Network capacity – Base Station and mobiles at UHF frequencies – scenario 11a

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

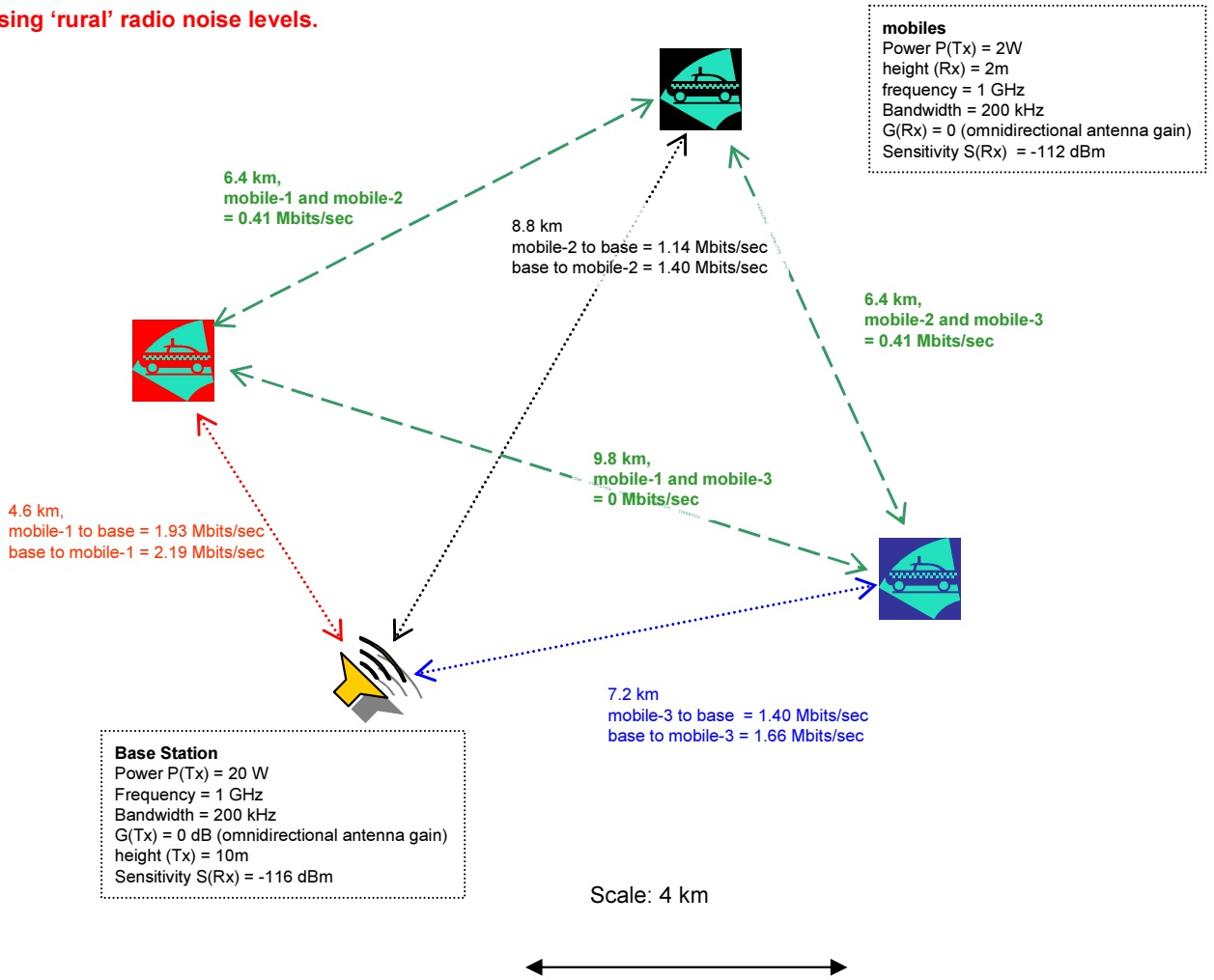
Environmental noise less than receiver sensitivity S(Rx), using 'rural' radio noise levels.

Examine Channel Capacities

A 'full-net' is shown here with a benign 'rural' level noise background below Rx sensitivities S, as a baseline for examining channel capacities.

Channel Capacity

- The theoretical maximum channel capacities for each link are shown. These are dependent on the received SNR and channel bandwidth (200 kHz).
- Generally capacity increases with link connectivity but even when a full connectivity of 1.0 is achieved, the capacity can still be increased by raising the SNR further.
- The capacity is different on the two directions in each mobile-base link due to the different equipment parameters at each end. The higher P(Tx) at the Base more than offsets the lower S(Rx) at the mobiles so capacities are higher from base to mobile than vice versa.
- The capacities for the duplex links between mobiles and base are high due to the wide bandwidth. They mostly fall in the mid to upper levels of the 'wideband' range between 64 kb/sec and 2 Mbits/sec. The base to mobile-1 link could be classified as 'broadband'. Some would be sufficient for ADSL-Lite and all are good enough for standard image quality image streaming. All are good enough for 2G applications and low end 3G (UMTS).
- The mobile to mobile links are considerably lower capacity. No connectivity between mobiles 1 and 3. The other two links are 'wideband', good enough for 2G applications and low end 3G (UMTS) but less than 50% of required capacity for digital image streaming.



Network capacity – Base Station and mobiles at UHF frequencies – scenario 11b

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 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 capacity will be reduced.

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

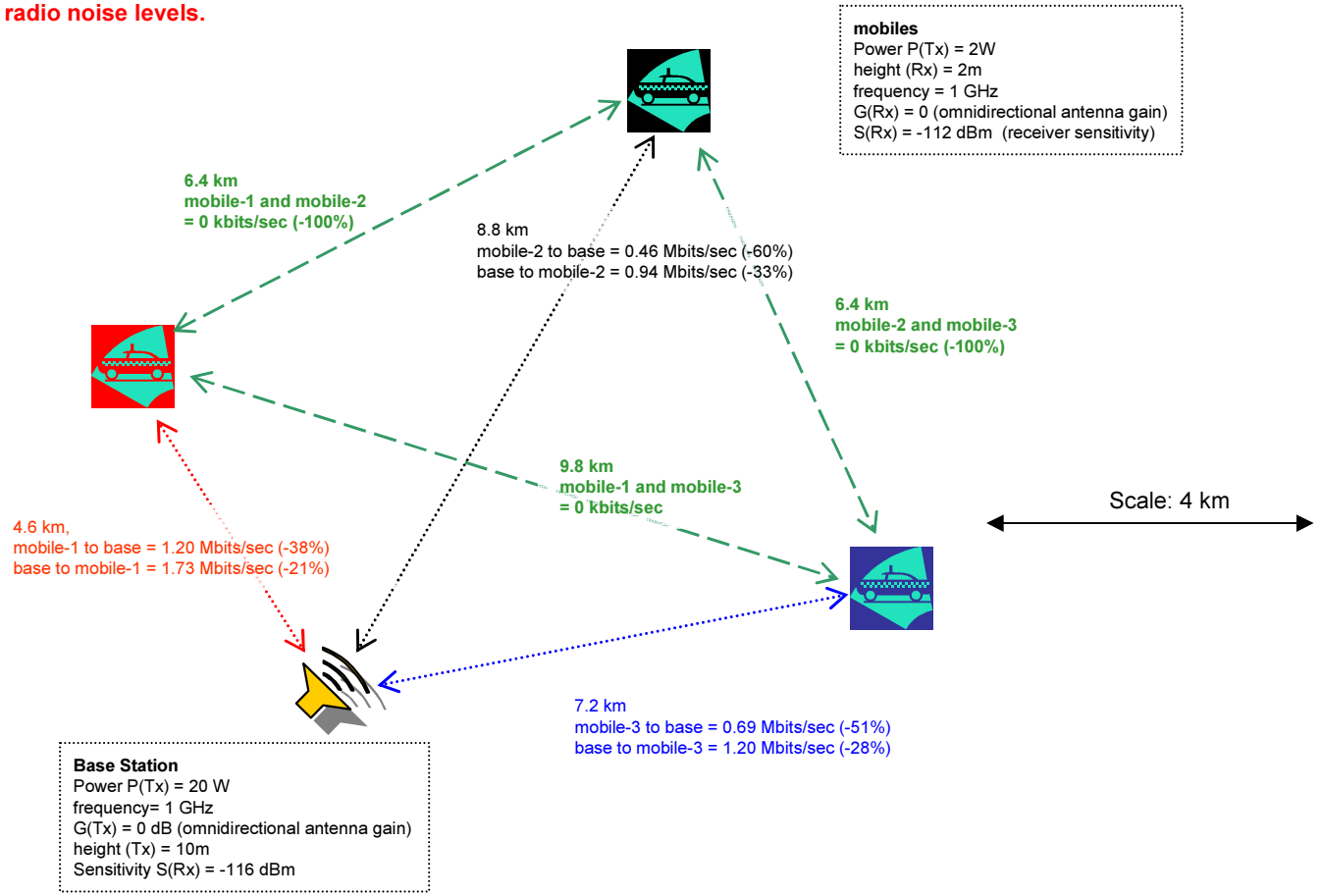
• The base station to mobile links are reduced in capacity by less than 50%, although the reductions are still significant. The higher Base Tx power of 20W helps somewhat to overcome the higher noise background at the mobile Rx.

• 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 capacity reduced by 60% although there is still enough to support low end 3G (UMTS). However capacity is less than half required for digital image streaming and only the link between Base and mobile-1 can support this in duplex.

• If the noise floor were to rise further, the weakest connection in the '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 capacity – 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.
- The noise floor is 'urban'at -105 dBm.
- This processing gain combined with the very large spreading bandwidth, overcomes the raised noise floor and greatly increases the capacity on all the channels.
- The only exception is the longest link between mobile-1 to mobile-3 although this is just on the edge of having a data throughput, whereas previously the SNR was far too low.
- All the links between Base and mobiles can support Wireless 802.11b and up to mid-range 3G applications (HSDPA/HSUPA) . The stronger links could support 3G HSPA+.