Ericsson / TeliaSonera Case Study: Examining Indoor WCDMA Trial Experiences in Kista, Sweden

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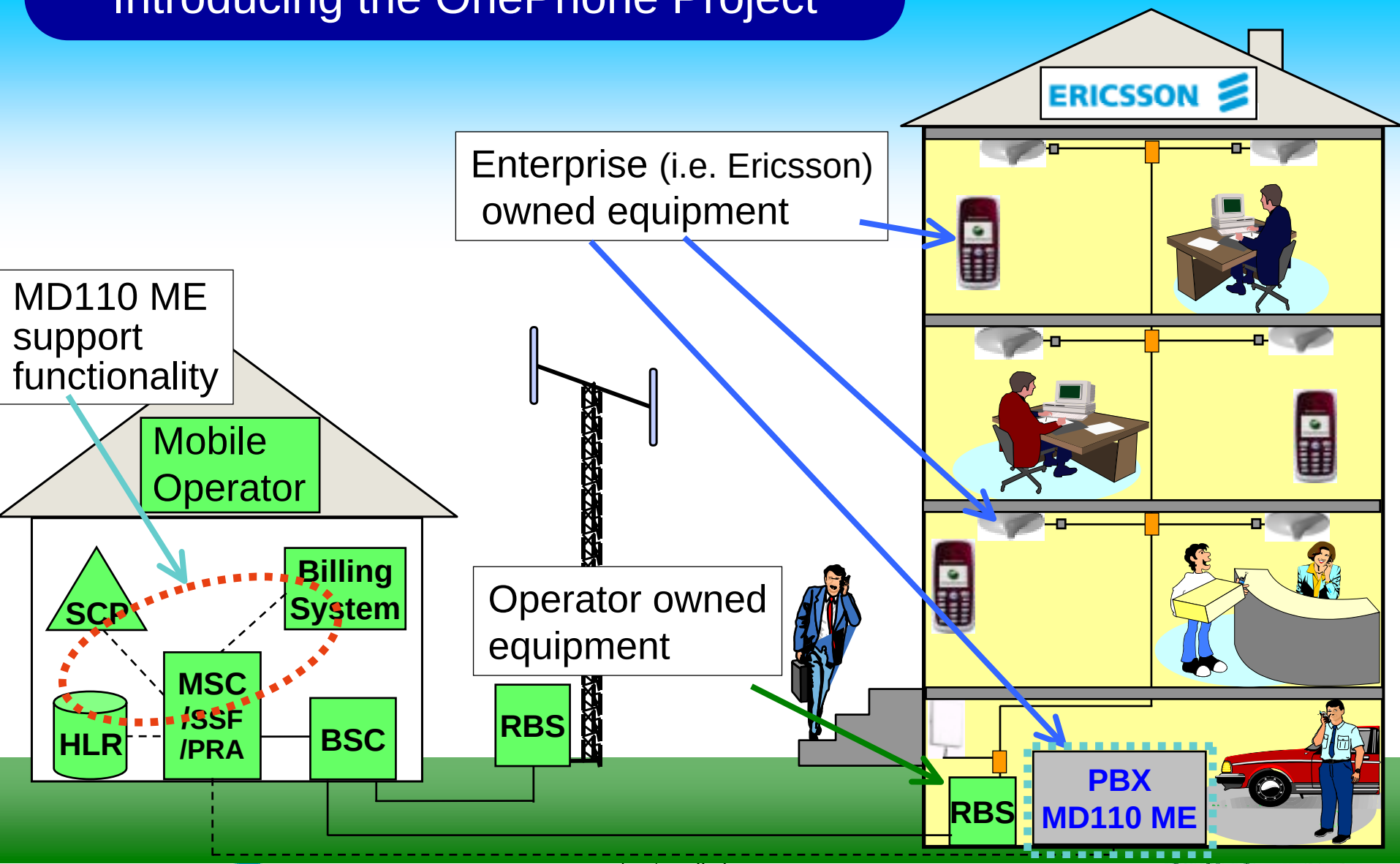
Outline

- **Introducing the OnePhone Project**
- Examining the specific challenges of test and measurement for 3G in-building coverage
- Analysing tools and techniques for testing and measuring 3G in-building systems
- Determining the capacity requirements for 3G in-building solutions and identifying likely capacity hotspots

Introducing the OnePhone Project

- Multi-operator, multi-technology (2G, 3G, WLAN / Bluetooth) in-building system implementation for Ericsson office buildings
- Almost all employees will have a mobile phone only, eliminating almost all fixed phones
- Almost all Ericsson sites shall be equipped with in-building systems (In total: ~ 1 million m² and 120 buildings)
- Antenna systems designed, installed, and owned by Ericsson

Introducing the OnePhone Project



OnePhone Design Requirements

- Multi-operator, Multi-band 2G, 3G & WLAN
- WCDMA coverage
  - Speech 12.2 kbps and data up to 64/384 kbps within 95% of the office areas
- GSM 1800 coverage
  - > -75 dBm in 95% of the office areas
  - > -85 dBm in 95% of the other areas
- WLAN coverage
  - > -80 dBm in 75% of the office areas
- Elevators shall be covered
- Approximately 300 persons per cell
  - 100 mErl / sub (complete fixed line replacement)

OnePhone - Ericsson Headquarters in Kista

- Office building complex with 1300 employees, 51000 m^2
- Designed without macro WCDMA system activated
- GSM 1800 (3 x RBS 2202)
- WCDMA (3 x RBS 3202)
- 6 cells; 179 antennas
- Prepared for WLAN/Bluetooth (52 WLAN Injectors)

Ericsson Headquarters in Kista

- The first OnePhone site that includes both 2G and 3G live systems

Ericsson Headquarters – Building 18 Measurements

- Indoor Macro Node B: Pmax = 43 dBm, CPICH = 32 dBm
- Passive DAS losses range from 20 to 29 dB at UMTS frequencies
- CPICH EiRP ranges from 3 dBm to 12 dBm
- 73 antennas with cell radius per antenna ~10-15m
- Horizontal cell architecture, two cells:
  - Cell 1: (Building 18, floor 3, 4, 5 & 6. Total 218 users)
  - Cell 2: (Building 18, floor –1, 0, 1, 2. Total 78 users)
- Outdoor network in pre-commercial phase

Ericsson Headquarters, Building 18 – Equipment Room

Other Operator's
WCDMA RBS 3202 (to the right)

TeliaSonera's
2 x GSM RBS 2202

TeliaSonera's
WCDMA RBS 3202

Ericsson tri-band combining boxes used as interface to the operators' RBS

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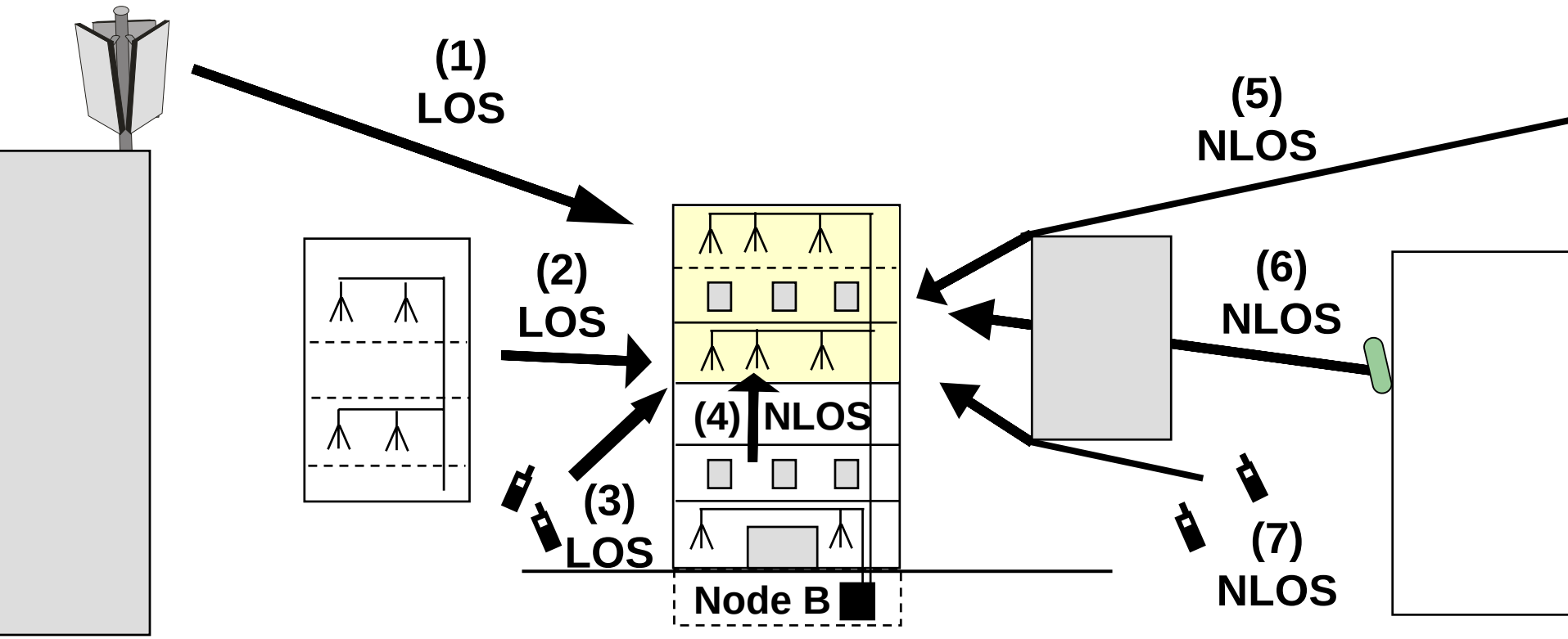
Interference sources



Minimising interference

- Low feeder loss, minimise pilot power (but consider also economics)
- Tune outdoor network, antenna tilt, antenna height and antenna direction
- Metal-coated windows (no metal coated windows in the Kista building)
- Use tunable distributed antenna system (e.g. adjustable tappers)

Measuring and optimising quality, capacity and performance

- Measure outdoor-to-indoor power levels, pilot power (CPICH Ec) and pilot power versus CPICH Ec/No
- Plan DAS (Distributed Antenna System) regarding feeder loss per antenna, cell radius per antenna
- Measure indoor CPICH Ec and CPICH Ec/No levels
- Set pilot power and SHO margin

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Test and Measurement Tools

QualcommTM6200
UMTS & GPRS test phone

Agilent E6473B
Extension Hub + battery

Agilent scanner (E6455C)

Laptop with Agilent analysing software Nitro

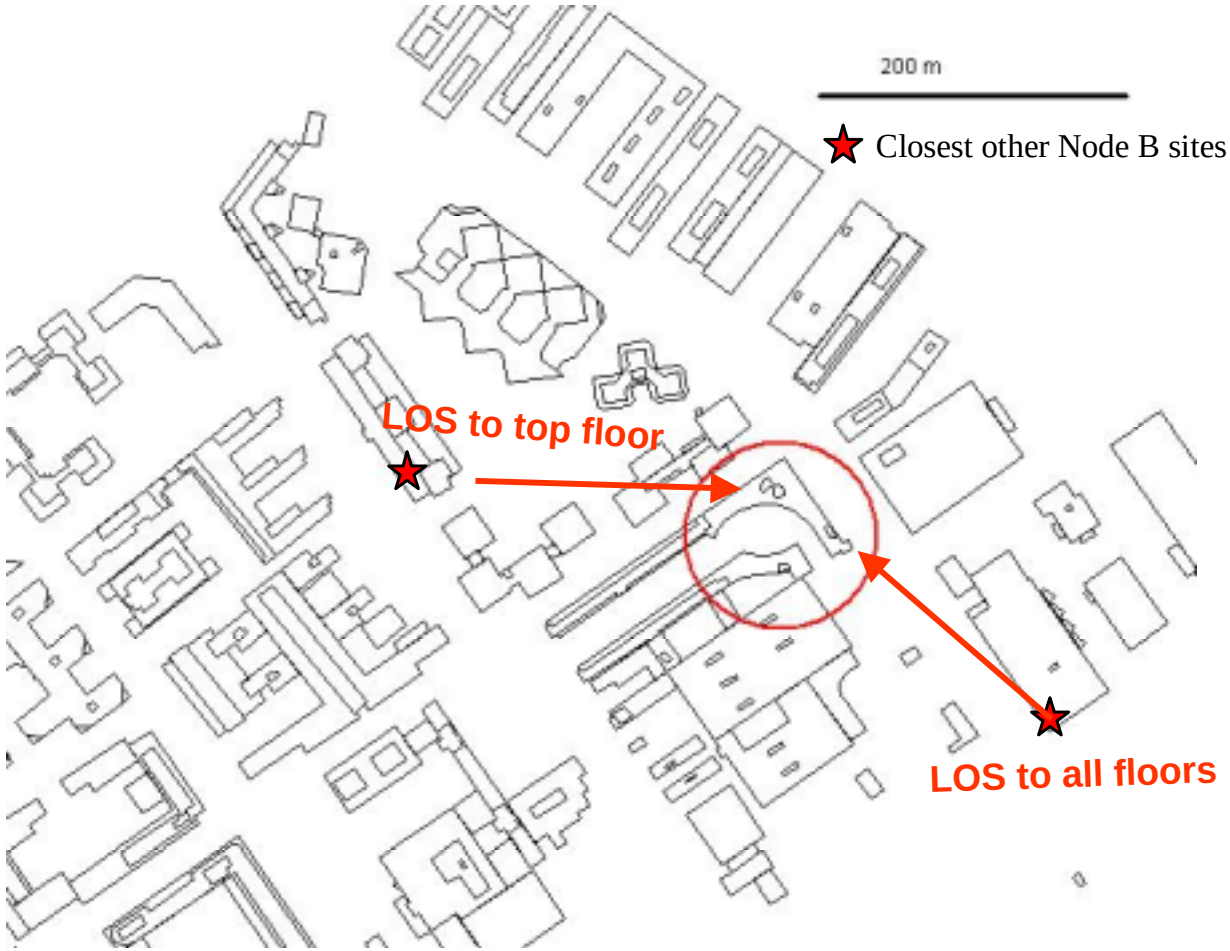
TEMS Investigation

- For portable data collection indoors and in other pedestrian areas
- Intuitive positioning by “Walk-and-Click”
- Maps, blueprints, or user drawings as background
- All TEMS Investigation WCDMA features readily available

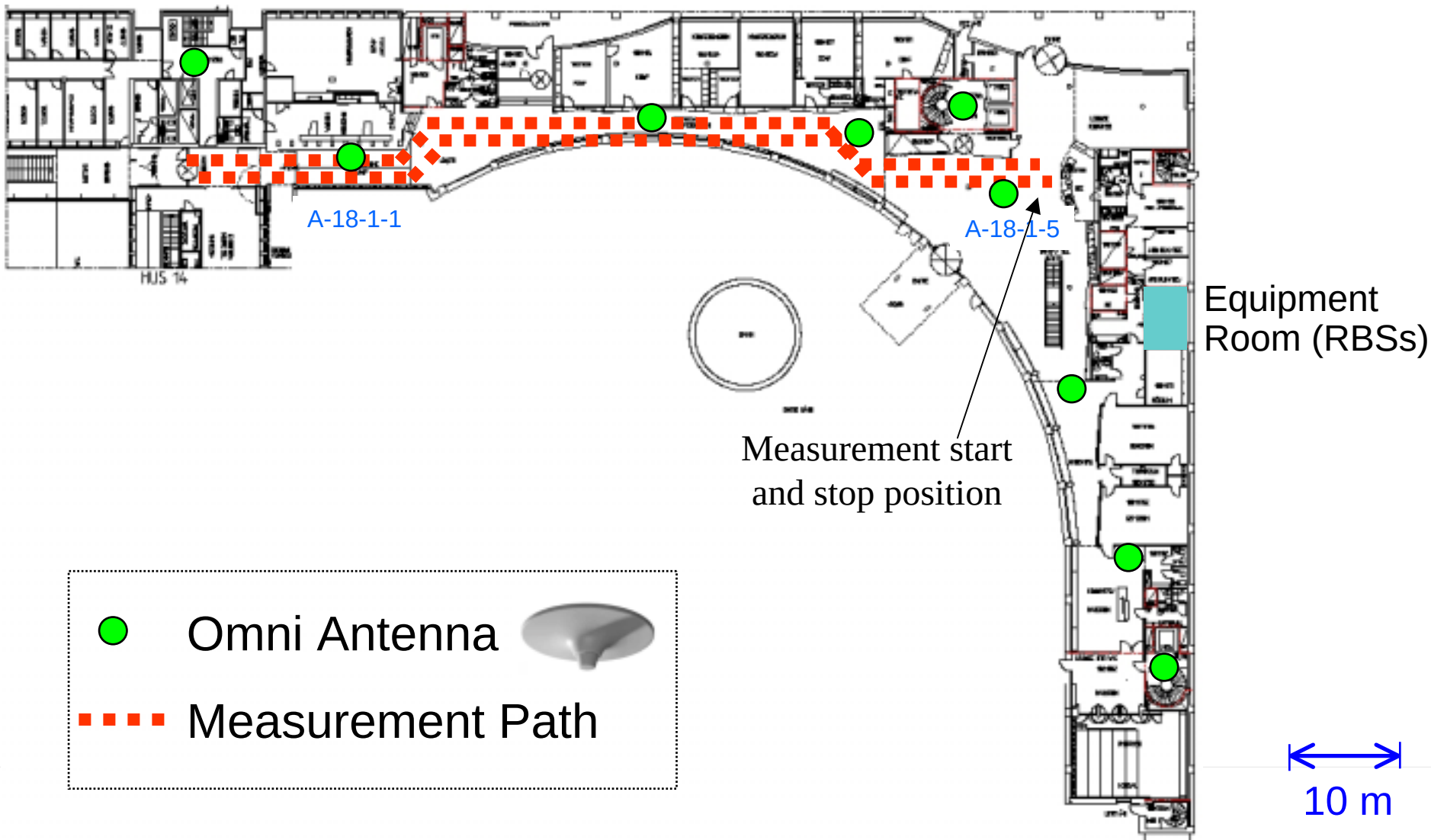
TEMS Transmitter WCDMA 2100 / 1900 1.0

- Transmit modes
  - CPICH scrambling code
  - Continuous Wave
- Software adjustable power output up to 1 Watt
  - 0 – 30 dBm, in 1 dB steps
- Size / Weight
  - 210 x 128 x 32 mm(8.25 x 5 x 1.25 in)
  - 0.9 kg (excluding battery)
- Configuration and set-up through PC / Pocket PC device, via RS232 interface (or Bluetooth for 1900 MHz version)
- Optional battery enables operation for a duration of up to 4 hours

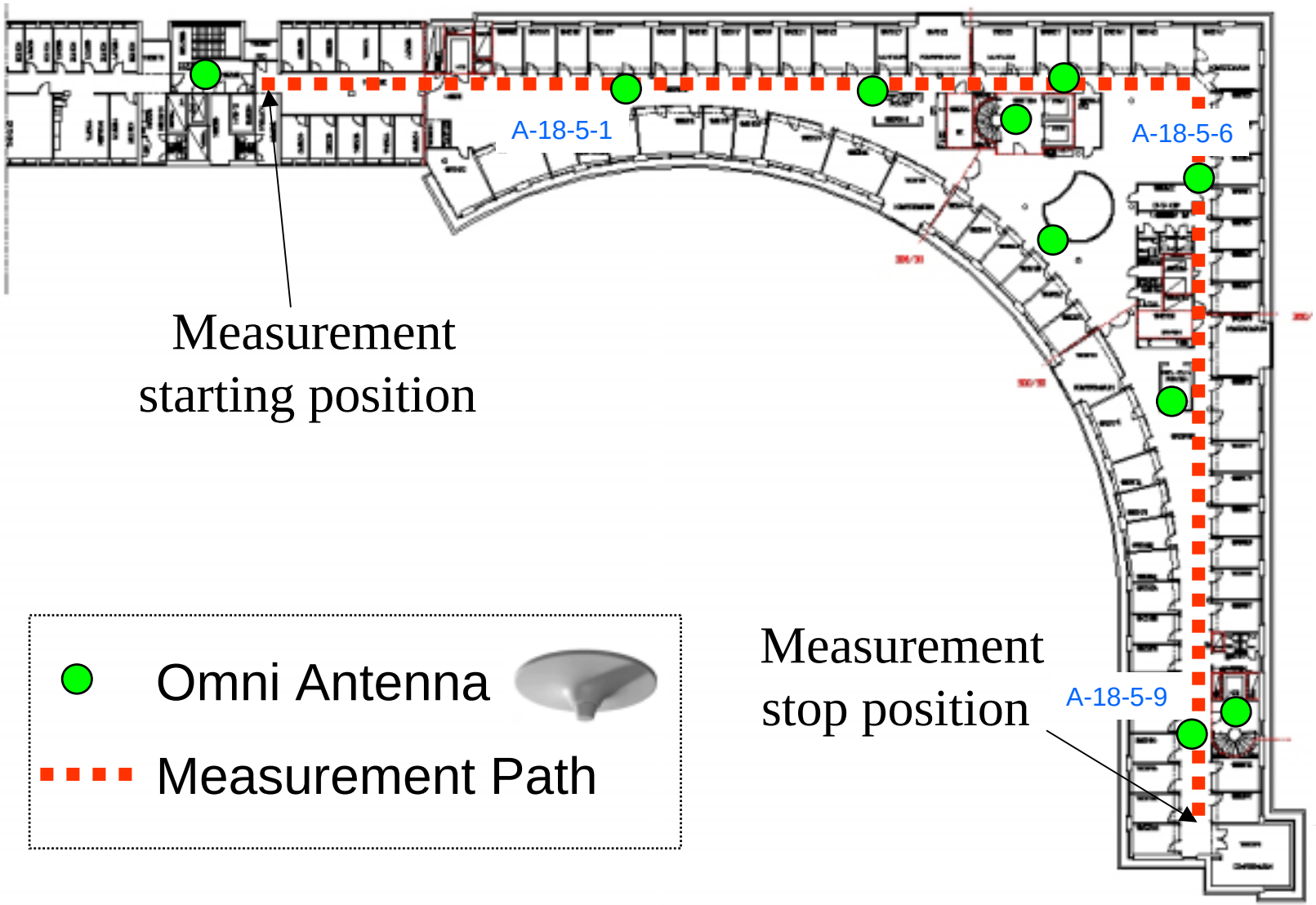
On-site measurements - planning



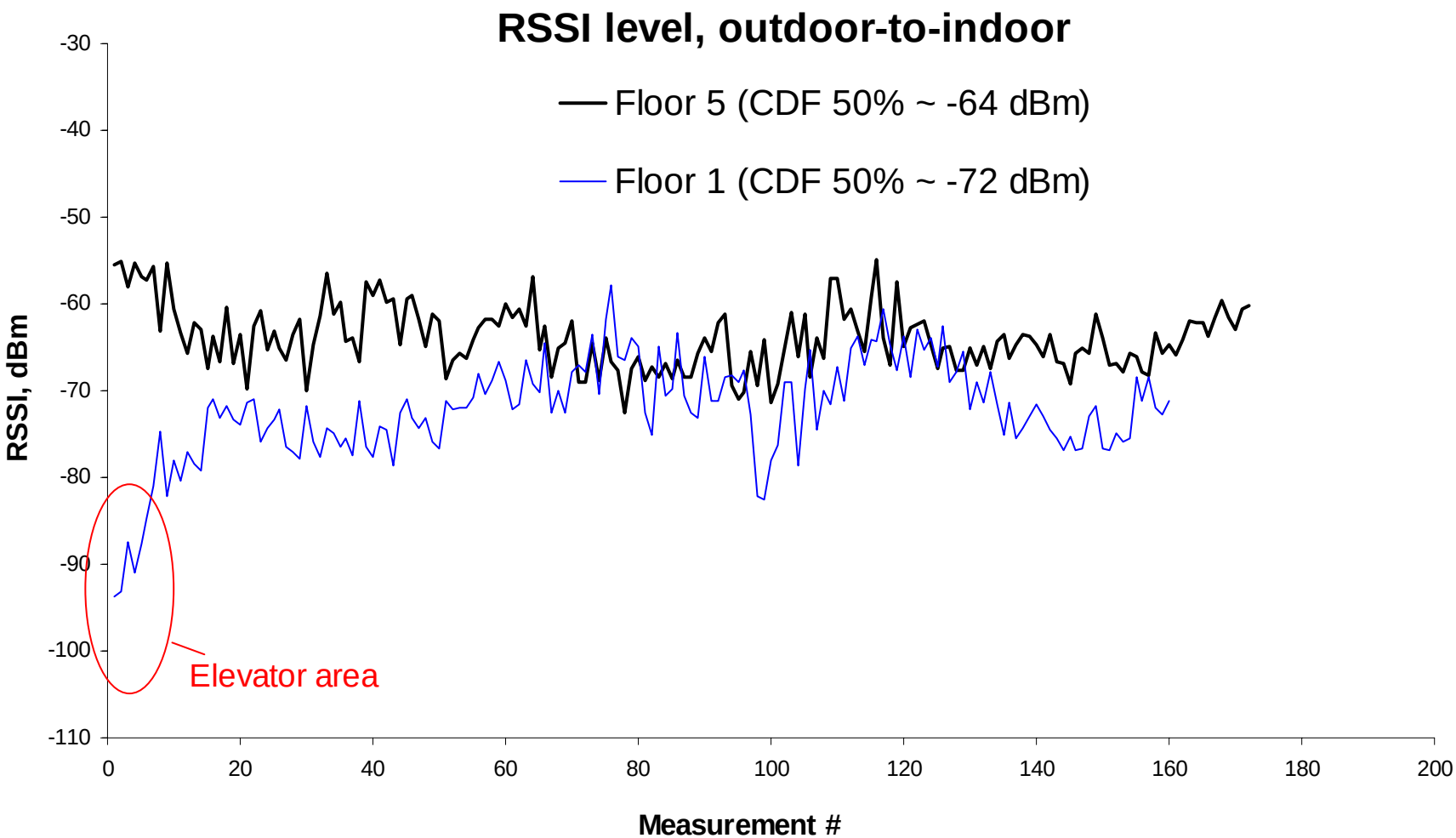
Ericsson Headquarters, Building 18 – Floor 1



Ericsson Headquarters, Building 18 – Floor 5



On-site measurements – Outdoor-to-indoor coverage



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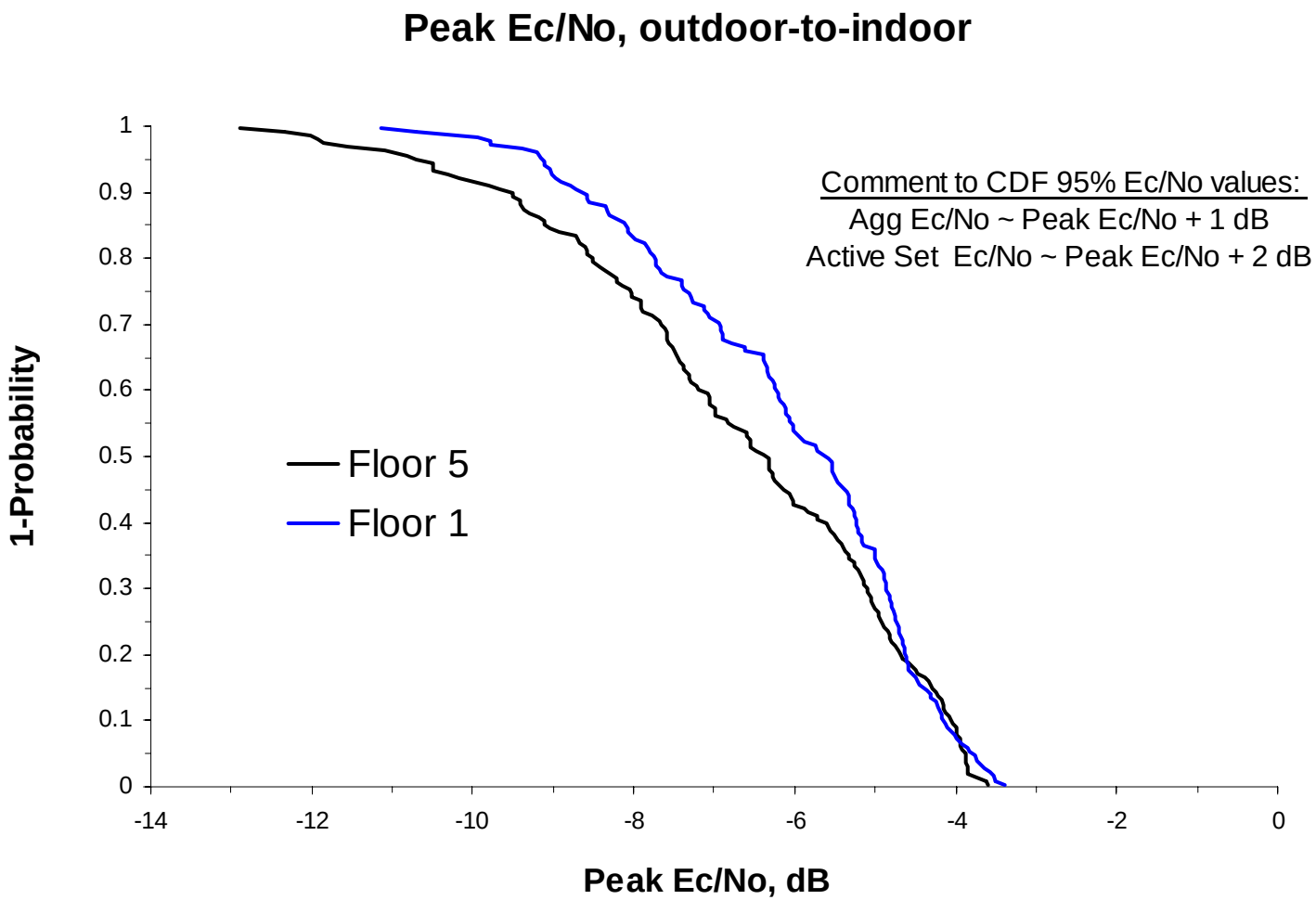
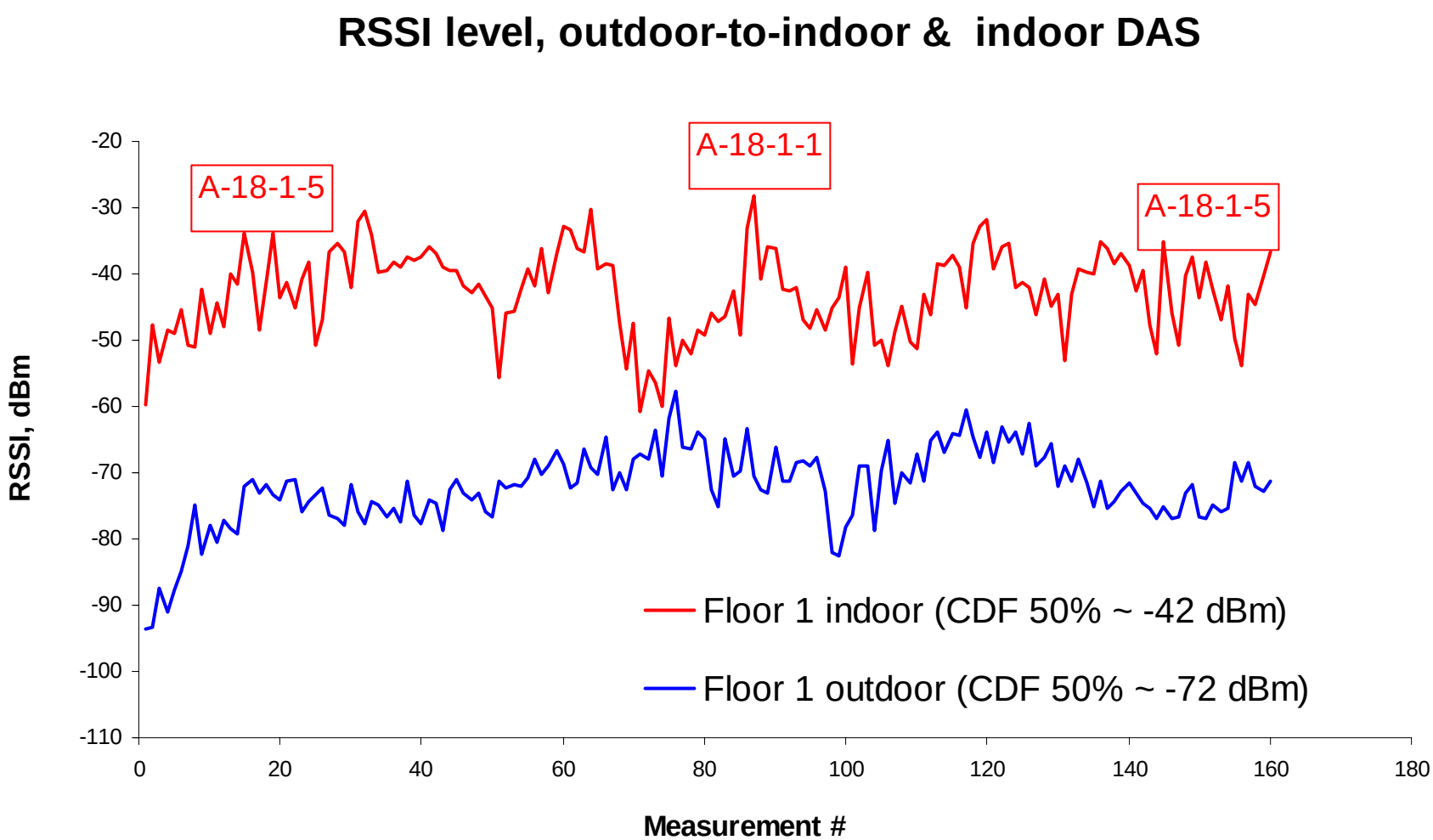
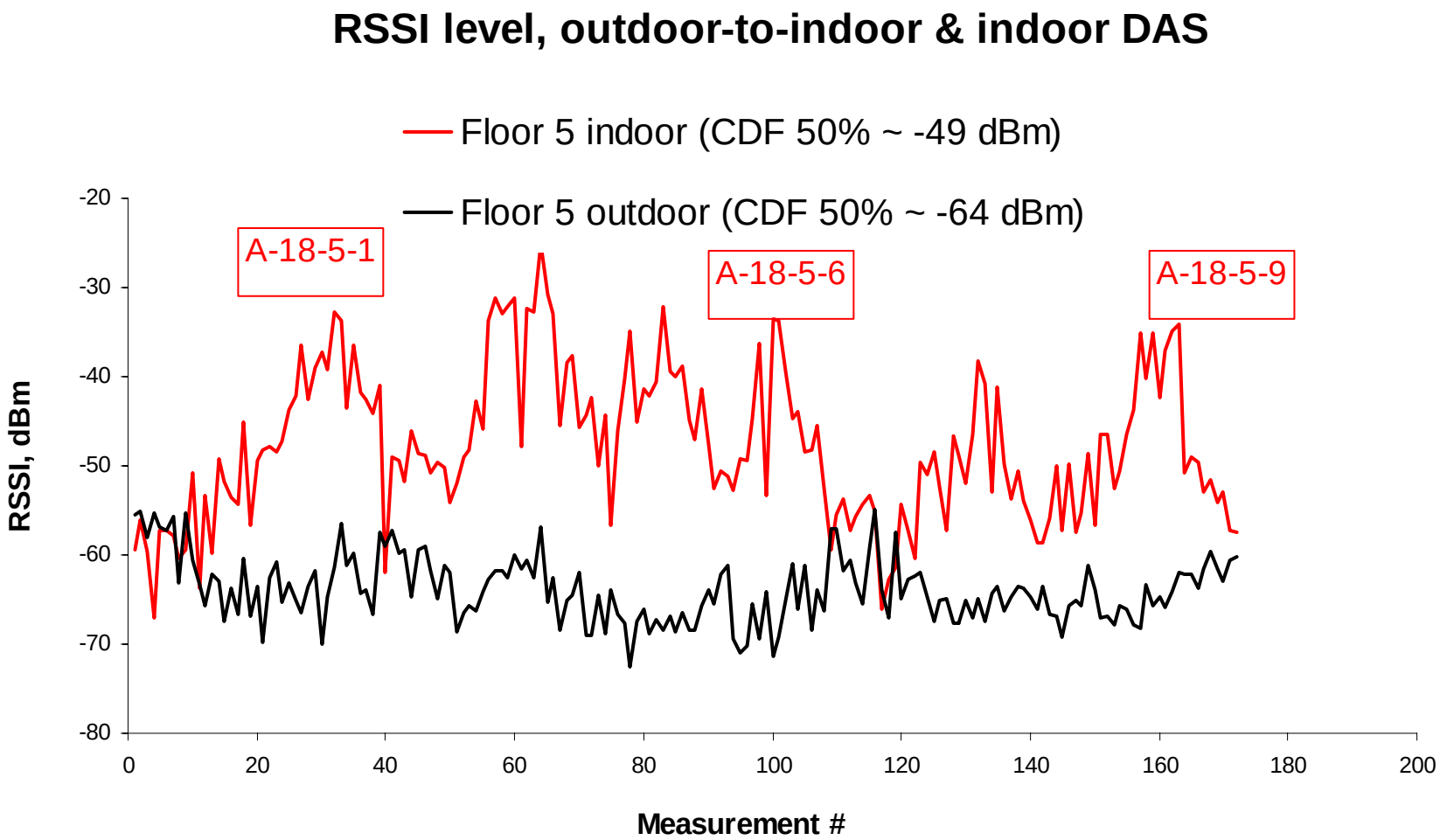


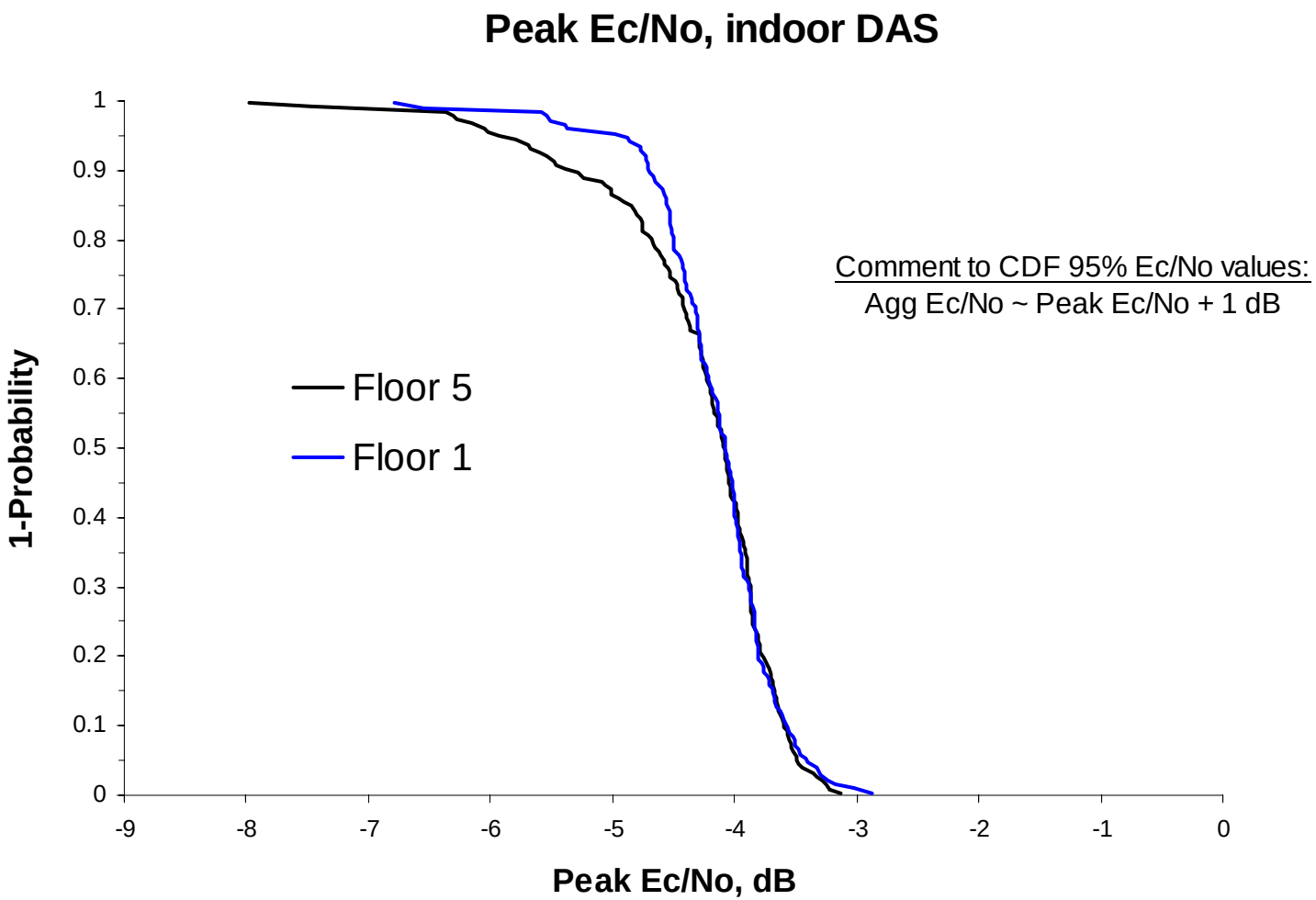
On-site measurements – With indoor DAS, floor 1



On-site measurements – With indoor DAS, floor 5



On-site measurements – With indoor DAS



On-site measurements – Initial results

- Low outdoor power levels compared to the indoor power levels → low interference - low i-factor (other-to-own-cell received power ratio)
- Peak Ec/No are > -6dB for 95% of the area (From outdoor the Ec/No was ~3dB lower)
- Average i-factor upper / lower floor: ~ 0.1/0.02

  → High capacity if also assuming high orthogonality factors
- SHO area upper / lower floors: 8% / 0%

  Indoor-to-outdoor connections upper / lower floors: 2.5% / 0%
- Improved coverage in basement (garage) and smooth handover in the elevator

On-site measurements – Some practical hints

- Prepare measurement map for the different floors
- Collect data for each floor individually. Measure between the floors – elevator area
- For multi-operator system the “worst” operator interference from outdoor will determine the DAS design – feeder loss

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GSM/GPRS/EDGE, WCDMA and WLAN

GSM/GPRS/EDGE, WCDMA, WLAN data capacity

- How to compare available capacity from the different radio systems?
  - What the standard says.
  - Speech/data allocation, mobile performance, at which layer…
  - Current “typical” network performance (average cell throughput), available spectrum
- Other factors
  - Mobiles availability (e.g. will we “soon” have GPRS/WLAN mobile terminals)
  - Economical considerations

GSM/GPRS/EDGE, WCDMA, WLAN data capacity

	Average data capacity per sector with available spectrum	Comments
GPRS	6 carriers × 8 timeslots × 8 kbps (ave cell throughput) 384 kbps	• No speech traffic, • Considers interference • FTP traffic The average cell throughput is 8 kbps per time slot. For a terminal capable of 4 time slots in the radio DL this means a user throughput of 32 kbps.
EDGE	6 carriers × 8 timeslots × 25 kbps 1200 kbps	• No speech traffic, • Considers interference • FTP traffic • All TRXs EDGE are capable The average cell throughput is 25 kbps per time slot. For a terminal capable of 4 time slots in the radio DL this means a user throughput of 100 kbps.
WCDMA	3×1700 kbps 5100 kbps	• No speech traffic, • Considers interference • FTP traffic For indoor, with i-factor = 0.2 and orthogonality factor = 0.2.
WLAN (802.11b)	3×4500 kbps 13500 kbps	• Considers interference • FTP traffic • **Assuming only one WLAN operator!** (Unlicensed frequency bands) For 802.11g/a about 4/28 times the 802.11b capacity.

* For more info look e.g. at: Anders Furuskär, “Can 3G services be offered in existing spectrum?", Teknisk Licentiat, KTH Sweden 2001

Summary

- Pre-design **measurements** should be used to help set WCDMA design criteria
- **Top floors** may require more antennas and / or more power per antenna to overcome higher interference from outdoor macro network
- **Low** interference for the indoor DAS in Kista (average i-factor < 0.2) which means high (DL) capacity
- **But** the indoor WCDMA DAS design (feeder loss) has to consider all operators as for some the interference maybe higher
- The **mobile terminals** will decide in the future which radio system will be dominant in the indoor **data** market