

Rohde&Schwarz Korea Technical Seminar

TS38.521-4 RF CONFORMANCE TEST SPEC OVERVIEW

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ROHDE & SCHWARZ

Make ideas real



COMPANY RESTRICTED

AGENDA





TS38.521-4 Test Specification Overview

GENERAL INFORMATION

COMPANY RESTRICTED

3GPP SPECIFICATION DOCUMENT

Spec. number	Description (NR; User Equipment (UE) conformance specification)
TS 38.521-1	Radio transmission and reception; Part 1: Range 1 standalone
TS 38.521-2	Radio transmission and reception; Part 2: Range 2 standalone
TS 38.521-3	Radio transmission and reception; Part 3: Range 1 and Range 2 Interworking operation with other radios
TS 38.521-4	Radio transmission and reception; Part 4: Performance
TS 38.521-5	Radio transmission and reception; Part 5: Satellite access Radio Frequency (RF) and performance (Draft)
TS 38.533	Applicability of radio transmission, Radio reception and Radio Resource Management test cases (RRM)

PERFORMANCE TEST?

▶ LTE Specification 과 비교

RAT	Specification	Test condition	Chapter	Test Description
LTE	TS36.521-1	Conducted	8	Demodulation Performance requirement
			9	CSI Reporting requirement
NR	TS38.521-4	Conducted	5	Demodulation Performance requirement
			6	CSI Reporting requirement
		Radiated	7	Demodulation Performance requirement
			8	CSI Reporting requirement
		Interworking	9	Demodulation Performance requirement
			10	CSI Reporting requirement

MINIMUM REQUIREMENT & TEST REQUIREMENT



Minimum Requirement (e,q : Rx throughput > 95%)

+ MU, TT ??



Test Requirement (e,q : Rx throughput > 93.x%)

MU, TT

▶ 한글로 표현해보면?

Test Tolerance (TT)	Measurement Uncertainty (MU)
허용 오차, 결과 편차	측정 불확도

Table 5.2.2.1.2-3: Minimum performance for Rank 2

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-5.1 FDD	10 / 15	16QAM, 0.48	TDLC300-100	2x2, ULA Low	70	14.8

Table 5.2.2.1.2_1.4-1: Test Requirements for Rank 2

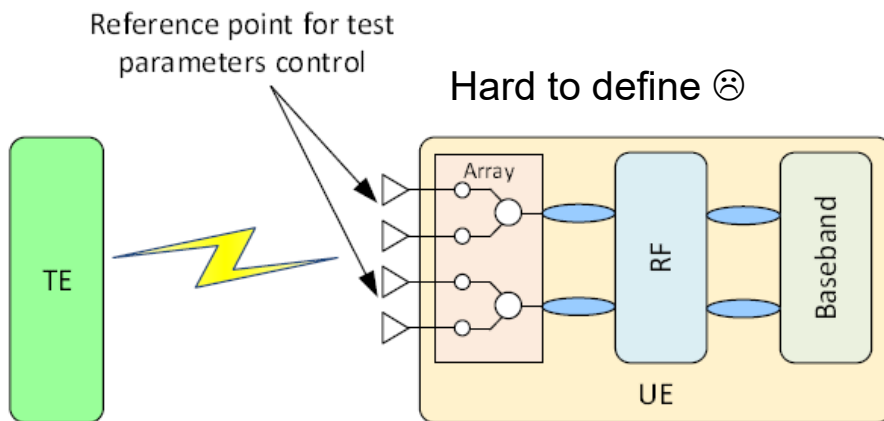
Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-5.1 FDD	10 / 15	16QAM, 0.48	TDLC300-100	2x2, ULA Low	70	15.7

MU : +/-0.9dB

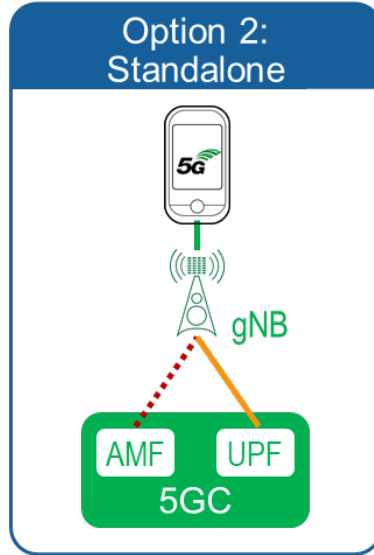
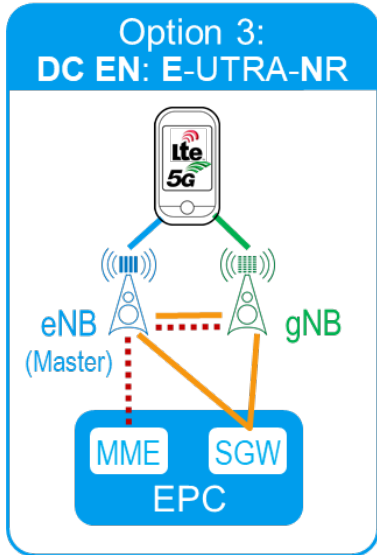
TEST MODE

- ▶ Mode 1: Condition with external noise source
- ▶ Mode 2: Noise free condition

$$SNR = \frac{\sum_{j=1}^{N_{RX}} E_s^{(j)}}{\sum_{j=1}^{N_{RX}} N_{oc}^{(j)}}$$



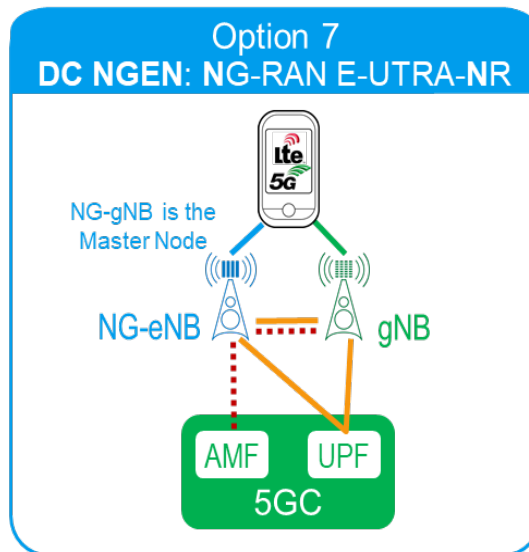
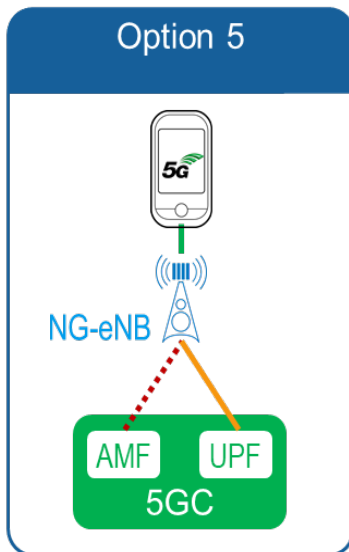
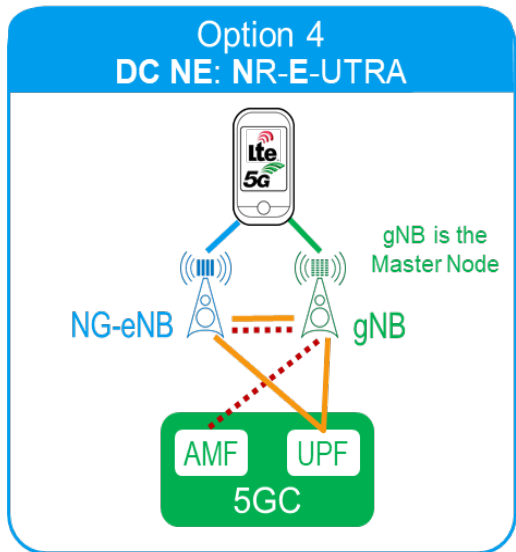
TEST COVERAGE ACROSS 5G NR CONNECTIVITY OPTIONS



— Data

..... Control

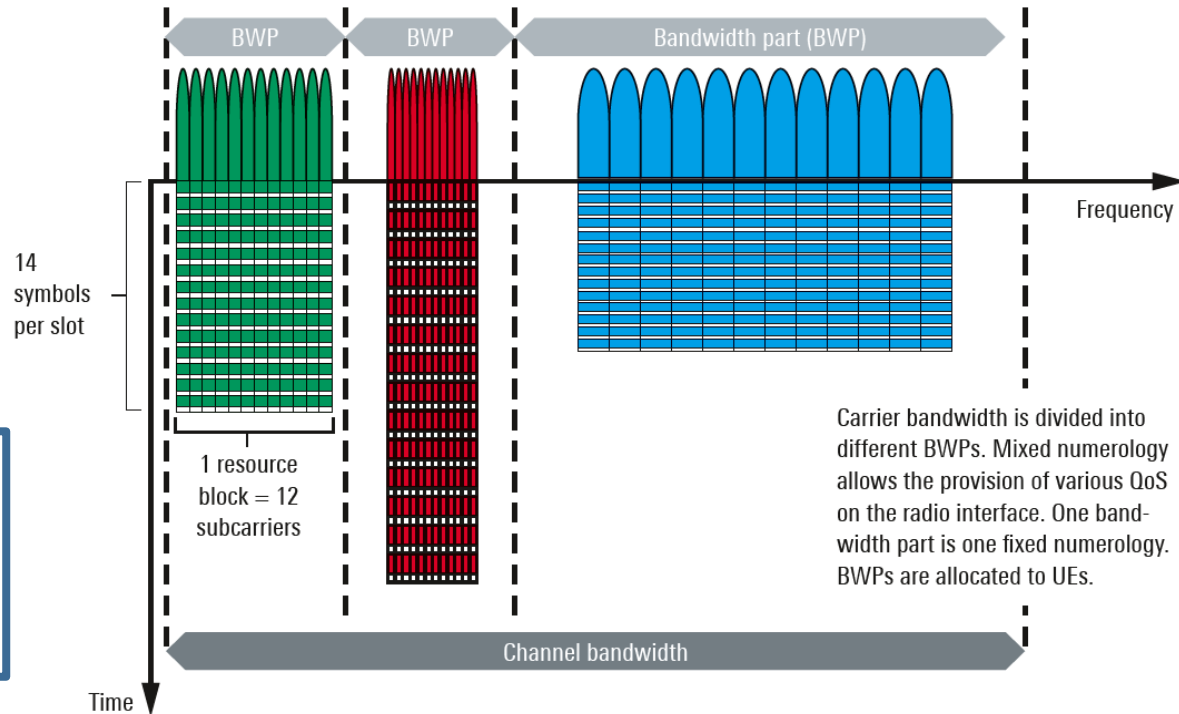
TEST COVERAGE ACROSS 5G NR CONNECTIVITY OPTIONS



5G NR F-OFDMA FEATURES FLEXIBLE NUMEROLOGIE

Subcarrier spacing (kHz)	15	30	60	120	240
Symbol duration (μ s)	66.7	33.3	16.7	8.33	4.17
CP duration (μ s)	4.7	2.3	1.2 (normal) 4.13 (extended)	0.59	0.29
Max. nominal bandwidth (MHz)	50	100	100 for FR1 200 for FR2	400	400
Max. FFT size	4096	4096	4096	4096	4096
Symbols per slot	14	14	14 12 (extended CP)	14	14
Slots per subframe	1	2	4	8	16
Slots per frame	10	20	40	80	160

5G NR F-OFDMA FLEXIBILITY IN SPECTRUM, BWP



5G NR idea:
Channel bandwidth
Using different BWP
and numerologies to
enable QoS on layer1

5G NR FLEXIBLE AIR INTERFACE SUMMARY

Parameter	FR1 (410 MHz – 7.125 GHz)	FR2 (24.25 – 52.6 GHz)
Carrier aggregation	Up to 16 carriers	
Bandwidth per carrier	5, 10, 15, 20, 25, 30, 40, 50, 60, 80, 90, 100MHz	50, 100, 200, 400 MHz
Subcarrier spacing	15, 30, 60 kHz	60, 120, 240 (not for data) kHz
Max. number of subcarriers	3300 (FFT4096 mandatory)	
Modulation scheme	QPSK, 16QAM, 64QAM, 256QAM; uplink also supports $\pi/2$ -BPSK (only DFT-s-OFDM)	
Radio frame length	10ms	
Subframe duration	1 ms (alignment at symbol boundaries every 1 ms)	
MIMO scheme	Max. 2 codewords mapped to max 8 layers in downlink and to max 4 layers in uplink	
Duplex mode	TDD, FDD	TDD
Access scheme	DL: CP-OFDM; UL: CP-OFDM, DFT-s-OFDM	



TS38.521-4 Test Specification Overview

DEMODULATION PERFORMANCE REQUIREMENT

CHAPTER 5. CONDUCTED REQUIREMENT

- ▶ 5.1 General Information
- ▶ 5.2 PDSCH Demodulation Requirement
- ▶ 5.3 PDCCH Demodulation Requirement
- ▶ 5.4 PBCH Demodulation Requirement
- ▶ 5.5 Sustained downlink data rate (SDR)

5.1 CONDUCTED REQUIREMENT (GENERAL INFO.)

► 5G NR Physical channels



Remark, no PHICH any longer, ACK/NACK sent asynchronously

Physical downlink control channel PDCCH:
Downlink and uplink scheduling decisions

Physical downlink shared channel PDSCH:
Downlink data

Physical broadcast channel PBCH:
Providing master information block

Physical uplink shared channel PUSCH:
Uplink data + UCI optionally

Physical uplink control channel PUCCH:
ACK/NACK for downlink packets, scheduling requests, channel status info

Physical random access channel PRACH:
Initial access

Remark, no PCFICH any longer, PDCCH size by higher layer signaling



5.1 CONDUCTED REQUIREMENT (GENERAL INFO.)

- ▶ Applicability for No. of Rx Antenna port

Table 5.1.1.2-1: Requirements applicability

Supported RX antenna ports	Test type	Test list
UE supports only 2RX	PDSCH	All tests in Clause 5.2.2
	PDCCH	All tests in Clause 5.3.2
	PBCH	All tests in Clause 5.4.2
UE supports only 4RX or both 2RX and 4RX	PDSCH	All tests in Clause 5.2.3
	PDCCH	All tests in Clause 5.3.3
	PBCH	All tests in Clause 5.4.2 or 5.4.3 ^{Note 1}
Note 1: : Requirements for PBCH with 4Rx is up to UE declaration		

*5.2.1 장의 1Rx Requirement는 RedCap 관련 항목으로 아직 FFS

** 5.4 장의 PBCH test 는 TS38.521-4 v17.7 기준으로 “Do not need to be tested”

5.1 CONDUCTED REQUIREMENT (GENERAL INFO.)

► Propagation Condition (Annex. B)

- Static condition + AWGN
- Tapped Delay Line Channel model (Multi-path fading)
- E-UTRA

Model	Number of channel taps	Delay spread (r.m.s.)	Maximum excess tap delay (span)
Extended Pedestrian A (EPA)	7	45 ns	410 ns
Extended Vehicular A model (EVA)	9	357 ns	2510 ns
Extended Typical Urban model (ETU)	9	991 ns	5000 ns

– NR FR1

Model	Number of channel taps	Delay spread (r.m.s.)	Maximum excess tap delay (span)	Delay resolution
TDLA30	12	30 ns	290 ns	5 ns
TDLB100	12	100 ns	480 ns	5 ns
TDLC300	12	300 ns	2595 ns	5 ns

5.1 CONDUCTED REQUIREMENT (GENERAL INFO.)

- ▶ Propagation Condition (Annex. B)
 - High Speed Train scenario

Parameter	Value	
	HST-750	HST-1000
D_s	300 m	300 m
D_{\min}	2 m	2 m
v	300 km/h	300 km/h
f_d	750 Hz for 15 kHz SCS test	1000 Hz for 30 kHz SCS test

LTE 때와 동일

NR 에서 신규 추가

5.2 PDSCH DEMODULATION REQUIREMENT

▶ 목적: 여러 상황에 대하여 PDSCH로의 Data 전송 성능 검증

Table 5.2.2.1.1.0-1: Tests purpose

Purpose	Test index
Verify the PDSCH mapping Type A normal performance under 2 receive antenna conditions and with different channel models, MCSs and number of MIMO layers	1-1, 1-2, 1-3, 1-5, 2-1, 2-2
Verify the PDSCH mapping Type A HARQ soft combining performance under 2 receive antenna conditions.	1-4
Verify the PDSCH mapping Type A performance requirements for Enhanced Receiver Type 1 under 2 receive antenna conditions.	3-1

Table 5.2.3.1.1.0-1: Tests purpose

Purpose	Test index
Verify the PDSCH mapping Type A normal performance under 4 receive antenna conditions and with different channel models, MCSs and number of MIMO layers	1-1, 1-2, 1-3, 1-5, 2-1, 2-2, 3-1, 4-1
Verify the PDSCH mapping Type A HARQ soft combining performance under 4 receive antenna conditions.	1-4
Verify the PDSCH mapping Type A performance requirements for Enhanced Receiver Type 1 under 4 receive antenna conditions.	5-1

- 여러가지 채널 모델
- 2 또는 4 Rx 안테나
- MCS 및 MIMO layer
- HARQ soft combining
- Enhanced performance Type

* 1Rx 조건은 Void (v16.04 기준)

5.2 PDSCH DEMODULATION REQUIREMENT

► Test Condition (e.g ; TC 5.2.2.1.1 2Rx / Test 1-4)

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-1.1 FDD	10 / 15	QPSK, 0.30	TDLB100-400	2x2, ULA Low	70	-0.8
1-2	R.PDSCH.1-1.2 FDD	10 / 15	QPSK, 0.30	TDLC300-100	2x2, ULA Low	70	0.2
1-3	R.PDSCH.1-4.1 FDD	10 / 15	256QAM, 0.82	TDLA30-10	2x2, ULA Low	70	24.6
1-4	R.PDSCH.1-2.1 FDD	10 / 15	16QAM, 0.48	TDLC300-100	2x2, ULA Low	30	1.1
1-5	R.PDSCH.1-8.1 FDD	10 / 15	16QAM, 0.48	HST-750	1x2	70	6.2

▼ Parameters of Test Step 3 / 4

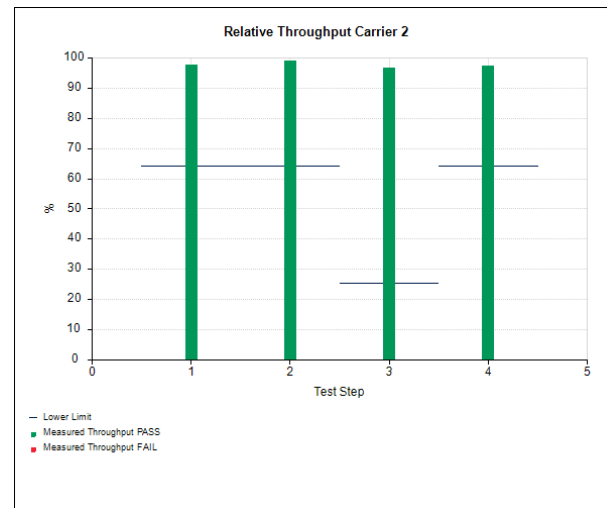
(NR) Downlink RMC ID	{R.PDSCH 1-2.1 FDD}	(NR) Signal-to-Noise Ratio (NR)	{2.00 dB}	Number of additional DMRS	1
(NR) MCS DL index	{13}	DMRS Antenna Ports Indexes	{1000}	Relative Test Requirement	30.000 %
(NR) Number of Layers	{1}	Fading Maximum Doppler Shift (NR)	{100 Hz}	Requested Downlink Power	{{Absolute, -60 dBm}, {Absolute, -62.30 dBm}}
(NR) PDSCH Modulation	{CP-OFDM 16QAM}	Fading Profile (NR)	{Tdlc300CorrelationLow}	Statistical Testing Mode	StaticTestLimit30
(NR) PDSCH Resource Block Allocation	{52}	Minimum Number of Subframes (MNSF)	22000	Test ID According to Specification	1-4

R&S CONTEST

5.2 PDSCH DEMODULATION REQUIREMENT

► Test Result (e.g ; TC 5.2.2.1.1 2Rx / Test 1-4)

▼ Throughput Measurement										
Test Step	Subframes	Samples Carrier 2 NR	ACKs Carrier 2 NR	NACKs Carrier 2 NR	DTXs Carrier 2 NR	Total Throughput Carrier 2 NR (%)	Current Throughput Carrier 2 NR (%)	Lower Limit (%)	Interim Result	
3	2000	1900	1877	23	0	98.79	98.79	25.32	Inside	
3	4000	3800	3687	113	0	97.03	95.26	25.32	Inside	
3	6000	5700	5533	167	0	97.07	97.16	25.32	Inside	
3	8000	7600	7277	323	0	95.75	91.79	25.32	Inside	
3	10000	9500	9422	78	0	99.18	112.89	25.32	Inside	
3	12000	11400	11333	67	0	99.41	100.58	25.32	Inside	
3	14000	13300	13156	144	0	98.92	95.95	25.32	Inside	
3	16000	15200	15067	133	0	99.12	100.58	25.32	Inside	
3	18000	17100	16672	428	0	97.50	84.47	25.32	Inside	
3	20000	19000	18524	476	0	97.49	97.47	25.32	Inside	
3	22000	20900	20180	720	0	96.56	87.16	25.32	Inside	



5.5 SUSTAINED DL DATA RATE (SDR)

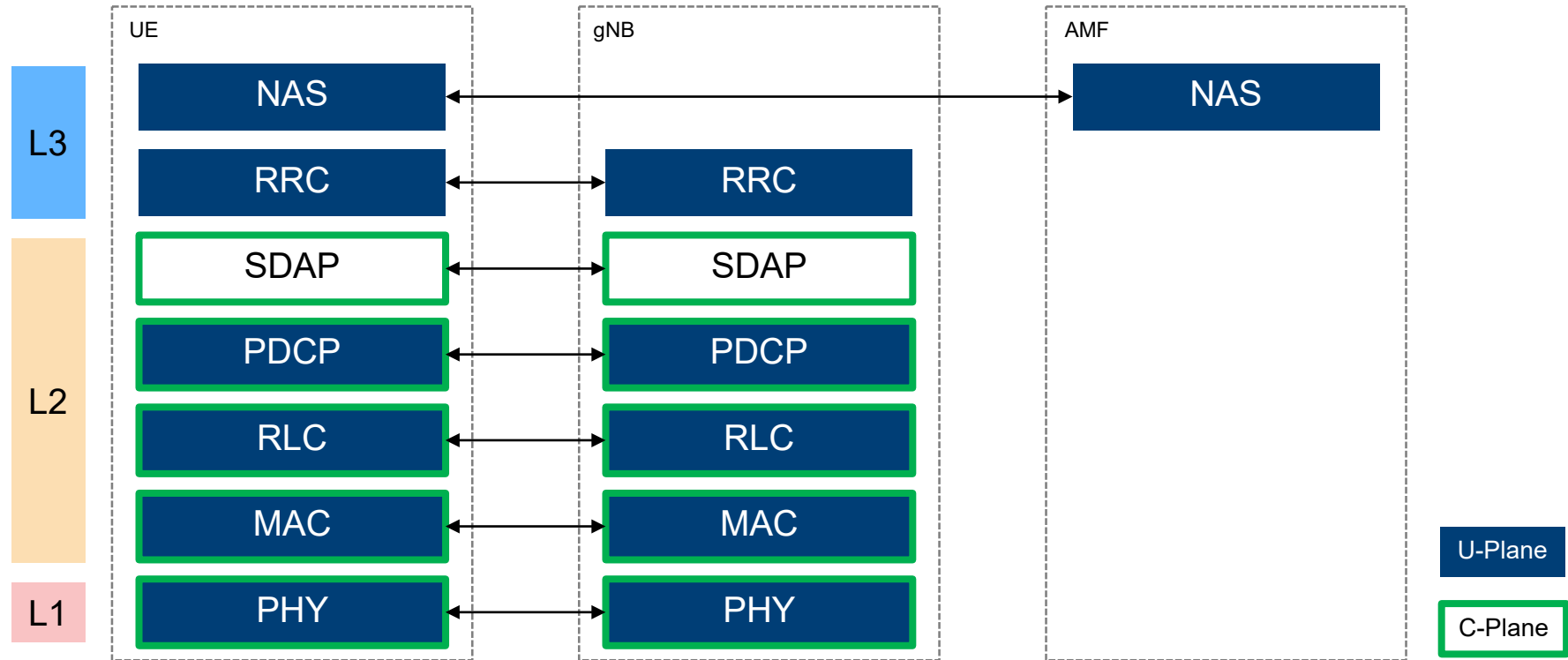
▶ 목적 : 단말이 UE Capability에 상응하는 Maximum data rate로 패킷 수신 시, Layer 1 과 Layer 2 의 지속적인 동작 과정을 모두 확인하는 것으로, Layer 1의 TB 및 Layer 2의 PDCP SDU 전송의 Success rate로 확인

▶ Minimum conformance requirements

– TB success rate = $100\% \times \frac{N_{DL_correct_rx}}{N_{DL_correct_newtx} + N_{DL_retx}} \geq 85\%$

– PDCP SDU success rate $\geq 85\%$ (sustained during at least 300 frames)

5G PROTOCOL LAYERS





TS38.521-4 Test Specification Overview

CSI REPORTING REQUIREMENT

CHAPTER 6. CONDUCTED REQUIREMENT

- ▶ 6.1 General Information
- ▶ 6.2 Reporting of Channel Quality Indicator (CQI)
- ▶ 6.3 Reporting of Precoding Matrix Indicator (PMI)
- ▶ 6.4 Reporting of Rank Indicator (RI)

6.1 CONDUCTED REQUIREMENT (GENERAL INFO.)

- ▶ Applicability for No. of Antenna port

Table 6.1.1.2-1: Requirements applicability

Supported RX antenna ports	Test type	Test list
UE supports only 2RX	CQI	All tests in Clause 6.2.2
	PMI	All tests in Clause 6.3.2
	RI	All tests in Clause 6.4.2
UE supports only 4RX or both 2RX and 4RX	CQI	All tests in Clause 6.2.3
	PMI	All tests in Clause 6.3.3
	RI	All tests in Clause 6.4.3

* 1Rx requirement 는 Rel.17 RedCap spec으로 현 시점으로 FFS. (TS38.521-1 v17.1.0 기준)

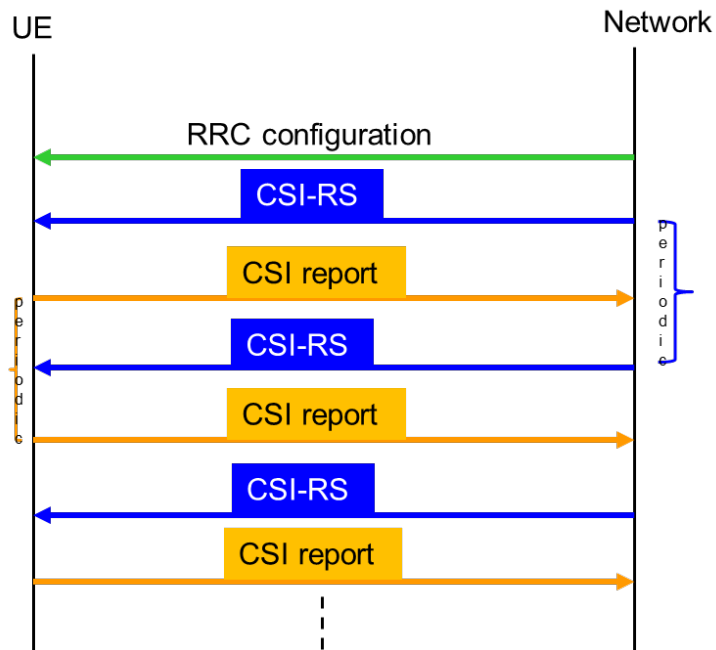
6.1 CONDUCTED REQUIREMENT (GENERAL INFO.)

- ▶ UL physical signals
 - Demodulation reference signals (**DMRS**) for PUSCH and PUCCH
 - Phase-tracking reference signals (**PTRS**) for PUSCH
 - Sounding reference signal (**SRS**)

- ▶ DL physical signals
 - Demodulation reference signals (**DMRS**) for PDSCH, PDCCH and PBCH
 - Phase-tracking reference signals (**PTRS**) for PDSCH
 - Channel-state information reference signal (**CSI-RS**)
 - Tracking reference signals (TRS)
 - Primary synchronization signal (PSS)
 - Secondary synchronization signal (SSS)

6.1 CONDUCTED REQUIREMENT (GENERAL INFO.)

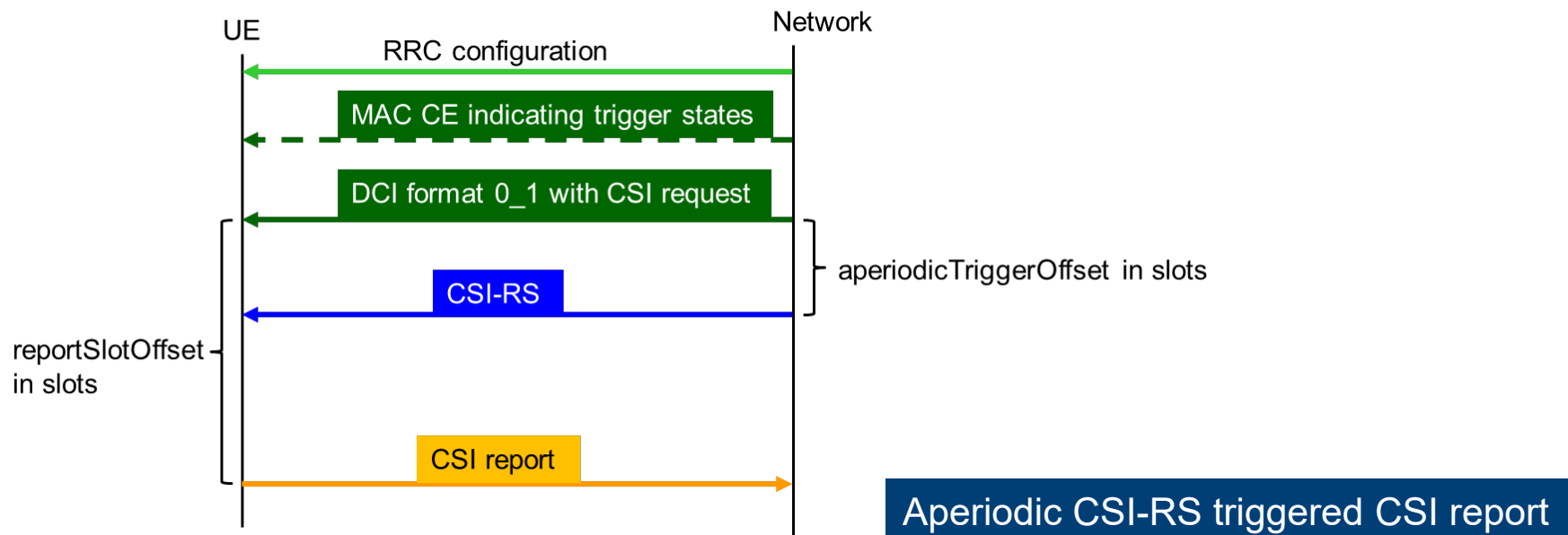
► CSI Reporting Periodic



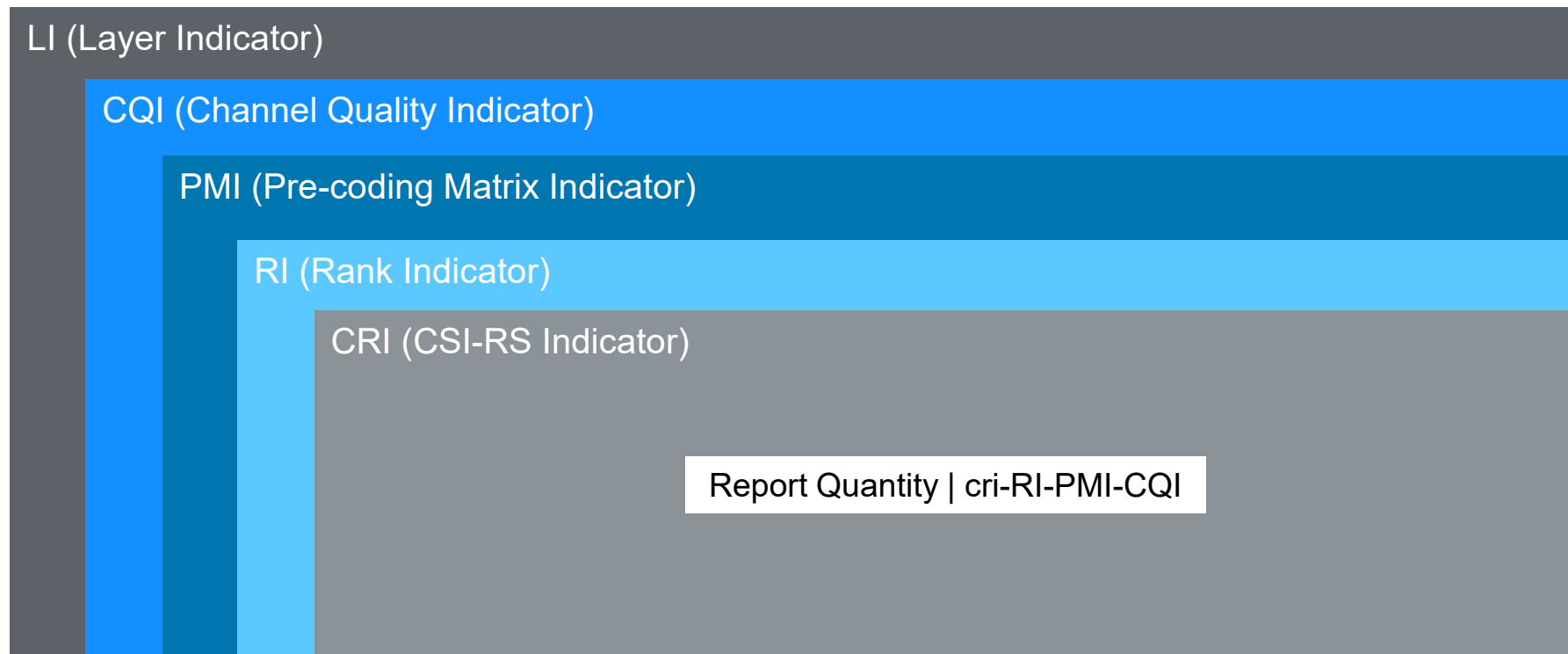
Periodic CSI-RS triggered CSI report

6.1 CONDUCTED REQUIREMENT (GENERAL INFO.)

► CSI Reporting Aperiodic



CSI (CHANNEL STATE INFORMATION)



CSI (CHANNEL STATE INFORMATION)

LI (Layer Indicator)

CQI (Channel Quality Indicator)



CSI-RS

CQI Reporting

Scheduling Information



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

CSI (CHANNEL STATE INFORMATION)

LI (Layer Indicator)

CQI (Channel Quality Indicator)

Table 5.2.2.1-5: 4-bit CQI Table 4

CQI index	modulation	code rate x 1024	efficiency
0	out of range		
1	QPSK	78	0.1523
2	QPSK	193	0.377
3	QPSK	449	0.877
4	16QAM	378	1.4766
5	16QAM	616	2.4063
6	64QAM	567	3.3223
7	64QAM	666	3.9023
8	64QAM	772	4.5234
9	64QAM	873	5.1152
10	256QAM	711	5.5547
11	256QAM	797	6.2266
12	256QAM	885	6.9141
13	256QAM	948	7.4063
14	1024QAM	853	8.3301
15	1024QAM	948	9.2578

MCS Index I_{MCS}	Modulation Order Q_m	Target code Rate $R \times [1024]$	Spectral efficiency
0	2	120	0.2344
1	2	157	0.3066
2	2	193	0.3770
3	2	251	0.4902
4	2	308	0.6016
5	2	379	0.7402
6	2	449	0.8770
7	2	526	1.0273
8	2	602	1.1758
9	2	679	1.3262
10	4	340	1.3281
11	4	378	1.4766
12	4	434	1.6953
13	4	490	1.9141
14	4	553	2.1602
15	4	616	2.4063
16	4	658	2.5703
17	6	438	2.5664
18	6	466	2.7305
19	6	517	3.0293
20	6	567	3.3223
21	6	616	3.6094
22	6	666	3.9023

6.2 REPORTING OF CQI

- ▶ 목적 : 단말의 Wideband CQI report 정확성을 확인하고, Median CQI -1~+1 범위내에서의 BLER 이 10% 이내로 동작하는지 확인

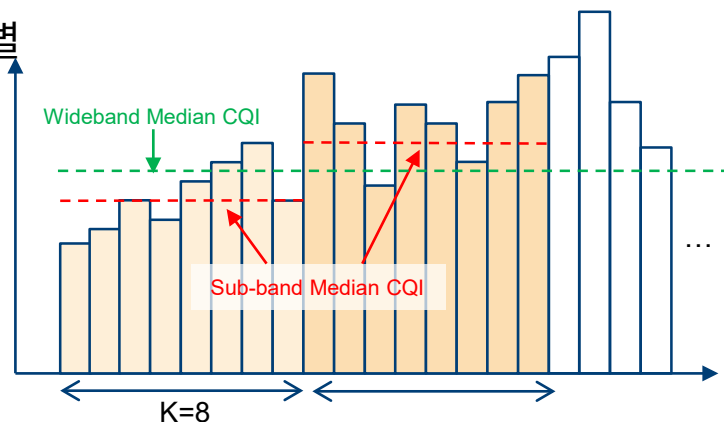
- ▶ Wideband and Sub-band

- **Median CQI**; 시험하는 대역폭 (Wideband)을 Sub-band size (k)에 따라 N 개의 Sub-band로 나누며, cqi-BitsPerSubband 에 따라 시험 항목을 구별

$$N = \left\lceil \frac{N_{RB}^{DL}}{k} \right\rceil$$

e.q)

- BW 10Mhz : $N_{RB}^{DL} = 50$
- Sub-Band size (k) = 8 RB
- $N = \left\lceil \frac{50}{8} \right\rceil = 7$

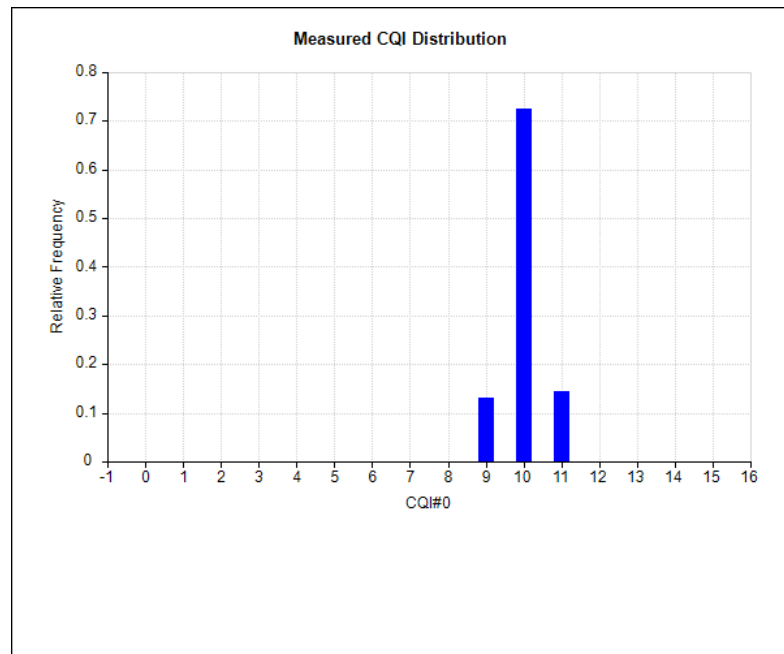


6.2 REPORTING OF CQI

- ▶ Test procedure (e.g; TC 6.2.2.1.1 2Rx FDD FR1 periodic CQI reporting under AWGN)
 - 시험할 BW, SCS에 대한 Reference channel (RMC), propagation condition, antenna 및 SNR 등을 Table 6.2.2.2.1.1.3-1에 맞춰 시뮬레이터에 의해 설정
 - 매 5ms 마다 wideband CQI report 를 수집하며, 2000개의 wideband CQI report가 수집될 때까지 연결 유지
 - 수집된 CQI report에서 Median CQI 를 계산 (50% distribution)
 - 계산된 Median CQI 를 기준으로 PDSCH 전송을 수집하며, ACK+NACK가 1000개가 될 때까지 수집하여 $NACK / (ACK+NACK) \leq 0.1$ 인지 확인
 - 결과에 따라 Median CQI+1 / Median CQI-1 에 대해 반복 확인 (90% 이상이어야 passed)

6.2 REPORTING OF CQI

► Test result (TC 6.2.2.1.1.1)



▼ Pass/Fail Analysis	
Median CQI	13
Lower Limit	2
Upper Limit	14
Result	Inside

CQI indices inside the set [MEDIAN-1...MEDIAN+1]	100.0 %
Lower Limit	90.0 %
Result	Inside

CSI (CHANNEL STATE INFORMATION)

LI (Layer Indicator)

CQI (Channel Quality Indicator)

PMI (Pre-coding Matrix Indicator)

Codebook index	Number of layers v	
	1	2
0	$\frac{1}{\sqrt{2}} \begin{bmatrix} 1 \\ 1 \end{bmatrix}$	$\frac{1}{2} \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$
1	$\frac{1}{\sqrt{2}} \begin{bmatrix} 1 \\ j \end{bmatrix}$	$\frac{1}{2} \begin{bmatrix} 1 & 1 \\ j & -j \end{bmatrix}$
2	$\frac{1}{\sqrt{2}} \begin{bmatrix} 1 \\ -1 \end{bmatrix}$	-
3	$\frac{1}{\sqrt{2}} \begin{bmatrix} 1 \\ -j \end{bmatrix}$	-



6.3 REPORTING OF PMI

- ▶ 전제 조건: 단말이 Precoding gain 을 얻으면 Throughput 향상에 도움이 될 것이다.
- ▶ 목적: PMI reporting의 정확도와 이를 통해 시스템 Throughput이 향상되었는지 여부를 판단

$$\gamma = \frac{t_{ue}}{t_{rnd}} \geq \text{test requirement}$$

γ : pre-coding gain

t_{ue} : throughput with UE PMI report

t_{rnd} : throughput with random PMI

- ▶ Test requirement examples

Table 6.3.2.1.1-2: Minimum requirement

Parameter	Test 1
γ	1.3

4Tx antenna

Table 6.3.2.1.4.3-2: Minimum requirement

Parameter	Test 1
γ	5.0

32 Tx antenna

6.3 REPORTING OF PMI

▶ Report sample (TC 6.3.3.1.1 FDD FR1 Single PMI 4TX..)

Subframes	Samples	ACKs	NACKs	DTXs	Current Throughput	Total Throughput
106000	53000	22843	30157	0	1.38 Mbps	1.38 Mbps

▼ Measurement of Throughput Ratio t_{ue} / t_{rnd}

t_{ue}	1.945600 Mbps
t_{rnd}	1.379200 Mbps
t_{ue} / t_{rnd}	1.411
Lower Limit (= gamma)	1.290
Result	Inside

✔ Result: **Inside**

> UE PMI report를 사용한 경우 약 1.411배의 Throughput 성능 향상 확인!

CSI (CHANNEL STATE INFORMATION)

LI (Layer Indicator)

CQI (Channel Quality Indicator)

PMI (Pre-coding Matrix Indicator)

RI (Rank Indicator)

CQI • 채널 환경이 좋으니 256QAM으로 더 많은 Data를 보내자! (Higher order modulation)

RI • 안테나를 여러 개 써서 더 많이 보낼까? (MIMO)

CQI • 채널 환경이 나쁘니 QPSK로 Data 손실이 없도록 하자! (More stability)

RI • 서로 방해하지 않게 하나로만 보내자! (SISO)

6.4 REPORTING OF RI

- ▶ 목적: RI reporting의 정확도를 확인하고, 시스템이 Fixed RI를 이용한 경우 (MIMO scheme을 시스템이 제어)와 DUT의 RI reporting 에 따라 동작했을 경우, 시스템 Throughput이 항상 측면에서 어느 쪽이 유리한 지 확인
- ▶ Minimum Conformance requirement
 - Throughput ratio with Fixed Rank 1 ; $\gamma_1 \leq$ Throughput ratio with RI reporting
 - Throughput ratio with Fixed Rank 2 ; $\gamma_2 \leq$ Throughput ratio with RI reporting

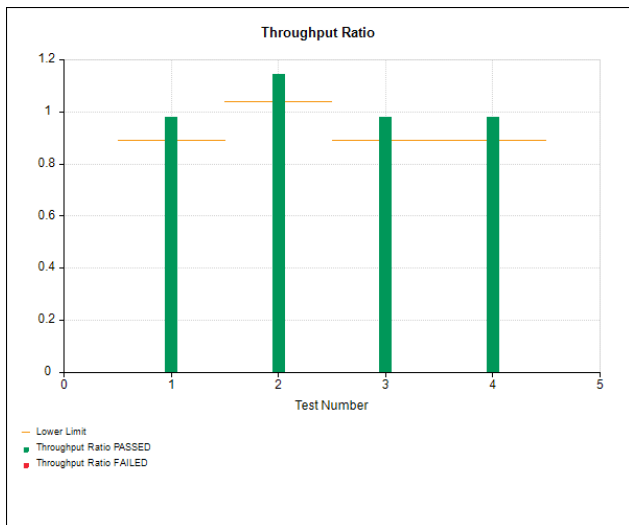
- ▶ CSI report type : Periodic

Derivation Path: TS 38.508-1 [8], clause 4.6.3, Table 4.6.3-41			
Information Element	Value/remark	Comment	Condition
CSI-ResourceConfig ::= SEQUENCE {			
resourceType	periodic		
}			

6.4 REPORTING OF RI

- Report sample (TC 6.4.3.1_1 4Rx RI reporting, FDD)

	Test 1	Test 2	Test 3	Test 4
γ_1	N/A	1.05	0.9	N/A
γ_2	0.9	N/A	N/A	0.9



Subframes	Samples	ACKs	NACKs	DTXs	Current Throughput	Total Throughput
106000	53000	36305	16695	0	2.19 Mbps	2.19 Mbps

▼ Measurement of Throughput Ratio $t_{\text{reported}} / t_{\text{fix}}$	
t_{reported}	2.192000 Mbps
t_{fix}	2.240000 Mbps
$t_{\text{reported}} / t_{\text{fix}}$	0.979
Lower Limit (= γ)	0.890
Result	Inside

✓ Result: Inside

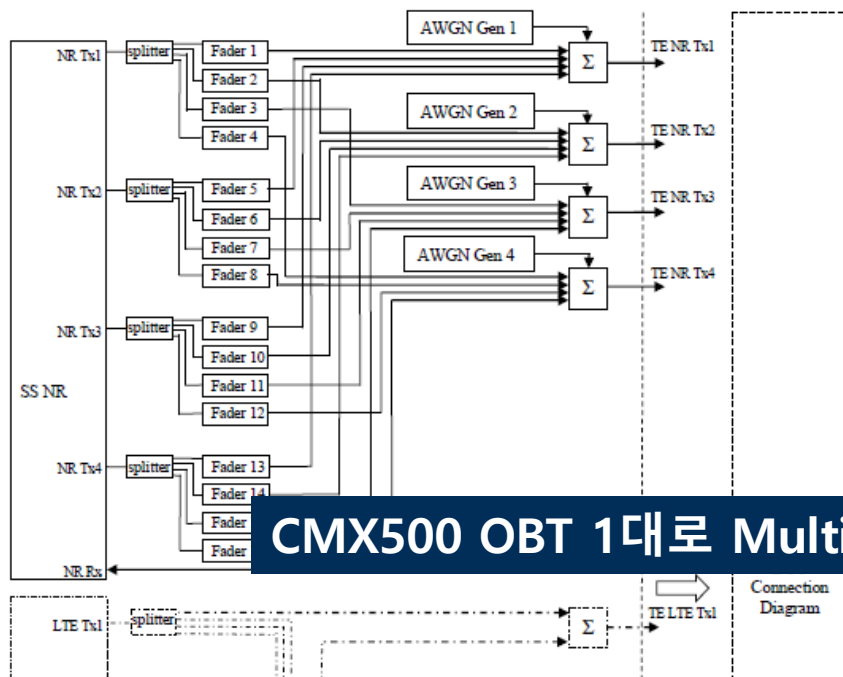


TS38.521-4 Test Specification Overview

PX 및 CSI TEST CONFIGURATION

PX 및 CSI TEST SETUP (CONDUCTED)

▶ TS38.508-1 Annex.A Connection diagram



기지국 에뮬레이터
(R&S CMX500)



Test 단말(DUT)

CMX500 OBT 1대로 Multi layer Channel simulation!!

Thank you for your attention!

Q&A

*"If you want to go fast, go alone.
If you want to go far, go together!"*

African proverb