Dutch Authority for Digital Infrastructure
Ministry of Economic Affairs and Climate Policy
For a **safely connected** Netherlands

Maintaining performance in high-speed microwave links

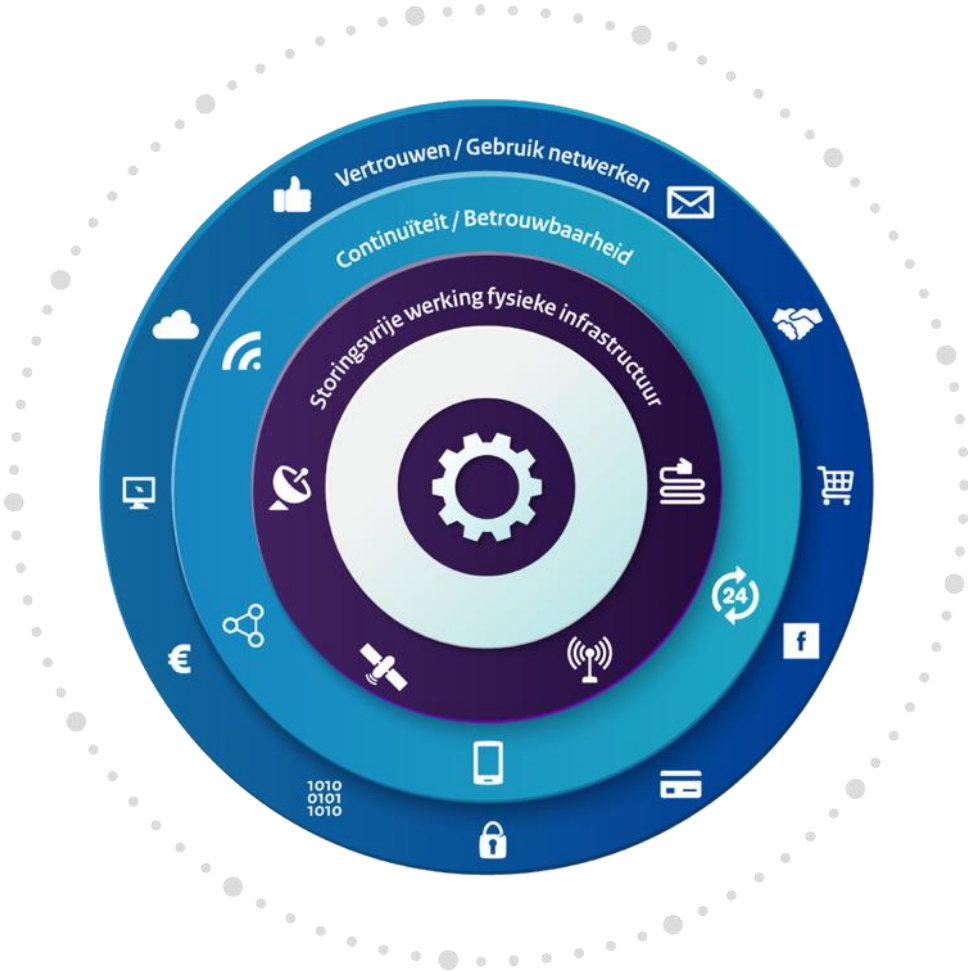
Bart Somers

Dutch Authority for Digital Infrastructure

A day without telecommunications, could you manage?

Fortunately, the Netherlands has reliable (tele)communication networks.

And that's what the Dutch Authority for Digital Infrastructure (RDI) is all about.



Mission

Ensuring a securely connected Netherlands

Who am I?

- Bart Somers MSc.
- Senior Network Specialist @ RDI
- Focus on
  - fixed service (microwave links)
  - Private 5G networks
- Master Computer Science
  - Forensic computing and cybercrime investigations
- HAM radio operator PE1RIK

- Master Thesis:
- Finding Forensic Artifacts in Long-term Frequency Band Occupancy Measurements using Statistics and Machine Learning
- 2021 University College Dublin
- https://doi.org/10.1007/978-3-031-56580-9_14

Topics:

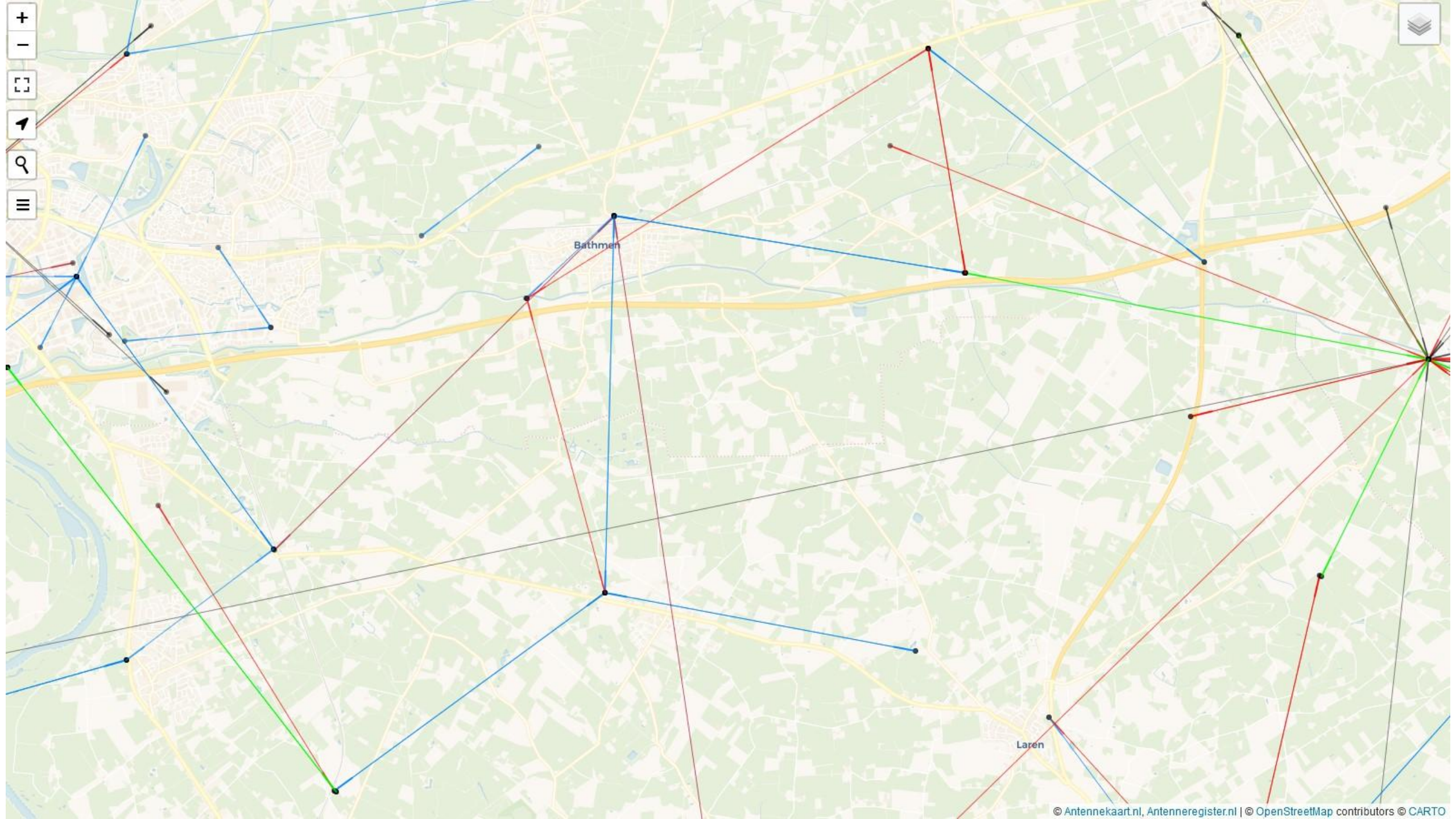
1. Microwave links in NL
2. Link planning
3. Adaptive capacity
4. What to monitor?

Microwave links: Radio-cables?

- ITU name: Fixed Service, FS.
- Building blocks for backhaul connections
- Fronthaul Connection of basestations for mobile network
- Where cables are not feasible
  - Speed of installing?
  - Obstacles?
  - Latency

Microwave links (FS) in the Netherlands

- Approx 30% of basestations connected via FS
- > 7500 microwave links in NL (June 2026)
- Frequencies ranging from 6 – 86 GHz
- Bandwidths from 20 Mbps to >> 10 Gbps
- An example:


Bathmen
Laren
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Demands and challenges for microwave links

DEMANDS

- Capacity
- Reliability
- Availability

CHALLENGES

- Interference
- Propagation changes
- Distance
- Strict link planning and coordination
- Subject to licensing

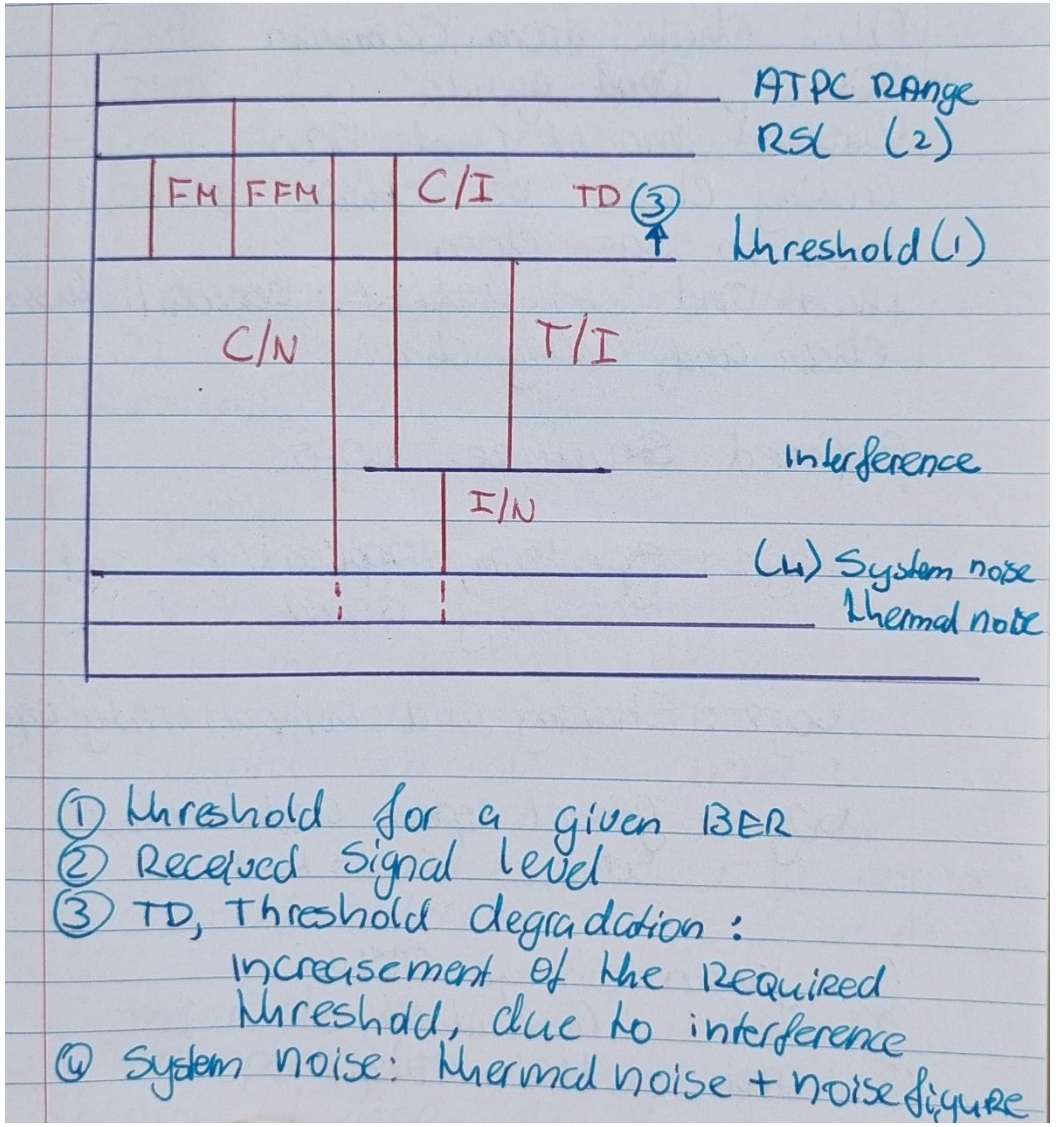
Some technical terms

- BER: Bit Error Ratio
  - Typical reference value for FS: 10^{-6}
- Threshold:
  - Minimum required received signal level for given BER value
- FM: Fade Margin
- ATPC: Automatic Transmitter Power Control
- ACM: Adaptive Coding and Modulation

- Availability:
  - Percentage of time the link is available in the planned capacity
  - Typical value: 99,99% / 99,995%
  - Downtime: 52 / 26 minutes per year.

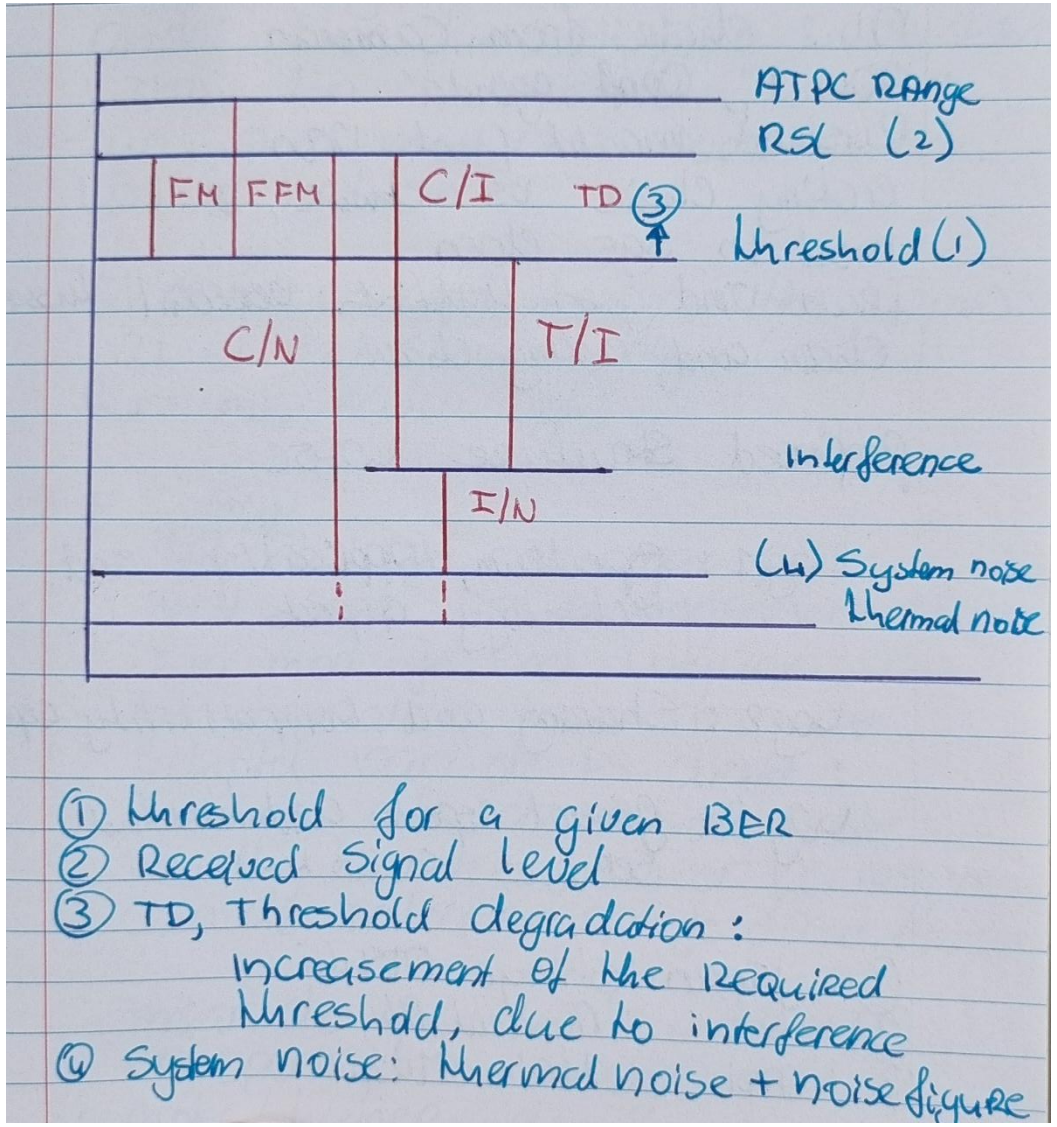
Planning a link, old-school

- Fixed capacity, fixed modulation
- Transmit power based on:
  - Required threshold
  - Fademargin for propagation changes due to weather / interference
- Standards used:
  - ITU-R P.452
  - ITU-R P.530



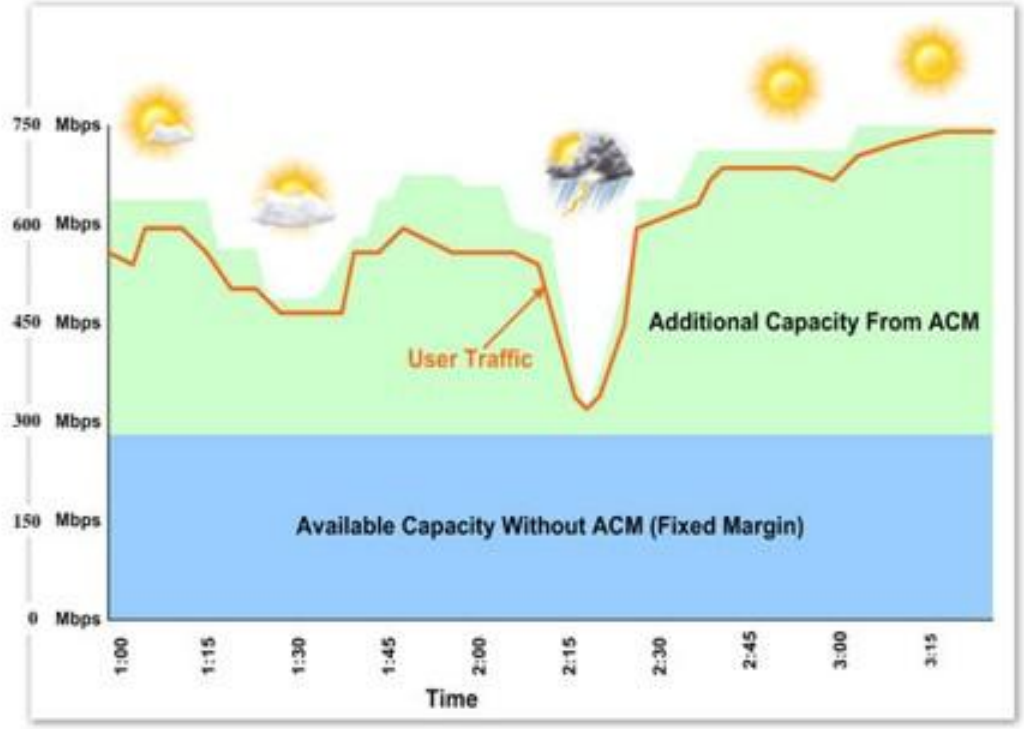
Power-savings

- Decrease transmit power
- Only when propagation is good
- And with a high Fade Margin



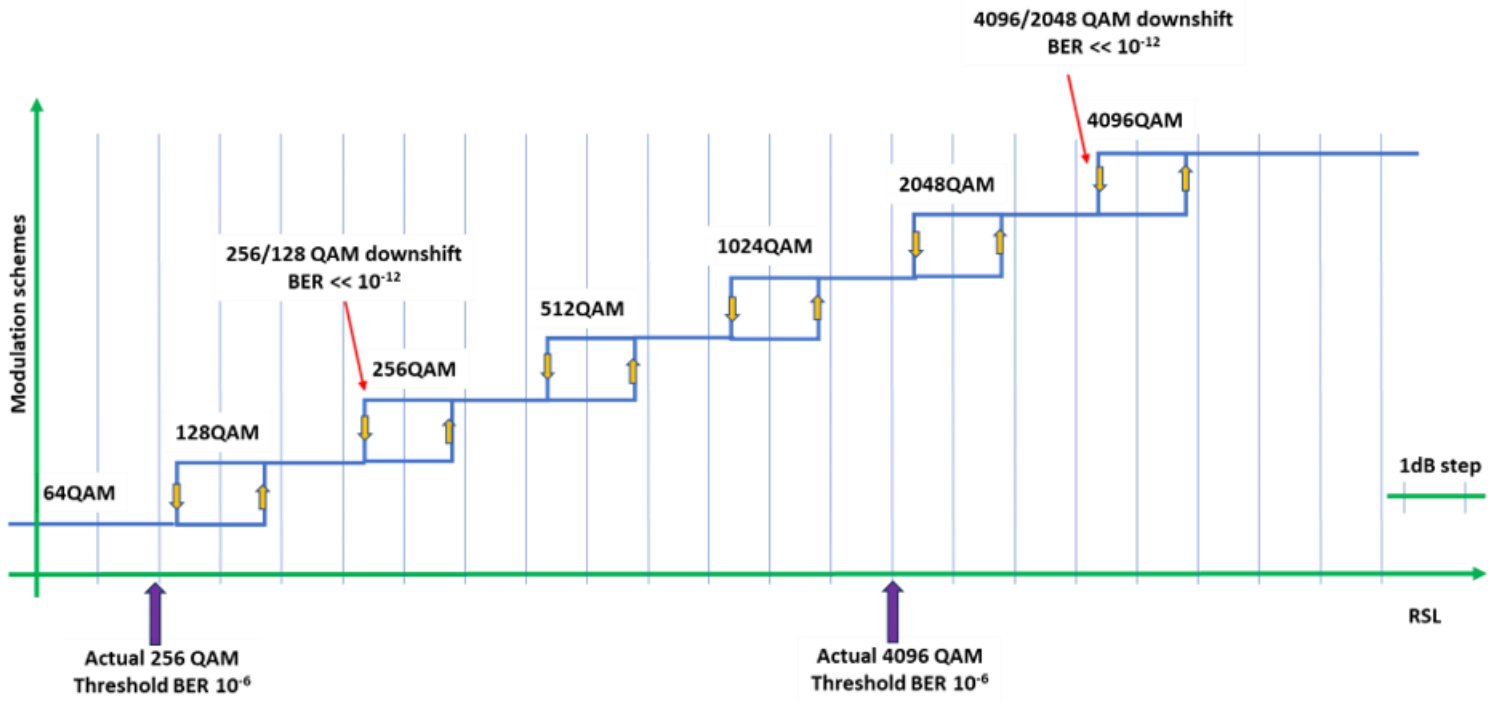
A waste of valuable radio spectrum capacity?

- Dynamic capacity:
- Adaptive Coding and Modulation
- Adapt capacity on propagation conditions
- Use high FM for extra capacity



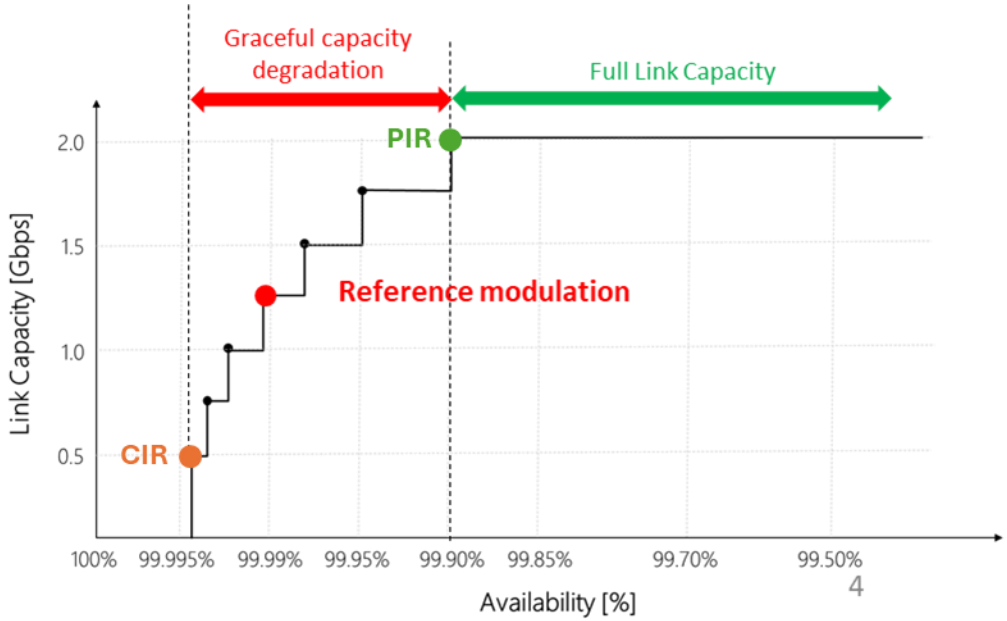
Adaptive Coding and Modulation

- Dynamic capacity switching
- Always use low fade margin
- Maximize throughput under current conditions



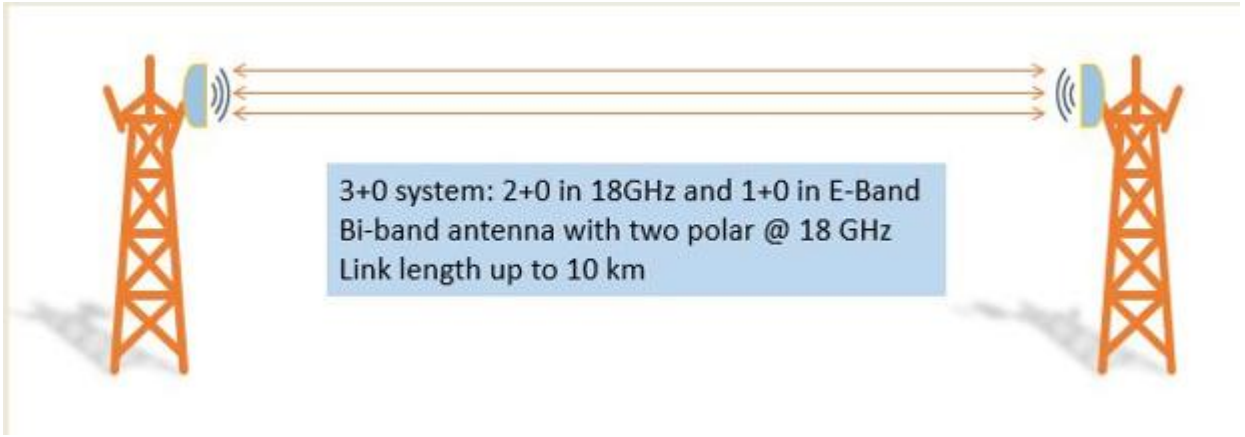
Planning a link, new style

- CIR: Committed Information Rate
  - Keep network alive
  - Guarantee calls to emergency service
- Reference Modulation
  - Reference of the link, used for planning and coordination
- PIR: Peak Information Rate
  - Less availability



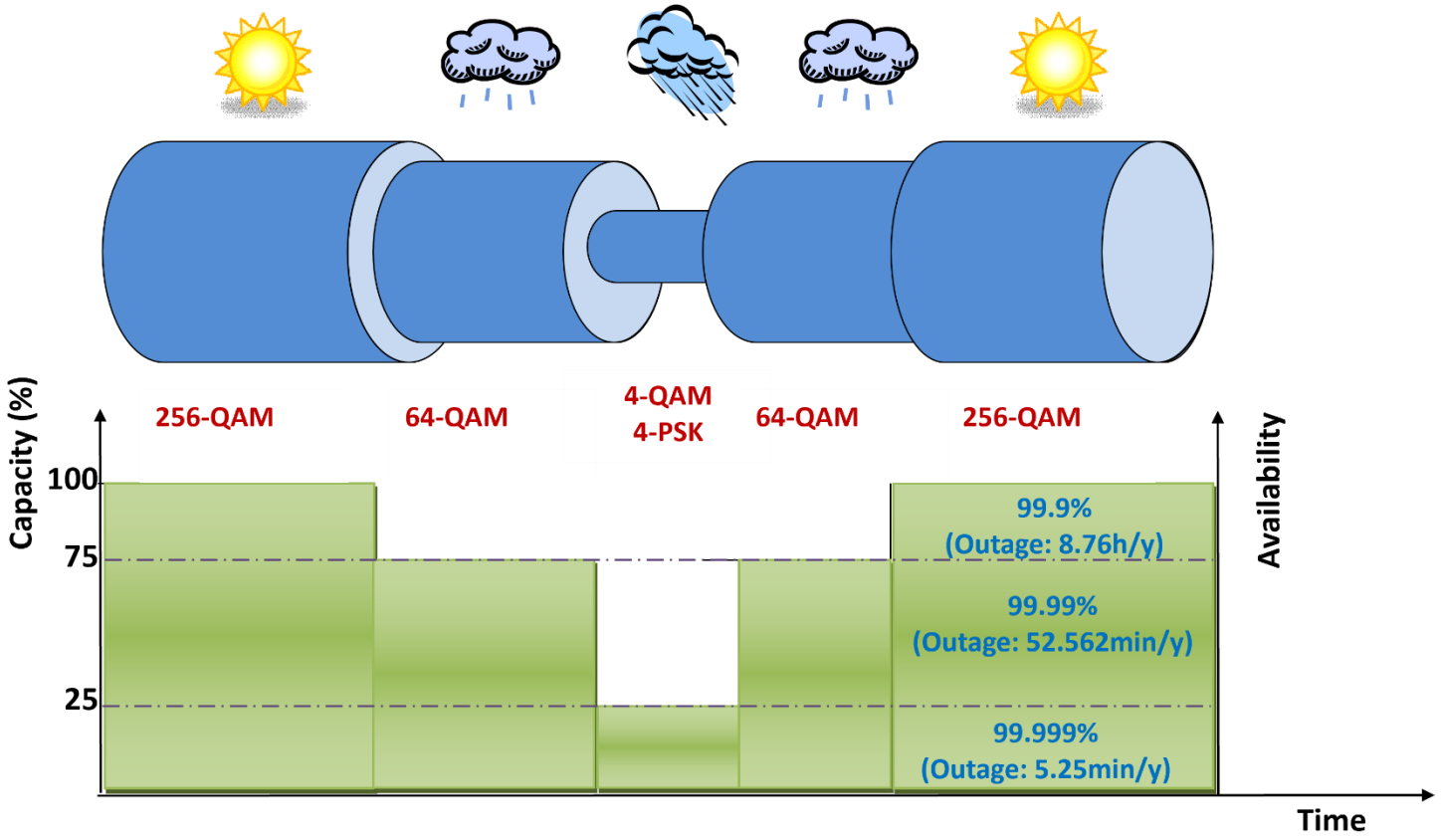
Planning a link, new style

- Use dual-band options:
  - 18 GHz combined with 80 GHz
  - Very high reliability on 18 GHz, very high capacity on 80 GHz
  - Different influence of weather on both frequencies
- Use dual polarization:
  - Double the capacity of the channel
  - Different influence of weather on both polarizations



What to measure for weather monitoring?

- ATPC state
- ACM state
- Current modulation scheme
- Current fademargin
- Current BER value
- Time since last change (up or down)
- Interference



Is fade margin alone useful?

- ACM links operate on typical FM around 5 – 10 dB FM in stable state
- Decreasing FM in highest modulation:
  - Probably the first cloud appears
- Decreasing FM in lowest modulation:
  - Probably a downpour occuring

ATPC or ACM? Who's first?

- Implementation of manufacturer
- First ACM: Prioritize on power consumption
- First ATPC: Prioritize on capacity
- No standards?

Any questions?

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