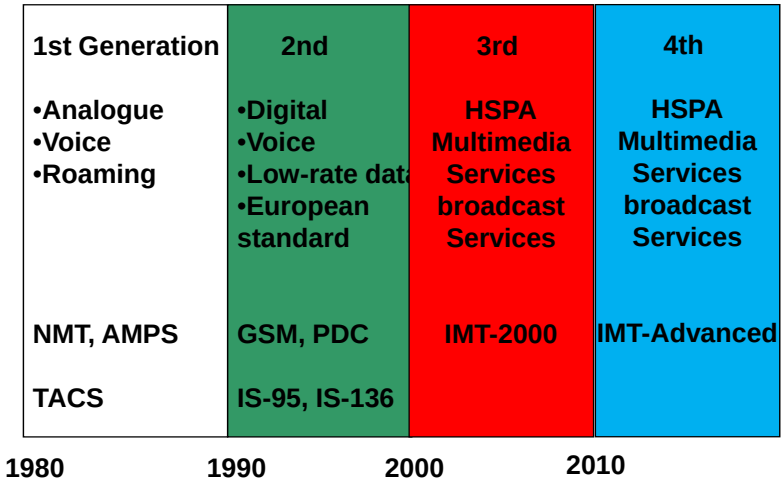
# Dimensioning, configuration and deployment of Radio Access Networks.

## part 1:
## General considerations

# Mobile Telephony Networks

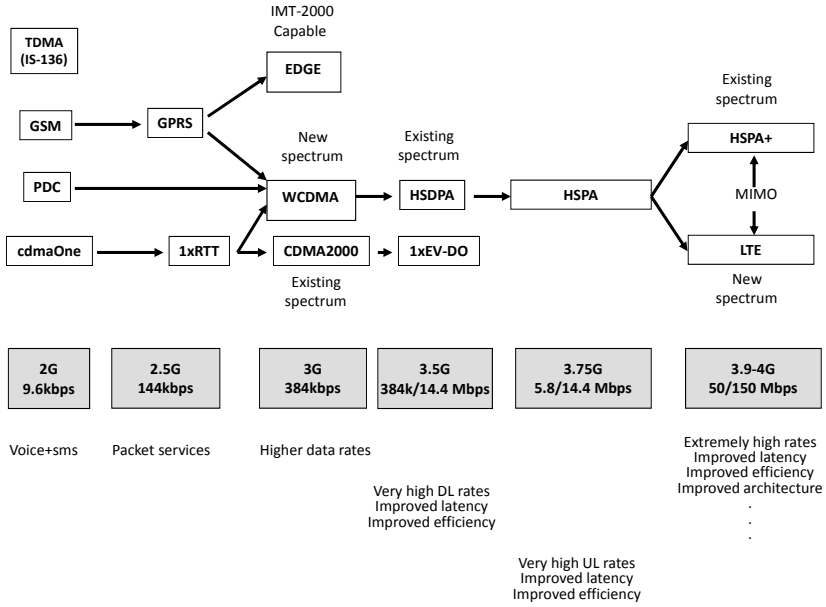
# The Evolution of Mobile Telephony



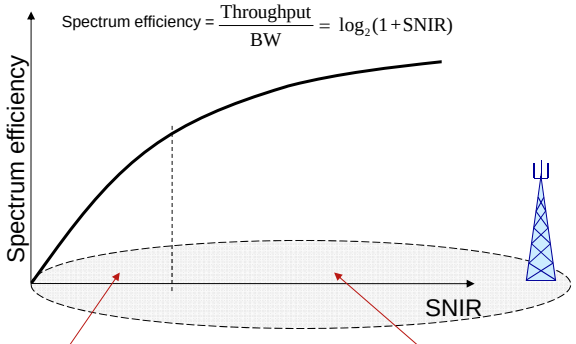

# Evolving Mobile Generation

- **1G was innovation**
  - I can actually make a phone call in my car!
- **2G was revolution**
  - New infrastructure, frequencies and mobile terminals
  - No backward compatibility, no NMT-GSM handovers
- **3G was evolution**
  - New radio interface, reuse part of 2G network
  - 2G/3G handovers
- **4G will be innovation, revolution and evolution**
  - New radio access and multi-frequency usage, multi-access
  - Enhanced mobility and control functionality

## Evolution of cellular systems



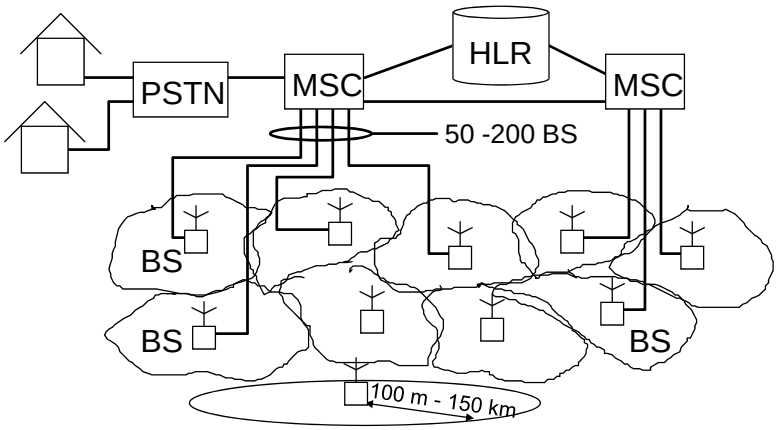

## High data rates in mobile communications – Shannon's limit



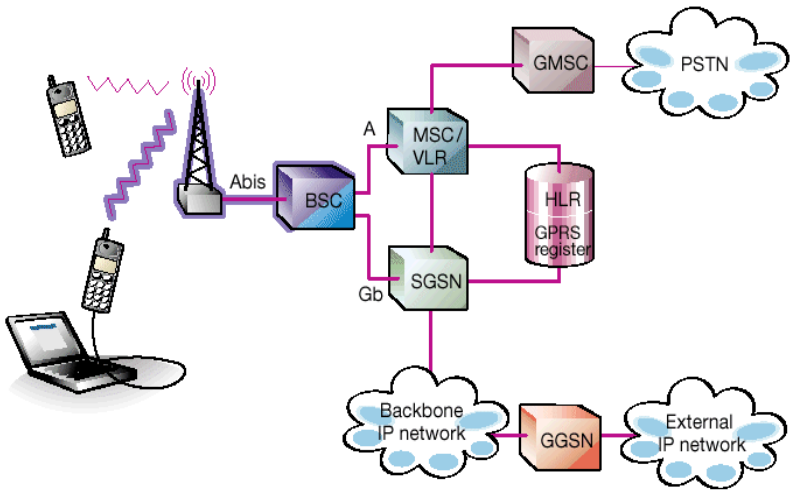

**Power-limited region (cell edge)**
- Low SNIR → Throughput proportional to SNIR
- Low bandwidth utilization (spectrum efficiency)

**BW-limited region (close to the site)**
- High SNIR → Throughput proportional to **log(SNIR)**
- Throughput saturation due to very high SNIR (close to site)
- Large SNIR increase leads to small throughput increase
- High bandwidth utilization (spectrum efficiency)

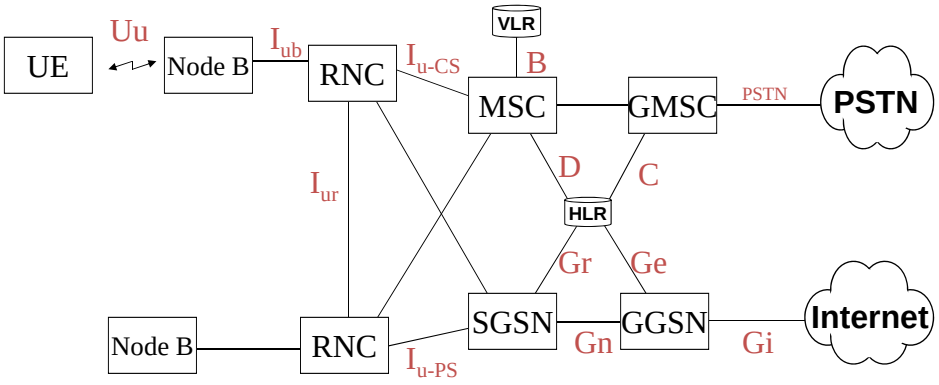
# Mobile Telephony Network




# GSM Voice and data architecture

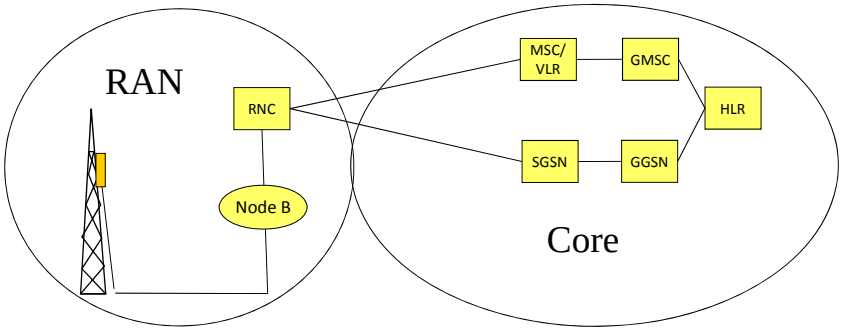


## UMTS Network Architecture




## The cost of a 3G Network

Mobile Networks generally consist of a Radio Access Network (RAN), a Core Network (Core) and mobiles




70-80% 20-30%

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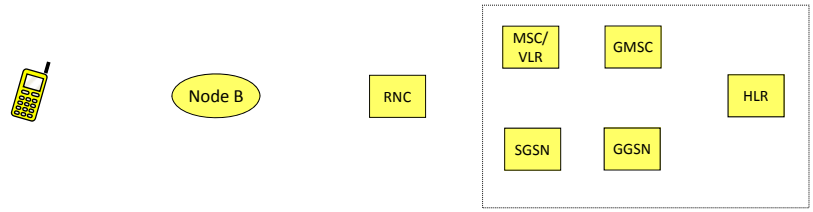
# Users of a 3G Network

The relative equipment volumes needed to build a network vary between vendors but can generally be estimated to:




| 1E6 | 1E3 | 10 | 1 |
|---|---|---|---|
| Mobiles | Bas stations | Network Control | Core Net |

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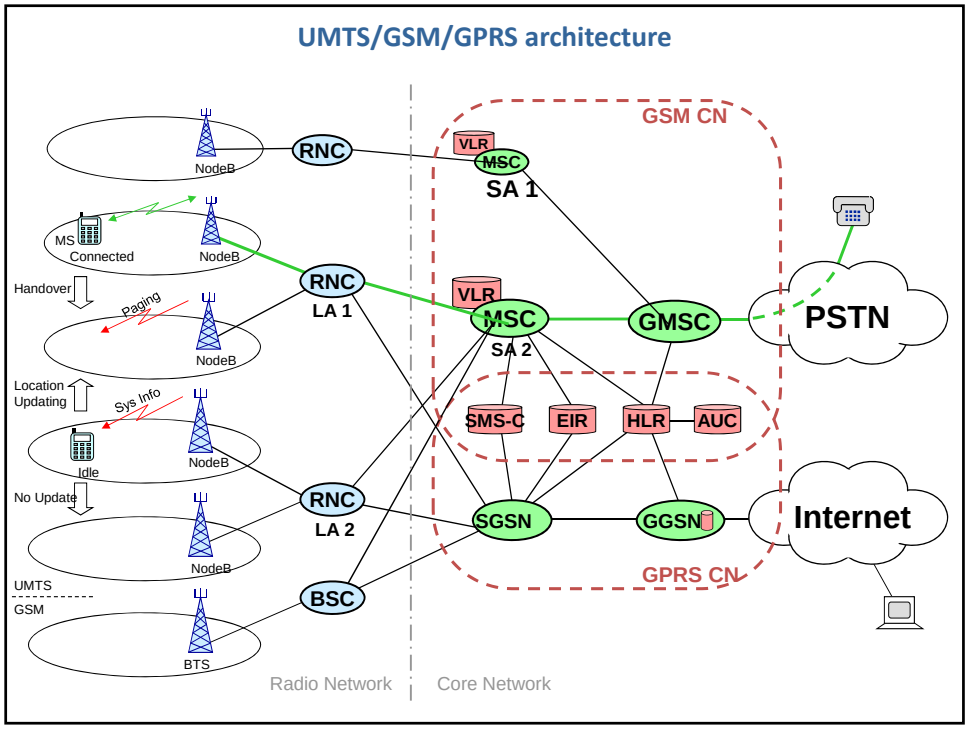
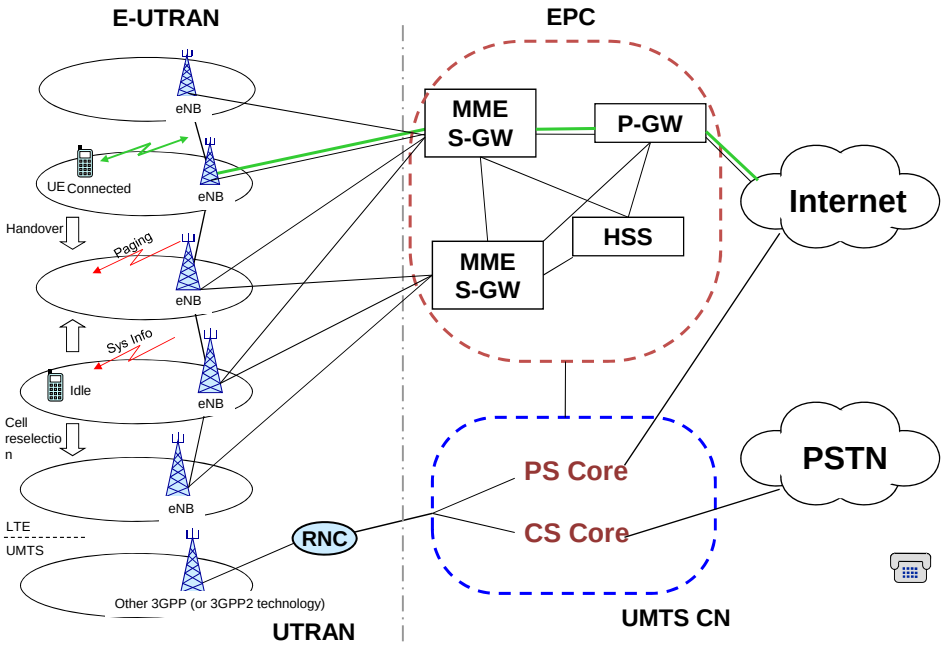
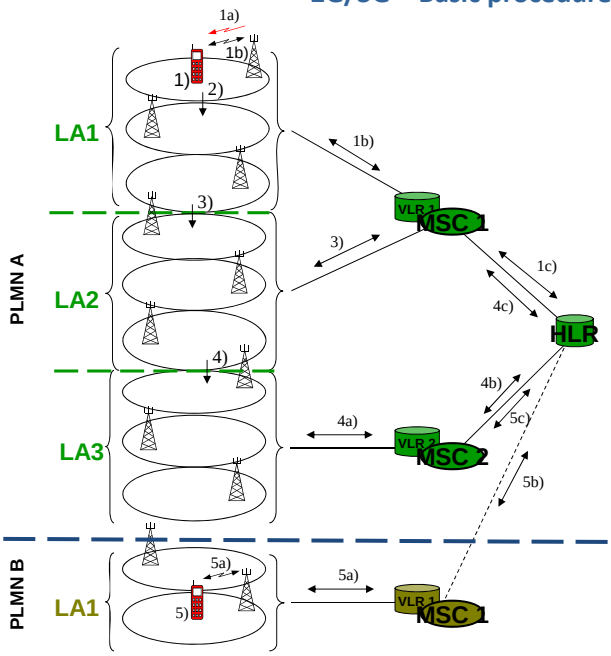


## Evolved Packet System (EPS) / Long Term Evolution (LTE) architecture




## 2G/3G – Basic procedures




1) Power on!
1a) read System Information =>
- neighbours to monitor
- Location Area Identity (stor
- etc.

1b) Location Updating
1c) Update location
Download subscriber data

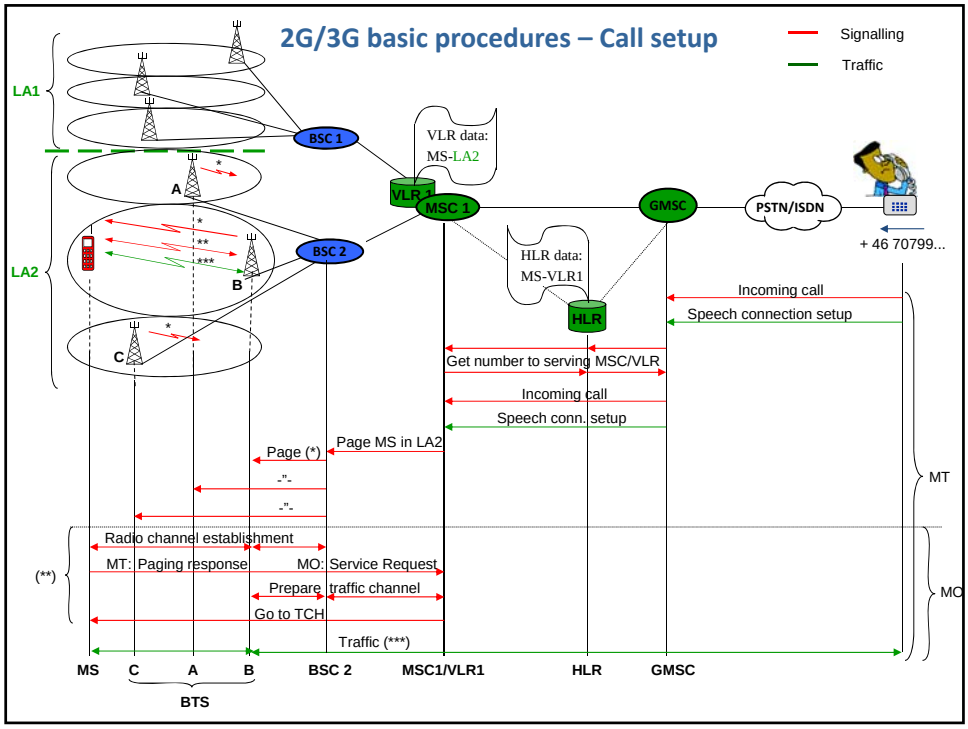
MS is Idle
Compares: serving cell <->neighbours

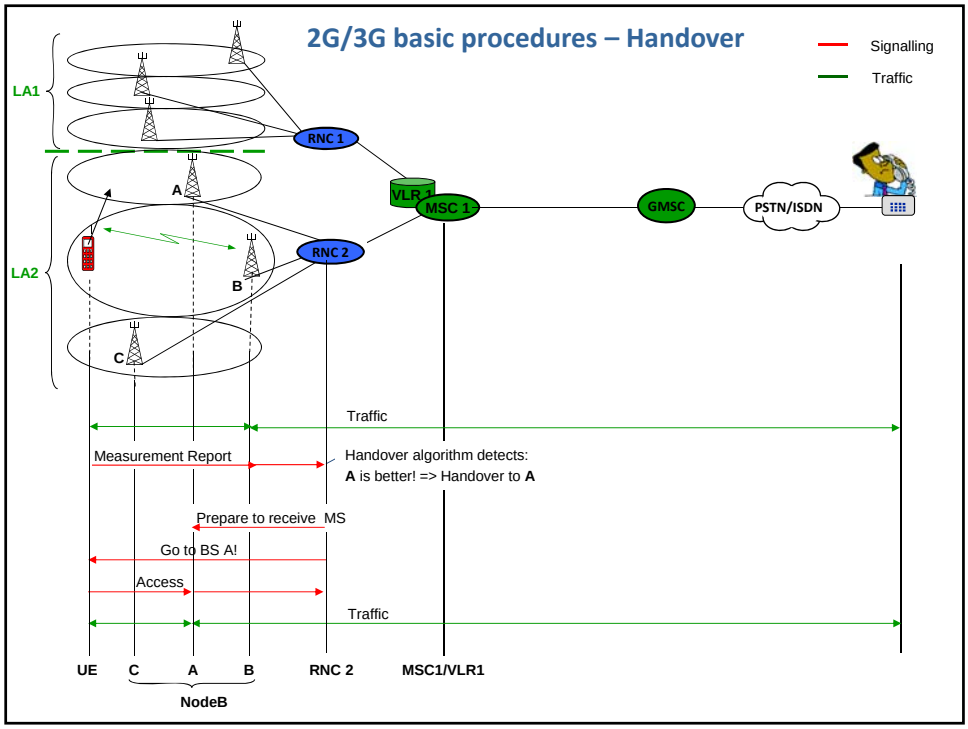
2)Intra LA cell change
no updating needed

3)Intra MSC /VLR LA change
Location Updating (VLR)

4)Inter MSC /VLR cell change
4a) Loc. Upd.
4b) Update loc.
Download sub. data
4c) Cancel location

5)Power on! (Roaming MS)
5a) Loc. Upd.
5b) Update loc.
Download sub. data
5c) Cancel loc.


2G/3G basic procedures – Call setup
Signalling
Traffic
LA1
LA2
BSC 1
BSC 2
A
B
C
VLR data:
MS-LA2
VLR 1
MSC 1
GMSC
PSTN/ISDN
+ 46 70799...
HLR data:
MS-VLR1
HLR
Incoming call
Speech connection setup
Get number to serving MSC/VLR
Incoming call
Speech conn. setup
Page MS in LA2
Page (*)
-"-
-"-
MT
Radio channel establishment
MT: Paging response
MO: Service Request
Prepare traffic channel
Go to TCH
Traffic (***)
(**)
MO
MS
C
A
B
BTS
BSC 2
MSC1/VLR1
HLR
GMSC


2G/3G basic procedures – Handover
Signalling
Traffic
LA1
LA2
RNC 1
RNC 2
A
B
C
VLR 1
MSC 1
GMSC
PSTN/ISDN
Traffic
Measurement Report
Handover algorithm detects:
A is better! => Handover to A
Prepare to receive MS
Go to BS A!
Access
Traffic
UE
C
A
B
NodeB
RNC 2
MSC1/VLR1

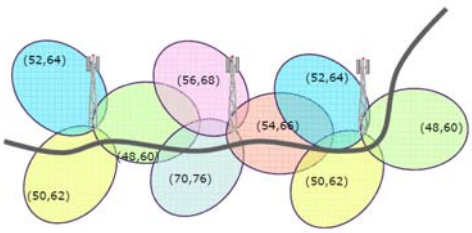
# Network Roll-out

Network roll-out involves a number of processes for planning of

- Radio
- Capacity
- Coverage
- Transmission

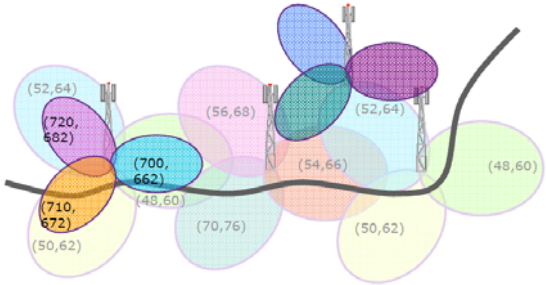
# GSM 900 initial roll-out

- 4/12 Reuse pattern for control Channels
- 3/9 for Traffic Channels
- Required sensitivity > 9 dB C/I



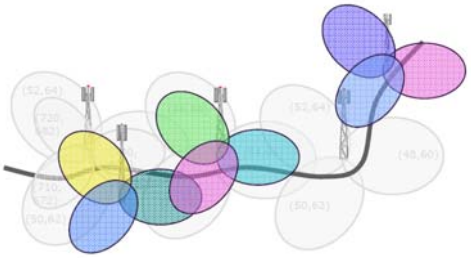
# GSM 1800 adding voice capacity

- Co-incident cell boundaries or
- Seperate networks

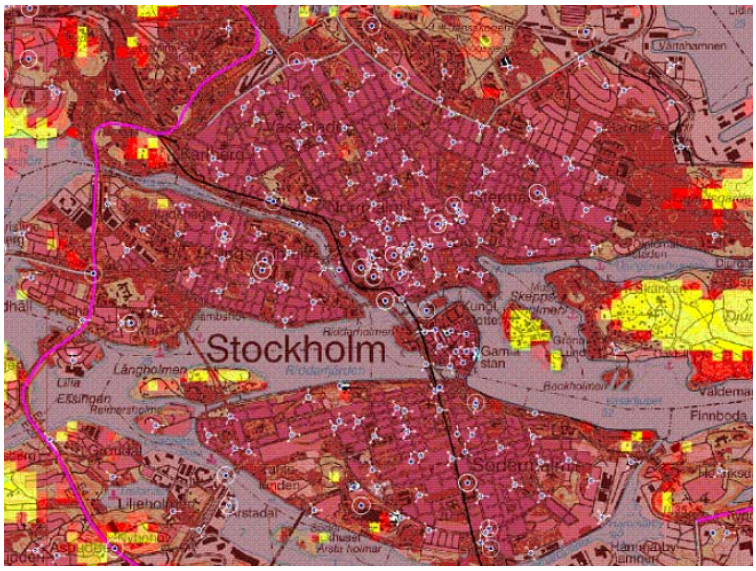



# UMTS (3G) adding data capacity

- 3G rel 99 both voice and data
- HSPA adds packet data up to 24Mbps
- Where needed…



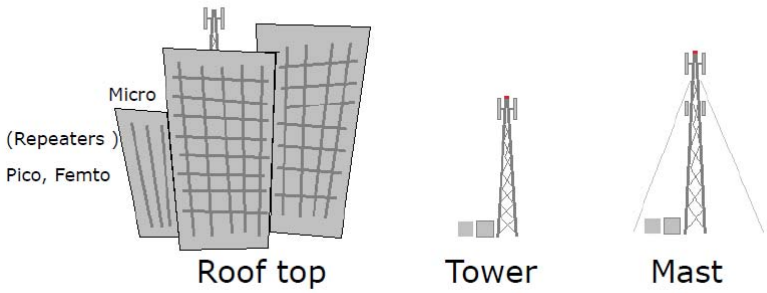
# Coverage Map




# Capacity and Quality Improvments

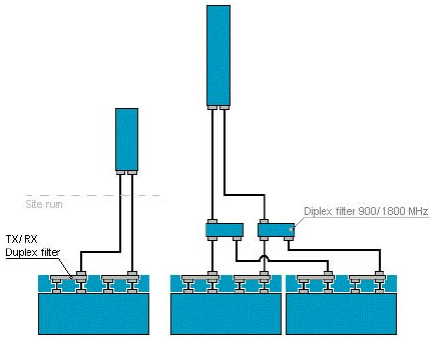
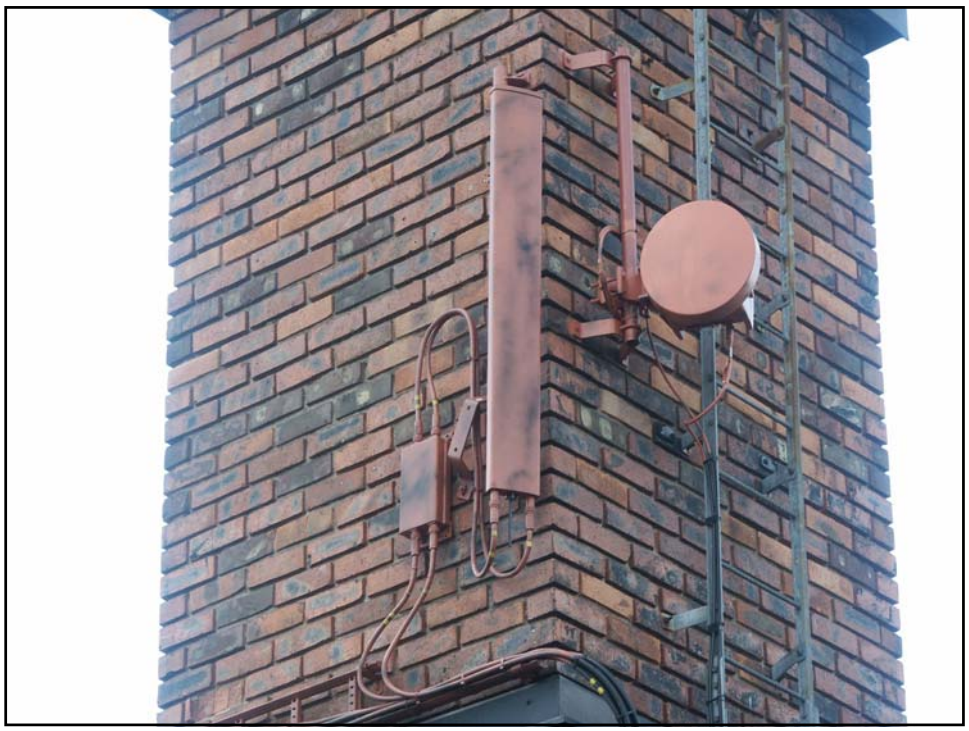
- Building New sites (GSM, UMTS or LTE)
  - Coverage
  - Capacity
- Adding Frequencies (e.g. 1800)
- Swapping network elements
  - New technology
  - Adding carriers
- Network optimization
  - Kpi based
  - SON

# Site Equipment




# Site Room Equipment

- Active equipment
  - BTS/NodeB/ (RRU)/MRS
  - (Repeaters / Booster)
- Transmission
  - Modem, Fibre, radio/micro wave link.
- Support system
  - Electrical system /BBU
  - Air condition
  - Alarm/monitoring
- Antenna System
  - Coaxial Cables / Jumpers / Connectors /lightning protection
  - (TMA's)
  - Antennas

# Tower/Antenna Equipment

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