教育部「5G行動寬頻人才培育跨校教學聯盟計畫」
5G行動網路協定與核網技術聯盟中心

課程: 5G系統層模擬技術

第十二週：RI、PMI、CQI估算與Adaptive MCS

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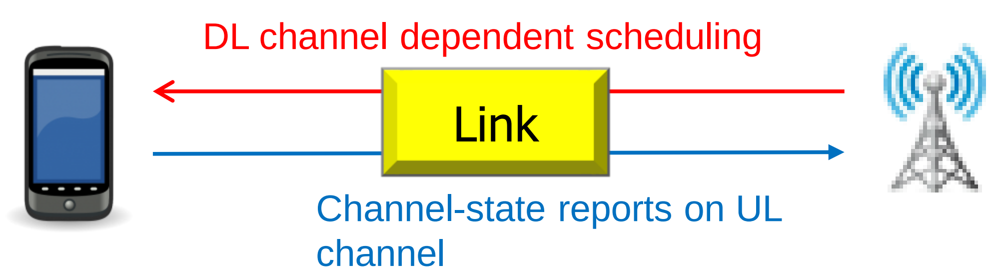
Outline

12.1 Channel-State Reporting

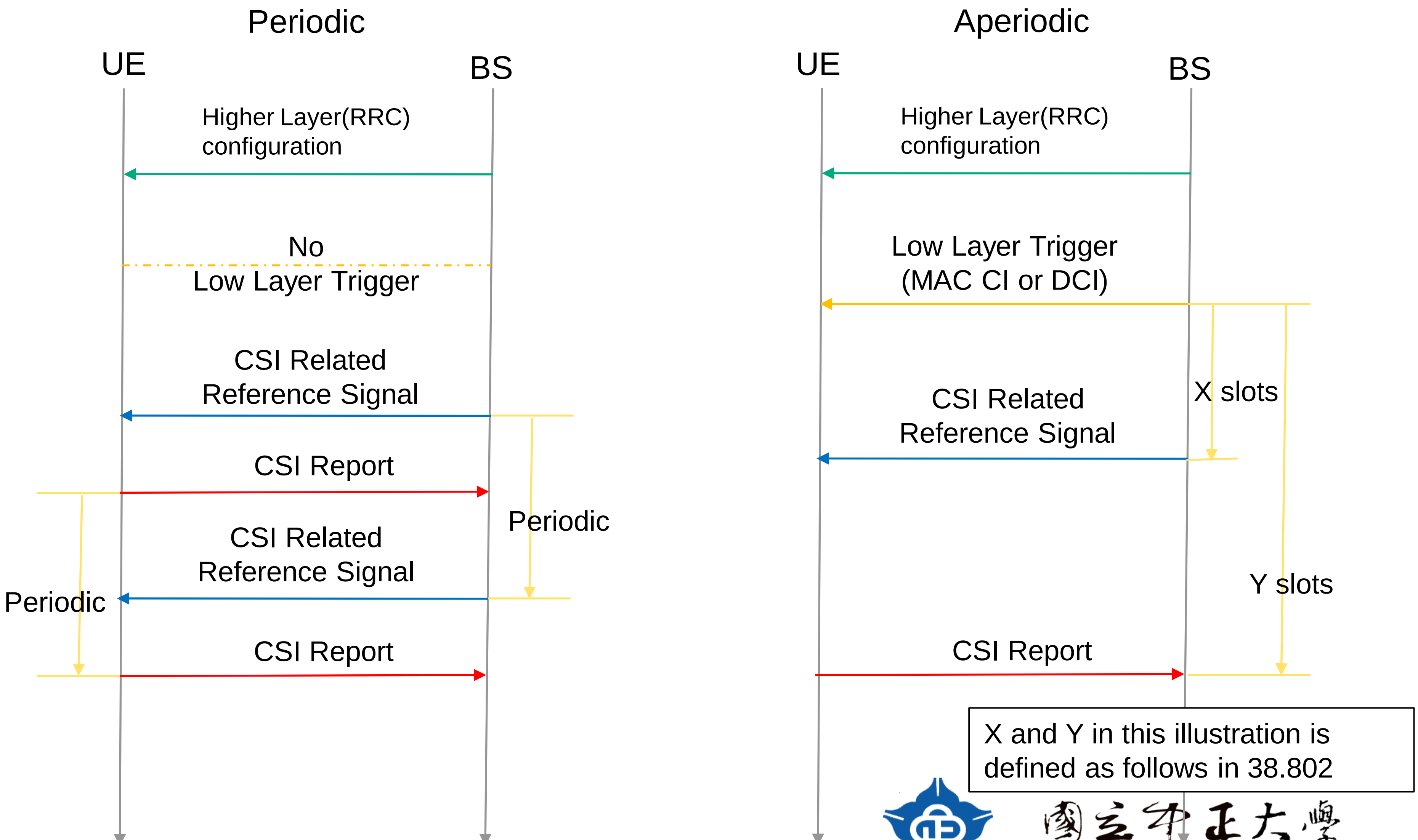
- Channel-state reporting is an important part of the support for downlink channel-dependent scheduling, provided by terminals to the network, reporting on which the latter can base its scheduling decisions
- The channel-state reports consist of one or several pieces of information:
    - Rank indication (RI)
    - Precoder matrix indication (PMI)
    - Channel-quality indication (CQI)



12.1 Channel-State Reporting(1/3)

- NR supports three types of CSI reporting
  1. Aperiodic CSI reporting
     - Delivered when explicitly requested by the network by means of the channel-state request flag included in uplink scheduling grants.
  2. Periodic CSI reporting
     - It can be configured by higher layer. Higher-layer configuration includes at least reporting periodicity and timing offset.
  3. Semi-persistent CSI reporting
     - Configuration of CSI reporting can be activated or de-activated.

12.1 Channel-State Reporting(2/3)



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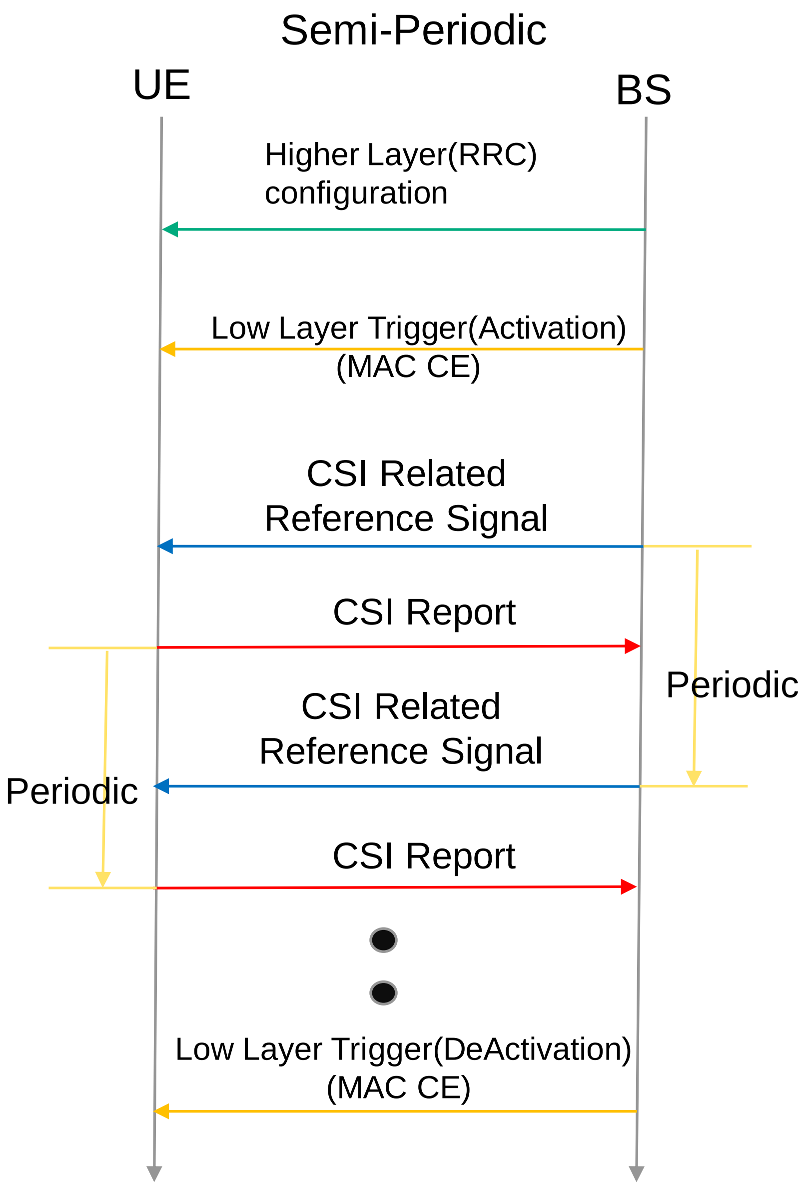
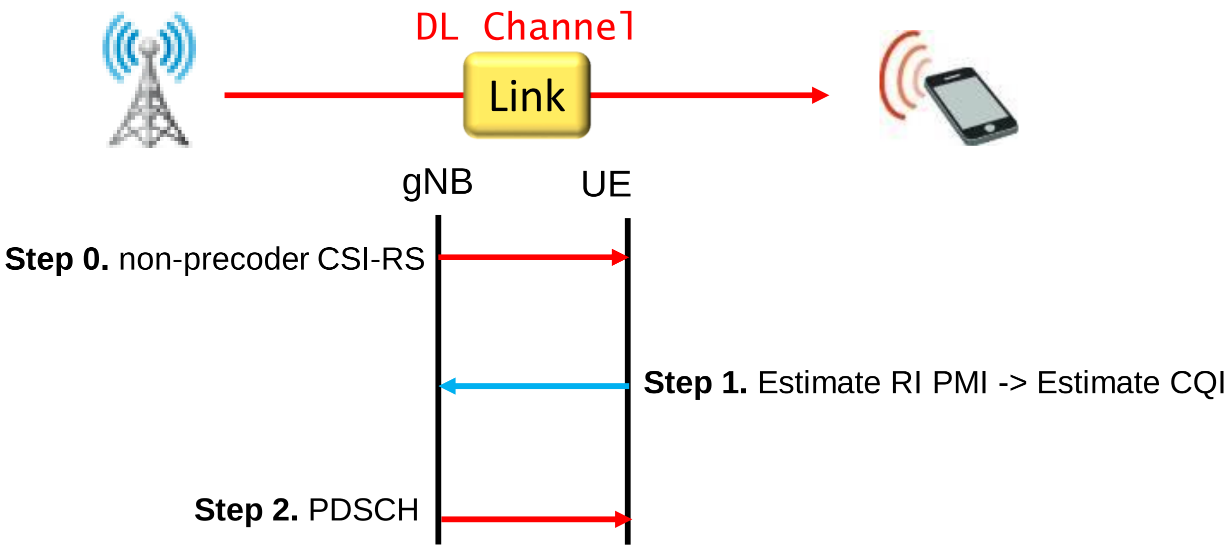
12.1 Channel-State Reporting(3/3)



12.1.1 Periodic CSI reporting



12.1.1 Periodic CSI reporting(1/5)

- 現行5G NR的CSI為每5ms估算一次
- CSI feedback delay為6ms，估算後6ms開始使用
- 而TDD與FDD會發生不一樣的狀況
  - TDD在不同時間下，會有不同的傳輸方向(上/下行)，因此會造成CSI延遲的情況
  - 例如，當要估算UL的CSI時，卻有DL傳輸在進行時，此時就不能夠做UL的CSI估算，要等到下一次UL時才能做估算。(CSI feedback delay 也是如此)
  - 而FDD無此問題

Uplink-downlink configuration	Downlink-to-Uplink Switch-point periodicity	Subframe number									
		0	1	2	3	4	5	6	7	8	9
0	5 ms	D	S	U	U	U	D	S	U	U	U
1	5 ms	D	S	U	U	D	D	S	U	U	D
2	5 ms	D	S	U	D	D	D	S	U	D	D
3	10 ms	D	S	U	U	U	D	D	D	D	D
4	10 ms	D	S	U	U	D	D	D	D	D	D
5	10 ms	D	S	U	D	D	D	D	D	D	D
6	5 ms	D	S	U	U	U	D	S	U	U	D

[1] 3GPP 36.211 Table4.2-2 Uplink downlink configurations

12.1.1 Periodic CSI reporting(2/5)

- TDD在不同時間下，會有不同的傳輸方向(上/下行)，因此會造成CSI延遲的情況
- 例如，當UL要算CSI時，卻在做DL傳輸，此時就不能夠做UL的CSI估算，要等到下一次UL時才能做估算。(CSI feedback delay 也是如此)
- 而FDD無此問題

Uplink-downlink configuration	Downlink-to-Uplink Switch-point periodicity	Subframe number									
		0	1	2	3	4	5	6	7	8	9
0	5 ms	D	S	U	U	U	D	S	U	U	U
1	5 ms	D	S	U	U	D	D	S	U	U	D
2	5 ms	D	S	U	D	D	D	S	U	D	D
3	10 ms	D	S	U	U	U	D	D	D	D	D
4	10 ms	D	S	U	U	D	D	D	D	D	D
5	10 ms	D	S	U	D	D	D	D	D	D	D
6	5 ms	D	S	U	U	U	D	S	U	U	D

[1] 3GPP 36.211 Table4.2-2 Uplink downlink configurations

12.1.1 Periodic CSI reporting(3/5)

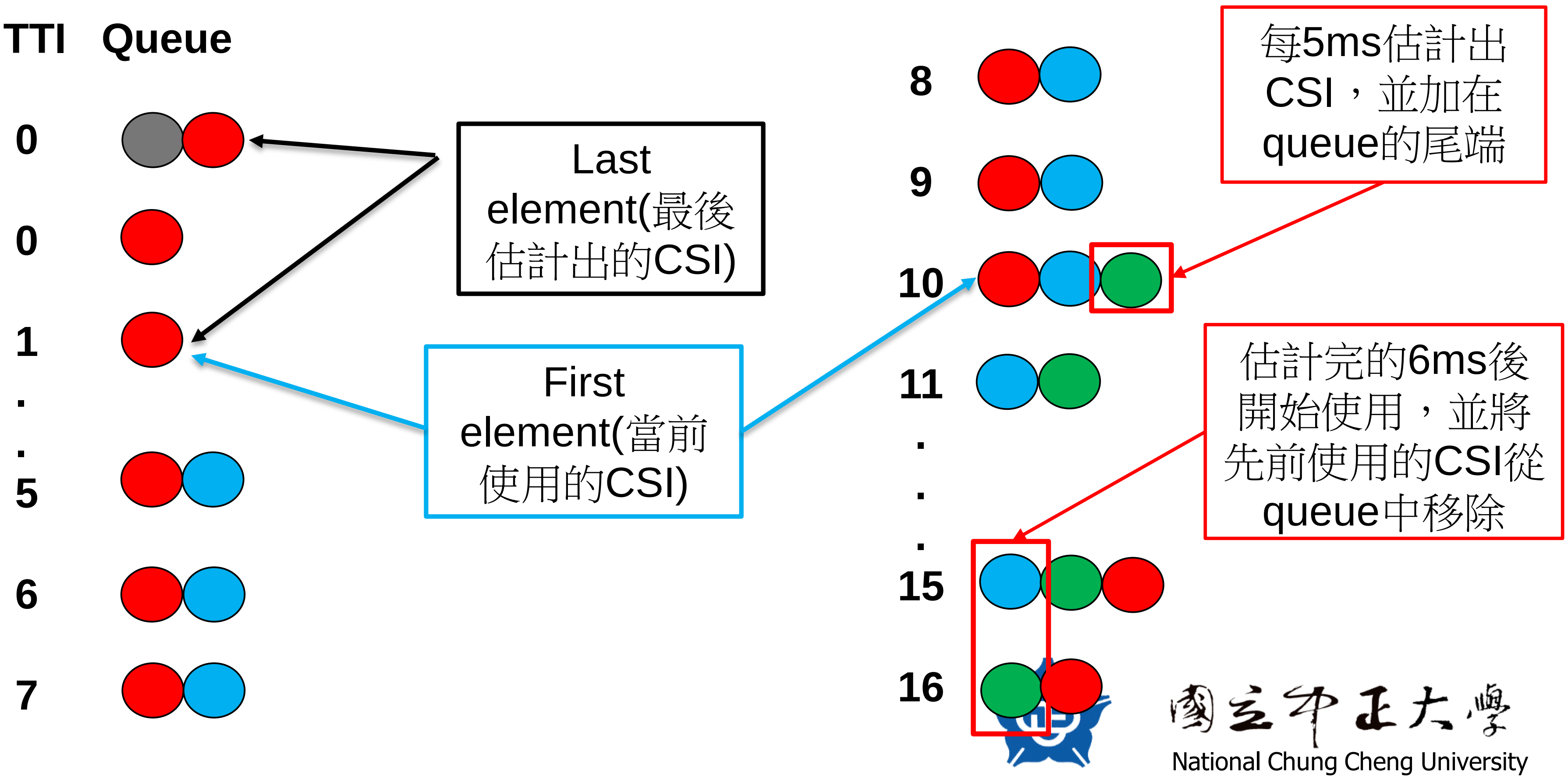
- 目前WiSE利用queue來處理CSI
- 給定queue的初始值，將最新估計出的CSI值加進queue的最尾端(enqueue)，當CSI feedback delay到了時，將當前queue最前端的值移除(dequeue)，開始使用6ms前估計出的值。

12.1.1 Periodic CSI reporting(4/5)

- For FDD

For CSI Feedback Delay = 6
CSI periodicity = 5

Enqueue: TTI 0, 5,10, 15……
Dequeue: TTI 0, 11, 16, 21, 26….



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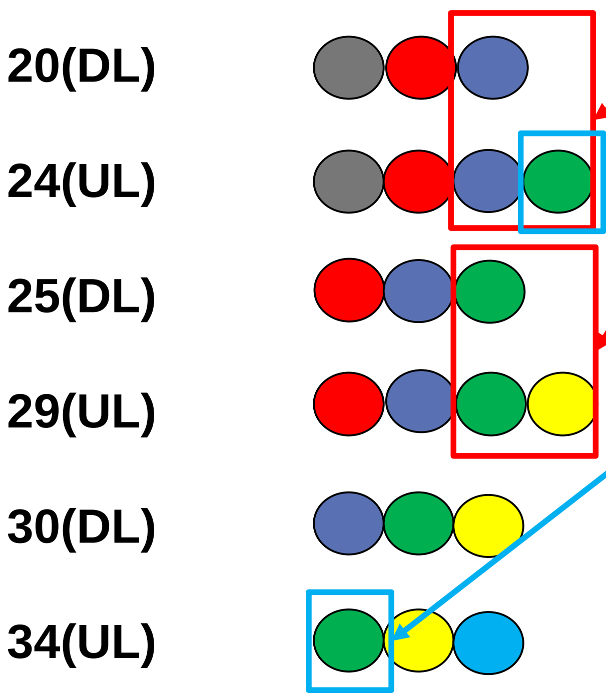
12.1.1 Periodic CSI reporting(5/5)

- For TDD UL

Configuration : DDDSU

For CSI Feedback Delay = 6
CSI periodicity = 5

TTI(DL/UL) **UL Queue**



原本CSI為每5ms 估計一次，也就是0, 5, 10, 15…的時候估計，但是此時在做DL傳輸，無法做UL CSI估計，因此改為下一個UL時再估計

CSI估計出來後6ms開始使用，但是30(24+6)ms時在做DL傳輸，所以改為下一個UL(34)時開始使用

在此一TDD configuration下，每一個UL都會做CSI估計(enqueue)，以及使用新的CSI (dequeue)

Outline

12.2 RI(Rank Indicator)

- Rank indication (RI), providing a recommendation on the number of layers that should preferably be used for downlink transmission to the terminal.
- RI only needs to be reported by terminals that are configured to be in one of the **spatial-multiplexing** transmission modes.
- RI Estimation
  - Using the different number of the transmission rank(layer) cause the different capacities
    - The higher number of the transmission rank(layer) is, the larger ILI(inter-layer interference) is.
    - The higher number of the transmission rank(layer) is, the lower receive power is.
    - The higher number of the transmission rank(layer) is, the more amount of the transmission is.
  - The capacity of a MIMO channel can be written as

$$C = log_2\{\det[I_n + SINR \cdot (HH^H)]\}$$

  - WiSE SLS estimates the capacity of different RI and chooses the best capacity's RI for transmission.

Outline

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12.3.3 Grid of beam map and beam group

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12.4 CQI

12.4.1 Subband CQI

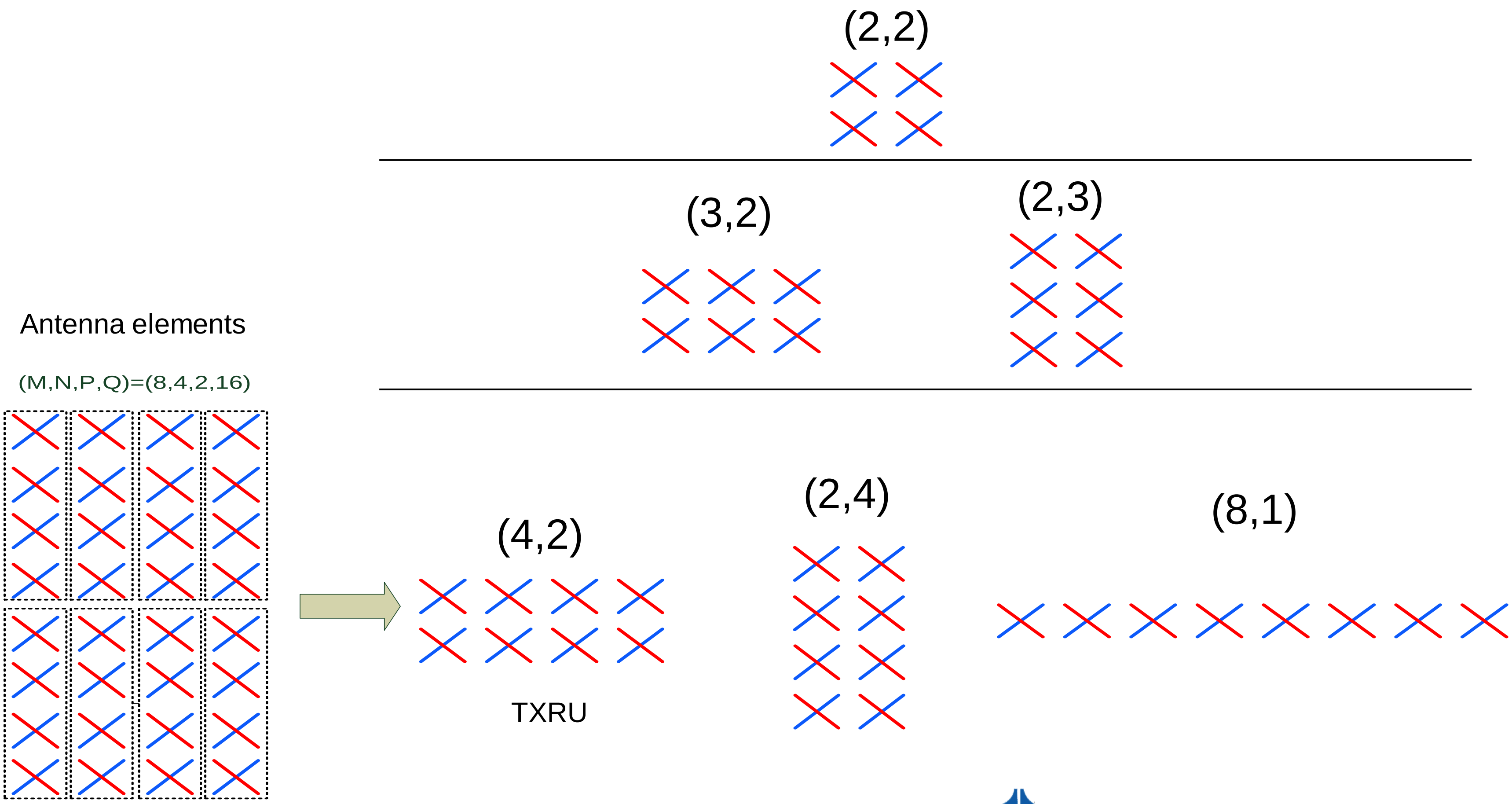
12.4.2 CQI Estimation

12.3 Codebook & PMI

- PMI
  - Indicating which of the **precoder matrices should preferably be used**.
  - The reported precoder matrix is determined assuming the number of layers indicated by the RI.

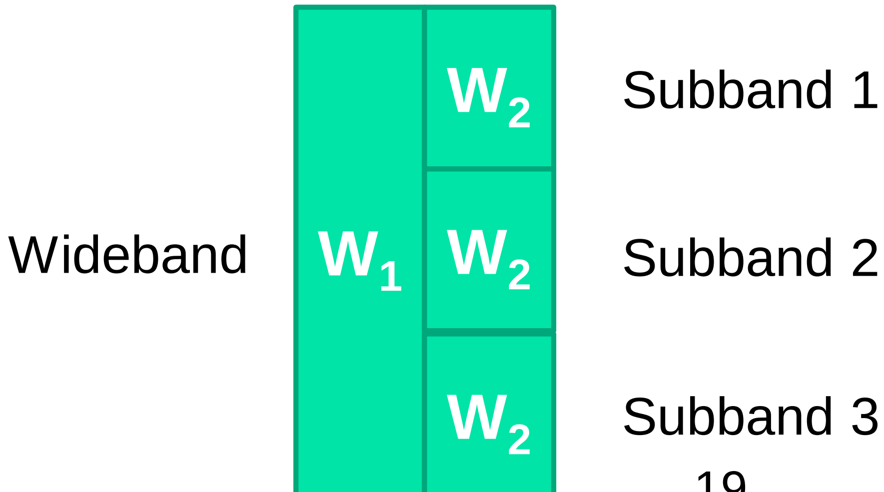
12.3.1 Hierarchical Codebook Structure(1/3)

- Antenna Configurations



12.3.1 Hierarchical Codebook(2/3)

- In real deployment, it is impossible to have a constant codebook that is optimized for all antenna configurations.
- Hierarchical structure codebook
  - A precoding matrix $\boldsymbol{W}$ in the codebook is represented as:
$$\boldsymbol{W} = \boldsymbol{W}_1\boldsymbol{W}_2$$
  - The first matrix $\mathbf{W_1}$ targets wideband and long-term channel properties.
  - The second matrix $\mathbf{W_2}$ targets frequency-selective and short-term channel properties.
  - Precoder matrix index (PMI) $\mathbf{i_1}$ is used to select W_1 matrix.
  - PMI $\mathbf{i_2}$ is used to select W_2 matrix.



12.3.1 Hierarchical Codebook(3/3)

- The values of N_1 and N_2 are configured with the higher-layer parameter codebookConfig-N1 and codebookConfig-N2.
- The values of O_1 and O_2 are configured with the higher-layer parameter codebook-Over-Sampling-RateConfig-O1 and codebook-Over-Sampling-RateConfig-O2.
- The supported configurations of (N_1,N_2) and (O_1,O_2) for a given number of CSI-RS ports are given in Table. The number of CSI-RS ports, P, is $2N_1N_2$.

Number of CSI-RS antenna ports, *P*	(N_1,N_2)	(O_1,O_2)
8	(2,2)	(4,4), (8,8)
12	(2,3)	(8,4), (8,8)
	(3,2)	(8,4), (4,4)
16	(2,4)	(8,4), (8,8)
	(4,2)	(8,4), (4,4)
	(8,1)	(4,-), (8,-)
20	(2,5)	(8,4)
	(5,2)	(4,4)
	(10,1)	(4,-)
24	(2,6)	(8,4)
	(3,4)	(8,4)
	(4,3)	(4,4)
	(6,2)	(4,4)
	(12,1)	(4,-)
28	(2,7)	(8,4)
	(7,2)	(4,4)
	(14,1)	(4,-)
32	(2,8)	(8,4)
	(4,4)	(8,4)
	(8,2)	(4,4)
	(16,1)	(4,-)

12.3.2 Long-term Codebook W_1 of Rel-13

$$\boldsymbol{W}_1 = \begin{pmatrix} \boldsymbol{X}_1 \otimes \boldsymbol{X}_2 & \boldsymbol{0} \\ \boldsymbol{0} & \boldsymbol{X}_1 \otimes \boldsymbol{X}_2 \end{pmatrix}_{2N_1N_2 \times 2L_1L_2}$$

Kronecker product

$$\mathbf{A} \otimes \mathbf{B} = \begin{bmatrix} a_{11}\mathbf{B} & \cdots & a_{1n}\mathbf{B} \\ \vdots & \ddots & \vdots \\ a_{m1}\mathbf{B} & \cdots & a_{mn}\mathbf{B} \end{bmatrix}$$

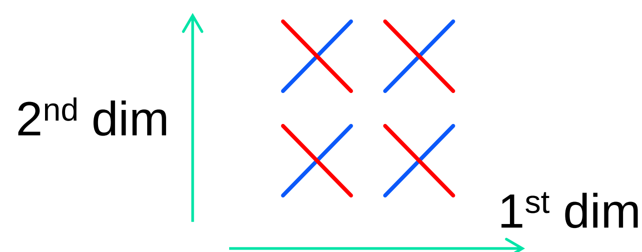
- $\boldsymbol{X}_1$ is a N_1xL_1 matrix with L_1 column vectors being an O_1x oversampled DFT vector of length N_1:

$$\boldsymbol{v}_l = \begin{bmatrix} 1 & e^{\frac{j2\pi l}{N_1 O_1}} & \ldots & e^{\frac{j2\pi (N_1-1) l}{N_1 O_1}} \end{bmatrix}^t = \begin{bmatrix} 1 & e^{\frac{j2\pi l}{16}} \end{bmatrix}^t$$

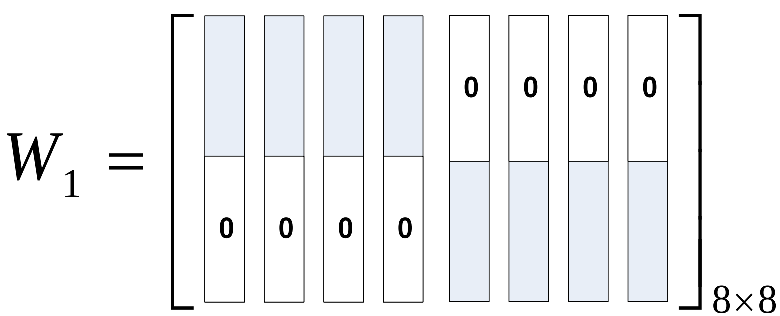
- $\boldsymbol{X}_2$ is a N_2xL_2 matrix with L_2 column vectors being an O_2x oversampled DFT vector of length N_2:

$$\boldsymbol{v}_m = \begin{bmatrix} 1 & e^{\frac{j2\pi m}{N_2 O_2}} & \ldots & e^{\frac{j2\pi (N_2-1) m}{N_2 O_2}} \end{bmatrix}^t = \begin{bmatrix} 1 & e^{\frac{j2\pi m}{16}} \end{bmatrix}^t$$

- N_1 and N_2 are the numbers of antenna ports per pol in 1^{st} and 2^{nd} dim.(N_1 =2and N_2=2)



One Beam group contains 4 beams (L_1L_2=4)



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12.3.2 Short-term Feedback W_2 of Rel-13

- Short-term codebook W2 is designed with dynamic column selection for different antenna polarizations and co-phasing φ^p among selected beams.
- W_2 can be represented as:

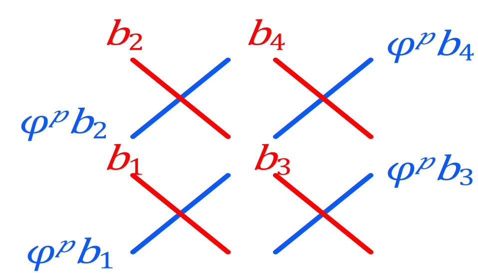
co-phasing term

$$\text{Rank1: } \boldsymbol{W}_2 = \frac{1}{\sqrt{N_1 N_2}} \begin{bmatrix} e^n \\ \varphi^p e^n \end{bmatrix} \qquad \varphi^p = e^{\frac{j2\pi p}{2}}$$

- where e^n denotes beam selection vector which is the n column of identity matrix $\mathbf{I}_{N_1 N_2}$

Select 2nd beam

$$W_1 W_2 = \begin{bmatrix} a_1 & b_1 & c_1 & d_1 & 0 & 0 & 0 & 0 \\ a_2 & b_2 & c_2 & d_2 & 0 & 0 & 0 & 0 \\ a_3 & b_3 & c_3 & d_3 & 0 & 0 & 0 & 0 \\ a_4 & b_4 & c_4 & d_4 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & a_1 & b_1 & c_1 & d_1 \\ 0 & 0 & 0 & 0 & a_2 & b_2 & c_2 & d_2 \\ 0 & 0 & 0 & 0 & a_3 & b_3 & c_3 & d_3 \\ 0 & 0 & 0 & 0 & a_4 & b_4 & c_4 & d_4 \end{bmatrix} \begin{bmatrix} 0 \\ 1 \\ 0 \\ 0 \\ \varphi^p\, 0 \\ \varphi^p\, 1 \\ \varphi^p\, 0 \\ \varphi^p\, 0 \end{bmatrix} = \begin{bmatrix} b_1 \\ b_2 \\ b_3 \\ b_4 \\ \varphi^p b_1 \\ \varphi^p b_2 \\ \varphi^p b_3 \\ \varphi^p b_4 \end{bmatrix}$$



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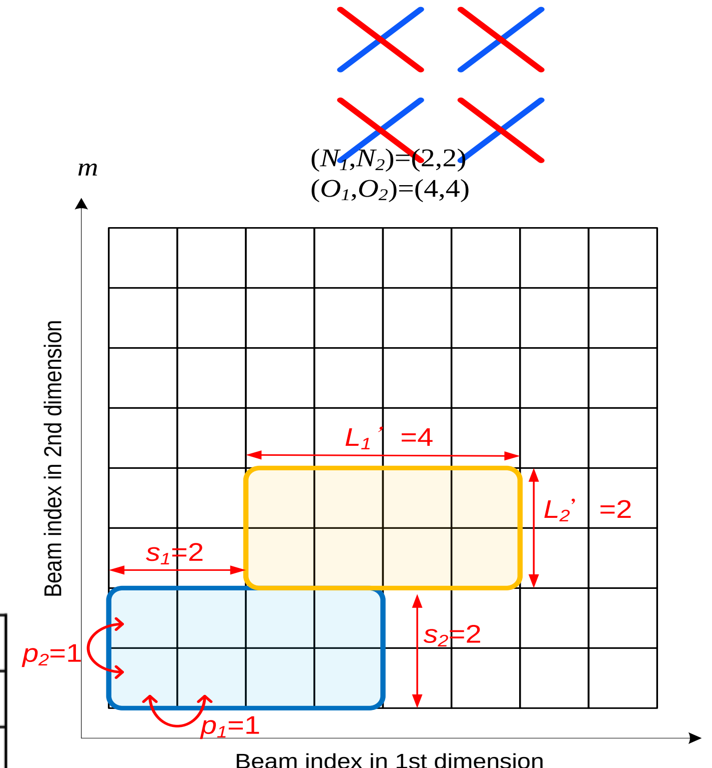
12.3.3 Grid of Beam Map and Beam group

- There are $N_d O_d$ beams in the d^{th} dimension
- Beam group index: i_{11}, i_{12}
  - i_{11} indicates beam group index in the 1st dim.
  - i_{12} indicates beam group index in the 2nd dim.
- For rank1 and rank 2
- $i_{11} = 0 \ldots \frac{N_1 O_1}{s_1} - 1$
- $i_{12} = 0 \ldots \frac{N_2 O_2}{s_2} - 1$

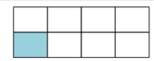
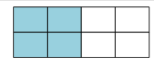
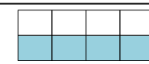


$(i_{11}, i_{12})=(0,0)$

Parameter per dimension (d = 1, 2)	Remark
N_d	Numbers of TXRU per polarization
O_d	Oversampling factors
s_d	Beam group spacing
L_d	Number of beams in each beam group
p_d	Beam spacing (Difference of two adjacent beam indices in each beam group)

12.3.4 LTEFD MIMO ClassA Precoder

- Config1~Congfig4
- Rank1~Rank4
- 3GPP 36.213

Config	Beam group
1	
2	
3	
4	

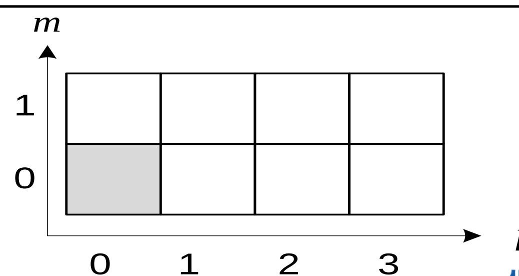
Value of *Codebook-Config*	$i_{1,1}$	$i_{1,2}$	i_2			
			0	**1**	**2**	**3**
1	$0,1,\cdots,O_1N_1-1$	$0,1,\cdots,O_2N_2-1$	$W^{(1)}_{i_{1,1},i_{1,2},0}$	$W^{(1)}_{i_{1,1},i_{1,2},1}$	$W^{(1)}_{i_{1,1},i_{1,2},2}$	$W^{(1)}_{i_{1,1},i_{1,2},3}$
where $W^{(1)}_{l,m,n}=\frac{1}{\sqrt{P}}\begin{bmatrix}v_{l,m}\\ \varphi_n v_{l,m}\end{bmatrix}$						

$$\varphi_n = e^{j\pi n/2}$$

$$v_l = \begin{bmatrix}1 & e^{j\frac{2\pi l}{O_1N_1}} & \ldots & e^{j\frac{2\pi l(N_1-1)}{O_1N_1}}\end{bmatrix}$$

$$u_m = \begin{bmatrix}1 & e^{j\frac{2\pi m}{O_2N_2}} & \ldots & e^{j\frac{2\pi m(N_2-1)}{O_2N_2}}\end{bmatrix}$$

$$v_{l,m} = v_l \otimes u_m = \begin{bmatrix}u_m & e^{j\frac{2\pi l}{O_1N_1}}u_m & \ldots & e^{j\frac{2\pi l(N_1-1)}{O_1N_1}}u_m\end{bmatrix}^T$$



l : Horizontal beam index
m : Vertical beam index

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12.3.4 LTEFD MIMO ClassA Precoder - Config1, Rank 1

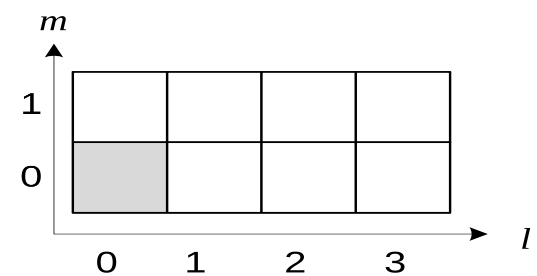
Value of *Codebook-Config*	$i_{1,1}$	$i_{1,2}$	i_2			
			0	**1**	**2**	**3**
1	$0,1,\cdots,O_1N_1-1$	$0,1,\cdots,O_2N_2-1$	$W^{(1)}_{i_{1,1},i_{1,2},0}$	$W^{(1)}_{i_{1,1},i_{1,2},1}$	$W^{(1)}_{i_{1,1},i_{1,2},2}$	$W^{(1)}_{i_{1,1},i_{1,2},3}$
where $W^{(1)}_{l,m,n}=\frac{1}{\sqrt{P}}\begin{bmatrix} v_{l,m} \\ \varphi_n v_{l,m}\end{bmatrix}$						

$$\varphi_n = e^{j\pi n/2}$$

$$v_l = \begin{bmatrix} 1 & e^{j\frac{2\pi l}{O_1N_1}} & \ldots & e^{j\frac{2\pi l(N_1-1)}{O_1N_1}} \end{bmatrix}$$

$$u_m = \begin{bmatrix} 1 & e^{j\frac{2\pi m}{O_2N_2}} & \ldots & e^{j\frac{2\pi m(N_2-1)}{O_2N_2}} \end{bmatrix}$$

$$v_{l,m} = v_l \otimes u_m = \begin{bmatrix} u_m & e^{j\frac{2\pi l}{O_1N_1}}u_m & \ldots & e^{j\frac{2\pi l(N_1-1)}{O_1N_1}}u_m \end{bmatrix}^T$$



12.3.4 LTEFD MIMO ClassA Precoder - Config1, Rank 2

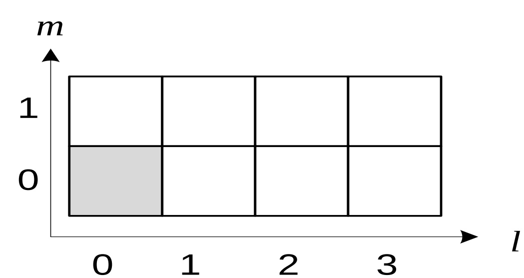
2 Layers, Codebook-Config = 1				
$i_{1,2}=0,\cdots,N_2O_2-1$				
$i_{1,1}$	i_2			
	0	**1**	**2**	**3**
$0,\cdots,N_1O-1$	$W^{(2)}_{i_{1,1},i_{1,1},i_{1,2},i_{1,2},0}$	$W^{(2)}_{i_{1,1},i_{1,1},i_{1,2},i_{1,2},1}$	$W^{(2)}_{i_{1,1},i_{1,1},i_{1,2},i_{1,2},2}$	$W^{(2)}_{i_{1,1},i_{1,1},i_{1,2},i_{1,2},3}$
where $W^{(2)}_{l,l',m,m',n}=\frac{1}{\sqrt{2P}}\begin{bmatrix} v_{l,m} & v_{l',m'} \\ \varphi_n v_{l,m} & -\varphi_n v_{l',m'} \end{bmatrix}$.				

$$\varphi_n = e^{j\pi n/2}$$

$$v_l = \begin{bmatrix} 1 & e^{j\frac{2\pi l}{O_1N_1}} & \dots & e^{j\frac{2\pi l(N_1-1)}{O_1N_1}} \end{bmatrix}$$

$$u_m = \begin{bmatrix} 1 & e^{j\frac{2\pi m}{O_2N_2}} & \dots & e^{j\frac{2\pi m(N_2-1)}{O_2N_2}} \end{bmatrix}$$

$$v_{l,m} = v_l \otimes u_m = \begin{bmatrix} u_m & e^{j\frac{2\pi l}{O_1N_1}}u_m & \dots & e^{j\frac{2\pi l(N_1-1)}{O_1N_1}}u_m \end{bmatrix}^T$$



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12.3.4 LTEFD MIMO ClassA Precoder - Config2, Rank 1

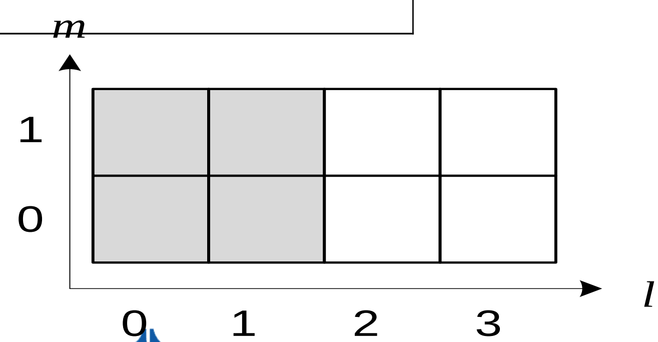
Value of *Codebook-Config*	$i_{1,1}$	$i_{1,2}$	i_2			
			0	**1**	**2**	**3**
2	$0,1,\ldots,\frac{N_1O_1}{2}-1$	$0,1,\ldots,\frac{N_2O_2}{2}-1$	$W^{(1)}_{2i_{1,1},2i_{1,2},0}$	$W^{(1)}_{2i_{1,1},2i_{1,2},1}$	$W^{(1)}_{2i_{1,1},2i_{1,2},2}$	$W^{(1)}_{2i_{1,1},2i_{1,2},3}$
Value of *Codebook-Config*	$i_{1,1}$	$i_{1,2}$	i_2			
			4	**5**	**6**	**7**
2	$0,1,\ldots,\frac{N_1O_1}{2}-1$	$0,1,\ldots,\frac{N_2O_2}{2}-1$	$W^{(1)}_{2i_{1,1}+1,2i_{1,2},0}$	$W^{(1)}_{2i_{1,1}+1,2i_{1,2},1}$	$W^{(1)}_{2i_{1,1}+1,2i_{1,2},2}$	$W^{(1)}_{2i_{1,1}+1,2i_{1,2},3}$
Value of *Codebook-Config*	$i_{1,1}$	$i_{1,2}$	i_2			
			8	**9**	**10**	**11**
2	$0,1,\ldots,\frac{N_1O_1}{2}-1$	$0,1,\ldots,\frac{N_2O_2}{2}-1$	$W^{(1)}_{2i_{1,1},2i_{1,2}+1,0}$	$W^{(1)}_{2i_{1,1},2i_{1,2}+1,1}$	$W^{(1)}_{2i_{1,1},2i_{1,2}+1,2}$	$W^{(1)}_{2i_{1,1},2i_{1,2}+1,3}$
Value of Codebook-Config	$i_{1,1}$	$i_{1,2}$	i_2			
			12	**13**	**14**	**15**
2	$0,1,\ldots,\frac{N_1O_1}{2}-1$	$0,1,\ldots,\frac{N_2O_2}{2}-1$	$W^{(1)}_{2i_{1,1}+1,2i_{1,2}+1,0}$	$W^{(1)}_{2i_{1,1}+1,2i_{1,2}+1,1}$	$W^{(1)}_{2i_{1,1}+1,2i_{1,2}+1,2}$	$W^{(1)}_{2i_{1,1}+1,2i_{1,2}+1,3}$
where $W^{(1)}_{l,m,n}=\frac{1}{\sqrt{P}}\begin{bmatrix} v_{l,m} \\ \varphi_n v_{l,m}\end{bmatrix}$						

$$\varphi_n = e^{j\pi n/2}$$

$$v_l = \begin{bmatrix} 1 & e^{j\frac{2\pi l}{O_1N_1}} & \ldots & e^{j\frac{2\pi l(N_1-1)}{O_1N_1}} \end{bmatrix}$$

$$u_m = \begin{bmatrix} 1 & e^{j\frac{2\pi m}{O_2N_2}} & \ldots & e^{j\frac{2\pi m(N_2-1)}{O_2N_2}} \end{bmatrix}$$

$$v_{l,m} = v_l \otimes u_m = \begin{bmatrix} u_m & e^{j\frac{2\pi l}{O_1N_1}}u_m & \ldots & e^{j\frac{2\pi l(N_1-1)}{O_1N_1}}u_m \end{bmatrix}^T$$



National Chung Cheng University

Outline

12.1 Channel-State Reporting

Periodic CSI reporting

12.2 RI

13.3 Codebook & PMI

12.3.1 Hierarchical codebook

12.3.2 Long-term/Short-term codebook

12.3.3 Grid of beam map and beam group

12.3.4 LTEFD MIMO ClassA Precoder

12.4 CQI

12.4.1 Subband CQI

12.4.2 CQI Estimation

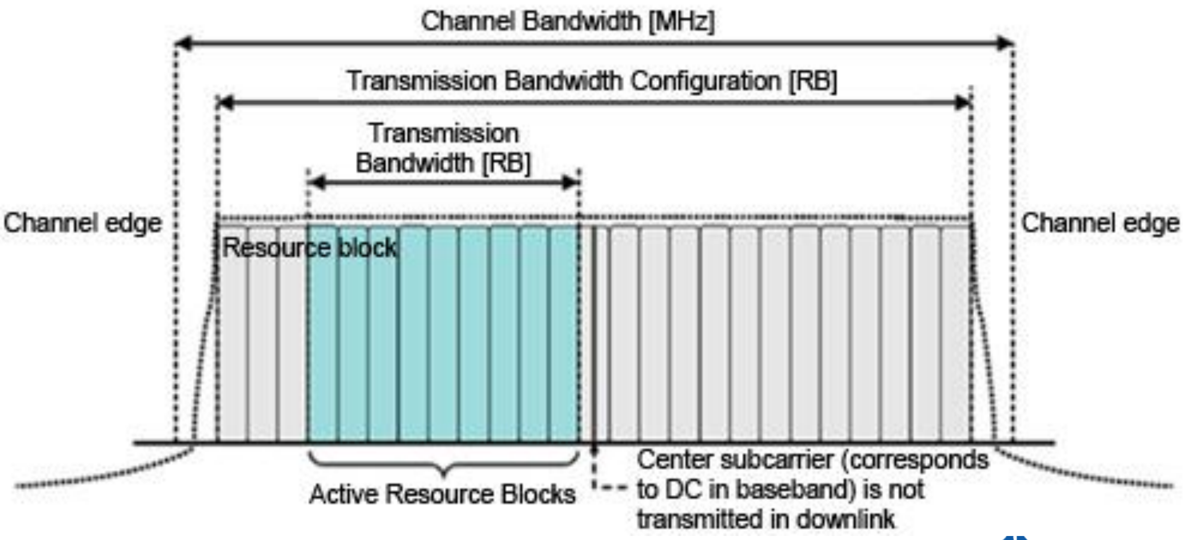
12.4 CQI

- The UEs report the CQI index to let the BS know the channel quality. If the channel quality is good, BS chooses the higher modulation order and code rate, and vice versa
- Using the recommended RI, PMI, and modulation-and-coding scheme (MCS) to make PDSCH transmissions be received with a block-error rate at most 10%.

CQI index	modulation	code rate x 1024	efficiency
0	out of range		
1	QPSK	78	0.1523
2	QPSK	120	0.2344
3	QPSK	193	0.3770
4	QPSK	308	0.6016
5	QPSK	449	0.8770
6	QPSK	602	1.1758
7	16QAM	378	1.4766
8	16QAM	490	1.9141
9	16QAM	616	2.4063
10	64QAM	466	2.7305
11	64QAM	567	3.3223
12	64QAM	666	3.9023
13	64QAM	772	4.5234
14	64QAM	873	5.1152
15	64QAM	948	5.5547

12.4.1 Subband CQI(1/5)

- The base station will allocate some Resource Blocks (RBs) to the mobile phone.
- Each RB falls on a different frequency, different RBs have different signal quality for UE
  - Some RBs have better signal quality for mobile phones, and some RBs have poor signal quality.

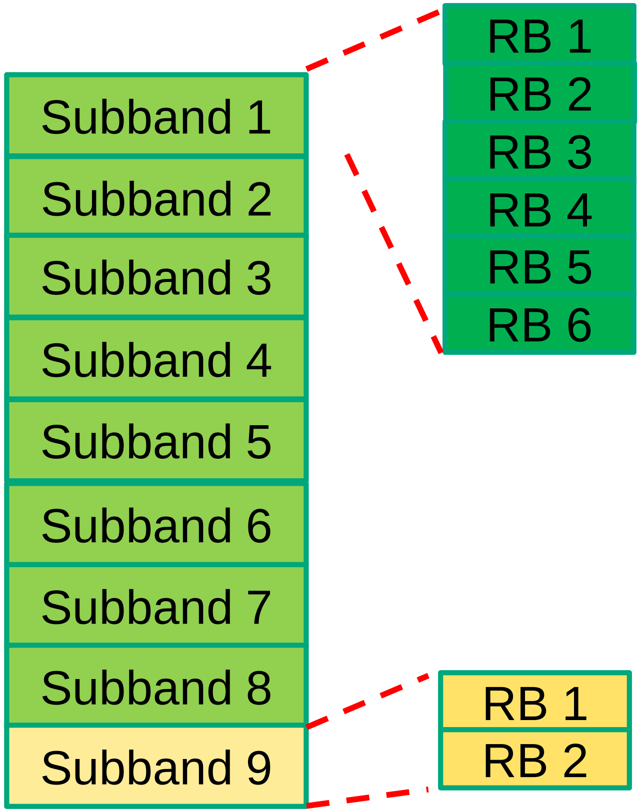


12.4.1 Subband CQI(2/5)

- How does the base station know which RB signals are better for the UE and which RB signals are not good?
  - Reported by the UE to the CQI of each RB.
- There are two types of CQI
  - Wideband CQI : UE will report the quality of the entire channel bandwidth.
  - Subband CQI : UE divides the entire channel into several subbands. Reward each channel's quality.

12.4.1 Subband CQI(3/5)

- The UE must divide the RB into several subbands, and the UE will separately report the CQI Index of these subbands.
- As a result, the base station can clearly know which part of the RB is better for the UE, and which part of the RB is relatively poor in channel quality.



Bandwidth = 10 MHz

12.4.1 Subband CQI(4/5)

- Two methods to report subband CQI
  - Higher Layer subband CQI
  - UE selected subband CQI。
- In higher layer subband CQI report, UE must report the CQI of each subband. Some subbands are better than average signal quality of the entire channel. BS will choose the better subband as the transmission resource.

12.4.1 Subband CQI(5/5)

- UE Selected Subband CQI
  - UE only needs to report the best M subband CQIs, so that the uploaded transmission resources can be saved more. Because the subbands returned are the top M subbands, their channel quality must be better than the average channel quality.

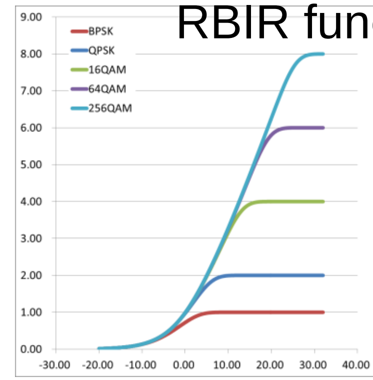
System Bandwidth N_{RB}^{DL}	Subband Size *k* (RBs)	*M*
6 – 7	NA	NA
8 – 10	2	1
11 – 26	2	3
27 – 63	3	5
64 – 110	4	6

[2] 3GPP 36.213 Table 7.2.1-5: Subband Size (*k*) and Number of Subbands (*M*) in S vs. Downlink System Bandwidth

12.4.2 CQI Estimation

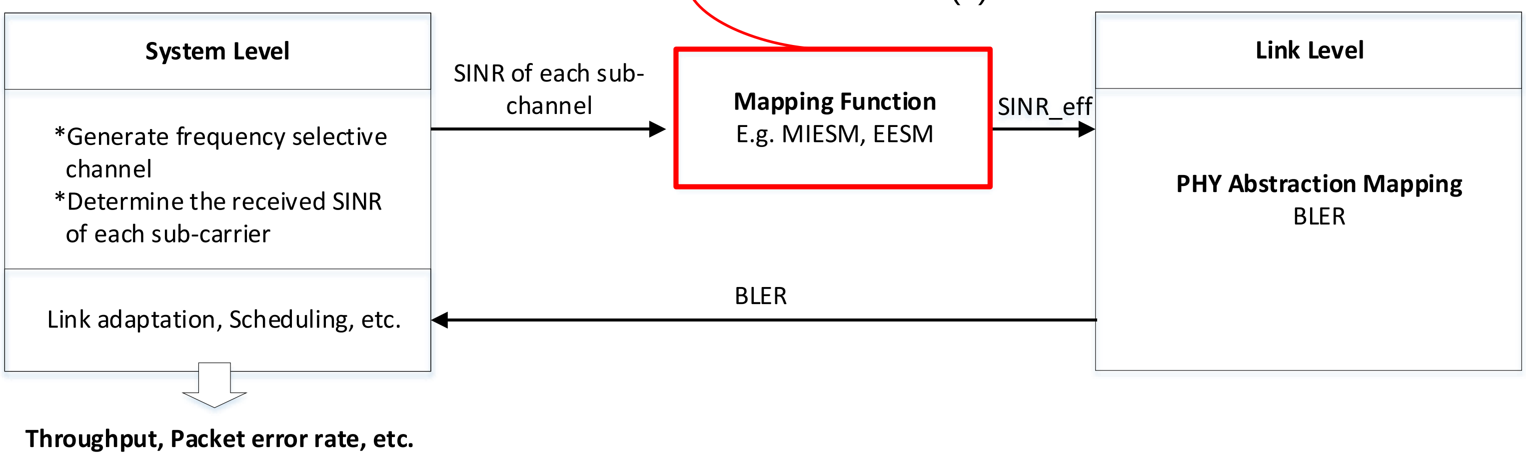
- PHY Abstraction (Link-to-System Mapping)

RBIR function



$$SINR_{eff} = RBIR^{-1}\left\{\frac{1}{K}\sum_{k=1}^{K} RBIR(SINR_k, Q)\right\}$$

RBIR(x) : stand for the information measure function



- Exponential Effective SINR Mapping (EESM)
- Mutual Information Effective SINR Mapping (MIESM)

參考資料

[1] 3GPP TS 36.211 V13.2.0 (2016-06), 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation (Release 13)

[2] 3GPP TS 36.213 V15.6.0 (2019-06), 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer procedures(Release 15)

Thank you