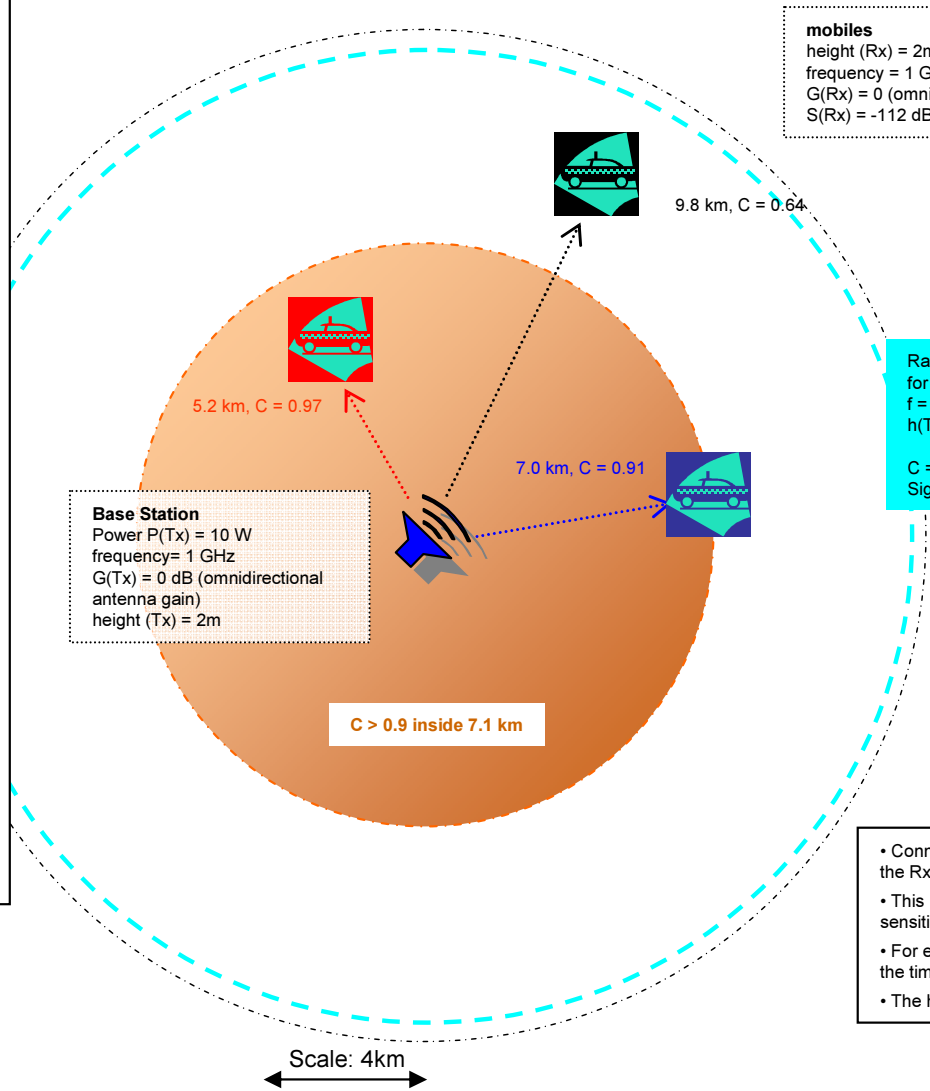
Network connectivity – Base Station and mobiles at UHF frequencies – scenario 1a

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)

Connectivity (C)

- "Broadcast only" network configuration. The base station is a person or vehicle with antenna height 2m and Tx power of 10W.
- Information can be sent from base station to mobiles but no information or requests from mobiles to base station.
- One way communications have obvious drawbacks from a flexible network control standpoint, but acts as useful baseline for comparison.
- The 'black' mobile has relatively weak connectivity (C = 0.64), the 'blue' has acceptable connectivity (C = 0.91) and the 'red' has quite strong C = 0.97. The C = 0.9 range (90% connection, 10% outage) of 7.1 km is shown, and may be a level below which connectivity is considered too low for reliable analogue voice. Some systems, particularly digital, may require higher connectivity for acceptable bit error rates.
- Number of one-way links in this configuration = 3
- Maximum Network Connectivity (NC) possible in this configuration if all links had perfect Connectivity C = 1.0 is NC = 3.0
- Actual NC = 2.52 (84%) of possible maximum 3.0 for this configuration. This is a reasonable NC within the limited capability of this configuration.
- Maximum number of links if all units had two-way links to each other = 12 (i.e. a radio 'net')
- If NC were a perfect 3.0 for this broadcast configuration, the connectivity would still only be 25% compared with 'full connectivity' for a net of 12 links.
- Actual NC of 2.52 is 21% of 'full net' connectivity.



- 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.

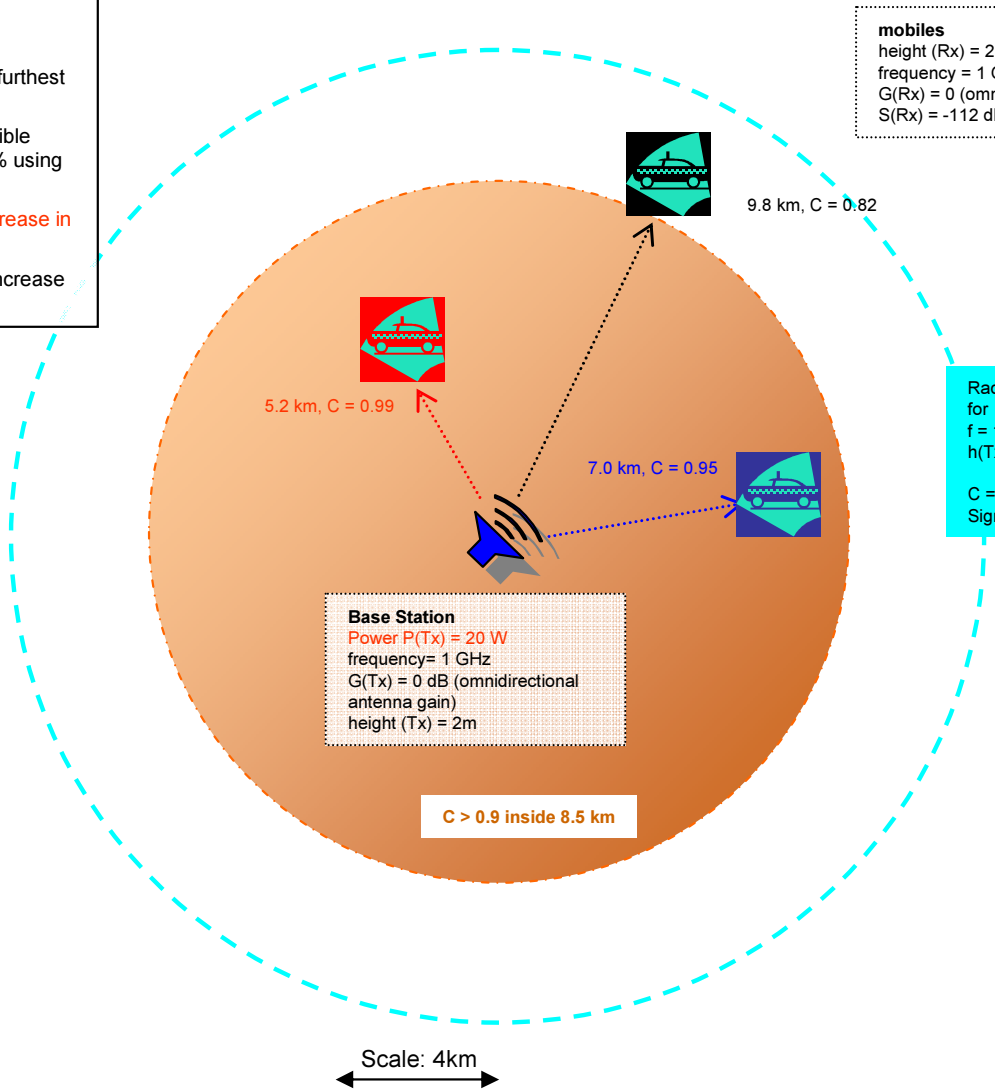
- A single frequency (1 GHz UHF) is used in this broadcast example but a different frequency might be used for each link for simultaneous transmission of differing information to each mobile.
- Different frequencies give different connectivities for a given range, but if they are near 1 GHz the differences will be slight.

Network connectivity – Base Station and mobiles at UHF frequencies – scenario 1b

Try higher base station transmitter power P(Tx) to improve connectivity.

Connectivity (C)

- Double the P(Tx) to 20W
- Two of the mobiles now have C at least 0.95 and the furthest has a relatively high C = 0.82.
- Actual Network Connectivity NC = 2.76 (92%) of possible maximum 3.0 for this configuration, increased from 84% using 10W.
- However, doubling Tx power only achieved an 8% increase in Network Connectivity.
- Actual NC is 23% of 12 link 'full net' connectivity, an increase of 2% from using 10W.



Network connectivity – Base Station and mobiles at UHF frequencies – scenario 1c

Base station P(Tx) remains at 20W.

Increase height of base station antenna from 2m to 10m. Allow for small cable loss from Tx to antenna.

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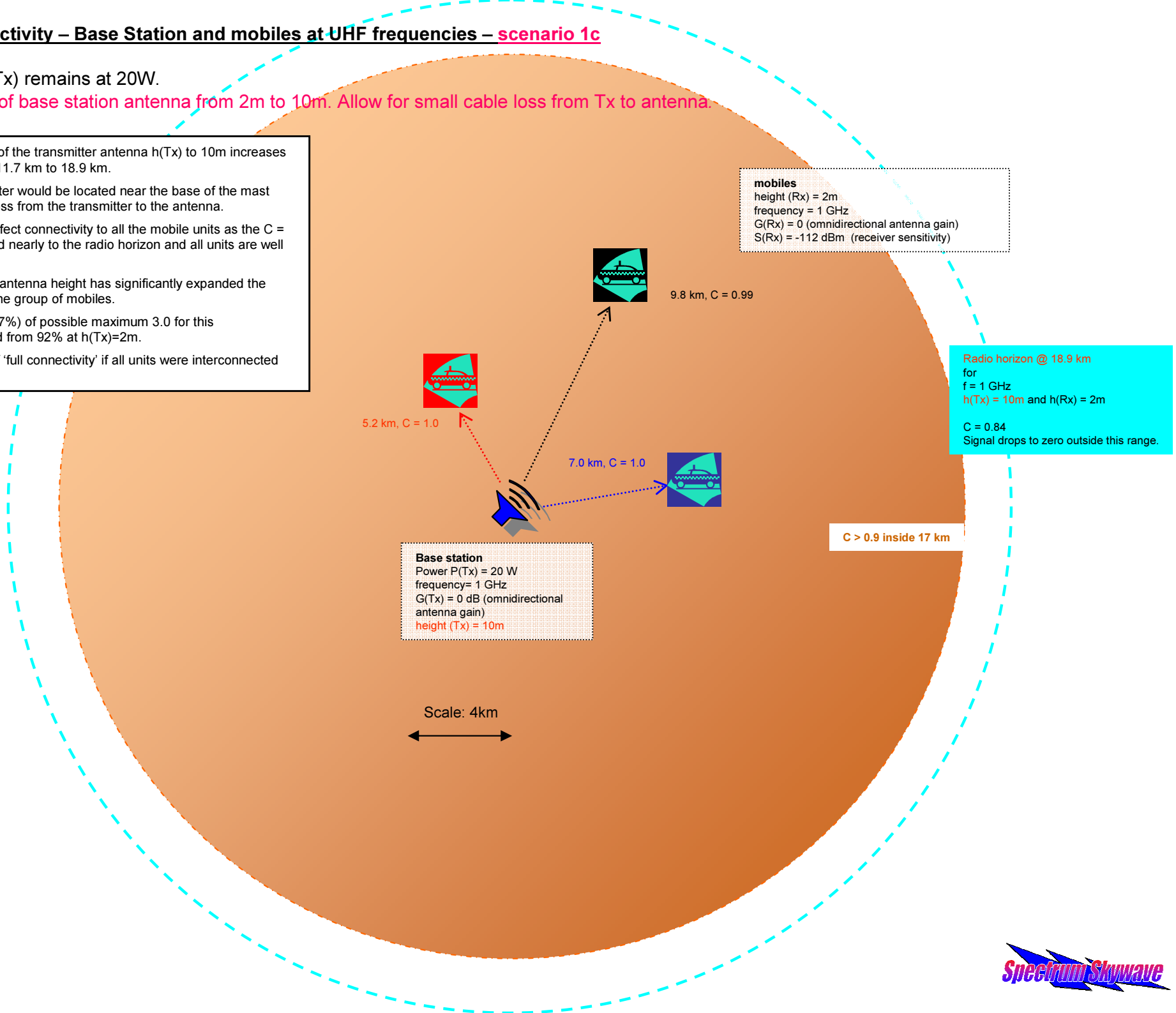
- Increasing the height of the transmitter antenna h(Tx) to 10m increases the radio horizon from 11.7 km to 18.9 km.
- As the actual transmitter would be located near the base of the mast there is a small cable loss from the transmitter to the antenna.
- There is now near perfect connectivity to all the mobile units as the C = 0.9 range has expanded nearly to the radio horizon and all units are well within that.
- Hence, raising the Tx antenna height has significantly expanded the area of operations for the group of mobiles.
- Actual NC = 2.99 (99.7%) of possible maximum 3.0 for this configuration, increased from 92% at h(Tx)=2m.
- Actual NC is 24.9% of 'full connectivity' if all units were interconnected by two-way links.

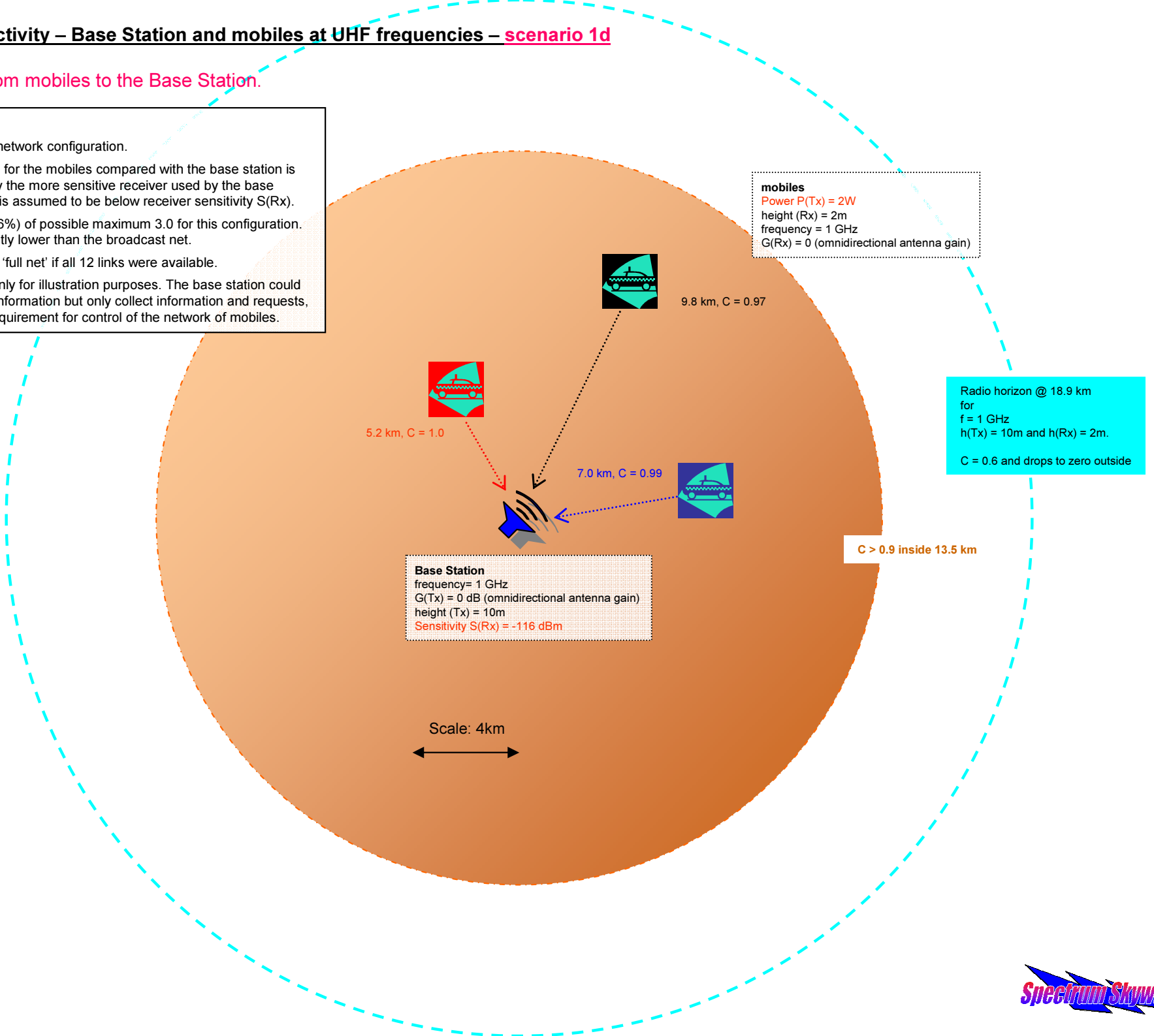


Network connectivity – Base Station and mobiles at UHF frequencies – scenario 1d

Examine links from mobiles to the Base Station.

Connectivity (C)

- "report back to base" network configuration.
- The lower power (2W) for the mobiles compared with the base station is offset to some extent by the more sensitive receiver used by the base station. The noise floor is assumed to be below receiver sensitivity S(Rx).
- Actual NC = 2.96 (98.6%) of possible maximum 3.0 for this configuration. The connectivity is slightly lower than the broadcast net.
- Actual NC is 24.6% of 'full net' if all 12 links were available.
- This configuration is only for illustration purposes. The base station could not issue directions or information but only collect information and requests, which is only half the requirement for control of the network of mobiles.

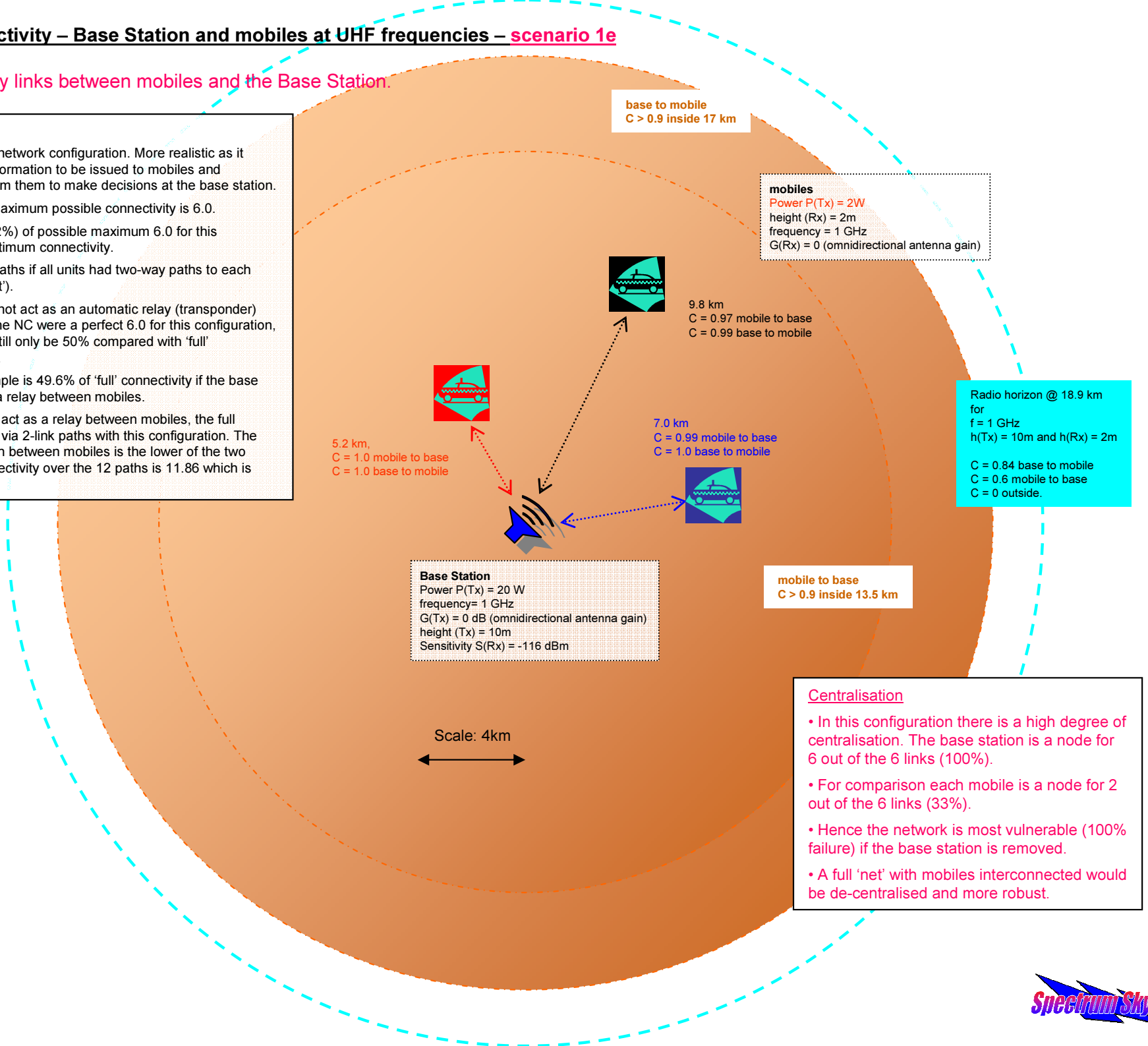


Network connectivity – Base Station and mobiles at UHF frequencies – scenario 1e

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

Connectivity (C)

- "Centralised - duplex" network configuration. More realistic as it 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.
- If the base station can act as a relay between mobiles, the full connectivity is achieved via 2-link paths with this configuration. The connectivity of each path between mobiles is the lower of the two links. The network connectivity over the 12 paths is 11.86 which is 98.8%.



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.