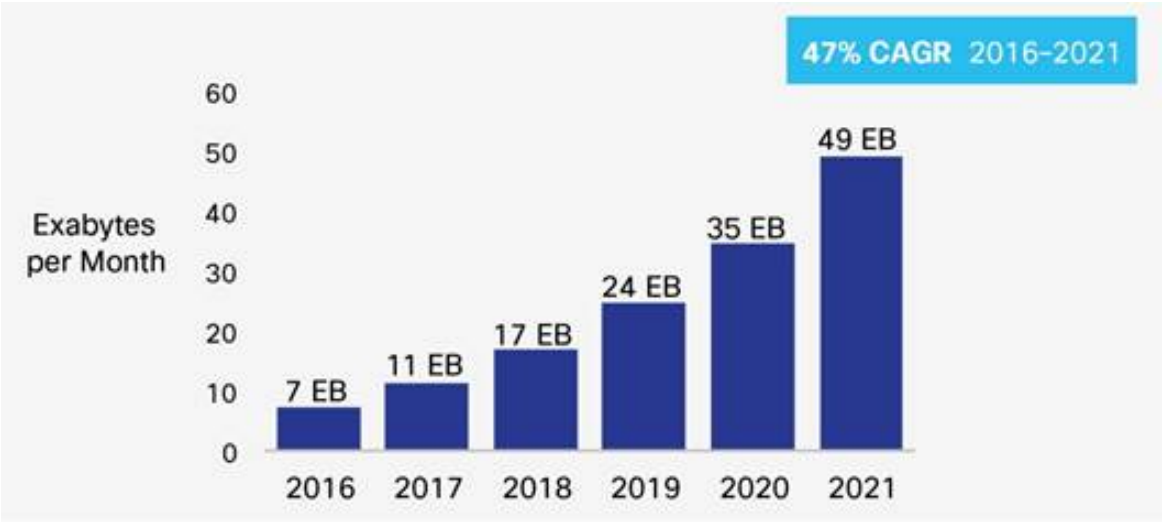
Mobile Networks





Requirements are on the rise





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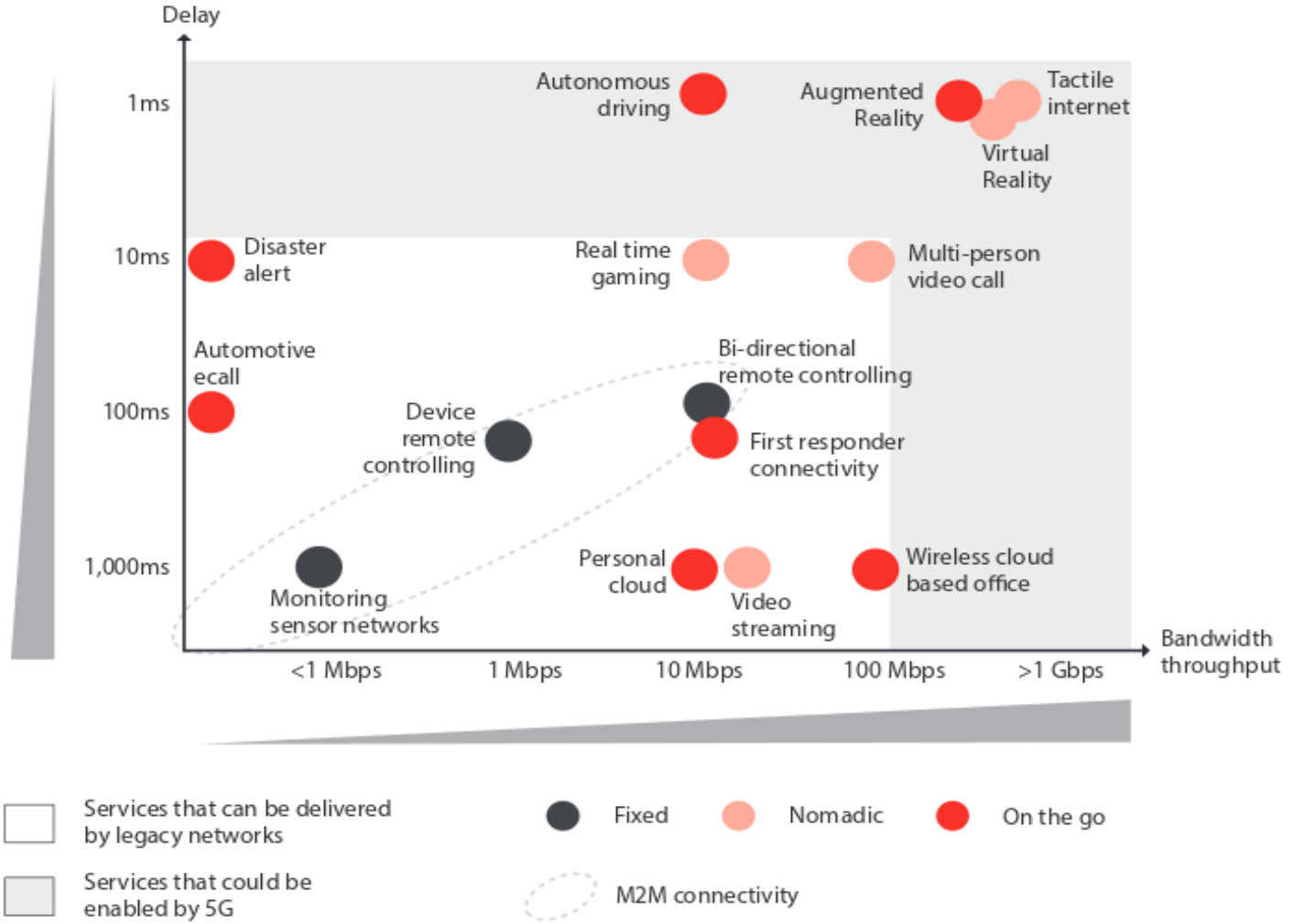
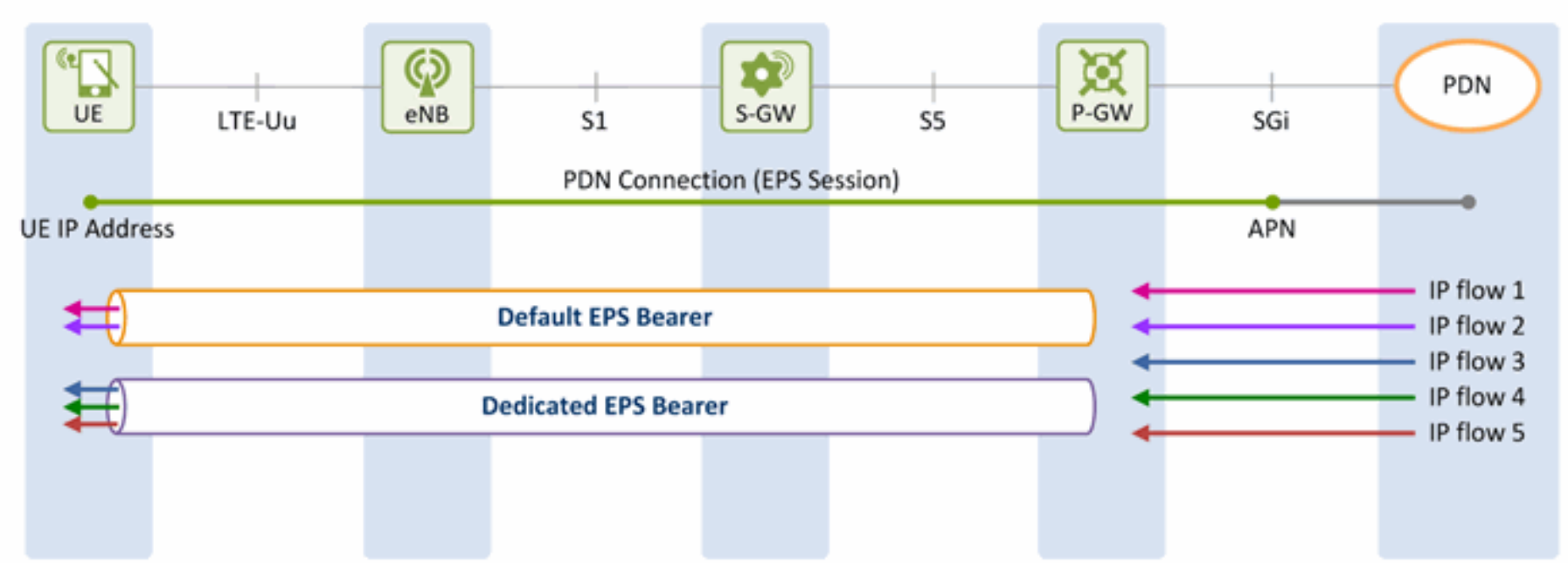


Figure 1: Bandwidth and latency requirements of potential 5G use cases

Source: GSMA Intelligence

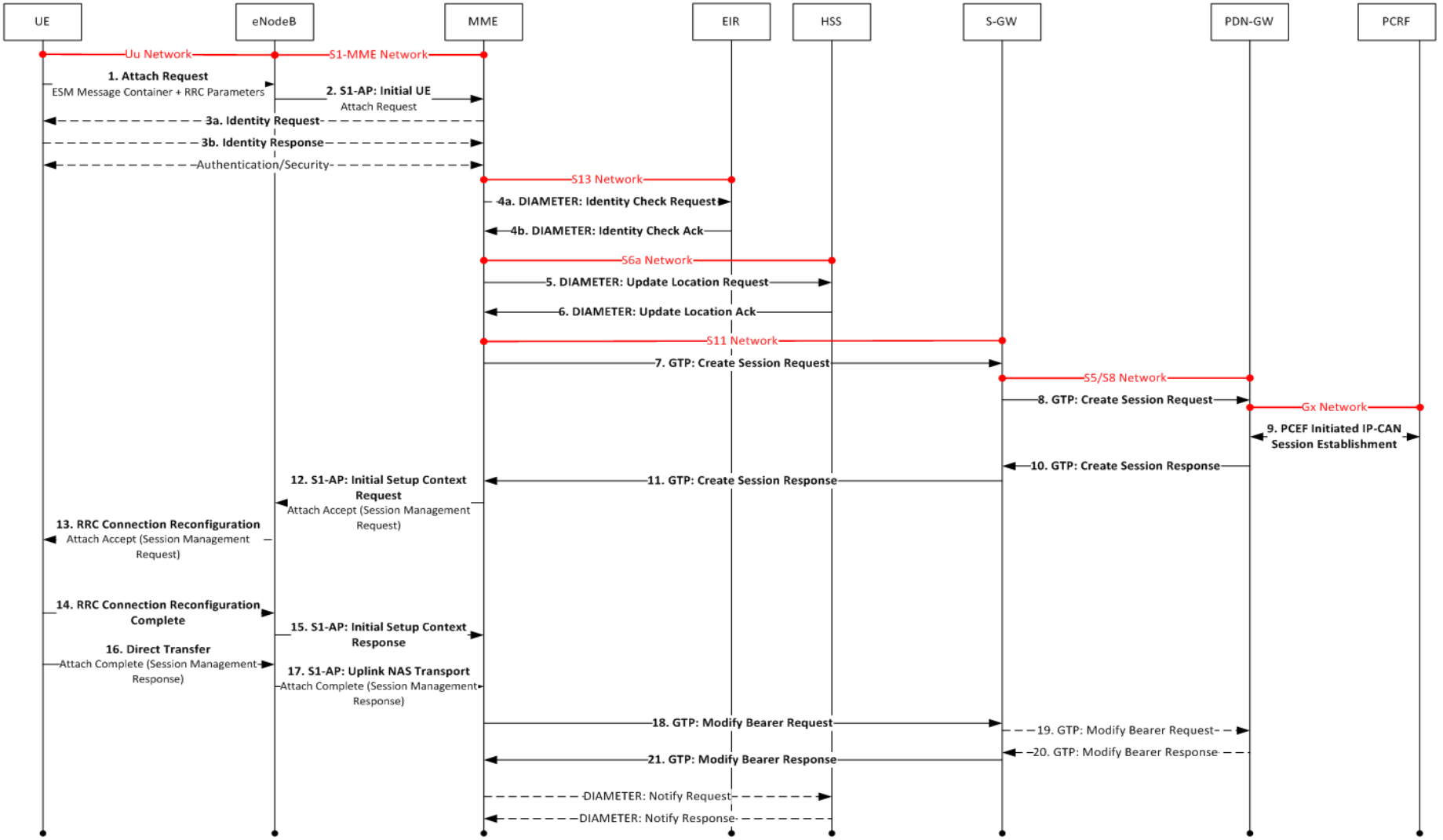
User-plane


UE
LTE-Uu
eNB
S1
S-GW
S5
P-GW
SGi
PDN
PDN Connection (EPS Session)
UE IP Address
APN
Default EPS Bearer
Dedicated EPS Bearer
IP flow 1
IP flow 2
IP flow 3
IP flow 4
IP flow 5

Control-plane

- Establishment of connections
- Security
- Mobility
- QoS

Control-plane



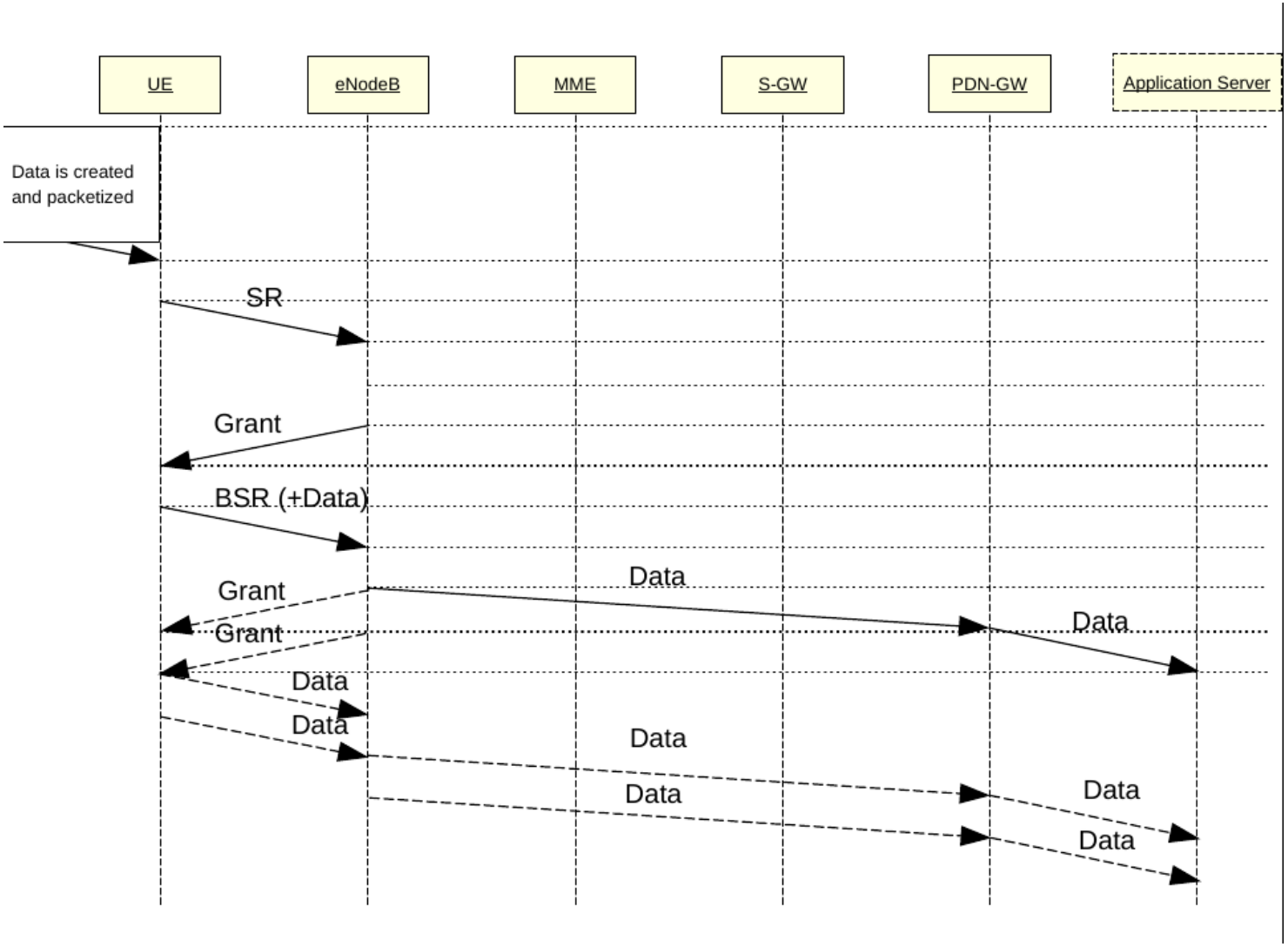
Core Network infrastructure

- Expensive to deploy, upgrade
- Few locations to cover nationwide areas
- Inflexible

Radio Access Network

- Thousands of Base Stations
- Ensures that UEs can connect to the network and use its services
- Part of any control operation, handovers, establishment of connections
- Management of the wireless medium and how the UEs use it

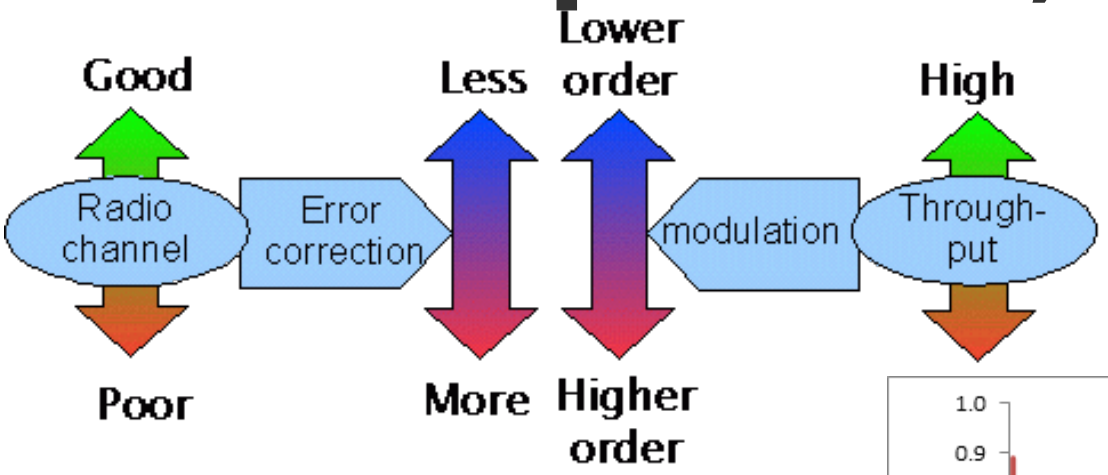
RAN needs to schedule the connected UEs

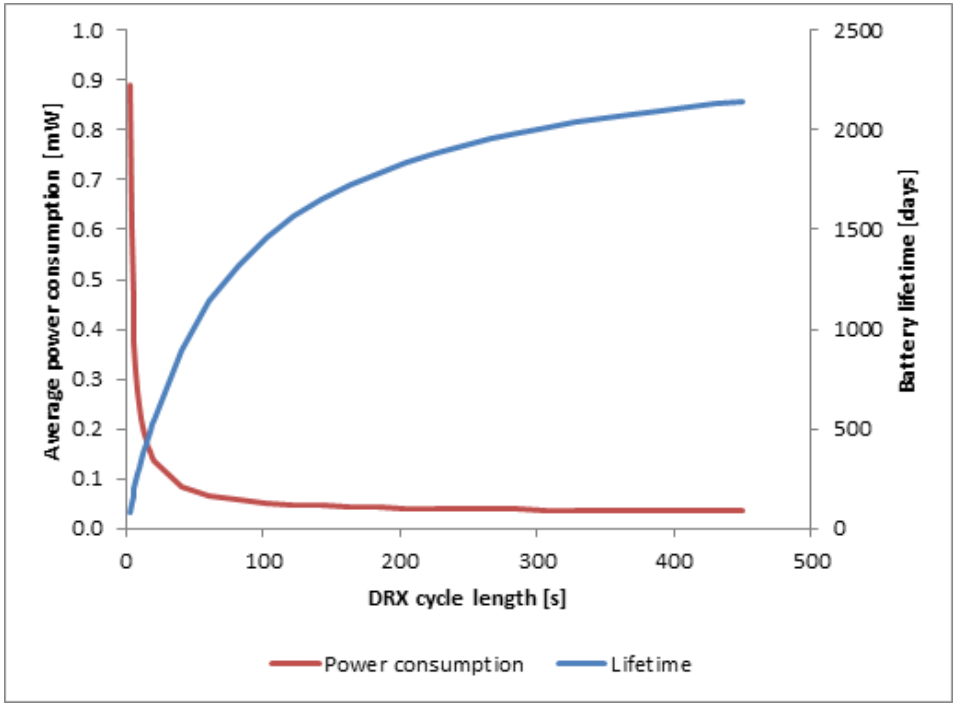


RAN needs to schedule the connected UEs

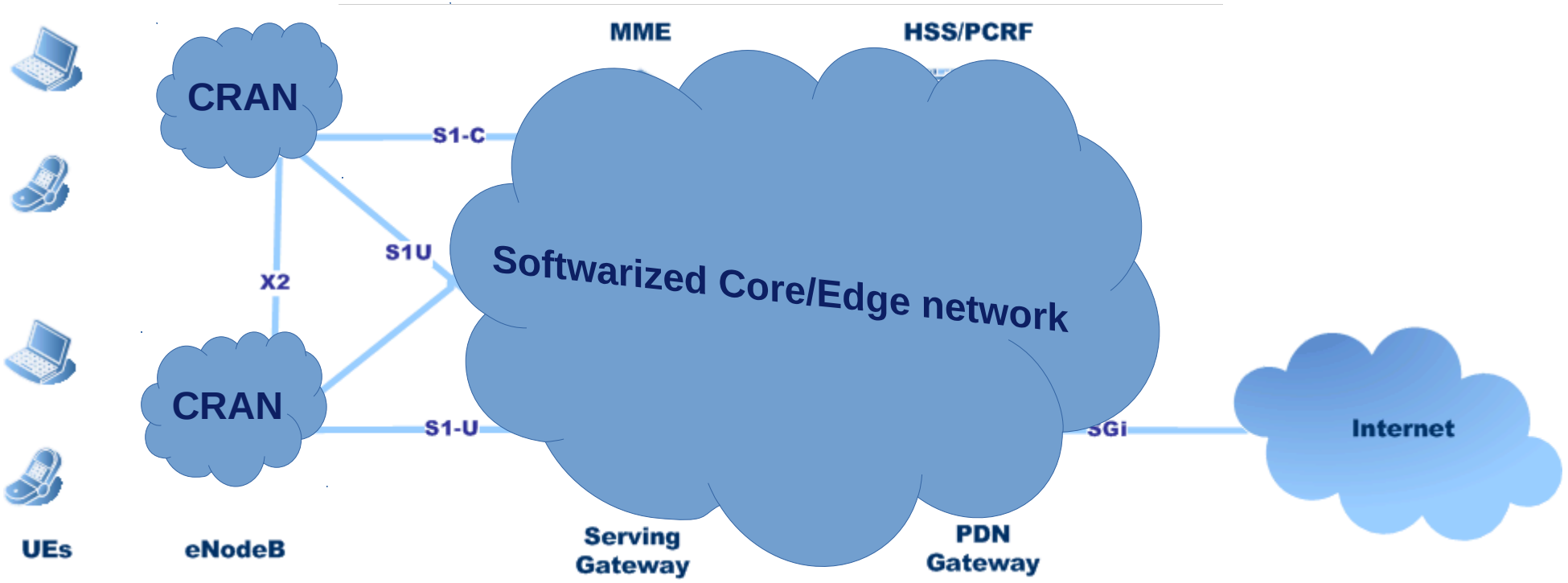
- Several different ways to do that exist
- We need to schedule the transmissions in a way that provides acceptable QoS to all devices, fairness and high overall high throughput
- No perfect solution exists
- Better scheduling usually comes with higher overhead and complexity

RAN performs link adaptation, etc.





NFV challenges: performance



NFV challenges: management

The current RAN is in need of major changes

- Current vision for 5G needs:
  - Higher throughput (up to 10 Gbps)
  - Higher UE density
  - Lower latency
  - And more...

Just do it?

Using best case LTE assumptions.

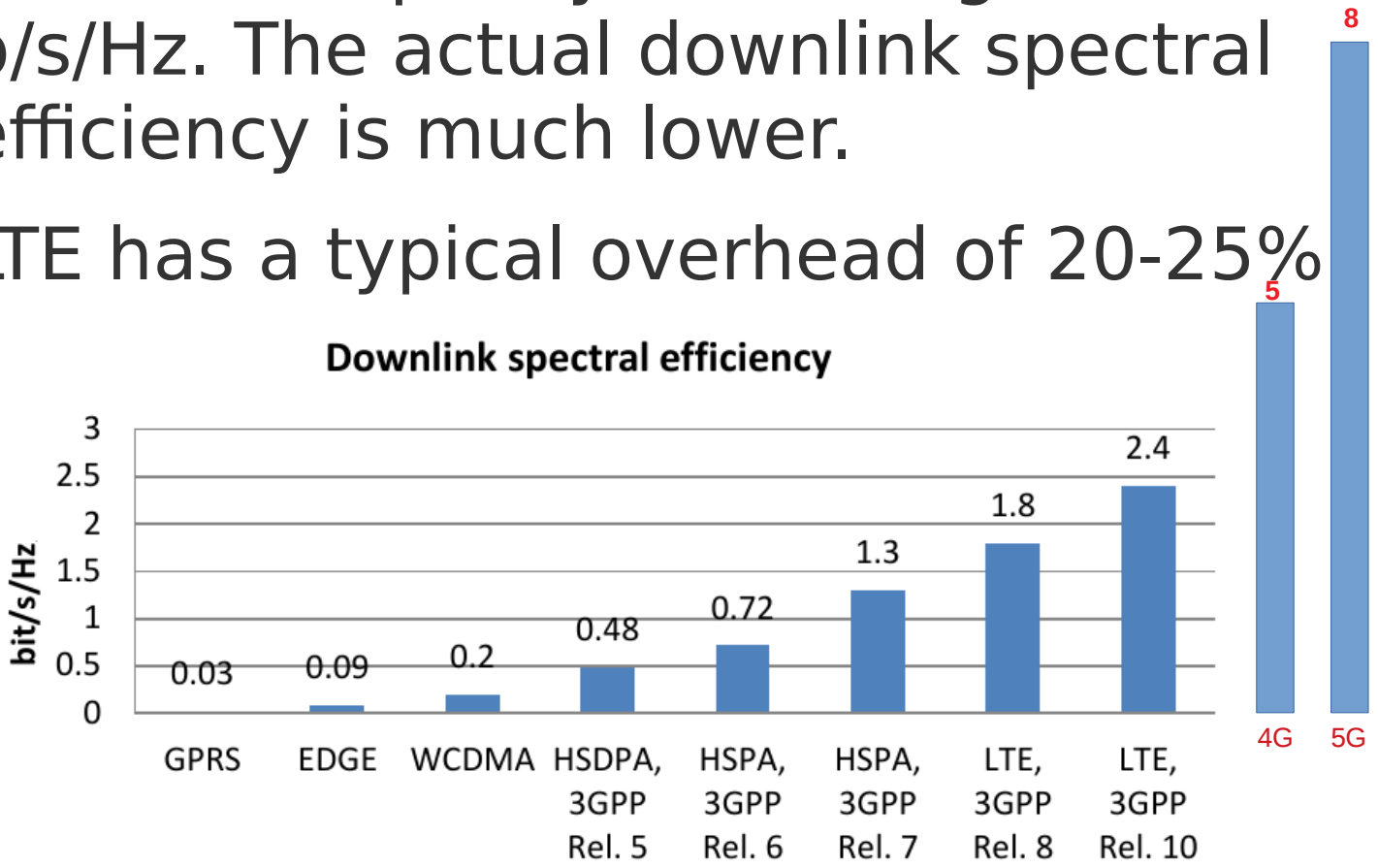
- 40db SNR
- 5x20 Mhz carriers
- Shannon capacity

$$C = \log_2\left(1 + \frac{S}{N}\right)$$

- We can get around 1.3 Gbps SISO
- With 4x4 MIMO we can get up to 5.2 Gbps
- With 8x8 MIMO we can get up to 10.4 Gbps

Spectral efficiency

- Shannon capacity with our great CQ is 13 b/s/Hz. The actual downlink spectral efficiency is much lower.
- LTE has a typical overhead of 20-25%



Spectral efficiency

- Shannon capacity with our great CQ is 13 b/s/Hz. The actual downlink spectral efficiency is much lower.
- LTE has a typical overhead of 20-25%
- With some more realistic numbers, still fictional hardware, great channel quality and no contention for resources we need around 200MHz to get 10Gbps

So, we just need

- More antennas
- More spectrum
- Great channel quality
- Lower overhead

How do we do that?

- Plenty-full spectrum and feasible antennas are only available in higher frequencies
- Higher frequencies mean more eNBs are needed for adequate coverage and CQ
- More eNBs means more interference and more infrastructure to connect them
- Centralization of some of the functions and cheaper eNBs with Ethernet connections is needed

In conclusion, there is no magic solution

- Several known bottlenecks
- Flexibility is key
- New performance, management and cost issues arise
- Infrastructure and spectrum will need to be reconsidered to approach some of the ambitious goals set for 5G

Thank you.

References

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certain references are missing, please contact.