3)

$$L\left(\log_2(L)-3\right)+4$$

Transform leng. $(L) = \frac{1024}{\beta}$

Active subcarriers $= \frac{640}{\beta}$ $\quad \beta = \{1, 2, 4, 8\}$

$\beta = 1$,

$L = 1024$, $N = 640$

$$\text{Tx complexity} = \frac{L\left[\log_2(L)-3\right]+4}{N}$$

$$= \frac{1024\left(\log_2(2^{10})-3\right)+4}{640}$$

$$= 11.21$$

$$\text{Rx complexity} = \text{Tx complexity} + 4$$

$$= 15.21$$

$\beta = 2$; $L = 512$, $N = 320$

$$\text{Tx complexity} = \frac{512\times\left(\log_2(2^9)-3\right)+4}{320}$$

$$= 9.61$$

$$\text{Rx complexity} = 13.61$$

$\beta = 4$; $L = 256$, $N = 160$

$$\text{Tx complexity} = \frac{256\left(\log_2(2^8)-3\right)+4}{160}$$

$$= 8.025$$

$$\text{Rx complexity} = 12.025$$

$n = 8$;

$L = 128$, $N = 80$

Tx complexity $= \frac{128\left[\log_2(2^7) - 7\right]}{80} + 4$

$= 6.45$

Rx complexity $= 10.45$

4)

5.5 = 15kHz

C.F = 2GHz

Coherence BW $= \frac{1}{\text{delay spread}}$

a). $BW_c = \frac{1}{2.5 \times 10^{-6}} = 400\text{kHz}$

b) $BW_c = \frac{1}{25 \times 10^{-6}} = 40\text{kHz}$

a) Coherence time $= \frac{c}{2Vf_c}$

$= \frac{3 \times 10^8}{2 \times (5/3.6) \times 2 \times 10^9} = 54\text{ms}$

b) coherence time $= \frac{3 \times 10^8}{2 \times \frac{300}{3.6} \times 2 \times 10^9} = 0.9\text{ms}$

3)

Maximum distance = $\frac{MW_c}{5.5}$

$MW_c = 400kHz$, pilot distance = $\frac{400 \times 10^3}{15 \times 10^3} = 26.6$

$MW_c = 40kHz$ pilot distance = $\frac{40 \times 10^3}{15 \times 10^3} = 2.6$

Maximum distance (OFDM Sym.) = $\frac{T_c}{T_{sym}}$

$T_{sym} = \frac{(1+CP)}{5.5} = \frac{\left(1+\frac{1}{4}\right)}{15kHz}$

$= 83.3\mu s$

$T_c = 54ms$; pilot distance = $\frac{54 \times 10^{-3}}{83.3 \times 10^{-6}} = 648.25$

$T_c = 0.9ms$; pilot distance = $\frac{0.9 \times 10^{-3}}{83.3 \times 10^{-6}} = 10.8$

for $MW_c = 400kHz$ ⇒ 27 subcarriers

$T_c = 54ms$ ⇒ 648 OFDM symbols

$MW_c = 40kHz$ ⇒ 3 subcarriers

$T_c = 0.9ms$ ⇒ 11 OFDM symbols

5)

$F_{c1} = 2\,GHz$

$F_{c2} = 30\,GHz$

$SIR = 30dB$

for SIR 30dB, CFO relative to $\delta \cdot 5 = 0.025$

Doppler shift $= 0.025$

max doppler shift $= \frac{f_c \times v}{c}$

min $\delta \cdot 5 = M \cdot D \cdot 5 \times 0.025$

for 2 GHz, $v = 3\,kmh^{-1}$

$$\text{max } D \cdot 5 = \frac{2 \times 10^9 \times 3/3.6}{3 \times 10^8} = 5.5\,Hz$$

$$\text{min } \delta \cdot 5 = \frac{5.5}{0.025} = 220\,Hz$$

2 GHz $v = 200\,kmh^{-1}$

$$\text{max } D \cdot 5 = \frac{2 \times 10^9}{3 \times 10^8} \times \frac{200 \times 3}{3.6} = 370.37\,Hz$$

$$\text{min } \delta \cdot 5 = \frac{370.37}{0.025} = 14.82\,kHz$$

for 30 GHz $v = 3\,kmh^{-1}$

$$\text{max } D \cdot 5 = \frac{30 \times 10^9}{3 \times 10^8} \times \frac{3}{3.6} = 83.33\,Hz$$

$$\text{min } \delta \cdot 5 = \frac{83.33}{0.025} = 3.33\,kHz$$

for 30 GHz, $v = 200\,kmh^{-1}$

$$\text{max } D \cdot 5 = 555.56\,Hz$$

$$\text{min } \delta \cdot 5 = 22.22\,kHz$$