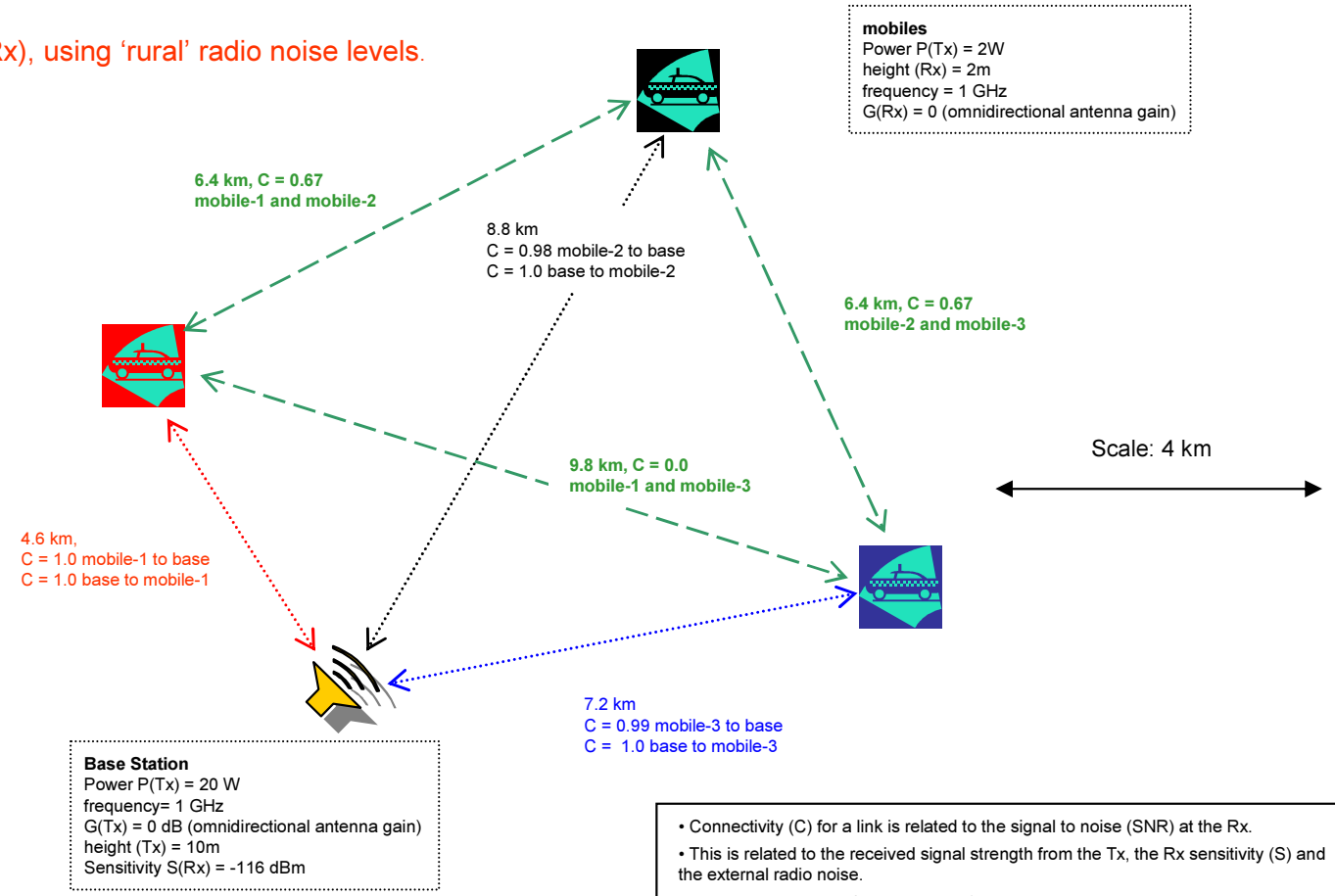
Network connectivity – Base Station and mobiles at UHF frequencies – scenario 10a

Baseline obstruction version (flat terrain <1m undulations, minimal buildings, no significant vegetation – forest/jungle)
All units using basic radios – Base station has better (higher power P(Tx), better sensitivity S(Rx)) than mobiles

Environmental noise less than receiver sensitivity S(Rx), using 'rural' radio noise levels.

• Scenario 2 examined adding inter-mobile links (green) to the 'centralised – duplex' base station to mobile company links, to give a 'full' net. The rise in connectivity was not large due to the wide spacing of the mobiles but the 'centralised – duplex' sub-net is very strongly connected.

• A 'full' net is shown here with a benign 'rural' level noise background below Rx sensitivities S, as a baseline for examining the effect of a higher noise floor.



• Connectivity (C) for a link is related to the signal to noise (SNR) at the Rx.

• This is related to the received signal strength from the Tx, the Rx sensitivity (S) and the external radio noise.

• For example a 10dB SNR results in C = 0.9, with connection 90% of the time and outage 10% of the time.

• The higher the SNR, the higher the connectivity.

Network Connectivity (NC)

• For the 'centralised - duplex' (between mobiles and base station) sub-net the network connectivity is NC = 5.97 across the 6 links (99.5%).

• For the 'full' net, adding in the mobile-mobile sub-net, the connectivity is 8.65 across the 12 links (72.1%).

• Across the 'full' net of 12 links, the 'centralised - duplex' sub-net of 6 links makes up 69% of the connectivity and the mobile-mobile sub-net the remaining 31%.

More challenging radio environment
Environmental noise > receiver sensitivity S(Rx), using 'urban' radio noise levels.

• At 1 Ghz the 'urban' noise level is -105 dBm for a typical 200kHz bandwidth, higher than the receiver sensitivity for the base station (-116 dBm) and mobiles (-112 dBm). Hence the signal to noise ratio (SNR) and connectivity will be reduced.

• The higher noise floor cuts all the mobile-mobile links, which were already weak, with low SNR margins.

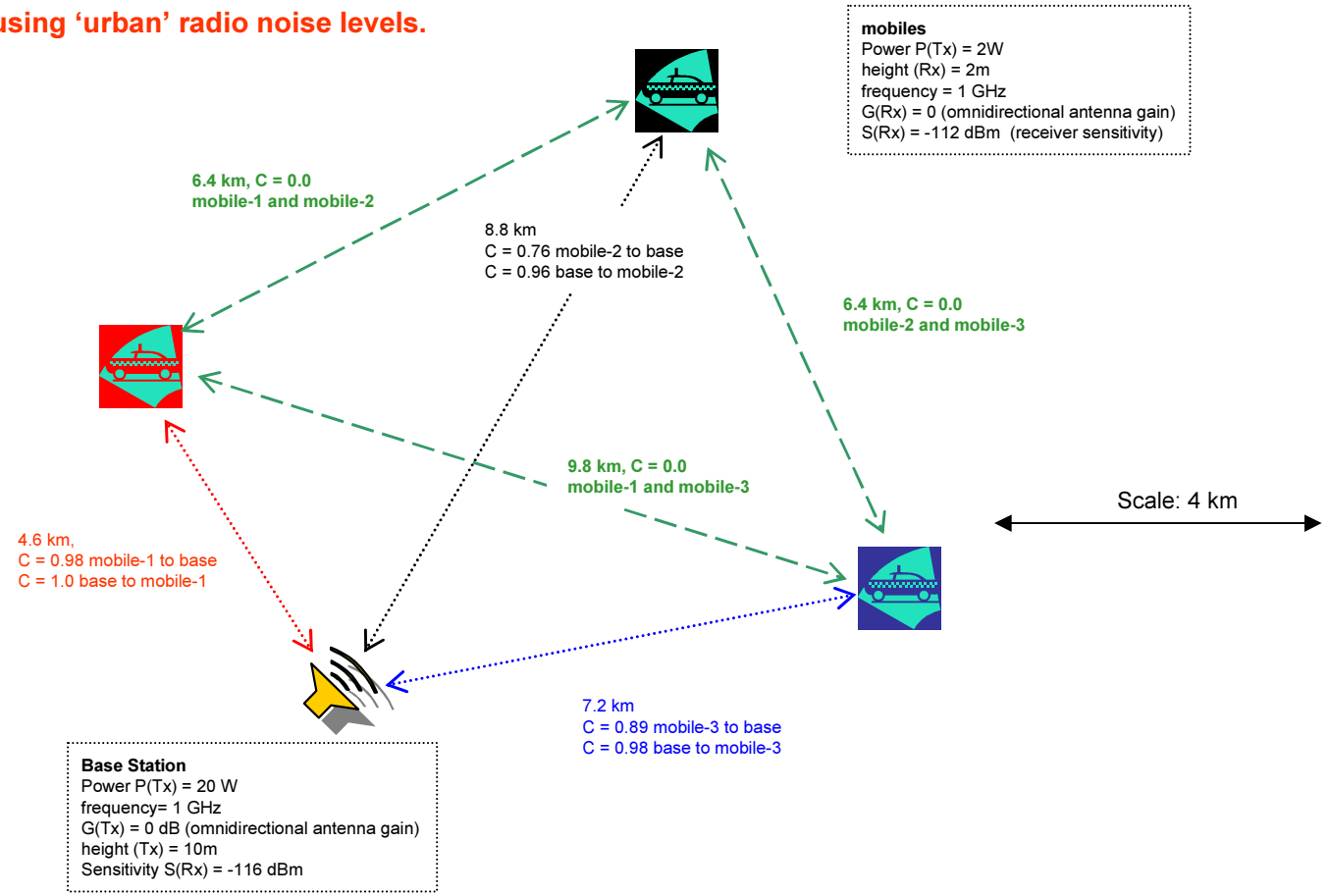
• The base station to mobile links are only reduced by a couple of percent as the high Tx power of 20W helps somewhat to overcome the higher noise background at the mobile Rx.

• However, as the noise floor is higher than the receiver sensitivity of the base station, and the mobile Tx powers are relatively low (2W), the mobile to base station links are weakened more than the base to mobiles. The more sensitive base station Rx does not help offset the low mobile Tx power as it did in the low noise environment.

• The longest path from mobile-2 to the base station has connectivity reduced to 0.76, useable for analogue voice but low quality and probably not strong enough for digital.

• If the noise floor were to rise further, the weakest connection in the 'centralised-duplex' base-mobile sub-net from mobile-2 to the base station would be severed if the noise floor was only 7dB above the 'urban' level.

• If the noise floor was to rise to 26dB above the 'urban' level than even the strongest link, base to mobile-1, would be severed.



Network Connectivity (NC) reduced by increased noise floor

• For the 'centralised - duplex' (between mobiles and base station) sub-net the connectivity is NC = 5.57 (reduced from 5.97) across the 6 links (92.8%, down from 99.5%). So this sub-net is still viable, robust against the noise floor rising, losing only ~8% of its connectivity.

• For the 'full' net the connectivity is also 5.57 (reduced from 8.65) across the 12 links (46.4%, down from 72.1%), due to the connectivity being lost between all pairs of mobiles, so that sub-net has a connectivity of zero.

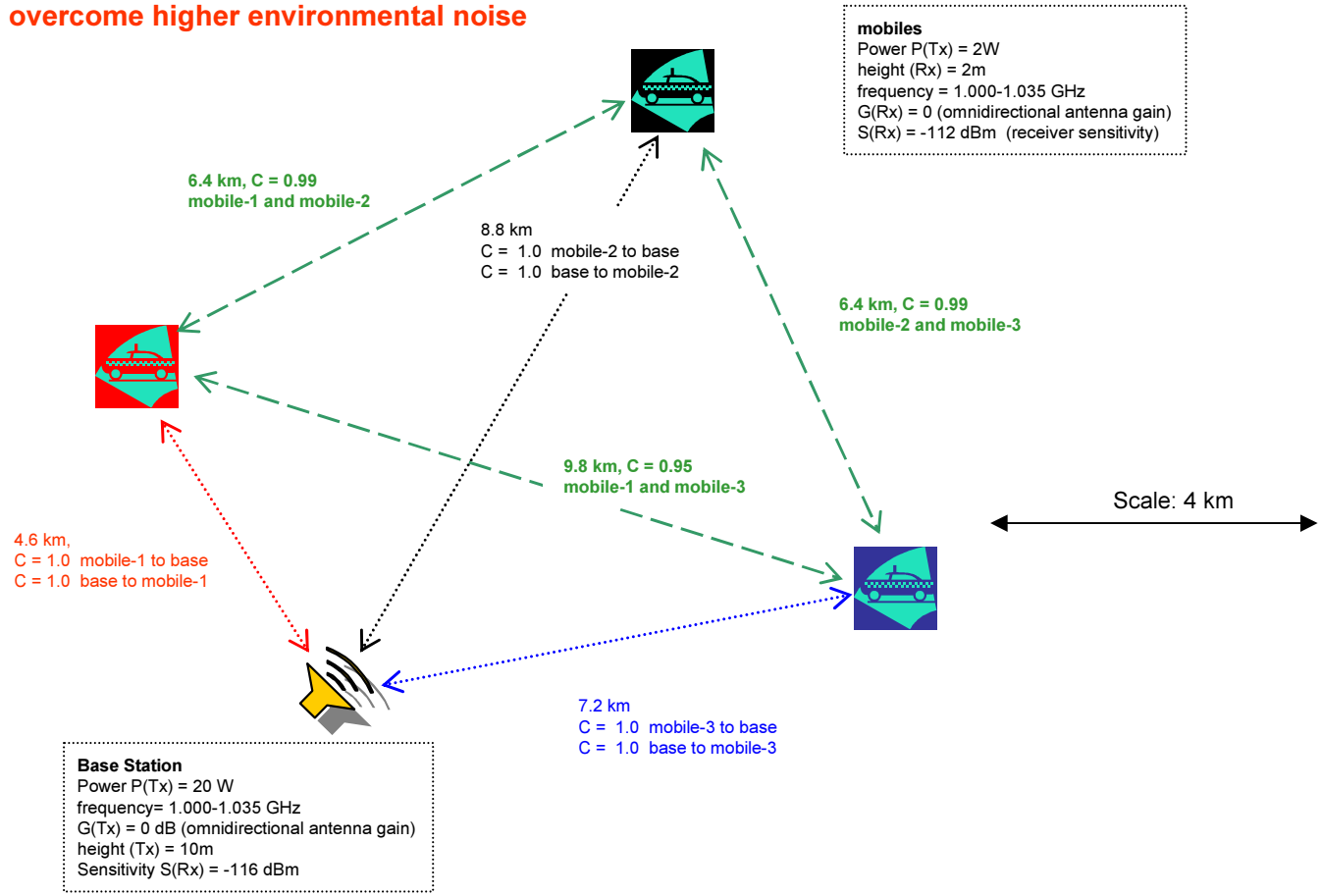
• Across the 'full' net of 12 links, the 'centralised - duplex' sub-net of 6 links makes up 100 % of the connectivity.

Network connectivity – Base Station and mobiles at UHF frequencies – scenario 10c

Baseline obstruction version (flat terrain <1m undulations, minimal buildings, no significant vegetation – forest/jungle)
All units using basic radios – Base station has better (higher power P(Tx), better sensitivity S(Rx)) than mobiles

Using direct sequence spread spectrum (DSSS) to overcome higher environmental noise

- A DSSS system is used between 1.000 GHz and 1.0035 GHz to give a 3.5 MHz spreading bandwidth across 175 channels, each of 200 kHz.
- The DSSS processing gain is 22.4dB on each path. This is enough to raise all the connectivities above 0.9.
- The processing gain is sufficient that the base station Tx power could be reduced to 1W from 20W and the connectivity on the longest path of 8.8 km would still be 1.0,



Network Connectivity modified by increased noise floor

- For the 'centralised - duplex' (between mobiles and base station) sub-net the connectivity is a full 6.0, increased from 5.57 across the 6 links (100%, up from 92.8%).
- For the 'full' net the connectivity is 11.86, increased from 5.57 across the 12 links (98.8% up from 46.4%). A large increase due to the connectivity being restored between all pairs of mobiles, so that sub-net contributes considerably. In fact the full-net connectivity is better than the original system under the lower 'rural' noise.
- Across the 'full' net of 12 links, the 'centralised - duplex' sub-net of 6 links makes up 50.6 % of the connectivity and the mobile-mobile sub-net contributes 49.4%.