Deploying a TETRA system with 100% coverage

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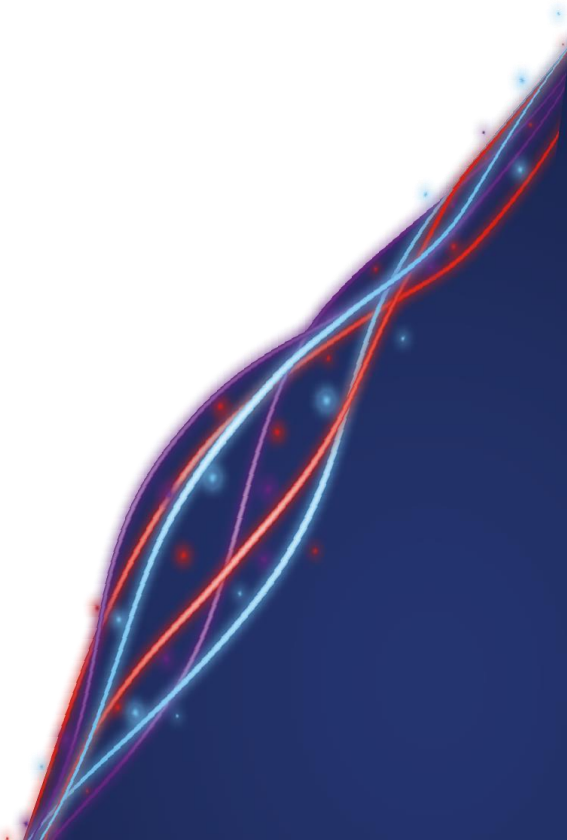
Agenda

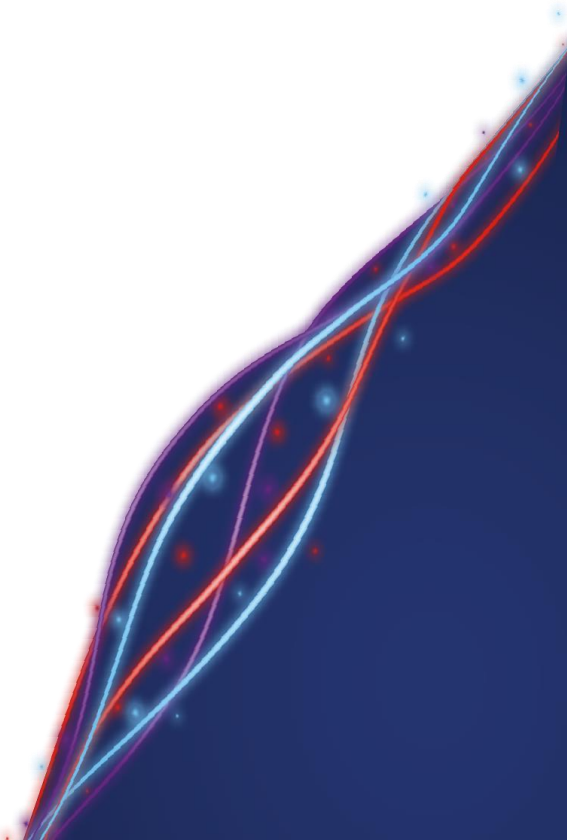
- Frequency band
- Topology
- Coverage requirements
- Mast position
- Link budget
- Antenna types
- GEO redundancy
- Type of backbone infrastructure
- Redundant backbone
- Frequency re-use and interference
- Digital dimension
- Management



Frequency band

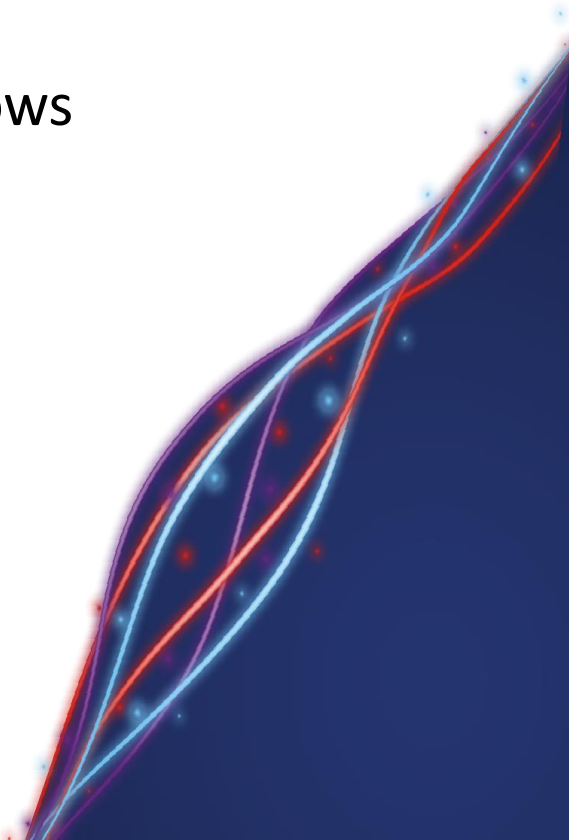
- VHF 80MHz-160MHz
  - Great for long distance
  - Weaker performance inside buidlings or tunnels
  - Rarely available in TETRA
- UHF 300-500MHz
  - Balanced performance in long distance and inside buildings and tunnels
  - Large variety of manufacturers available in TETRA
- UHF high 800MHz
  - Weak performance in long distance
  - Great performance inside buildings and tunnels
  - Less often available in TETRA

=> Anyhow frequency band country and authority dependent!



Topology

- Buildings, metal walls as well as mountains, valleys form barriers
- Ideal antenna mast position is at highest point with corresponding downtilt
- In case of lower position, buildings and mountains will create shadows
- Shadows need to be covered by either:
  - Repeaters
  - Other sites
  - Simulcast sites
- Be aware of fading and reflections, so keep a safety margin
- Keep also in mind the highest speed of your terminals and keep a margin for fading effects



Coverage requirements

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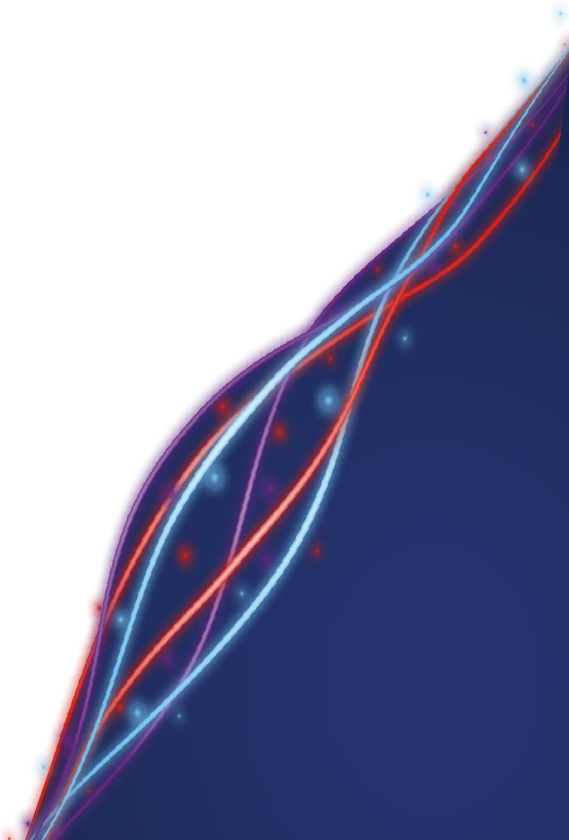
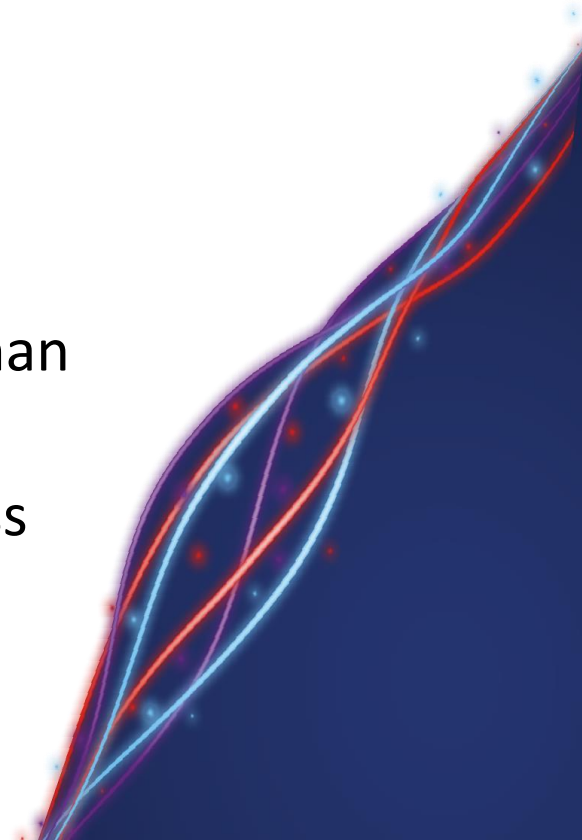
- Area coverage
  - Typical cellular cluster setup, with re-use pattern
- In-building coverage
  - Usually leaky feeder system installations with several repeaters (often optical)
  - Simulcast base station is a secondary option
- Line coverage
  - Directional antennas cover the needs best
  - Tunnels covered with simulcast base stations or repeaters and leaky feeders
- Underground coverage
  - Several levels to basement, each level or tunnel requires own leaky feeder system
  - Fiber repeaters or simulcast base stations serve best
- Vessel or container harbour coverage
  - Metal walls block the signal, moving containers or closing doors change conditions
  - Reflections are “unpredictable”, no over the air repeaters possible
- Redundant coverage
  - Critical subscribers covered by two sites
  - For the repeaters two donator base stations required
  - Redundant leaky feeder system



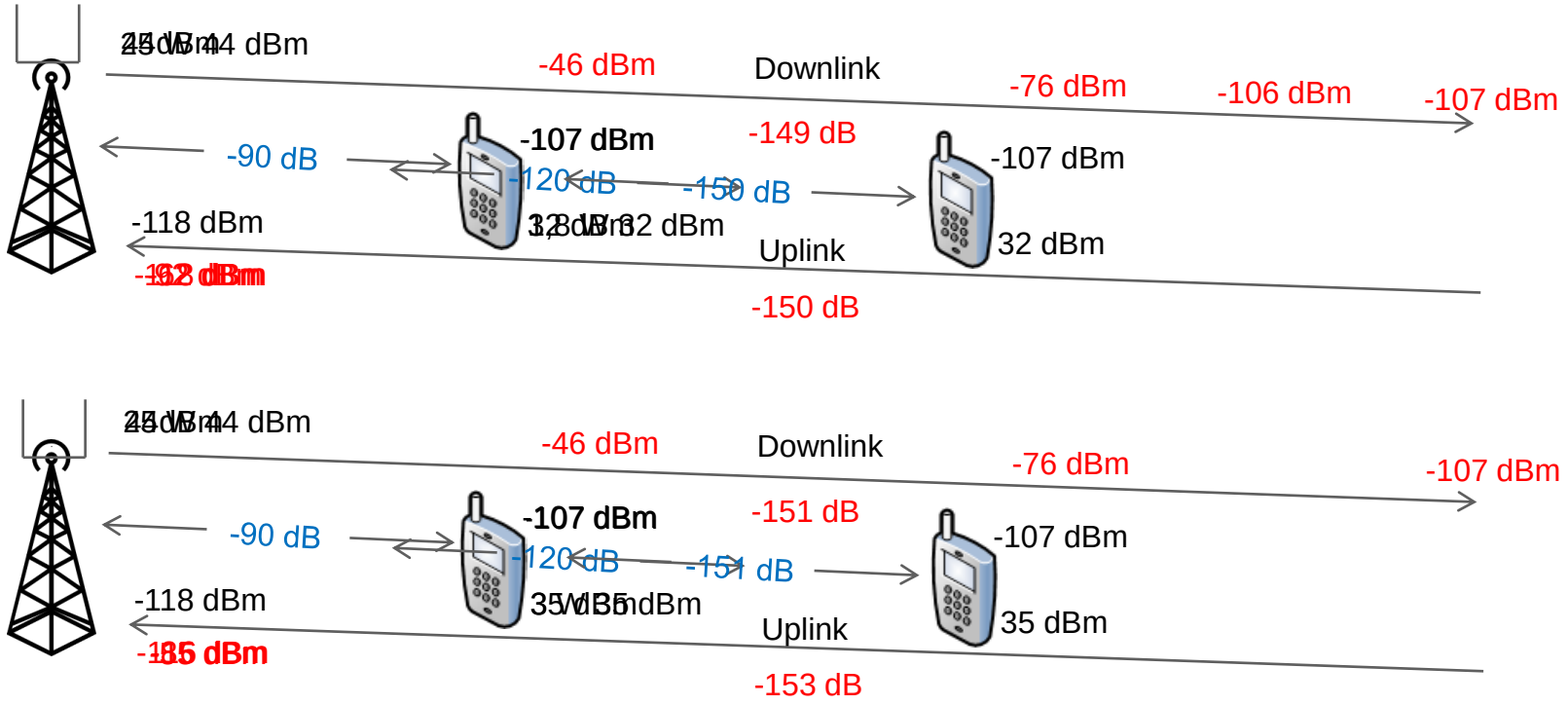
Mast position

- Highest position is usually best
- Optimal position: As high as needed only
- Be aware that a mast also casts a shadow in your coverage
- Tilted sectorised antenna to avoid
  - Gap below the antenna
  - Too far radiation of the signal causing interference in neighbour cell
- Two masts at two medium positions can sometimes cover better than one mast at highest position

=> Proper full picture RF planning (with clutter maps) is key to success



Link budget



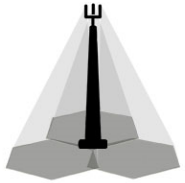
- Avoid crocodile effect: big mouth small ears
- Remember to use RX diversity, dual provides the biggest effect
- Stay in link-balance, consider cable and combiner losses in both directions

Antenna types

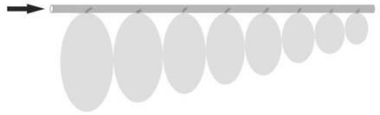
- Most common types:
  - Omni-directional

  - Directional

  - Sectorised



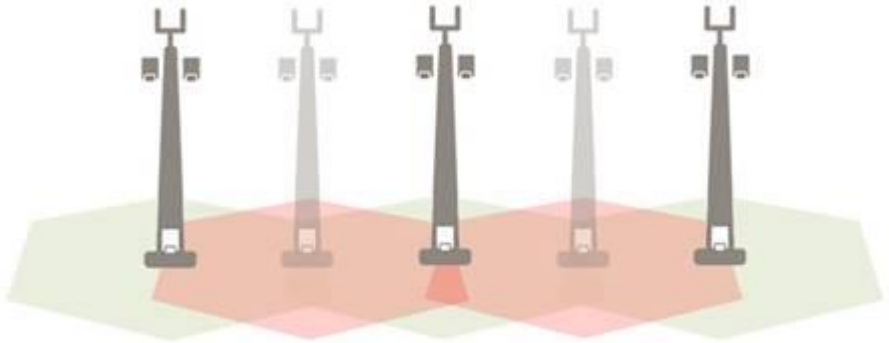
  - Leaky feeder systems



- Polarisation:
  - Typically vertical polarisation
  - Circular can be used for air-ground-air
- Gain achieved:
  - By length
  - By direction
- Downtilt:
  - Typically 1/10 of the mast height in degree in flat area

Geo redundancy

- Redundancy in general:
  - Backbone
  - Cabinet
  - Controller
  - Power supply
  - Carrier
  - Antenna system



- Geo redundancy
  - Overlapping cells, each area is covered by minimum two sites
  - Absolutely no single point of failure
  - 100% availability
    - in decentralized architecture
    - with redundant backbone connection

=> efficient, but costly “Ferrari“ solution

Type of backbone infrastructure

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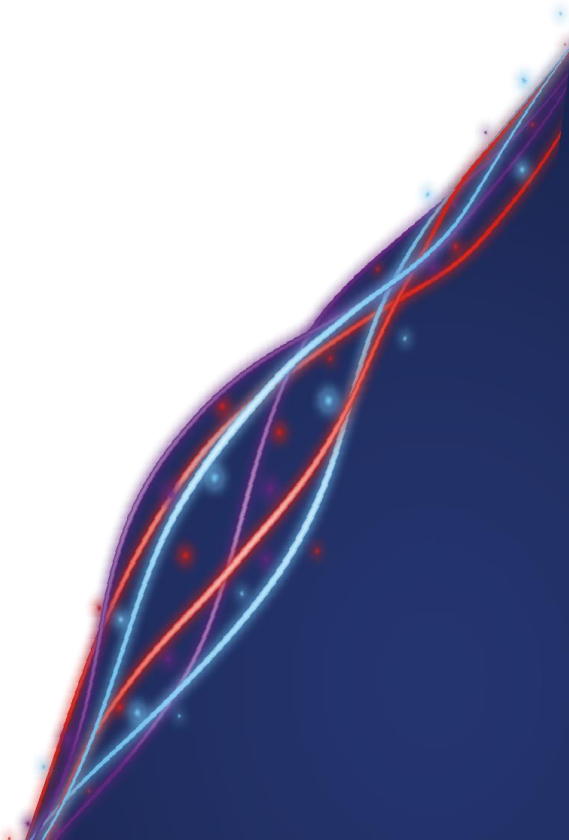
- Fiber
  - Privately owned, ring redundancy, full performance
- MPLS/leased line
  - Point to point connection or routed with proper SLA
  - Bandwidth and QoS guarantee
- Microwave
  - Privately owned, controlled throughput
  - Operators need to deal with maintenance and vulnerability
- Internet with static or dynamic IP
  - Proper SLA needs to be in place for the backbone routing
- LTE
  - More of a backup solution, but easily available
- Redundancy:
  - Any combination of the above can be used for redundancy
  - In decentralized systems also satellite connections are a proper redundancy solution



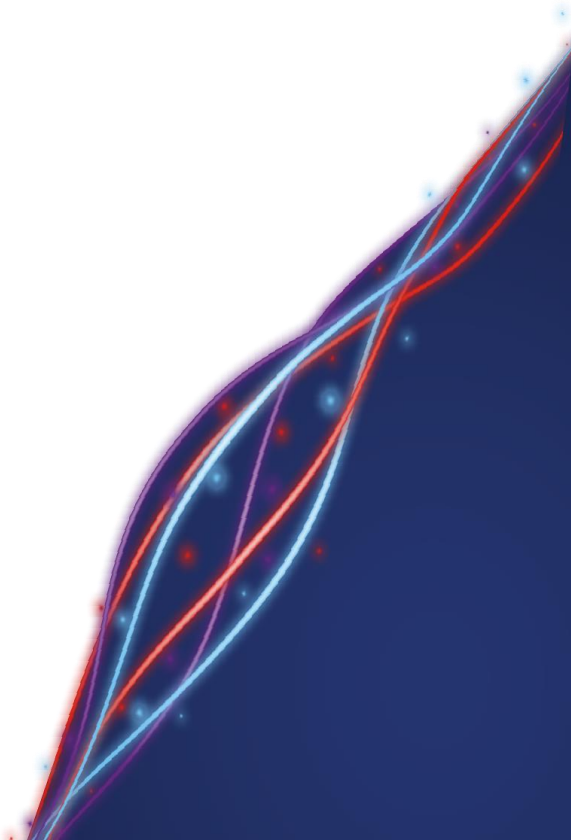
Frequency re-use and interference

- Typical re-use patterns are 3, 5, 7 or 9 clusters
  - Be aware the smaller the reuse number, the better the RF planning it needs
  - Overlapping to re-use areas with the same frequency needs to be avoided
  - Repeaters are difficult to add into clusters
  - The more reflection you have, the higher the cluster size shall be
- Be aware in your planning to avoid:
  - 3rd and 5th order intermodulation products as operating frequencies
  - 3rd order: $2xf_1$-$1xf_2$; 5th order: $3xf_1$-$2xf_2$
  - For calculation consider all frequencies, not only MCCHs
- Simulcast base station can be an option to avoid re-use or intermodulation issues
- Be aware that TETRA terminals cannot roam twice within 15s
  - E.g. issue in small tunnels on exit

Digital dimension

Analog was simple RF only, TETRA brings a digital dimension on top:

- One MCC/MNC or proper migration through networks
- Allowance for sufficient subscribers
- Control channels with sufficient capacity
  - based on subscribers at the site
- Traffic channels with sufficient capacity at all sites
  - based on calls and local listeners/talkers
- Handover parameter adjustment
- Synchronised sites for seamless handover
- Repetition timers for unacknowledged messages
- Priority scheme
- Feature allowance
  - E.g. group calls only
- Load impact by SDS traffic for GPS data inside or outside a call
- Backbone calculation



Management

- Backbone protocol for redundancy switching
- Declaration of neighbour cells
- Terminal restriction, load distribution
- Fall back handling:
  - Control channels
  - Priority scheme
  - Terminal redistribution
- Alarm reporting and issue fixing
- Constant maintenance and testing of fall back / redundancy paths

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Thank You!

Visit us at our booth F60 to discuss in more detail

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