Lecture #4

April-18

Note Title 3/27/2020

$$\underset{N\times 1}{\bar{x}(k)} = \begin{bmatrix} \bar{q}_1 & \bar{q}_2 & \cdots & \bar{q}_N \end{bmatrix} \begin{bmatrix} d(k,1) \\ d(k,2) \\ \vdots \\ d(k,N) \end{bmatrix}$$

Many QAM

ATSC

$\bar{d}$

$\triangleq F \leftarrow$ full DFT Matrix

$$\bar{x} = F\,\bar{d}$$

N_{CP}

$$\bar{x} \xrightarrow[CP]{\text{add}} \tilde{x}(k) = [x(k,N-N_{CP}+1)\ldots; x(k,1)\cdots x(k,N)]$$

$x[k,N]$

Recall:

→ code
→ tone
→ sub-carrier

$$\bar{q}_n = \begin{bmatrix} e^{j\frac{2\pi}{N}n0} \\ e^{j\frac{2\pi}{N}n1} \\ \vdots \\ e^{j\frac{2\pi}{N}n(N-1)} \end{bmatrix}$$

$N = 8$

$$F = \begin{bmatrix} \bar{q}_1 & \cdots & \bar{q}_8 \end{bmatrix}$$ (1 to N)

OR

$$F = \begin{bmatrix} \bar{q}_4 & \bar{q}_3 & \cdots & \bar{q}_0 & \bar{q}_{-1} & \cdots & \bar{q}_{-3} \end{bmatrix}$$

$+\frac{N}{2}$ to $-\frac{N}{2}+1$

upper guard band $N/2$

N_u

f

q_0

lower g.b.

$-N_u$

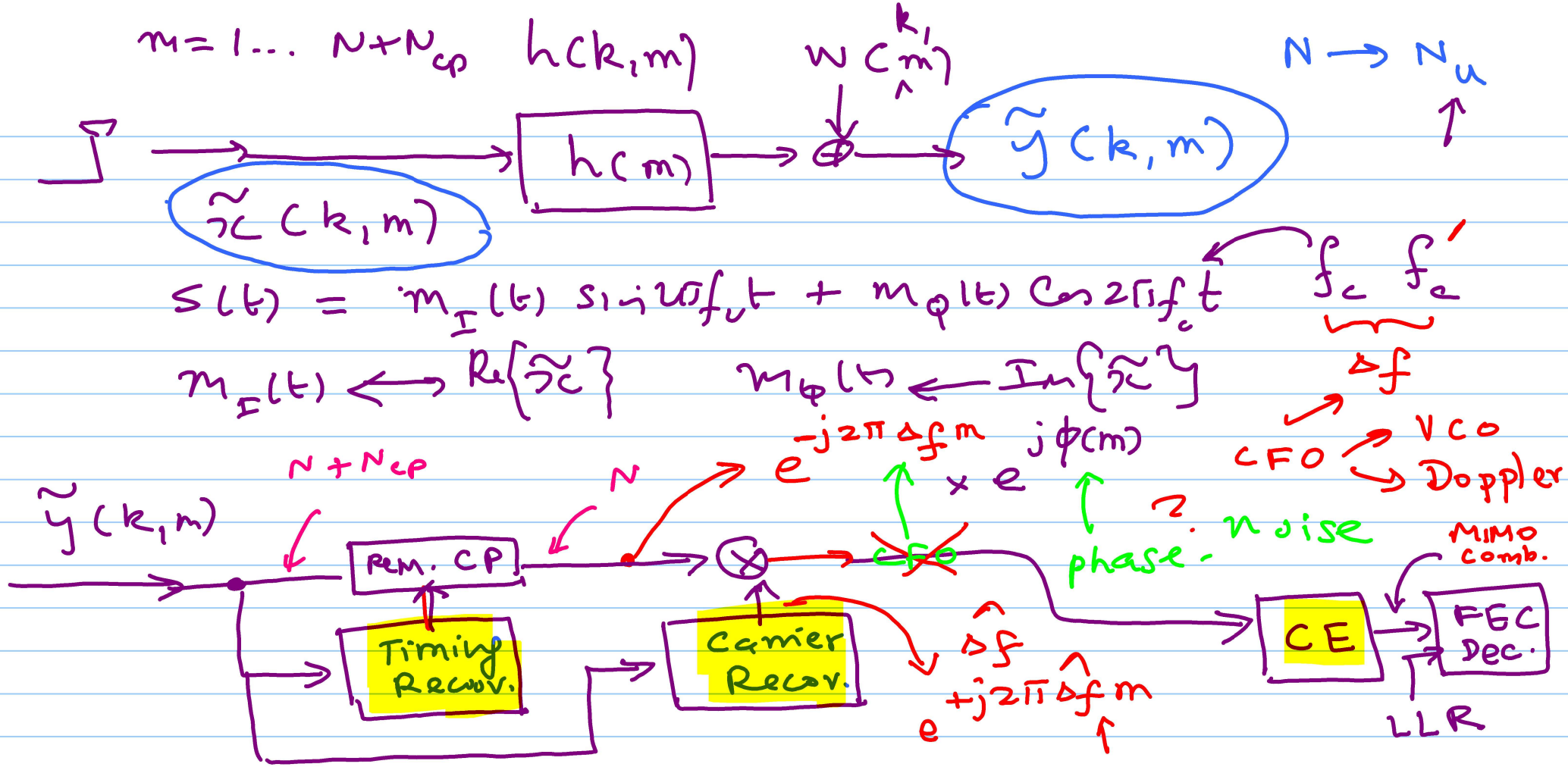
$-N/2+1$

$$\bar{x} = F\,\bar{d}$$

$$\bar{x} \rightarrow \sum_{i=-N/2+1}^{+N/2+1} d_i \bar{q}_i$$

$\bar{d}$: 0 0 x ⋮ x x 0 x ⋮ x x 0 (DC)

* zero DC
* spectral mask (band-limiting)


m = 1 ... N+N_cp
h(k,m)
w(k) m^
N → N_u
h(m)
x̃(k,m)
ỹ(k,m)
s(t) = m_I(t) sin 2πf_c t + m_Q(t) cos 2πf_c t
f_c f_c'
Δf
m_I(t) ⟷ Re{x̃}
m_Q(t) ⟷ Im{x̃}
N+N_cp
N
e^{-j2πΔfm}
× e^{jφ(m)}
CFO
VCO
Doppler
ỹ(k,m)
Rem. CP
CFO
phase
noise
MIMO comb.
Timing Recov.
Carrier Recov.
e^{+j2πΔfm}
CE
FEC Dec.
LLR