

Measurements of extreme rural scenarios

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R1-166599

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Background

To enable operators to provide service in very remote and maritime conditions, an “extreme rural” scenario has been defined for NR

– The extreme rural scenario is described in 38.913_draft_v2

Table 6.1.6-1: Attributes for extreme rural

Attributes	Values or assumptions
Carrier Frequency	Below 3 GHz With a priority on bands below 1GHz Around 700 MHz
System Bandwidth	40 MHz (DL+UL)
Layout	Single layer: Isolated Macro cells
Cell range	100 km range (Isolated cell) to be evaluated through system level simulations. Feasibility of Higher Range shall be evaluated through Link level evaluation (for example in some scenarios ranges up to 150-300km may be required).
User density and UE speed	User density: NOTE1 Speed up to 160 km/h
Traffic model	Average data throughput at busy hours/user: 30 kbps User experienced data rate: up to 2 Mbps DL while stationary and 384 kbps DL while moving NOTE2

NOTE1: Evaluate how many users can be served per cell site when the range edge users are serviced with the target user experience data rate.

NOTE2: Target values for UL are lower than DL, 1/3 of DL is desirable.

This contribution provides measurements from a live 3G network with extreme rural support to assist with the development of propagation and traffic distribution models

Pathloss, Propagation Distance and Delay Spread Measurements From Live 3G Cells

Two measurement campaigns and a drive survey were conducted on live 3G cells (band 5) configured for extreme range (up to 200 km) over a series of days

- UE periodic reporting activated on ~50 cells
- RACH statistics collected on ~500 cells

UE periodic reporting

- Provides correlated pathloss and propagation measurements for connected UEs
- Yielded ~360,000 measurement samples
- Reflects viable links only

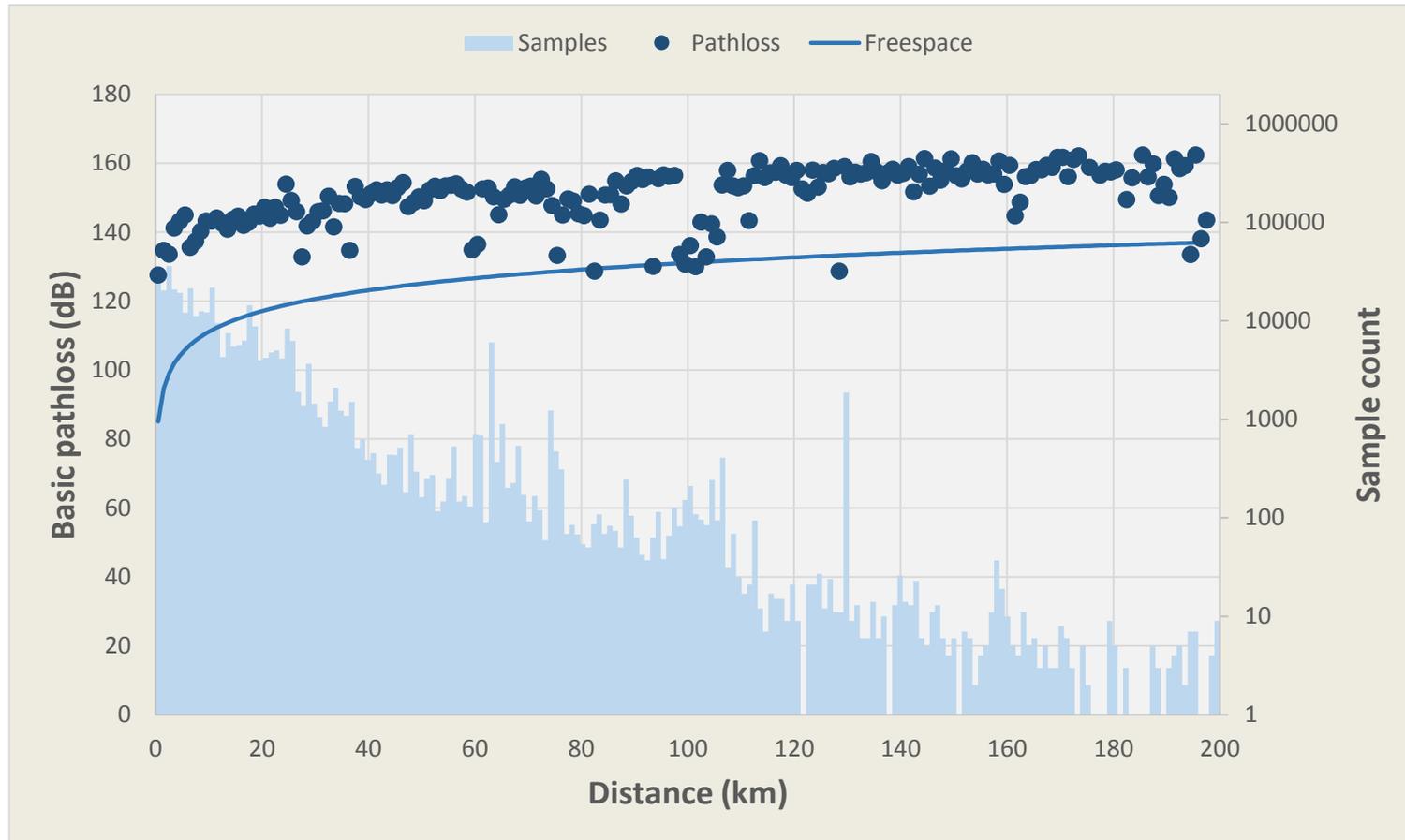
RACH statistics

- Provides propagation statistics based on RACH preamble
- Yielded 3.3 billion samples
- Reflects both successful and unsuccessful RACH attempts

These measurements validated with drive survey to collect RSCP data over 3 million samples; Drive survey also provided rms delay spread measurement

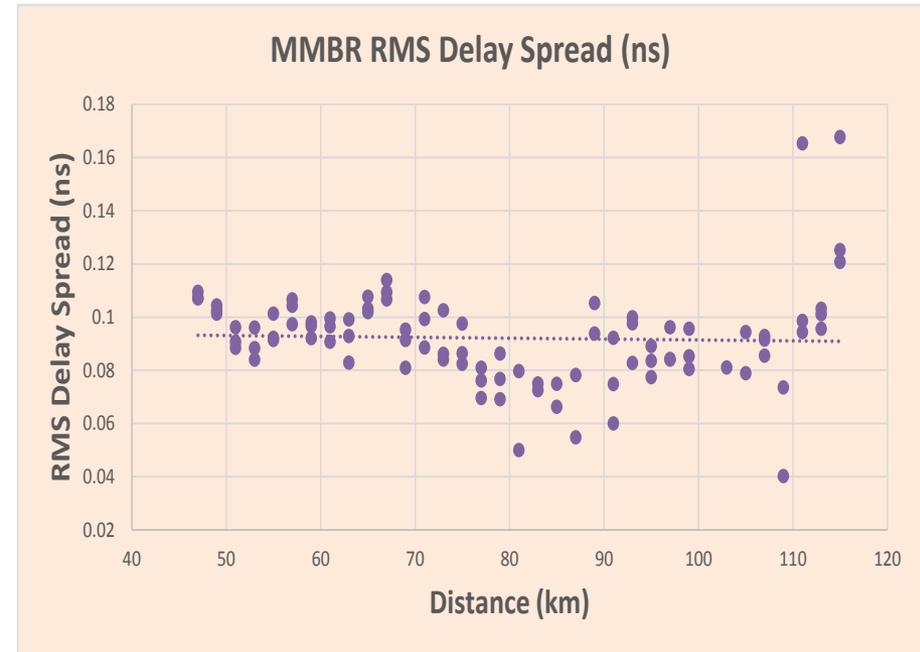
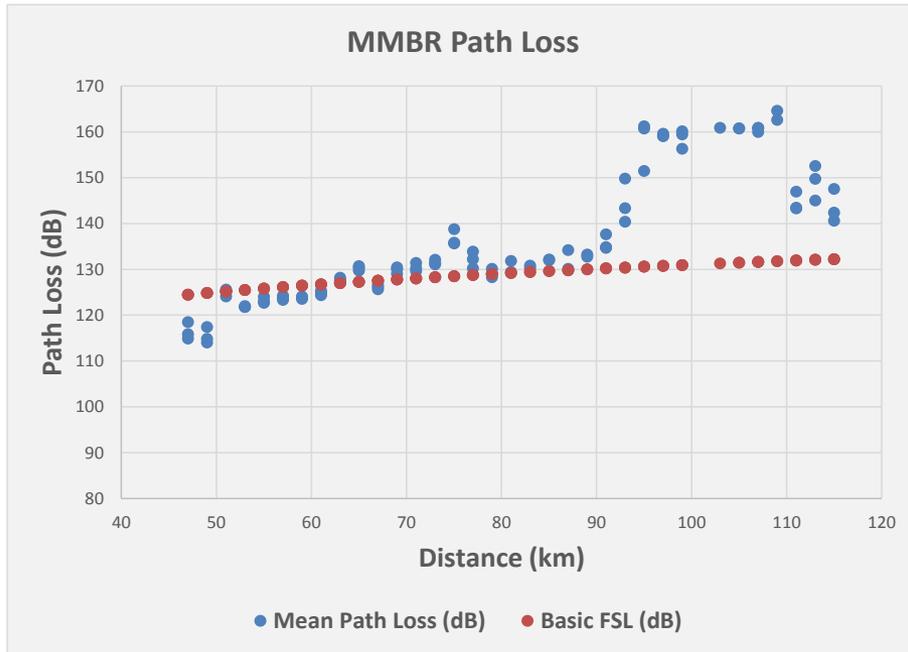


UE periodic reporting measurements useful for pathloss model development



Validated with Drive Survey Measurements for RSRP and Delay Spread

Drive Survey Measurements



MMBR: Mount Mowbullen, Queensland, Australia
Relative NodeB-UE height difference: 500m-600m

Path Loss based on RSCP measurements

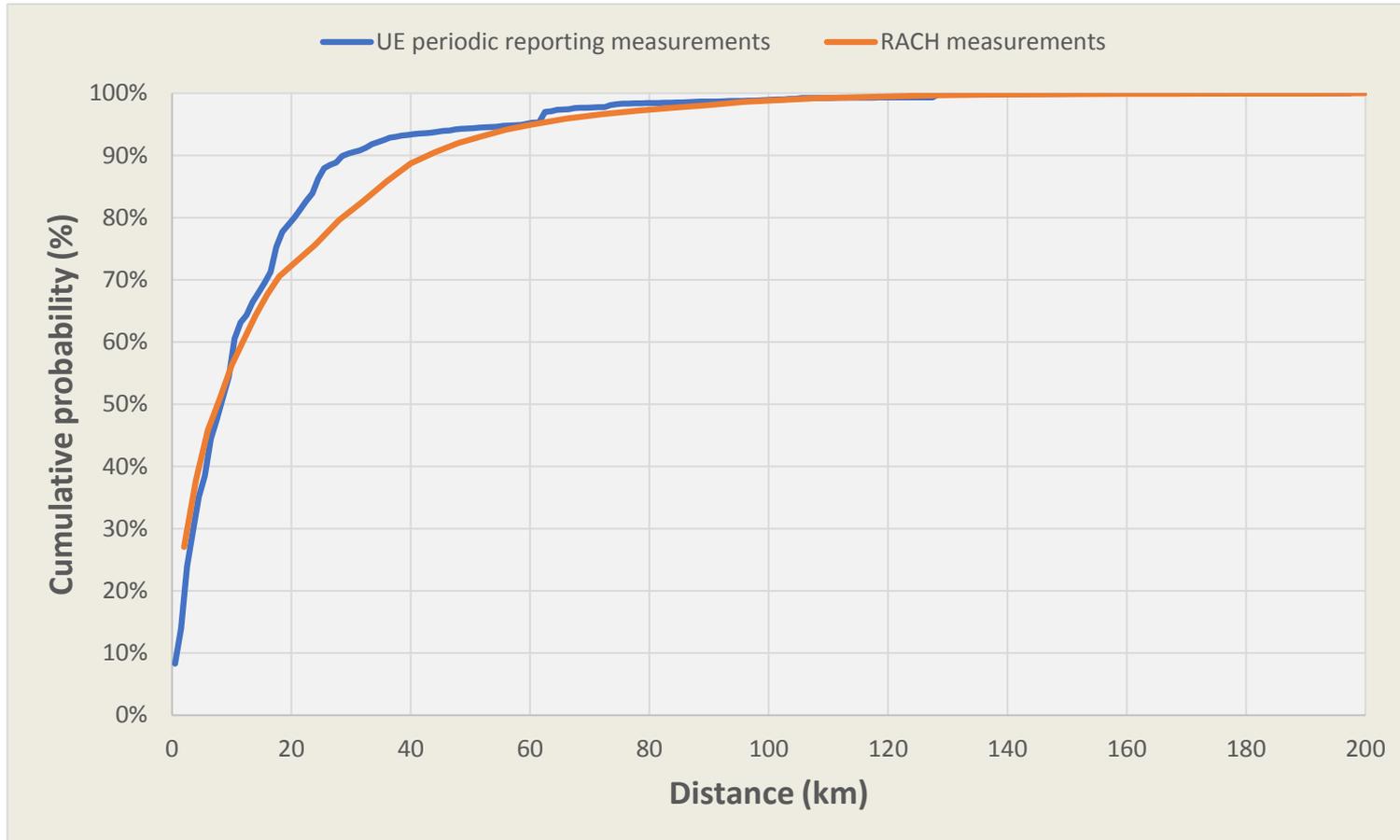
Average excess loss over & above FSL ~ 20 dB in the region of interest (long distances)

Average rms delay spread: ~ 100 ns

Consolidated data over all sectors



UE periodic reporting and RACH data useful for traffic distribution model development



Observations

Observation 1

- Extreme rural capability is being used today in live 3G networks and provides valuable service for operators and their customers

Observation 2

- Pathloss appears to follow free-space with an additional clutter loss; validated with drive survey

Observation 3

- RMS delay spread largely bunched around 100 ns

Observation 4

- Propagation distance statistics can be used to inform extreme rural traffic distribution

Proposal

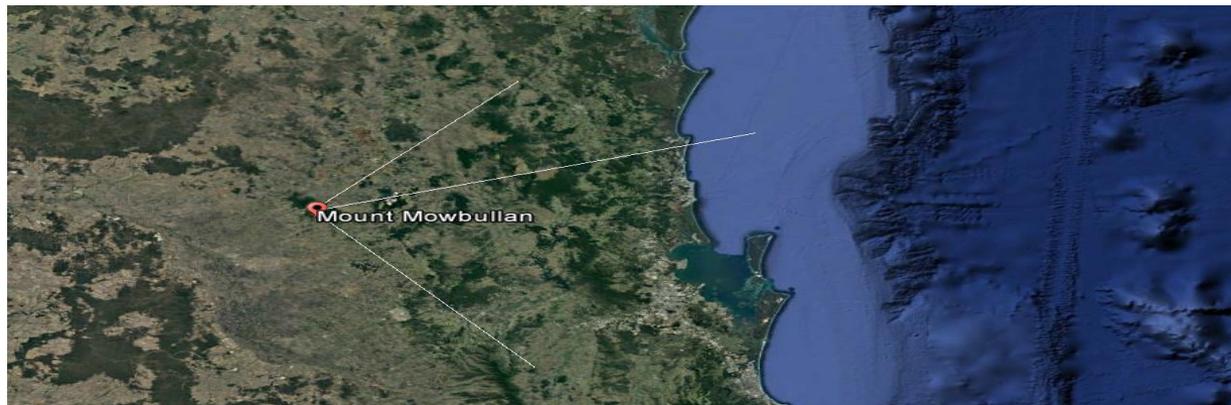
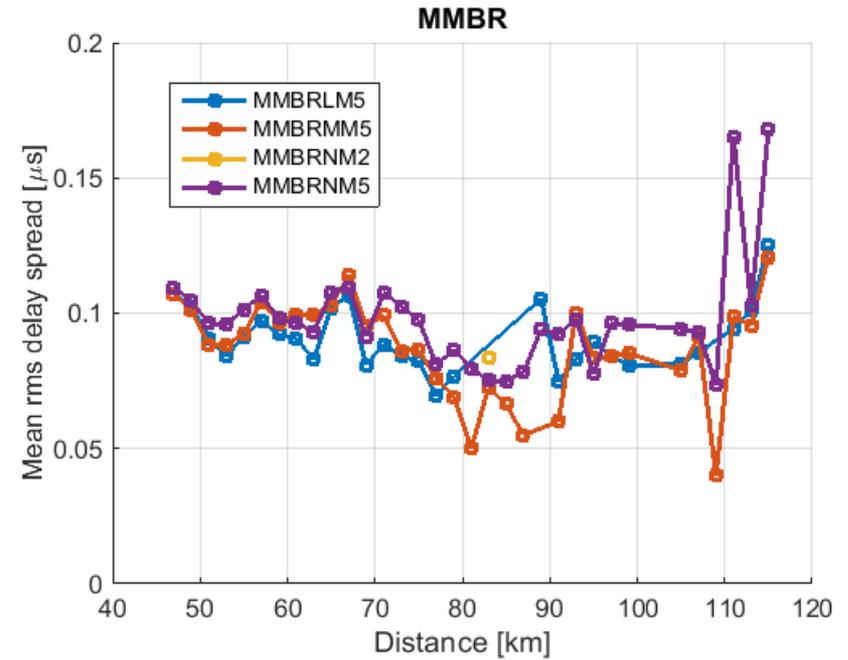
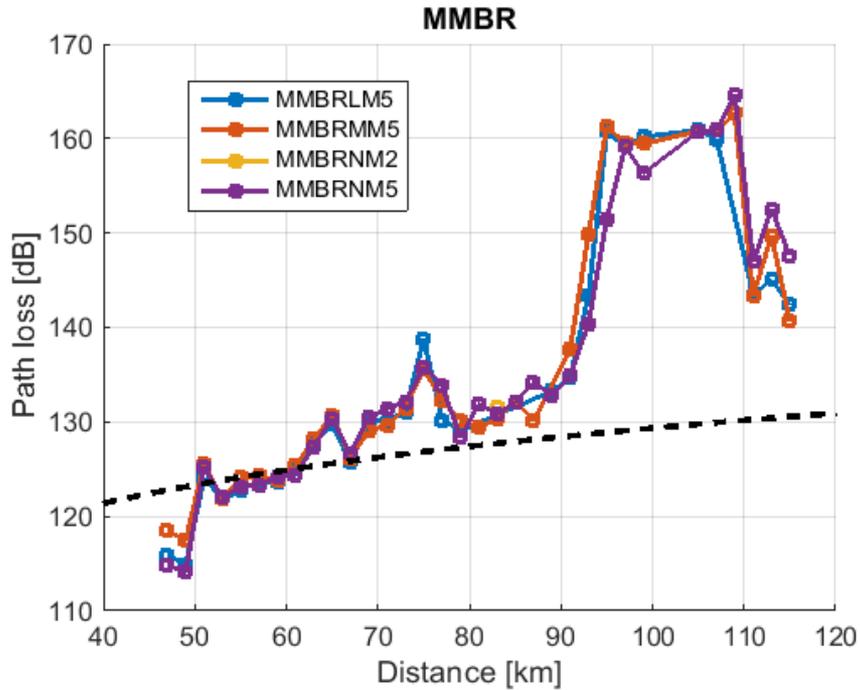
Proposal 1

- Use statistics from this measurement campaign to inform propagation and traffic distribution models for the extreme rural scenario
 - Path loss statistics
 - Delay spread statistics
 - User distribution statistics

Appendix

Extreme rural site examples

Drive Survey Measurements



Data from individual sectors

MMBR: Mount Mowbull,
Queensland, Australia

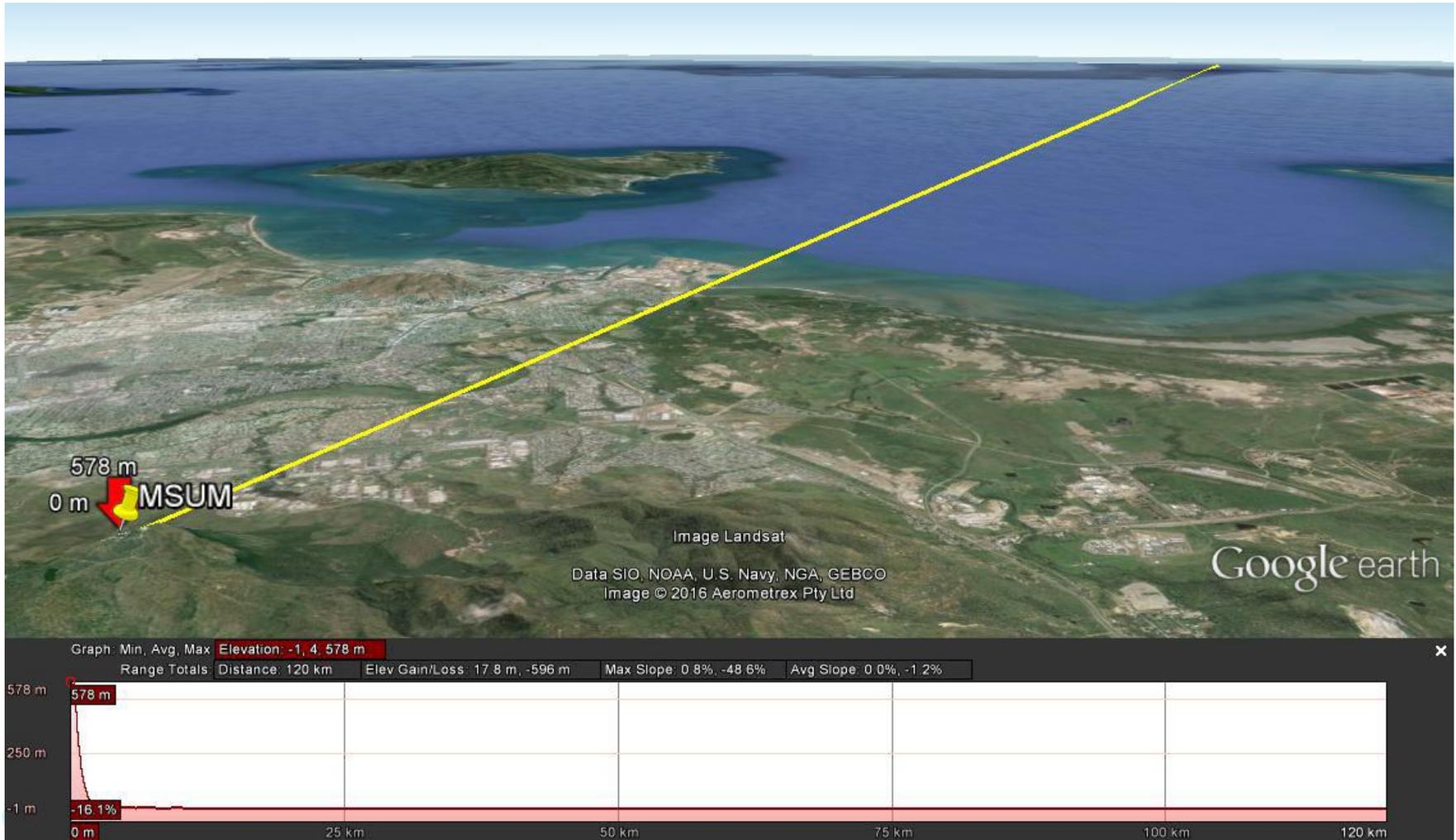
Relative NodeB-UE height
difference: 500m-600m

Path Loss based on RSCP
measurements

Case studies

MSUM – path profile

- High site on high hill overlooking large regional centre
- Long distance coverage out to sea up to 120 km

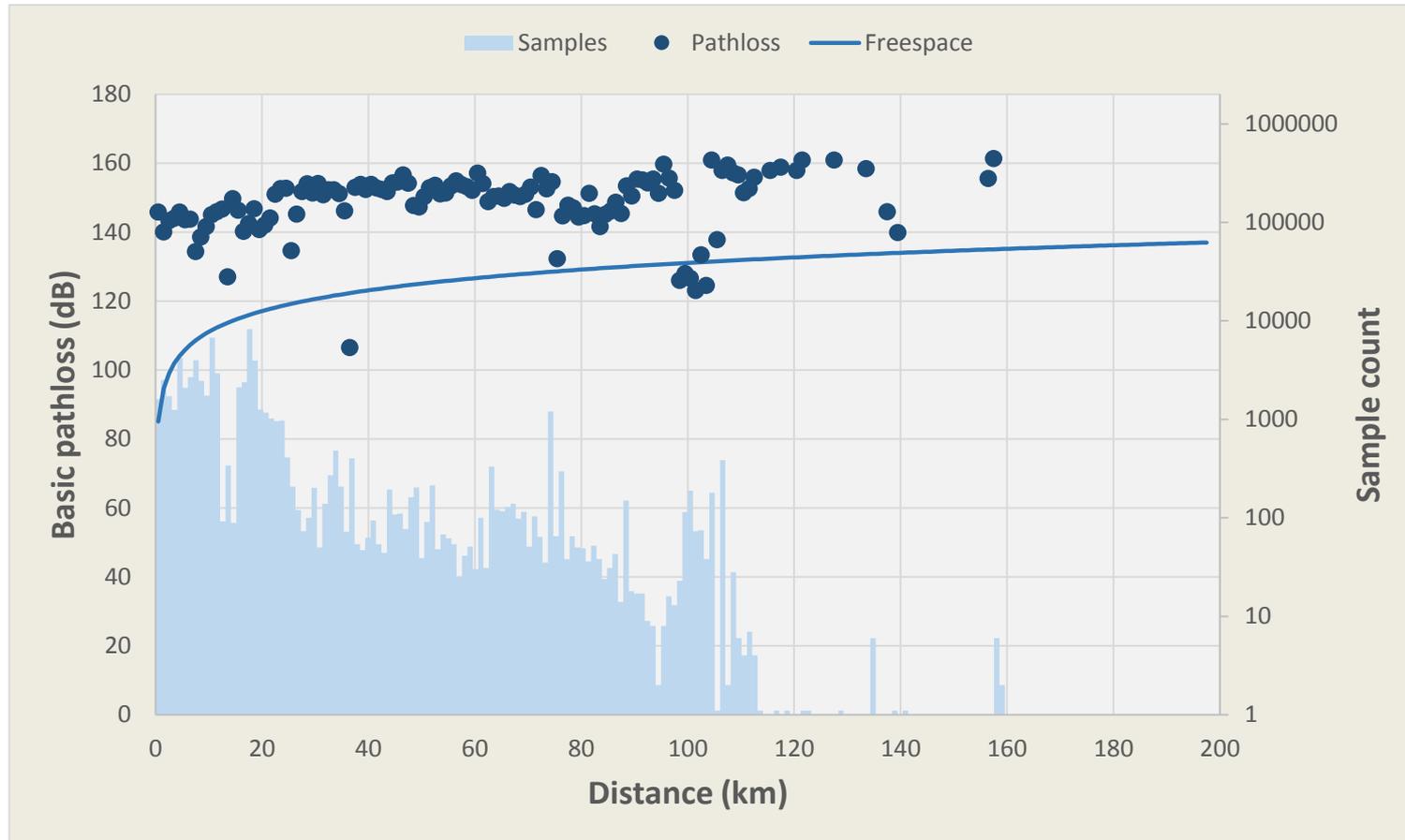


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Antenna height = 35 m (structure) + 678 m (hill) = 713 m

Case studies

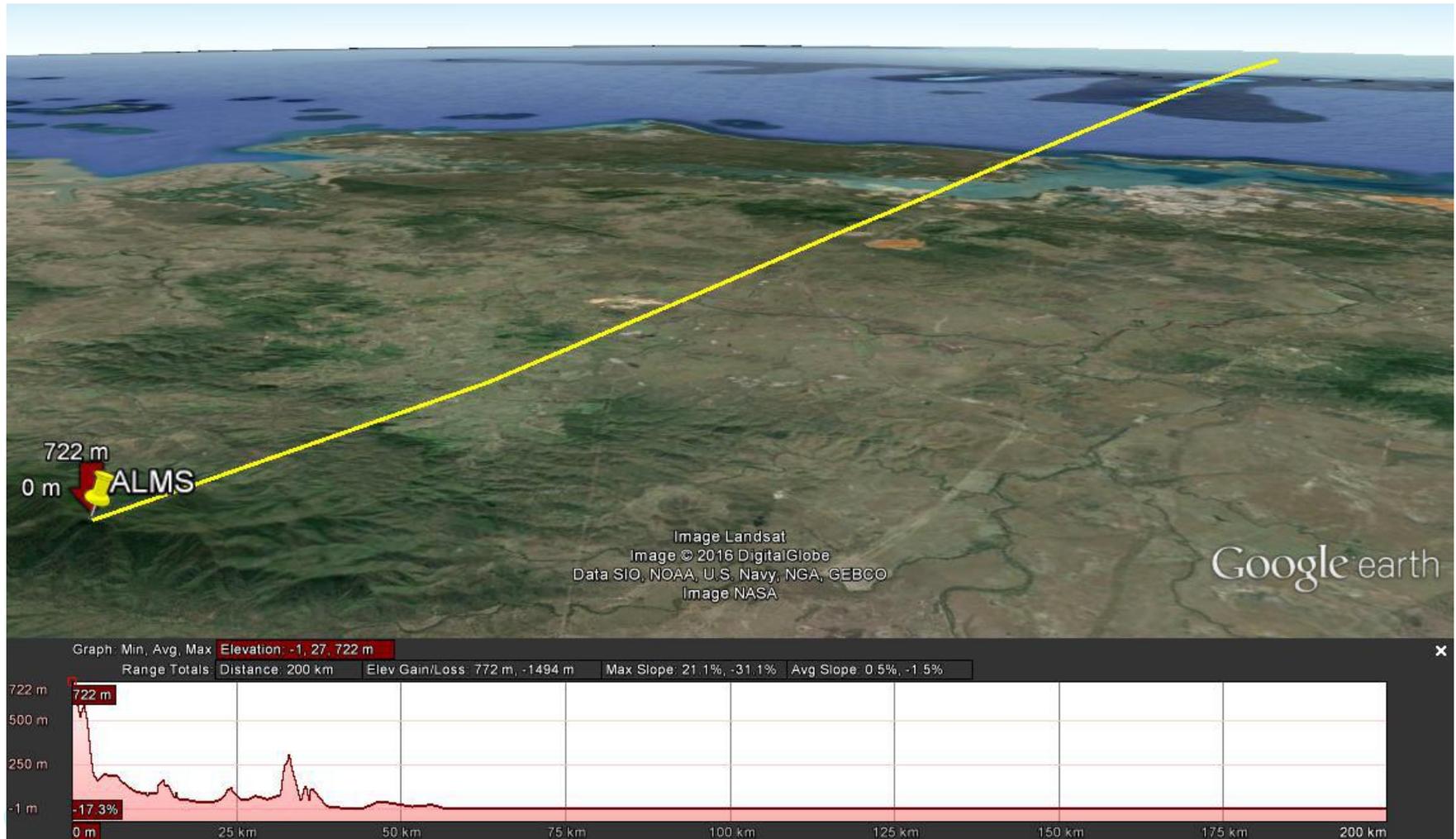
MSUM – propagation measurements



Case studies

ALMS – path profile

- High site on high hill overlooking large regional centre
- Long distance coverage out to sea up to 200 km

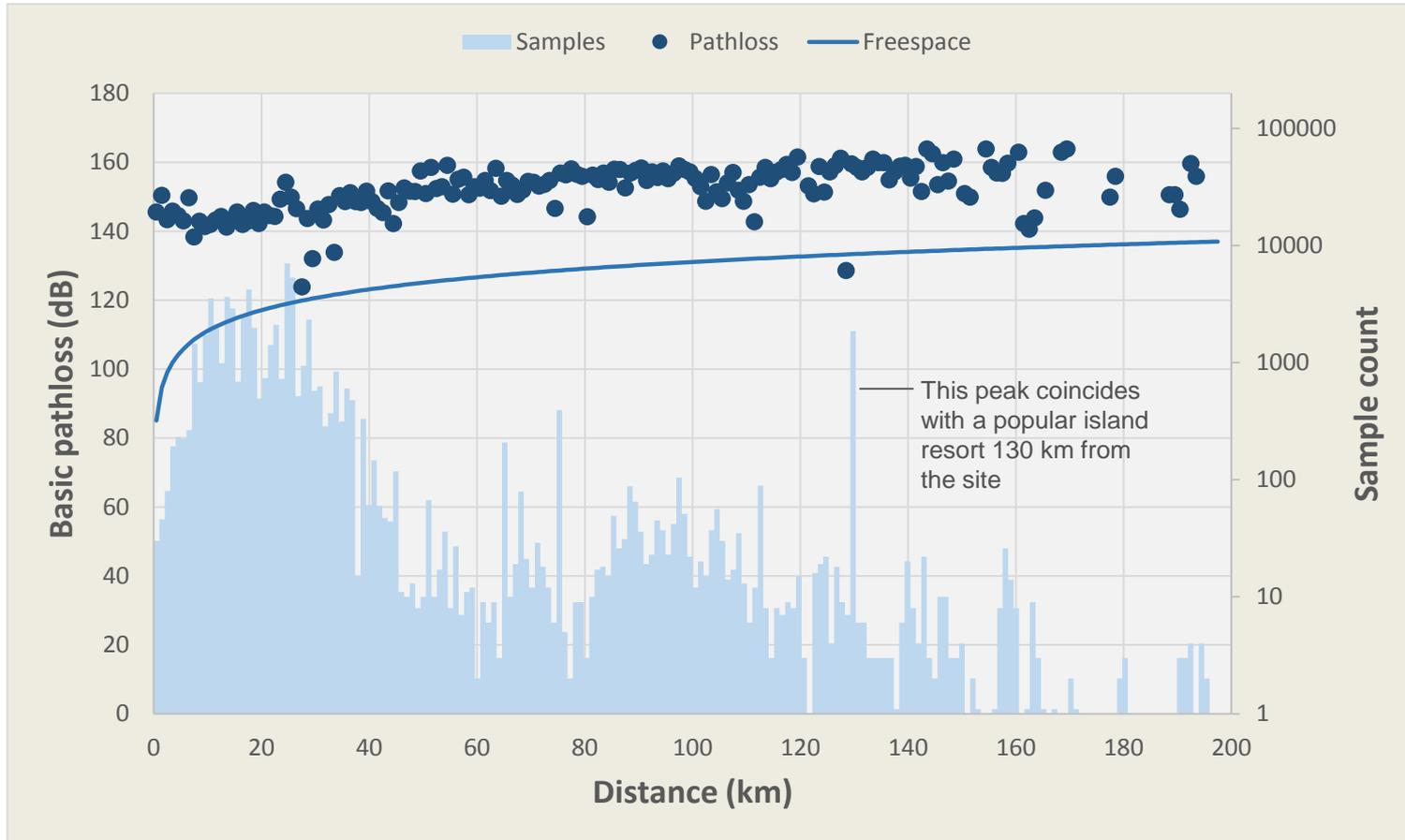


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Antenna height = 21 m (structure) + 722 m (hill) = 743 m

Case studies

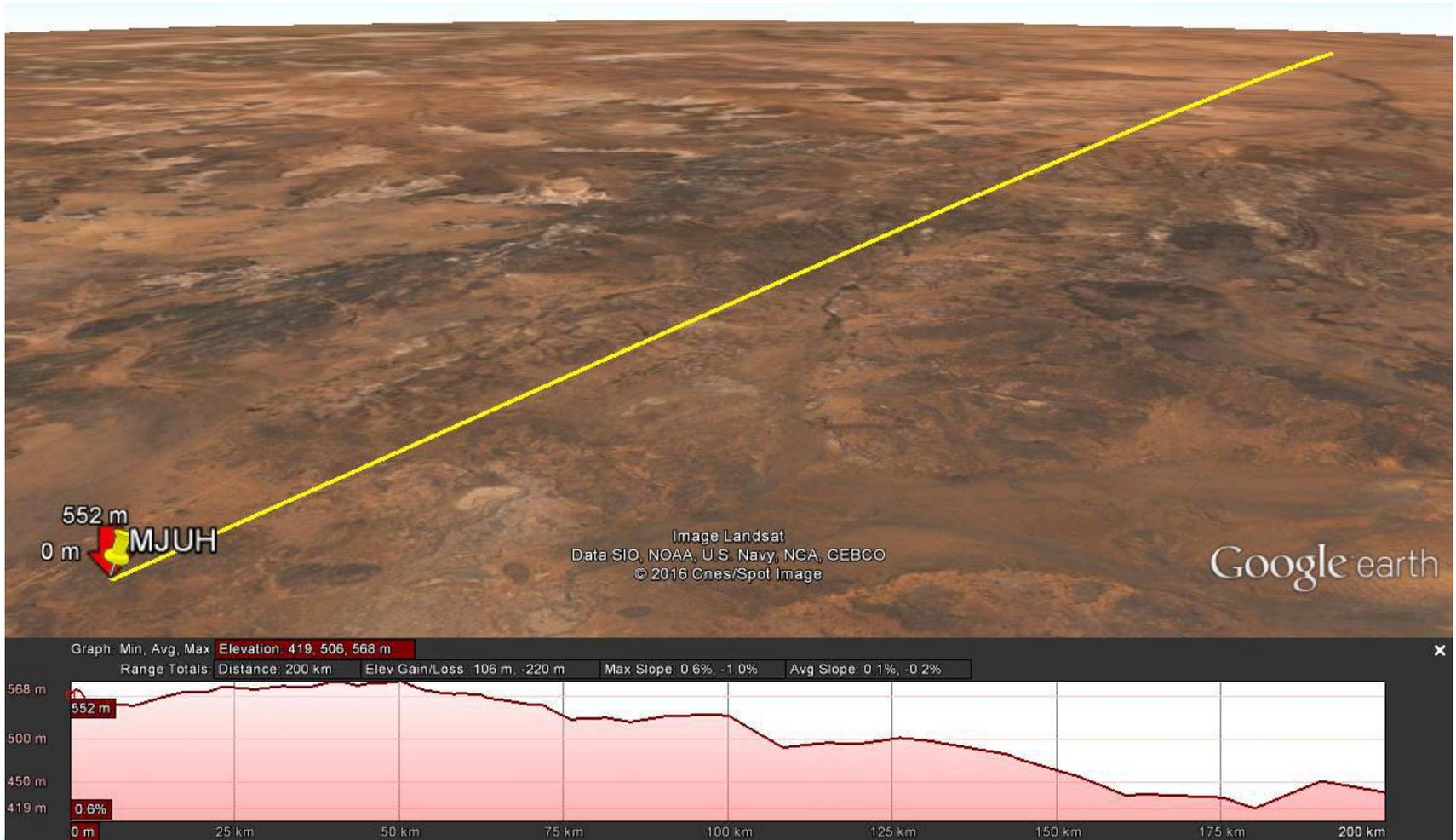
ALMS – propagation measurements



Case studies

MJUH – path profile

- High site overlooking desert and mining sites
- Long distance coverage out to 200 km over flat desert expanse

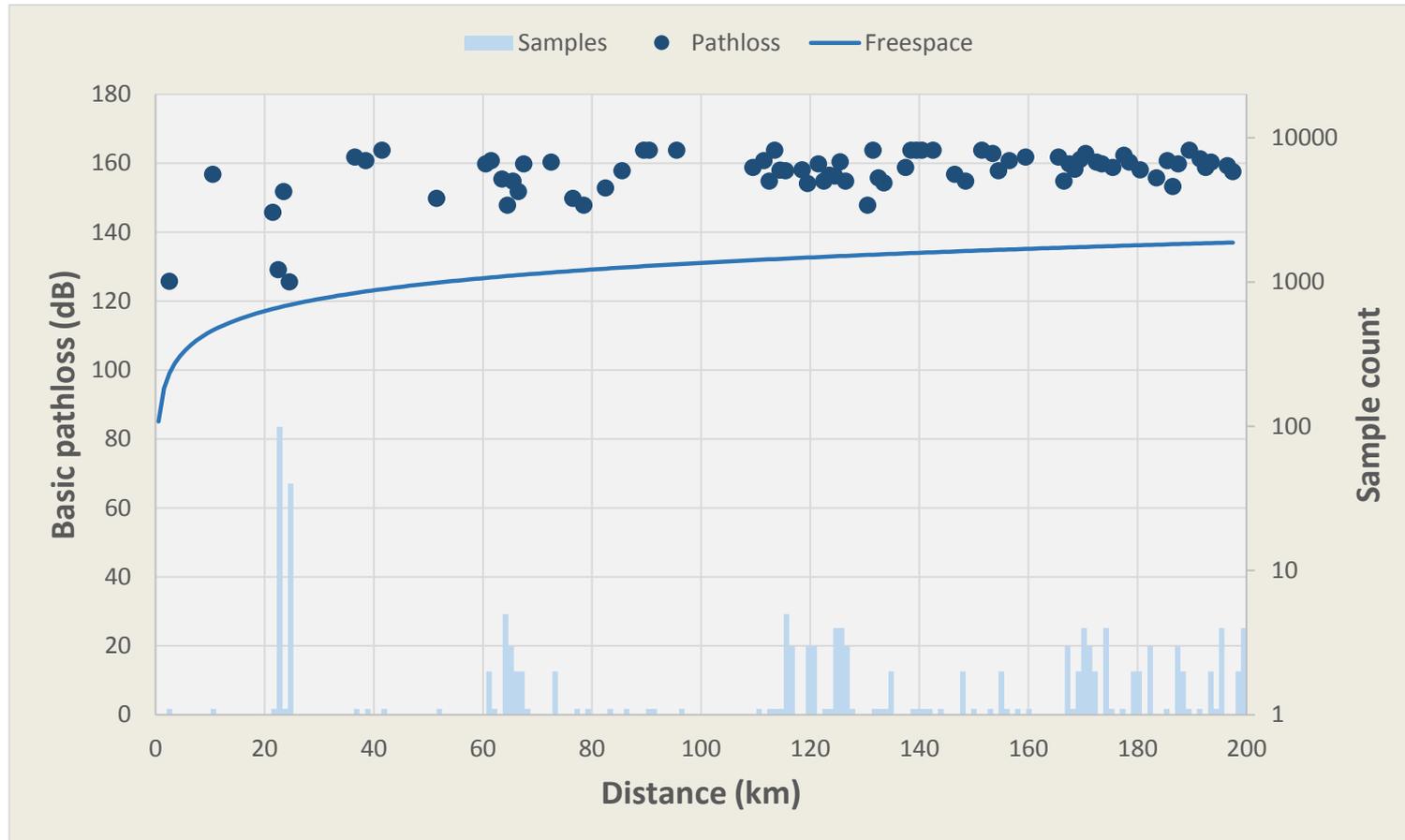


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Antenna height = 59 m (structure) + 552 m (hill) = 611 m

Case studies

MJUH – propagation measurements

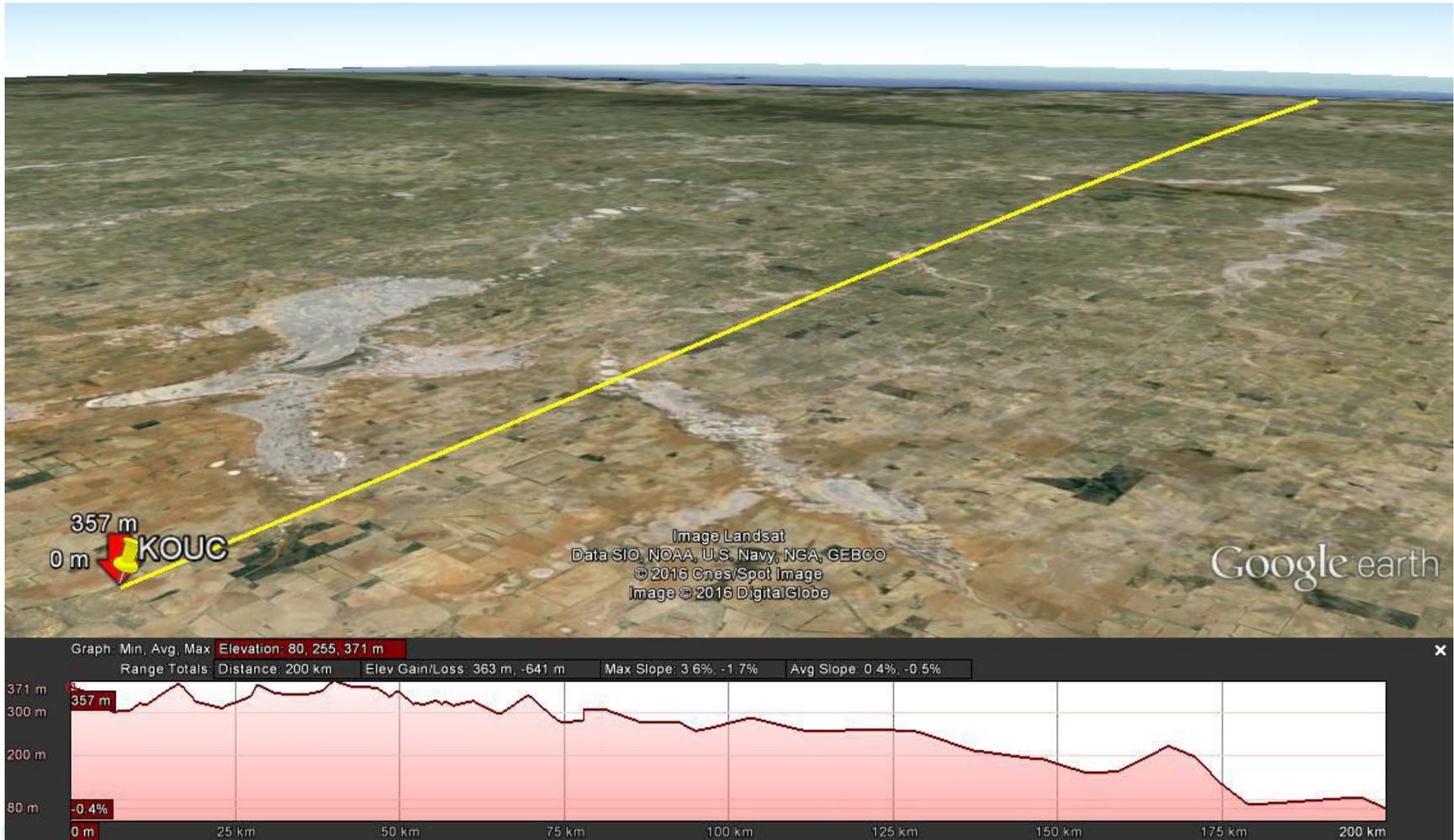


Low traffic site, but UEs spread over large distance range

Case studies

KOUC – path profile

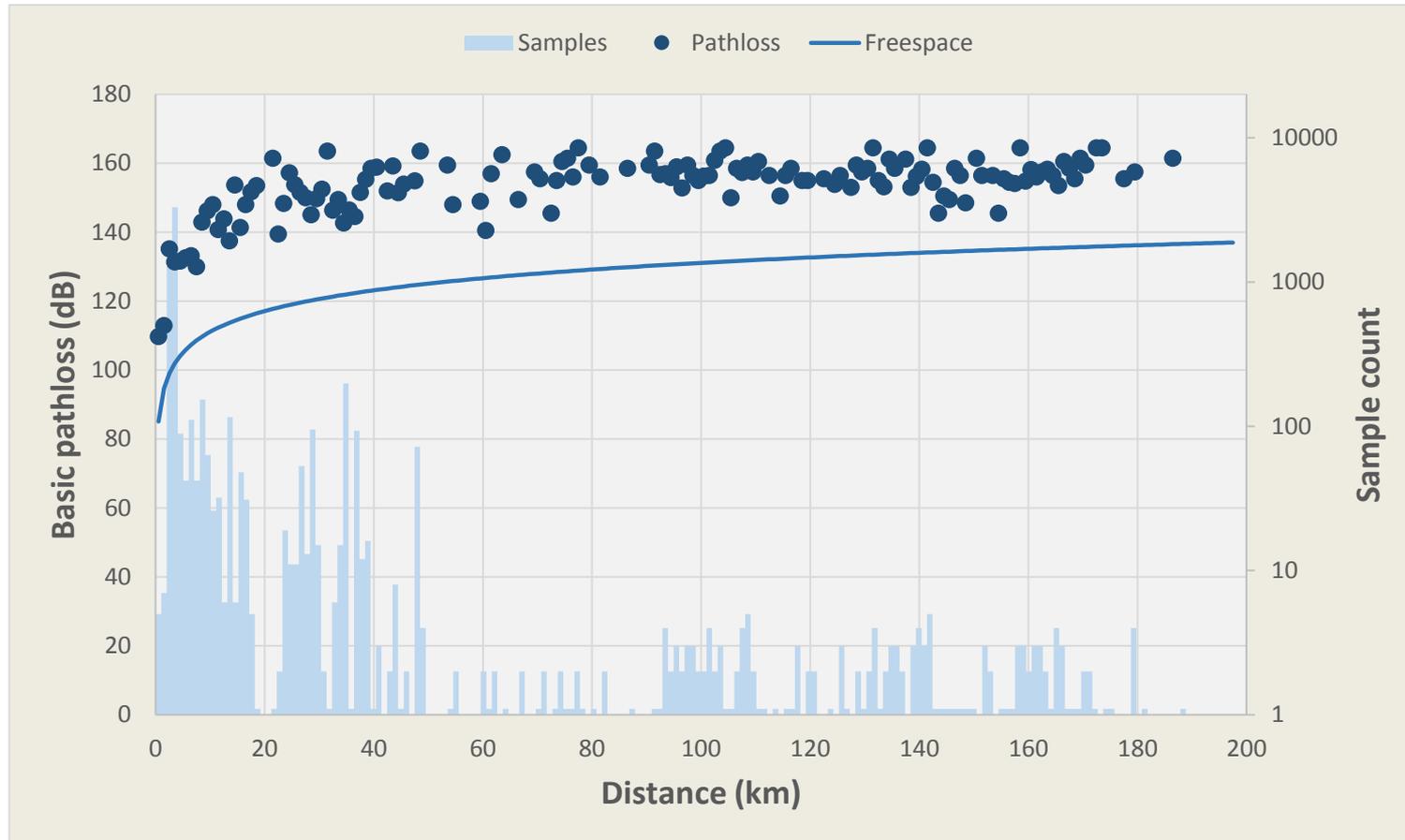
- High site overlooking small remote agricultural communities
- Long distance coverage out to 180 km over flat rural expanse



Antenna height = 60 m (structure) + 357 m (hill) = 417 m

Case studies

KOUC – propagation measurements



Low traffic site, but UEs spread over large distance range