

Network connectivity – Base Station and mobiles at UHF frequencies – scenario 2a

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

Benign radio environment – ‘rural’ noise level < receiver sensitivity S(Rx)

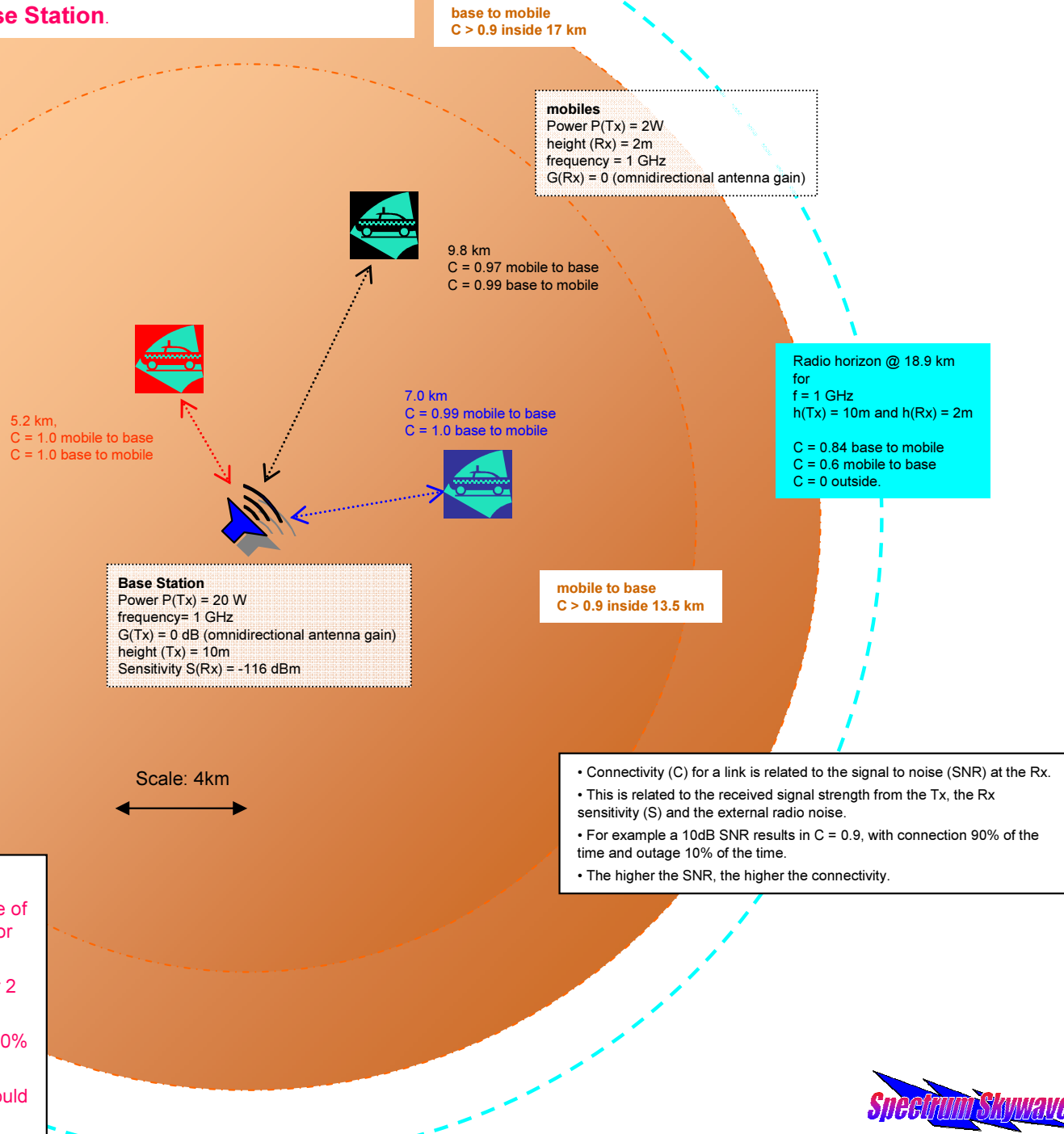
Examine two-way links between mobiles and the Base Station.

Connectivity (C)

- “Centralised - duplex” network configuration allows directions and information to be issued to mobiles and information gathered from them to make decisions at the base station.
- Number of links = 6. Maximum possible connectivity is 6.0.
- Actual NC = 5.95 (99.2%) of possible maximum 6.0 for this configuration. Nearly optimum connectivity.
- Maximum number of paths if all units had two-way paths to each other = 12 (full radio ‘net’).
- If the base station cannot act as an automatic relay (transponder) between mobiles, and the NC were a perfect 6.0 for this configuration, the connectivity would still only be 50% compared with ‘full’ connectivity of 12 paths.
- Actual NC in this example is 49.6% of ‘full’ connectivity if the base station does not act as a relay between mobiles.

Centralisation

- In this configuration there is a high degree of centralisation. The base station is a node for 6 out of the 6 links (100%).
- For comparison each mobile is a node for 2 out of the 6 links (33%).
- Hence the network is most vulnerable (100% failure) if the base station is removed.
- A full ‘net’ with mobiles interconnected would be de-centralised and more robust.



Network connectivity – Base Station and mobiles at UHF frequencies – scenario 2b

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

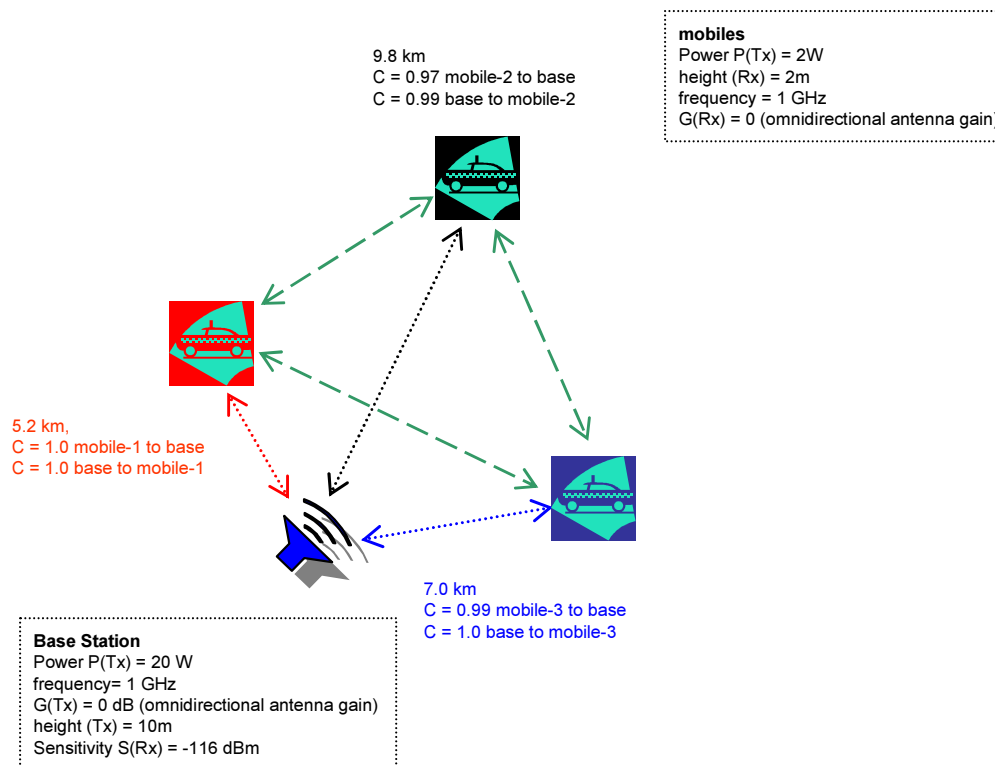
Benign radio environment – ‘rural’ noise level < receiver sensitivity S(Rx)

Examine adding two-way links between the mobiles

Connectivity (C) & Centralisation

- Maximum number of links if all units had two-way links to each other = 12 (full radio ‘net’)
- The links between mobiles will possibly not have as high connectivity as those between mobiles and base station, because of lower P(Tx) and less sensitive Rx.
- The extra connectivity allows mobiles to coordinate their actions without the delay of relaying via the base station.
- There are greater possibilities for devolved decision making to level of the mobile units for faster response to evolving situations.
- There is less centralisation compared with the ‘centralised-duplex’ configuration. The base station is a node for 6 out of the 12 links (50%), down from 100% in the ‘centralised duplex’. If the base station were removed, the network would still retain up to 50% of its potential connectivity. The decision making however may be impeded if control is usually exercised by the base station.
- Each mobile is also a node for 6 out of the 12 links (50%), up from 33% in the ‘centralised duplex’. If longer links in the net have low connectivity (e.g. < 0.9), the message may be relayed via mobiles over shorter links with higher connectivity.

Each mobile is now more valuable as a communications node than in the ‘centralised - duplex’ configuration where it was only a node for local activity. However this places a higher workload on the mobiles as a communication relay and possibly a decision making node.



- The downside to this configuration is the possibility of reduced decision making capacity in the interests of the network as a whole and its role within any wider organisation, unless the base station retains control via the ‘centralised – duplex’ links.
- Strategic decision making contrary to the networks role in a wider set of objectives (e.g. lack of resolve) may spread through this configuration faster than ‘centralised - duplex’, particularly if mobiles do not have wider contextual information that the base station has.
- However positive tactical decision making may also occur faster in the field to exploit opportunities with only broad direction from the base station and less requirement for micro-management. This would also depend on a sufficient level of initiative and situational awareness at the mobiles.

Network connectivity – Base Station and mobiles at UHF frequencies – scenario 2c

Baseline obstruction version (flat terrain <1m undulations, minimal buildings, no significant vegetation – forest/jungle)

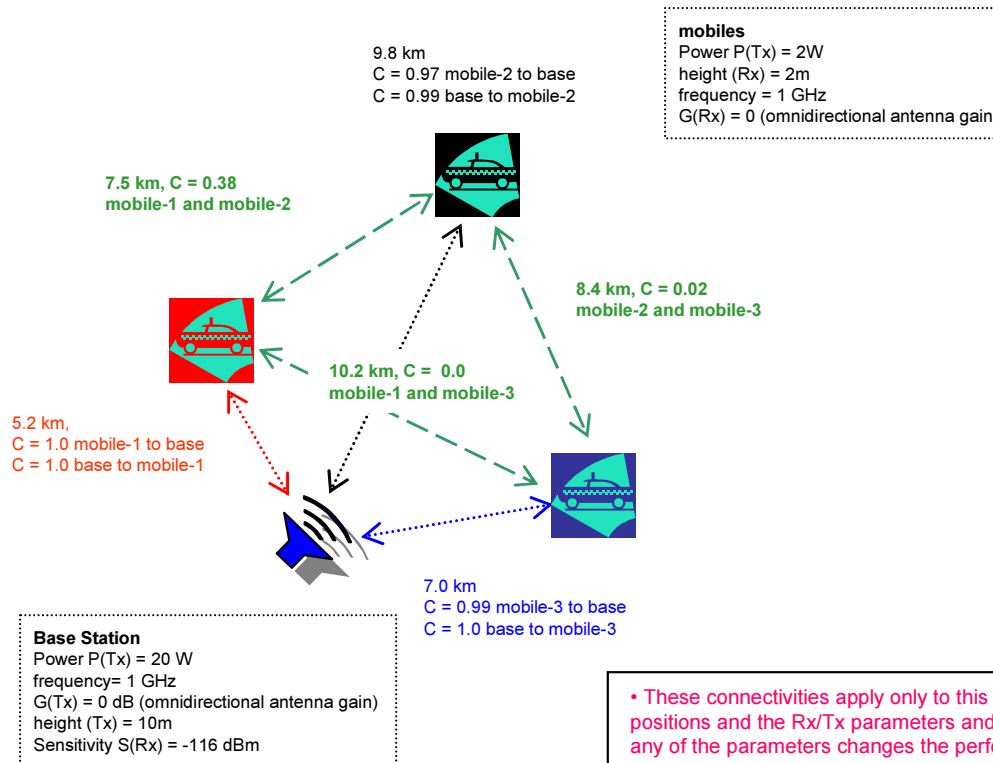
All units using basic radios – Base station has better (higher power P(Tx), better sensitivity S(Rx)) than mobiles

Benign radio environment – ‘rural’ noise level < receiver sensitivity S(Rx)

Examine mobile to mobile links within the ‘full net’.

Connectivity (C)

- The links between mobiles (shown in green) will have the same SNR and connectivity in both directions (i.e. symmetrical), as the Tx and Rx are identical, unlike the base station to mobile links which are asymmetrical.
- The inter-mobile links are generally weaker than the mobile to base station links due to the lower Tx power and Rx sensitivity.
- Each mobile will have its own radio horizon and radius of given connectivities (e.g. $C = 0.9$) for communications with units of the same radio type, i.e. the other mobiles.
- The $C = 0.9$ radius around each mobile is only 4.7 km and the radio horizon 11.7km. They are not shown here to keep the diagram less complex.
- The connectivities between mobiles are very weak, emphasising how important the base stations’ higher antenna, greater Tx power and increased sensitivity are in maintaining the ‘centralised – duplex’ sub-net.
- The Network Connectivity (NC) is only 6.75 out of a possible 12.0 (56%), only slightly higher than the 49.6% using just links between mobiles and the base station.
- To take full advantage of the ‘full’ net configuration at these ranges the mobiles would require higher Tx power and/or higher antenna mountings. The higher antenna mountings may inhibit mobility for a vehicle or personnel on foot.
- The other option is to reduce the area of operations for the network so the mobiles remain within ~4.5km of each other to assure good connectivity.



- These connectivities apply only to this particular arrangement of positions and the Rx/Tx parameters and frequencies used. Changing any of the parameters changes the performance of the network.
- The Network Connectivity represents the cohesion of the network in transmitting information and decisions within itself. So NC is some measure of the networks ability to coordinate its actions. It does not however describe how efficient the situational awareness of its surroundings is.

