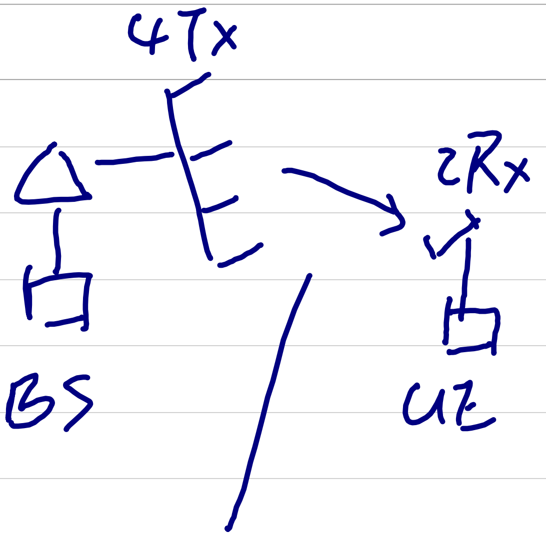


Rx signal = desired signal + interf + noise

$$SINR = \frac{P_{Rx}}{N + P_{interf}}$$

- path loss
- shadowing
- Rayleigh flat fading

Channel

$$\underbrace{H_{k.q.i}}_{\text{channel}} = \underbrace{\tilde{H}_{k.q.i}}_{\text{i.i.d.}} \underbrace{R_{t.q.i}^{\frac{1}{2}}}_{\text{cor. matrix}}$$

inst. k.
user q.
BS i.

$$\tilde{H}_{k.q.i} = \varepsilon \tilde{H}_{k-1.q.i} + \sqrt{1-\varepsilon^2} N_{k.q.i}$$

$\varepsilon = 1$ constant
$\varepsilon = 0$ no memory

1 2 3 4 . . . → transmission

↑ ↑ ↑ ↑ Tx select one user to serve

each user calculates: ① PMI → precoding matrix to use

② RI → 1 or 2 streams

Tx → Rx: 1 transmit only 1 symbol

2. transmit 2 symbols

(based on SNR)

MMSE RX.

$(HH^H + \text{interf} + \text{noise})$

1. system model

$$\underline{Y} = HX + n$$

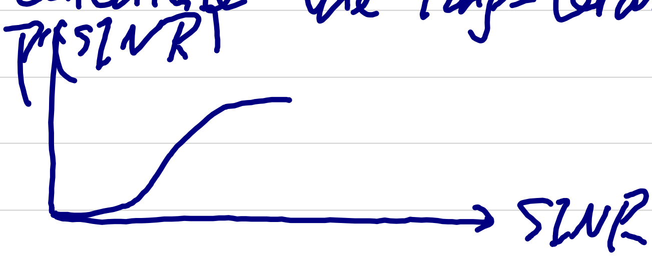
MMSE Rx

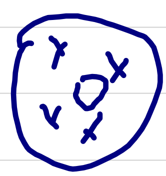
$$F = \left(HH^{-1} + \underbrace{H_i H_i^{-1} + \delta_n^2 I}_{\text{noise+interf}}\right)^{-1}$$

achivable rate

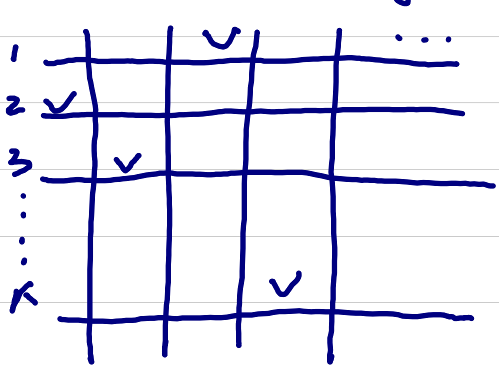
$$C = \log_2(1+SINR_1) + \log_2(1+SINR_2)$$

2. calculate the long-term SINR





3. PF scheduling over T very large number of slots.



Rate: 1 0 | 0 | R | 0 ...

t_c large: max rate

t_c small: round robin

i. discuss the CDF of each user based on t_c

ii. influence of the number of users

1. user distribution

drop: to generate user coordinate (fixed within every drop)

① coordinate of all base stations

② distance between users and central BS

phase of all users

coordinate of users

③ distance between interf BS and users

④ transmit correlation matrix $R_{t,q,i}$

BS 0: toeplitz matrix (function of user phase)

BS 1-6: identity matrix

$\rightarrow d_{q,i}$ user - center BS d_c

user - interf BS d_i

$\rightarrow R_{t,q,i}$

2. pathloss + shadowing

center: $128.1 + 37.6 \log_{10} \frac{d_c}{10^3} + 8$ randn(1, nUsers)

interf: $128.1 + 37.6 \log_{10} \frac{d_i}{10^3} + 8$ randn(nInterfs, nUsers)

db2pow(·)

$\rightarrow \Lambda_c, \Lambda_i$

3. fading

R $H_{k,q,i}$: spatial + temporal correlated fading

$\underline{\tilde{H}_{k,q,i}}$: temporal fading (Markov process)

$\tilde{H}_{k,q,i} = \epsilon \tilde{H}_{k-1,q,i} + \sqrt{1-\epsilon^2} N_{k,q,i}$ time correlation ϵ

i.i.d. $CN(0,1)$ ↓ memory

if $k == 1$

$\tilde{H}_{k,q,i} = \mathrm{sqrt}(\frac{1}{2}) \cdot [\mathrm{randn}(nRxs, nTxs) + 1i\,\mathrm{randn}(nRxs, nTxs)]$

else

end

→ $H_{k,q,i}$ isequal ? No → center

$\tilde{H}_{k,q,i}$ Yes → interf

4. CSI codebook (RI, PMI)

RI: number of streams/layers in transmission

PMI: index of the preferred precoder corresponding to RI

CQI: the maximum achievable rate by the selected RI, PMI

nTxs = 4   codebook size = 2x16

① input $u_0 - u_{15}$

② calculate corresponding $W_0 - W_{15}$: $W_n = I - 2\frac{u_n u_n^H}{u_n^H u_n}$ (4x4)

PMI

③ if RI == 1 % single layer : P(4x1)

precoder = $W_n^{\{1\}}$ → $W_n(:,1)$

else % double layer : P(4x2)

precoder(:,1) = $W_n(:,1)$

if ismember(pmi, [2 3 4 9 10 16])

precoder(:,2) = $W_n(:,2)$

elseif — - .

precoder(:,2) = $W_n(:,3)$ / $W_n(:,4)$

end

∴ precoder /= $\sqrt{2}$

end

④ uniform power allocation

if RI == 1

precoder x = $\sqrt{P}$

else

precoder x = $\begin{bmatrix} \sqrt{\frac{P}{2}} & \sqrt{\frac{P}{2}} \end{bmatrix}$

→ precoder

5. Linear precoding

1. obtain precoder for all PMI (single + double) 16×2
2. calculate R_n: (pp. 20?) corresponding (16 × 2)
   i. select interf precoder randomly
   ii. sum up intercell interf contribution for BS 1-6
   iii. (if RI == 2) interstream contribution
   iv. generate noise cov. matrix
3. calculate corresponding SINR (16 × 2)
4. rate 16×2 (sum of two streams if RI == 2)
5. define max rate as CQI

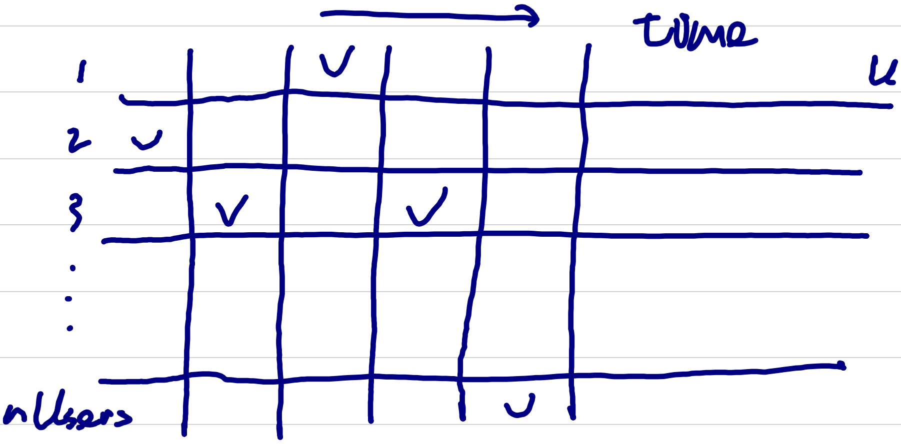
→ CQI for all users

6. proportional fairness scheduling

inst rate $CQI_{i,t}$

user i: 0 0 15 0 0 ..

avg rate



CQI of all users

① schedule

$$[\sim, \text{userIndex}] = \max \cdot \frac{QoS \times cqi}{\text{long-term rate}}$$

② update LT rate

```
for iuser = 1 : nUsers
  if iuser == userIndex % scheduled
```

$$R_{LT}(iuser) = \left(1 - \frac{1}{t_c}\right) \cdot R_{LT}(iuser) + \frac{1}{t_c} \cdot CQI(iuser)$$

```
  else
```

$$R_{LT}(iuser) = \left(1 - \frac{1}{t_c}\right) R_{LT}(iuser)$$

```
end
```

→ LT rate, user index ⇒ inst rate(k, userindex) = cqi(userindex)