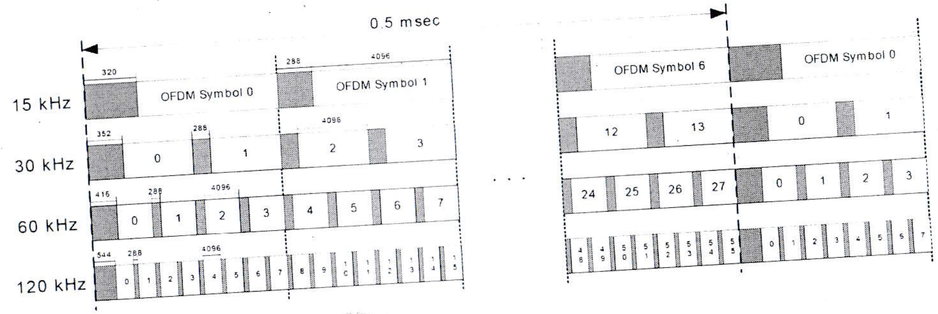
System dimensioning for 5G-NR

- NR baseband bandwidth = 50 MHz and usable baseband bandwidth = 49.5 MHz
  - NR uses guard band of 0.5 MHz for 50 MHz bandwidth
- Subcarrier spacing $\Delta f = 15$ kHz
- Total subcarriers required $N_c = 3300$ $(15 * 3300 = 49.5$ MHz$)$
- (I)FFT size used $N = 4096$
- OFDM symbol duration $T_u = \frac{1}{\Delta f}$
  - OFDM symbol duration is fixed once subcarrier spacing is fixed
- Sampling time in the last slide $T_s = \frac{T_u}{4096}$
- Sampling rate

$$F_s = \frac{1}{T_s} = \frac{4096}{T_u} = 4096 \cdot \Delta F = 4096 \cdot 15 = 61.44 \text{ MHz}$$

- Sampling rate required according to Nyquist criteria = 49.5 MHz

Time domain structure in detail (15 KHz)



- Recall for 50 MHz system: i) (I)FFT size $N = 4096$ ii) Number of CP samples: 288
- Total number of samples in 14 symbols: $14 \cdot (288 + 4096) = 61376$
- Recall sampling rate for 50 MHz system: 61.44 MHz.Samples generated in 1 msec=61440
- Extra samples $61440 - 61376 = 64$. 32 samples are added to CP of first and eigth symbol in each slot

b. Slot is 14 Symbols which is 1 msec. eg. No of slot in Subframe = 1

c. No of symbols = 2275 × 14

(3) ✓

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[27] S. P. Boyd, S. J. Kim, L. Vandenberghe, and A. Hassibi, "A tutorial on geometric programming," 2004.

[28] Y. Dai and X. Dong, "Power allocation for multi-pair massive mimo two-way af relaying with linear processing," *IEEE Trans. Wireless Commun.*, vol. 15, no. 9, pp. 5932–5946, Sep. 2016.

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(2) 4

$y_1 = h_1 x + n_1$

$y_2 = h_2 x + n_2$

$h_1^* y_1 + h_2^* y_2 = |h_1|^2 x + h_1^* n_1 + |h_2|^2 + h_2^* n_2$

$= (|h_1|^2 + h_2^2) x + h_1^* n_1 + h_2^* n_2$

b. $SNR = \dfrac{(|h_1|^2 + (h_2)^2)^2 P}{E[(h_1^* n_1 + h_2^* n_2)(h_1 h_1^* + h_2 n_2^*)]}$

$= \dfrac{(|h_1|^2 + |h_2|)^2 P}{|h_1|^2 \sigma^2 + |h_2|^2 \sigma^2} = \dfrac{|h_1|^2 + |h_2|^2 P}{2\sigma^2}$

c No.

4a)

a) B= C+CRC =33816+24 (TB+CRC)
b) Number of code blocks C=ceil(B/8448-24)=5;
c) Effective payload length B' = B+5*24= 33960,
d) Each code block size should be K'=B'/5= 6792;
e) Find Minimum value of lifting size such that
   Kb*Zc=K>K'
   22*320=7040>6792
f) Number of filler bitsF = K-K'= 7040-6792=248
g) Circular buffer length = 7040*3=21120;
h) RV_indices=0,4160,8000,13760

4b)

a) B= C+CRC =576+24 (TB+CRC)
b) Number of code blocks C=1;
c) Effective payload length B' = B+1*0= 600,
d) Each code block size should be K'=B'/1= 600;
e) Find Minimum value of lifting size such that
   Kb*Zc=K>K'
   22*28=616>600
f) Number of filler bits F = K-K'= 616-600=16
g) Circular buffer length = 616*3=1848;
h) RV_indices=0,364,700,1204