

**Source:** Panasonic  
**Title:** Simulation Results of Mapping Tables for Format 1b with Channel Selection  
**Agenda Item:** 6.2.1.1 Remaining details for A/N transmission  
**Document for:** Discussion and Decision

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## 1. Introduction

At the RAN1#62 meeting, the followings were agreed for ACK/NAK multiplexing for CA [1].

- *One mapping table for each of 2, 3, or 4 bits*
  - *Possibly 1 mapping table with nested property for bit range of 2 – 4*
- *2/3/4 PUCCH format 1a/1b resources for 2/3/4 bits, respectively*
- *Mapping table design shall optimize the performance for 2 CCs, wrt*
  - *Required SNR to meet ACK/NAK performance requirements*
  - *Implicit Rel-8 resource utilization*
  - *Ambiguity handling during DL CC reconfiguration*
  - *Equalization of individual ACK/NAK bit performance will be considered.*
  - *Overlapping states shall be avoided*
- *Companies shall provide their proposed mapping tables on the email reflector by Sep. 17, 11pm PST.*
  - *No mapping tables will be considered after the deadline*
  - *Calibration results can be provided using mapping tables in R1-104140*
  - *Evaluations will use simulation assumptions (other than the mapping tables) agreed previously in R1-104140.*

Regarding the agreement, we propose the ACK/NAK (A/N) mapping tables for PUCCH format 1b with channel selection for CA in R1-105476 [2]. In this contribution, we show the simulation results and the comparison of the tables proposed by Panasonic, NTT DOCOMO, LG Electronics, Qualcomm, Huawei, Nokia, Samsung, CATT and ZTE.

## 2. Simulation results

The link evaluation assumptions are shown in Appendix 1, and the simulation results are shown in Appendix 2. Figures 1-6 show the worst required SNR and the average SNR at 0.1% of NAK-to-ACK error among proposed mapping tables for 2/3/4 ACK/NAK (A/N) bits, and Tables 1-3 show the lists of the worst required SNR and the average SNR. For the evaluation of 3 ACK/NAK bits, PCell is configured to SDM and SCell is configured to non-SDM.

We are not sure the handling of either DTX states or support of Rel-8/9 format 1a/1b fallback from the proposal of LG Electronics, Huawei and ZTE. The support of Rel-8/9 format 1a/1b fallback depends on DTX states. If DTX states for supporting the fallback can be mapped without overlapping with ACK in their mapping tables, we assume they can support the fallback. Note that this is agreed design criterion in [1].

For example, according to LG Electronics' two ACK/NAK-bit mapping table, the ACK/NAK (A/N) state (ACK for PCell, and NAK for SCell) is mapped onto “-1” and the NAK/NAK (N/N) state is mapped onto “+1” on Ch1 which is linked to CCE used for carrying DL assignment for PCell data. If the ACK/DTX (A/D) state is mapped onto “-1” and the NAK/DTX (N/D) state is mapped onto “+1”,

which is not mentioned, the mapping table can support Rel-8/9 format 1a fallback and the DTX states do not overlap with ACK. Meanwhile, according to ZTE's two ACK/NAK-bit mapping table, the ACK/ACK (A/A) state is mapped onto “-1” and the NAK/NAK (N/N) state is mapped onto “+1”. In this case, if the ACK/DTX (A/D) state is mapped onto “-1” to support Rel-8/9 format 1a fallback, the DTX state overlaps with ACK, which contradicts the agreed criterion [1]. So we assume the mapping table can not support Rel-8/9 format 1a fallback.

According to the assumption above, we assume LG Electronics' mapping tables support Rel-8/9 format 1a/1b fallback and ZTE's do not support it. Huawei's support it partially, namely, Huawei's two ACK/NAK-bit mapping table supports Rel-8/9 format 1a fallback, three ACK/NAK-bit mapping table supports Rel-8/9 format 1a/1b fallback and four ACK/NAK-bit mapping table does not support Rel-8/9 format 1b fallback. We would like to check whether above understanding is correct from the proponents.

The two ACK/NAK-bit mapping tables proposed by Panasonic, NTT DOCOMO, LG Electronics, Qualcomm, Huawei, Nokia and Samsung can support Rel-8/9 format 1a fallback, while the two ACK/NAK-bit mapping tables proposed by CATT and ZTE can not.

Among the tables which can support Rel-8/9 format 1a fallback, Panasonic's tables and LG Electronics' tables perform the best with respect to both the worst required SNR and the average SNR. This is simply because Panasonic's tables are identical to LG Electronics' if DTX states are omitted from Panasonic's.

Between the tables which can not support Rel-8/9 format 1a fallback, ZTE's perform the best with respect to both the worst required SNR and the average SNR.

The performance degradation by supporting Rel-8/9 format 1a fallback is 0.3-0.4dB.

The three ACK/NAK-bit mapping tables proposed by Panasonic, NTT DOCOMO, LG Electronics, Qualcomm and Huawei can support Rel-8/9 format 1a/1b fallback, while the three ACK/NAK-bit mapping tables proposed by Nokia, Samsung, CATT and ZTE can not.

Among the tables which can support Rel-8/9 format 1a/1b fallback, Panasonic's and Qualcomm's perform the best in general with respect to the worst required SNR and the average SNR.

Among the tables which can not support Rel-8/9 format 1a/1b fallback, CATT's perform the best in general with respect to both the worst required SNR and the average SNR.

The performance (namely both the worst required SNR and the average SNR) degradation by supporting Rel-8/9 format 1a/1b fallback is 0-0.3dB.

The four ACK/NAK-bit mapping tables proposed by Panasonic, NTT DOCOMO, LG Electronics and Qualcomm can support Rel-8/9 format 1b fallback, while the four ACK/NAK-bit mapping tables proposed by Huawei, Nokia, Samsung, CATT and ZTE can not.

Among the tables which can support Rel-8/9 format 1b fallback, Panasonic's (and LG Electronics') perform the best with respect to the worst required SNR and the average SNR.

Among the tables which can not support Rel-8/9 format 1b fallback, CATT's perform the best with respect to the worst required SNR and the average SNR.

The performance degradation by supporting Rel-8/9 format 1b fallback is 0-0.1dB.

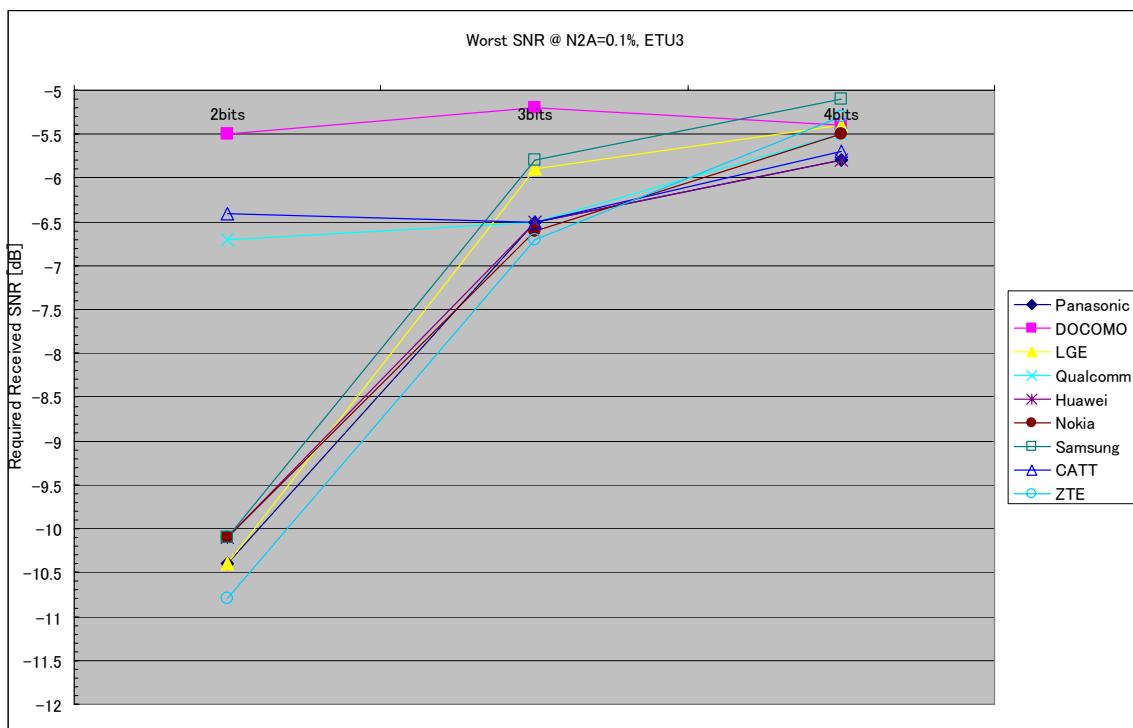


Figure 1 Worst required SNR comparison (2 A/N bits, NAK-to-ACK=0.1%, ETU 3km/h 5MHz)

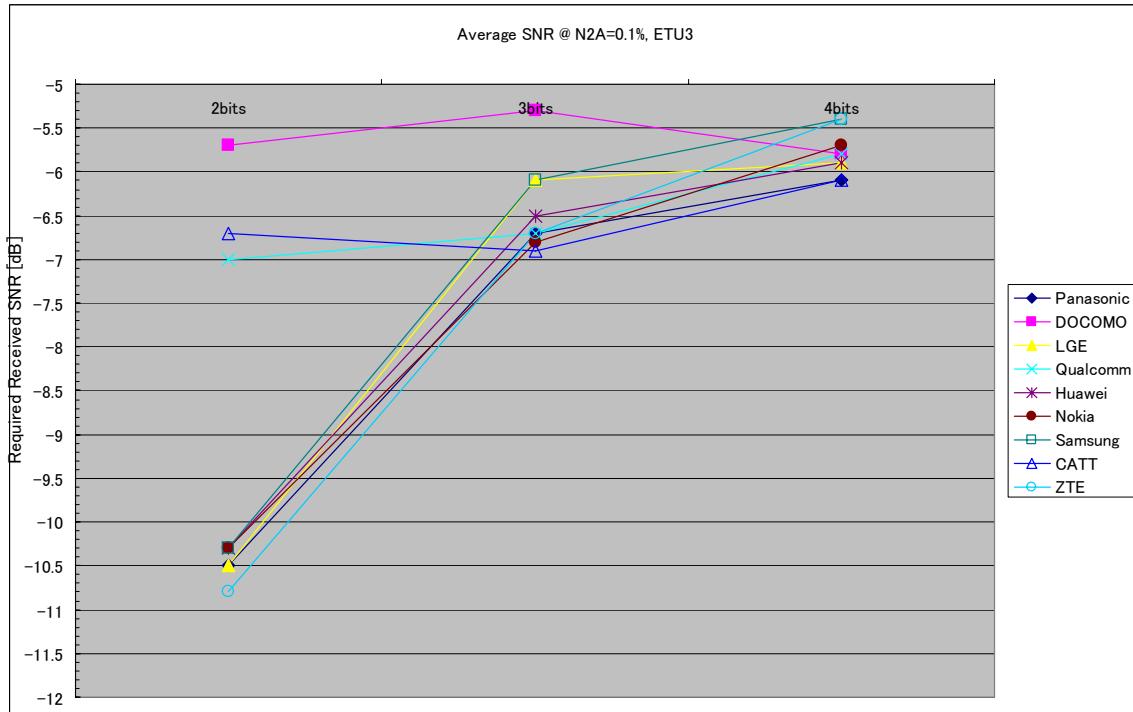


Figure 2 Worst required SNR comparison (2 A/N bits, NAK-to-ACK=0.1%, ETU 3km/h 5MHz)

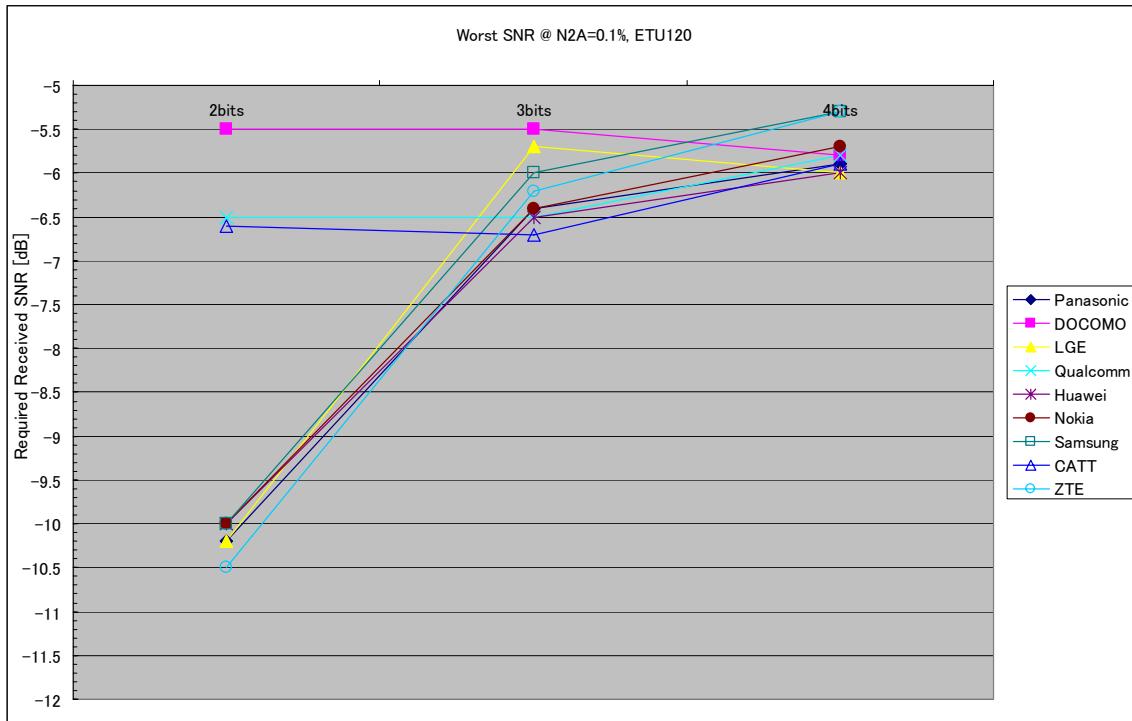


Figure 3 Worst required SNR comparison (3 A/N bits, NAK-to-ACK=0.1%, ETU 120km/h 5MHz)

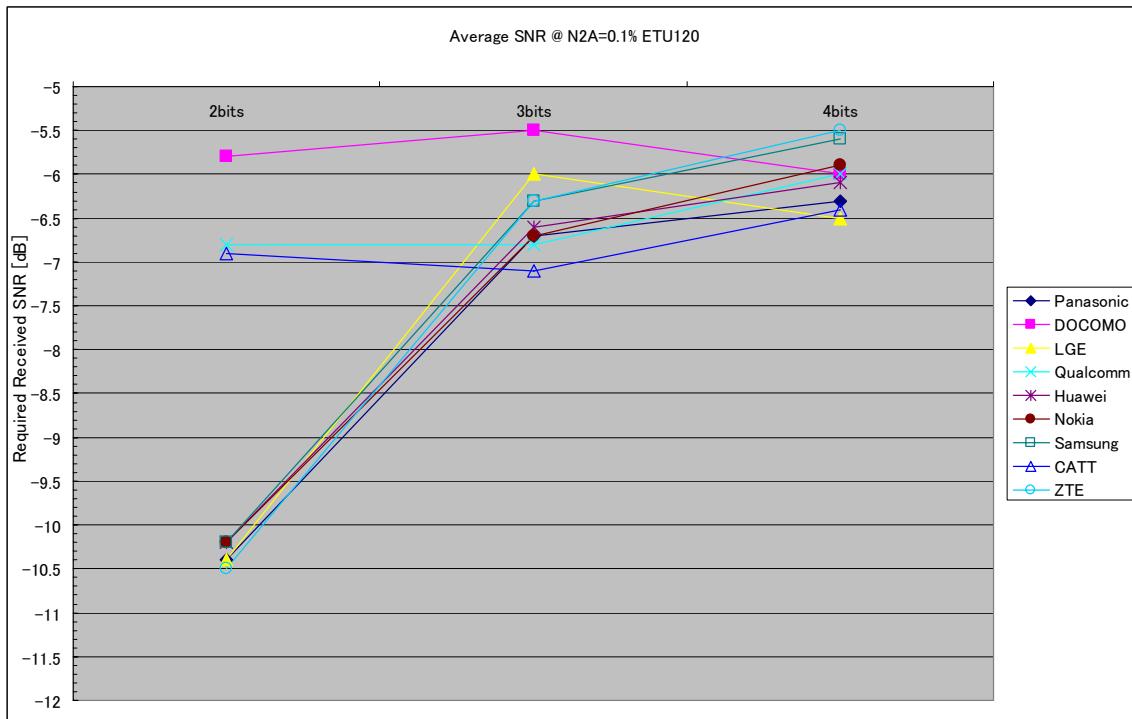


Figure 4 Worst required SNR comparison (3 A/N bits, NAK-to-ACK=0.1%, ETU 120km/h 5MHz)

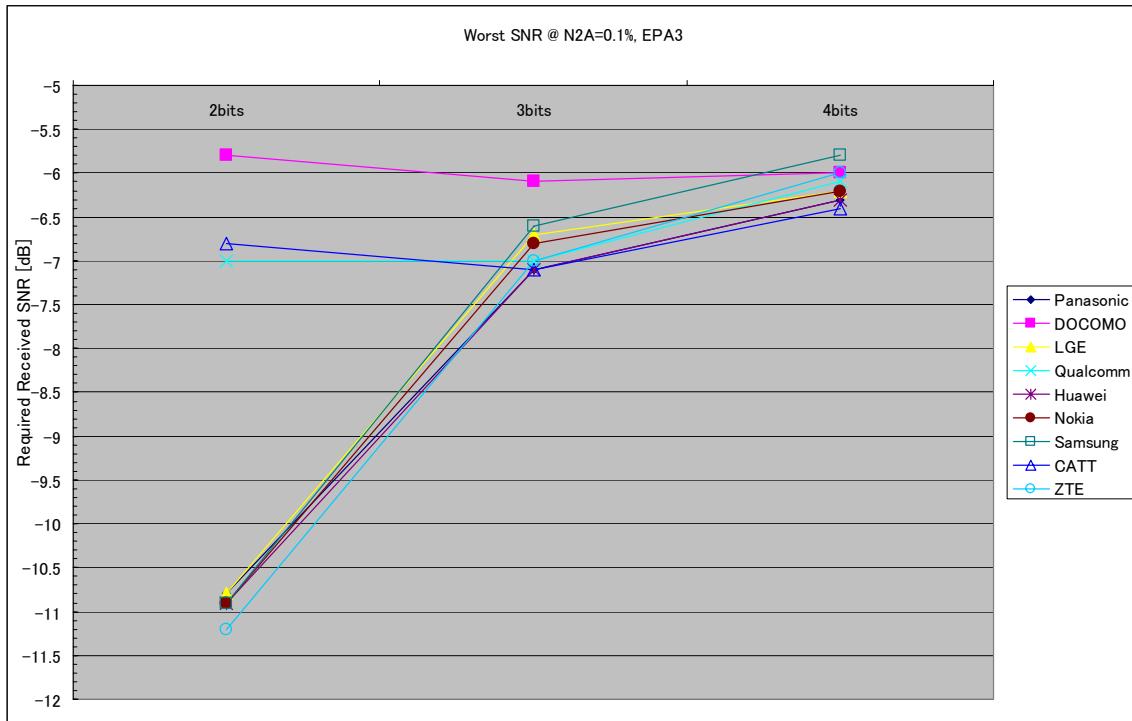


Figure 5 Worst required SNR comparison (4 A/N bits, NAK-to-ACK=0.1%, EPA 3km/h 10MHz)

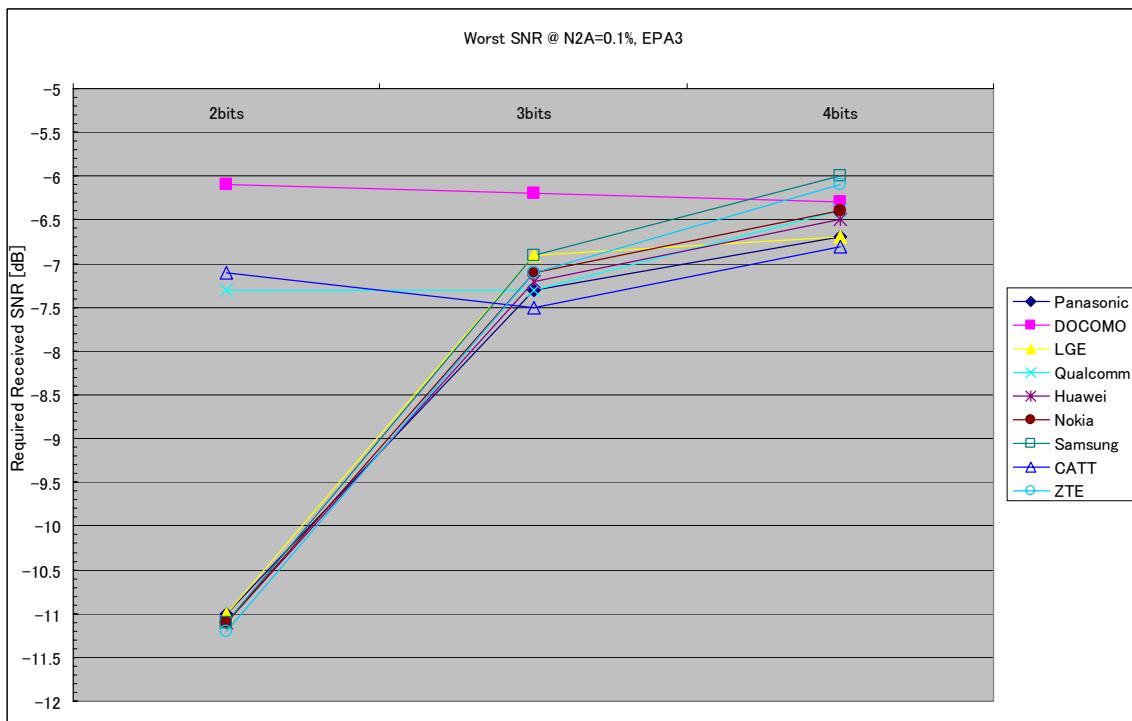


Figure 6 Worst required SNR comparison (4 A/N bits, NAK-to-ACK=0.1%, EPA 3km/h 10MHz)

Table 1 List of worst required SNR and average SNR (2 A/N bits)

		NAK-to-ACK (0.1%)			ACK-to-NCK (1%)		
		ETU 3km/h	ETU 120km/h	EPA 3km/h	ETU 3km/h	ETU 120km/h	EPA 3km/h
Panasonic	Worst[dB]	-10.4	-10.2	-10.8	-7.5	-7.5	-8.0
	Average[dB]	-10.5	-10.4	-11.0	-7.5	-7.5	-8.0
NTT DOCOMO	Worst[dB]	-5.5	-5.5	-5.8	-7.2	-7.1	-7.6
	Average[dB]	-5.7	-5.8	-6.1	-7.3	-7.2	-7.7
LG Electronics	Worst[dB]	-10.4	-10.2	-10.8	-7.5	-7.5	-8.0
	Average[dB]	-10.5	-10.4	-11.0	-7.5	-7.5	-8.0
Qualcomm	Worst[dB]	-6.7	-6.5	-7.0	-7.3	-7.3	-7.8
	Average[dB]	-7.0	-6.8	-7.3	-7.4	-7.4	-7.9
Huawei	Worst[dB]	-10.1	-10.0	-10.9	-7.5	-7.5	-8.0
	Average[dB]	-10.3	-10.2	-11.1	-7.5	-7.5	-8.0
Nokia	Worst[dB]	-10.1	-10.0	-10.9	-7.5	-7.5	-8.0
	Average[dB]	-10.3	-10.2	-11.1	-7.5	-7.5	-8.0
Samsung	Worst[dB]	-10.1	-10.0	-10.9	-7.5	-7.5	-8.0
	Average[dB]	-10.3	-10.2	-11.1	-7.5	-7.5	-8.0
CATT	Worst[dB]	-6.4	-6.6	-6.8	-7.3	-7.3	-7.8
	Average[dB]	-6.7	-6.9	-7.1	-7.4	-7.4	-7.9
ZTE	Worst[dB]	-10.8	-10.5	-11.2	-7.5	-7.5	-8.0
	Average[dB]	-10.8	-10.5	-11.2	-7.5	-7.5	-8.0

Table 2 List of worst required SNR and average SNR (3 A/N bits)

		NAK-to-ACK (0.1%)			ACK-to-NAK (1%)		
		ETU 3km/h	ETU 120km/h	EPA 3km/h	ETU 3km/h	ETU 120km/h	EPA 3km/h
Panasonic	Worst[dB]	-6.5	-6.4	-7.1	-7.1	-7.1	-7.6
	Average[dB]	-6.7	-6.7	-7.3	-7.2	-7.1	-7.7
NTT DOCOMO	Worst[dB]	-5.2	-5.5	-6.1	-6.9	-6.9	-7.5
	Average[dB]	-5.3	-5.5	-6.2	-6.9	-7.0	-7.5
LG Electronics	Worst[dB]	-5.9	-5.7	-6.7	-7.1	-7.0	-7.5
	Average[dB]	-6.1	-6.0	-6.9	-7.2	-7.1	-7.6
Qualcomm	Worst[dB]	-6.5	-6.5	-7.0	-7.1	-7.1	-7.5
	Average[dB]	-6.7	-6.8	-7.3	-7.1	-7.2	-7.6
Huawei	Worst[dB]	-6.5	-6.5	-7.1	-7.1	-7.0	-7.6
	Average[dB]	-6.5	-6.6	-7.2	-7.1	-7.1	-7.6
Nokia	Worst[dB]	-6.6	-6.4	-6.8	-7.0	-7.1	-7.6
	Average[dB]	-6.8	-6.7	-7.1	-7.0	-7.2	-7.6
Samsung	Worst[dB]	-5.8	-6.0	-6.6	-7.0	-7.0	-7.5
	Average[dB]	-6.1	-6.3	-6.9	-7.1	-7.1	-7.6
CATT	Worst[dB]	-6.5	-6.7	-7.1	-7.0	-7.2	-7.6
	Average[dB]	-6.9	-7.1	-7.5	-7.1	-7.2	-7.7
ZTE	Worst[dB]	-6.7	-6.2	-7.0	-7.1	-7.1	-7.6
	Average[dB]	-6.7	-6.3	-7.1	-7.1	-7.1	-7.6

Table 3 List of worst required SNR and average SNR (4 A/N bits)

		NAK-to-ACK (0.1%)			ACK-to-NAK (1%)		
		ETU 3km/h	ETU 120km/h	EPA 3km/h	ETU 3km/h	ETU 120km/h	EPA 3km/h
Panasonic	Worst[dB]	-5.8	-5.9	-6.3	-6.8	-6.7	-7.3
	Average[dB]	-6.1	-6.3	-6.7	-6.8	-6.7	-7.3
NTT DOCOMO	Worst[dB]	-5.4	-5.8	-6.0	-6.7	-6.7	-7.2
	Average[dB]	-5.8	-6.0	-6.3	-6.7	-6.7	-7.3
LG Electronics	Worst[dB]	-5.4	-6.0	-6.2	-6.6	-6.7	-7.1
	Average[dB]	-5.9	-6.5	-6.7	-6.8	-6.8	-7.3
Qualcomm	Worst[dB]	-5.5	-5.8	-6.1	-6.7	-6.7	-7.2
	Average[dB]	-5.8	-6.0	-6.4	-6.7	-6.7	-7.2
Huawei	Worst[dB]	-5.8	-6.0	-6.3	-6.8	-6.7	-7.3
	Average[dB]	-5.9	-6.1	-6.5	-6.8	-6.8	-7.3
Nokia	Worst[dB]	-5.5	-5.7	-6.2	-6.7	-6.6	-7.3
	Average[dB]	-5.7	-5.9	-6.4	-6.7	-6.7	-7.3
Samsung	Worst[dB]	-5.1	-5.3	-5.8	-6.6	-6.6	-7.1
	Average[dB]	-5.4	-5.6	-6.0	-6.7	-6.6	-7.1
CATT	Worst[dB]	-5.7	-5.9	-6.4	-6.7	-6.8	-7.3
	Average[dB]	-6.1	-6.4	-6.8	-6.8	-6.9	-7.4
ZTE	Worst[dB]	-5.3	-5.3	-6.0	-6.6	-6.7	-7.2
	Average[dB]	-5.4	-5.5	-6.1	-6.6	-6.7	-7.2

### 3. Conclusion

In this contribution, we showed the simulation results and the comparison of the tables proposed by Panasonic, NTT DOCOMO, LG Electronics, Qualcomm, Huawei, Nokia, Samsung, CATT and ZTE.

### References

- [1] 3GPP, R1-105020, CATT, “Ad Hoc Session Notes on Mapping Table Design in Rel-10 CA,” Aug. 2010.
- [2] 3GPP, R1-105476, Panasonic, “Mapping Tables for Format 1b with Channel Selection,” Oct. 2010.
- [3] 3GPP, R1-104140, CATT, “ACK/NAK Multiplexing Simulation Assumptions in Rel-10,” June-July 2010.

## Appendix 1: Assumptions

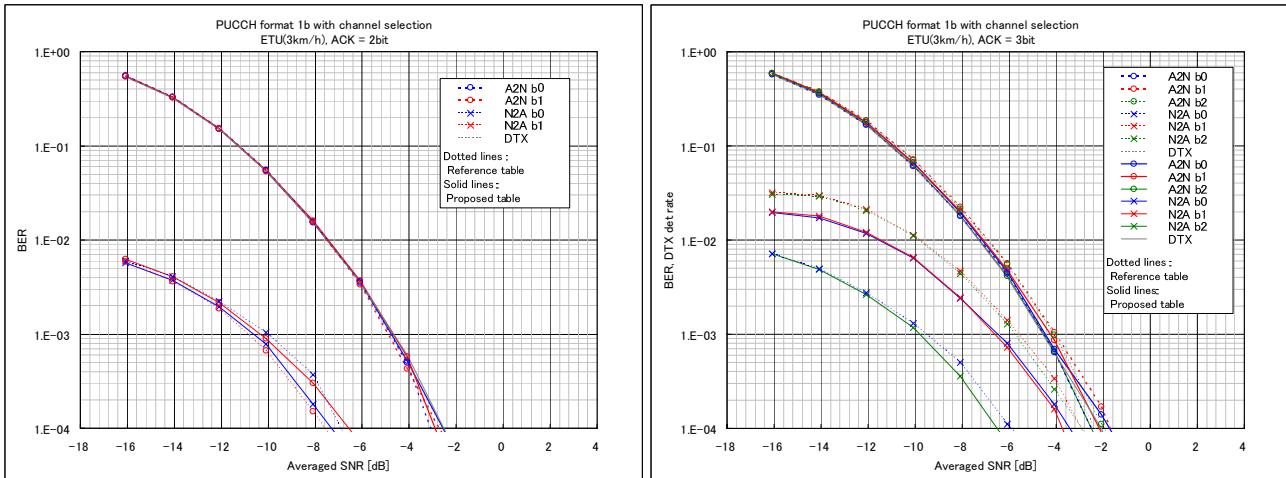
Table 4 Link evaluation assumptions

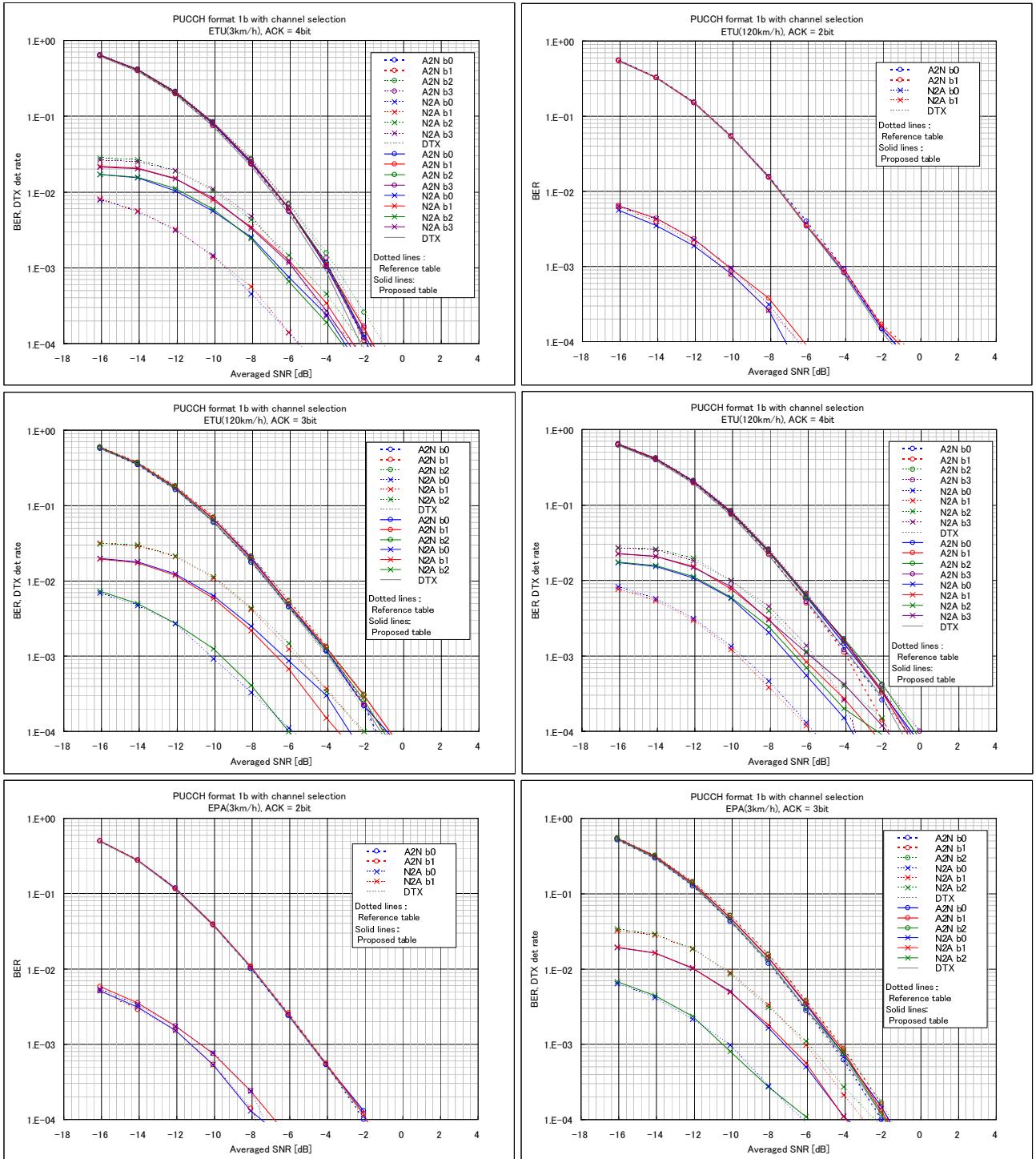
Parameters	Value
carrier frequency	2.0 GHz
System bandwidth	5 MHz for ETU, 10 MHz for EPA
channel model	ETU 3km/h 5 MHz, ETU 120km/h 5 MHz, EPA 3km/h 10 MHz
frequency hopping	at slot boundary
antenna setup	1Tx, 2Rx
RX antenna correlation	uncorrelated
channel estimation	practical
CP type	normal CP
signal bandwidth	180 kHz
RX false alarm detection threshold	$\text{Freq}(\text{PUCCH DTX} \rightarrow \text{ACK bits}) = \frac{\#(\text{false ACK bits})}{\#(\text{PUCCH DTX})} \leq 10^{-2}$
Noise estimation	Ideal
Number of UEs	1
Number of PRBs for PUCCH	1
$\Delta_{\text{shift}}$	2

## Appendix 2: Simulation results

Simulation results with the mapping tables proposed by Panasonic, NTT DOCOMO, LG Electronics, Qualcomm, Huawei, Nokia, Samsung, CATT and ZTE are shown below in solid lines. The mapping tables shown in Tables 5-1, 5-2 and 6 in R1-104140[3] are used as references of 2/3/4 A/N bits in dotted lines.

### Panasonic





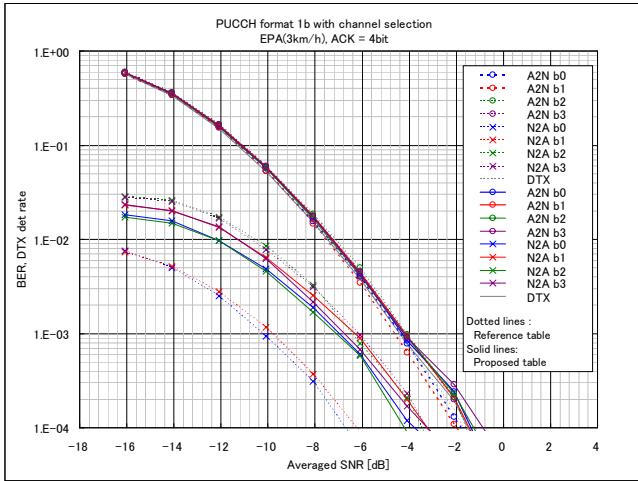
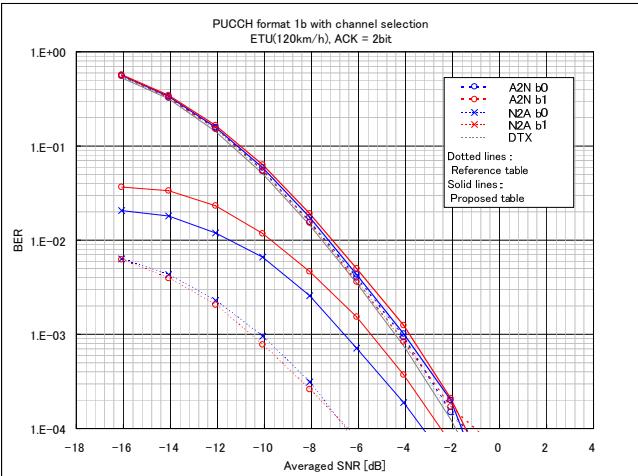
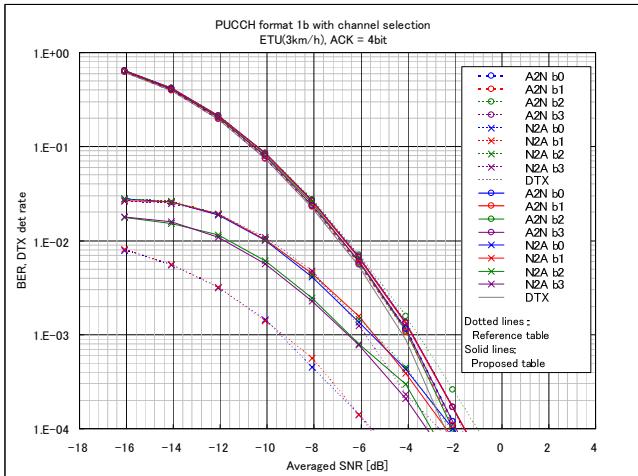
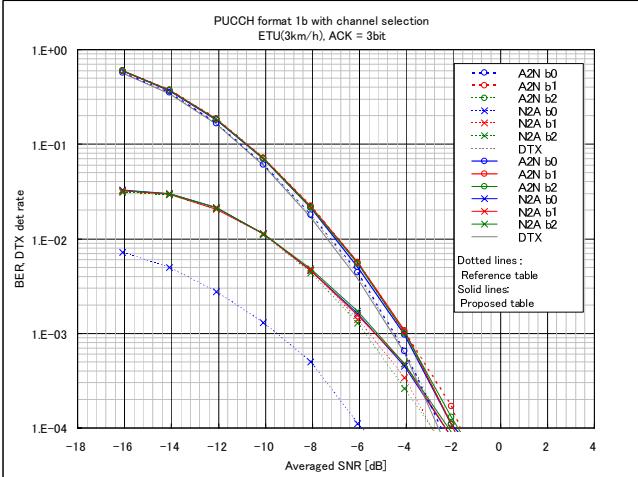
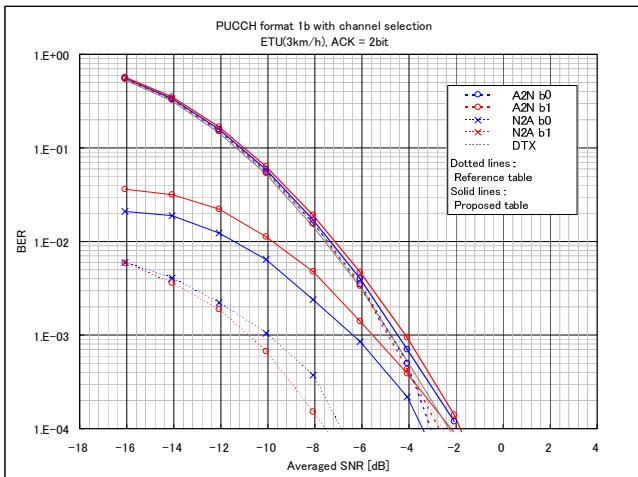


Figure 7 Simulation results of Panasonic's tables

## NTT DOCOMO



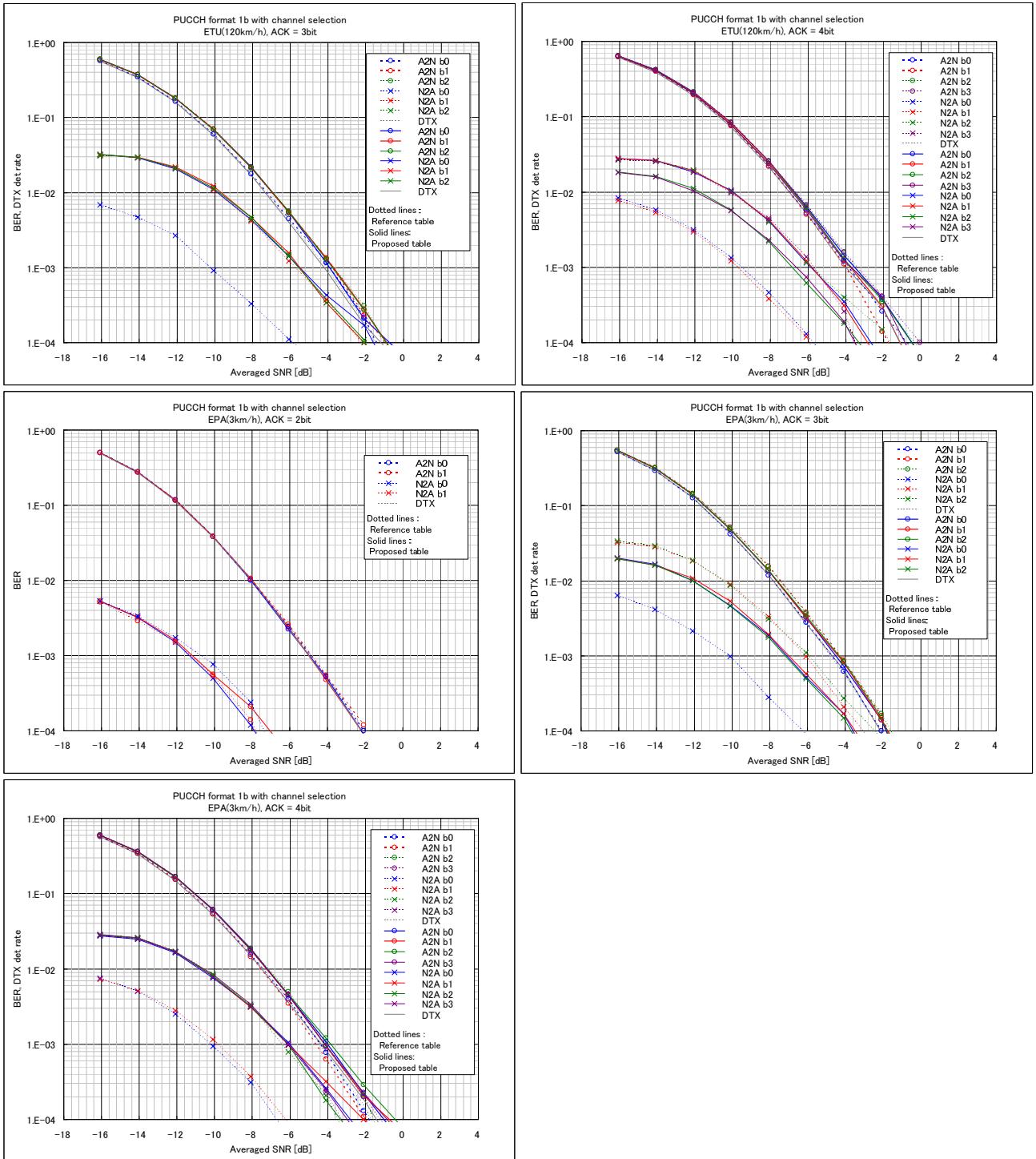
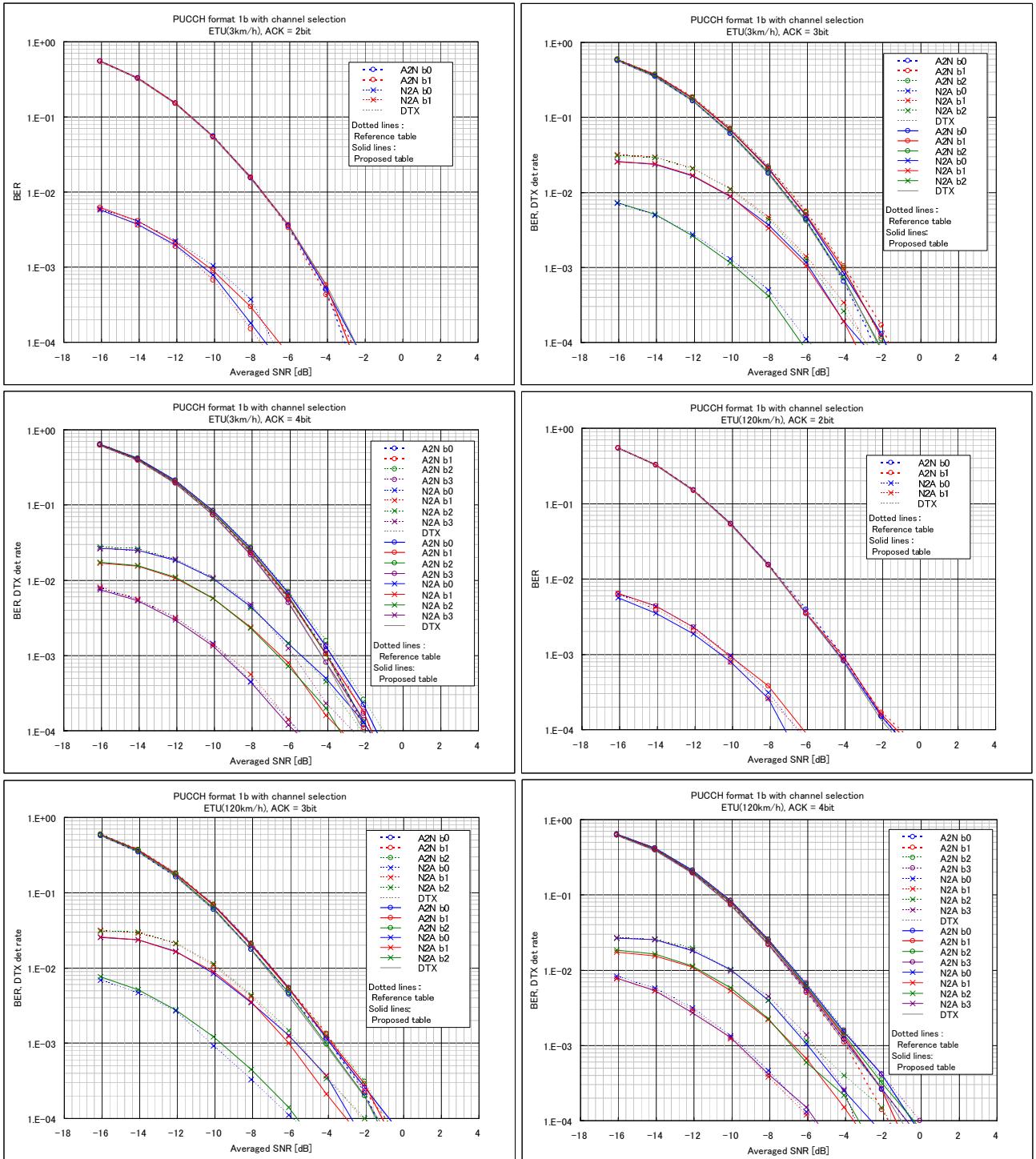


Figure 8 Simulation results of NTT DOCOMO's tables

## LG Electronics



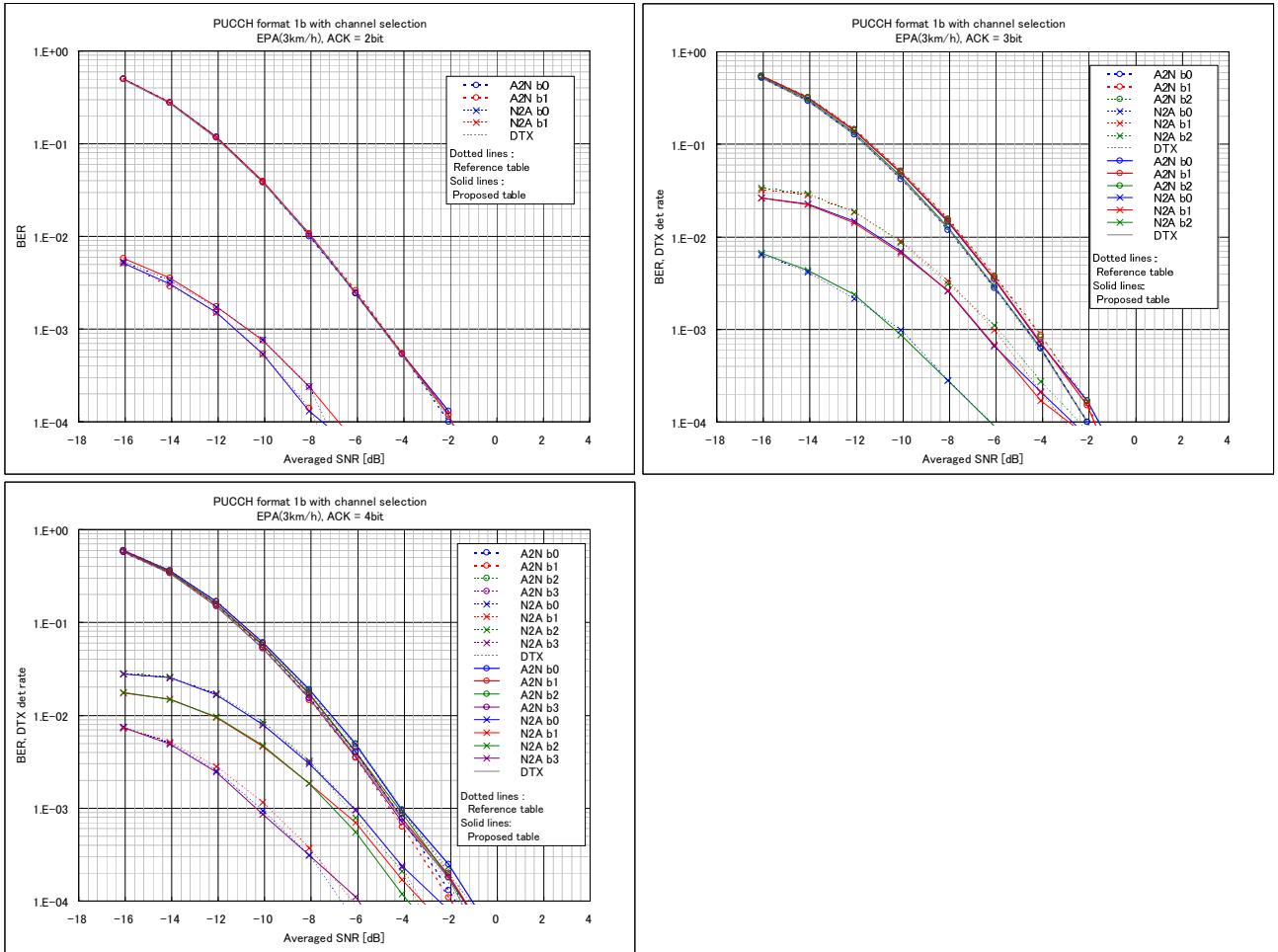
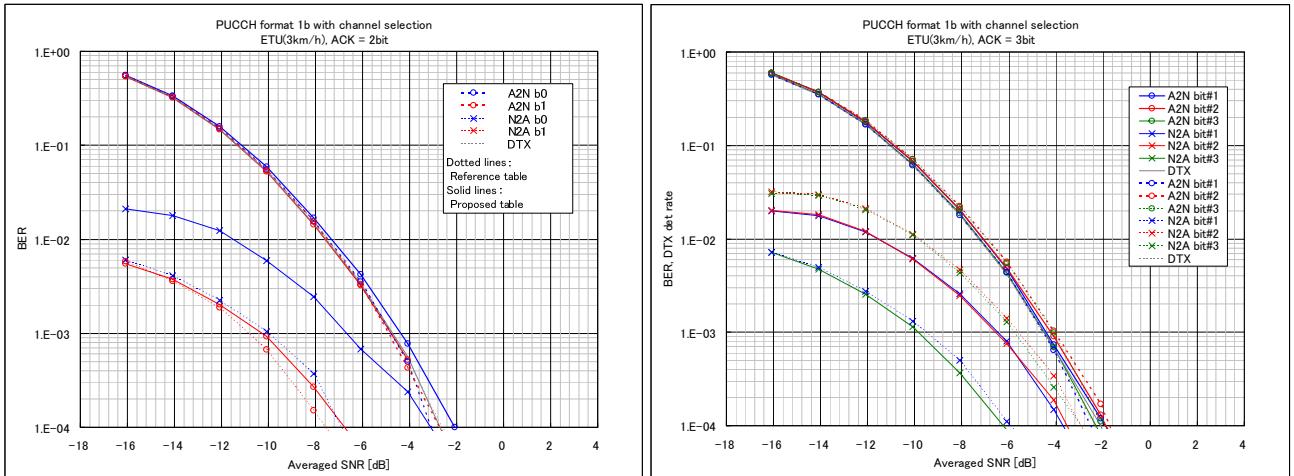
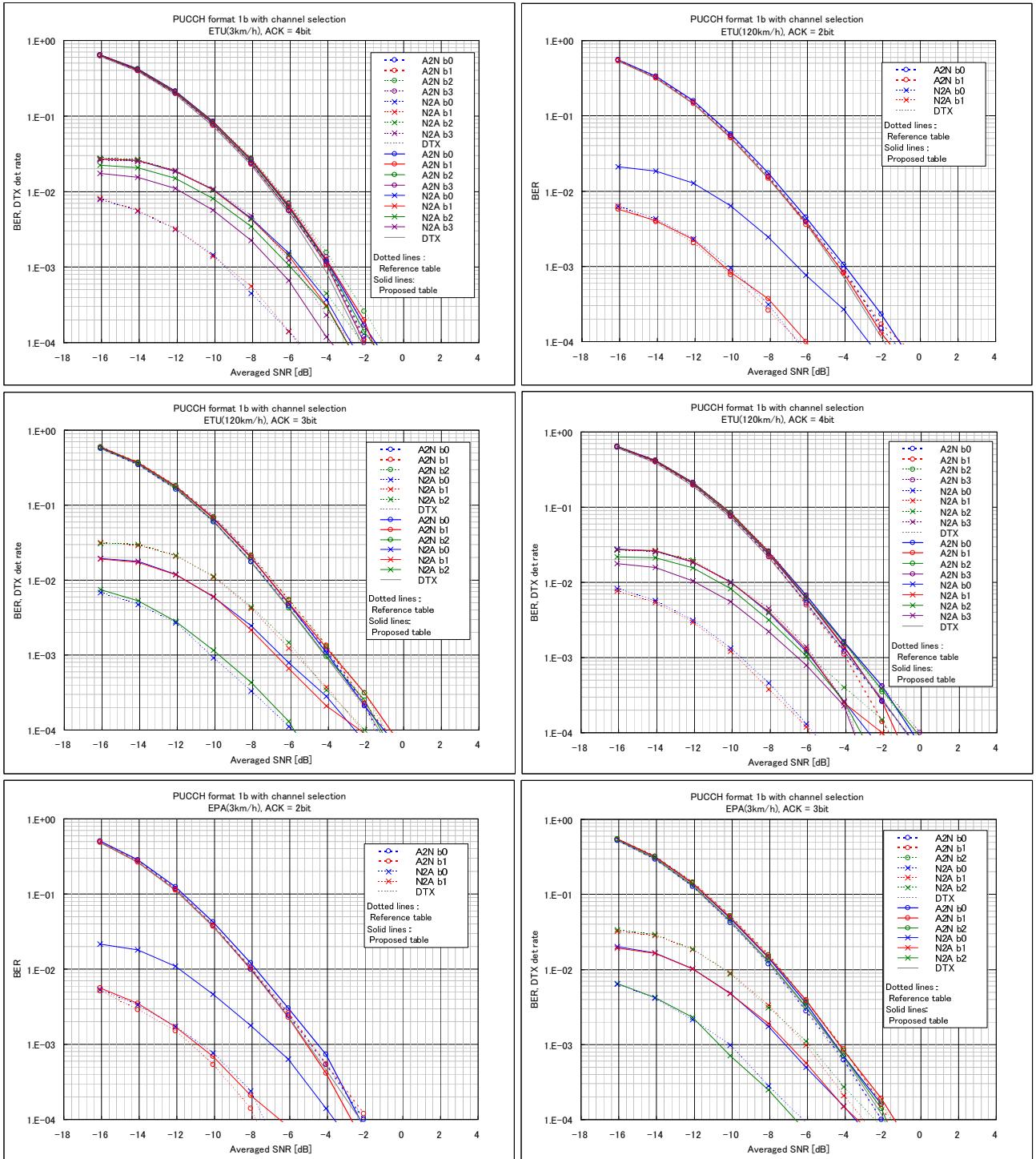


Figure 9 Simulation results of LG Electronics' tables

## Qualcomm





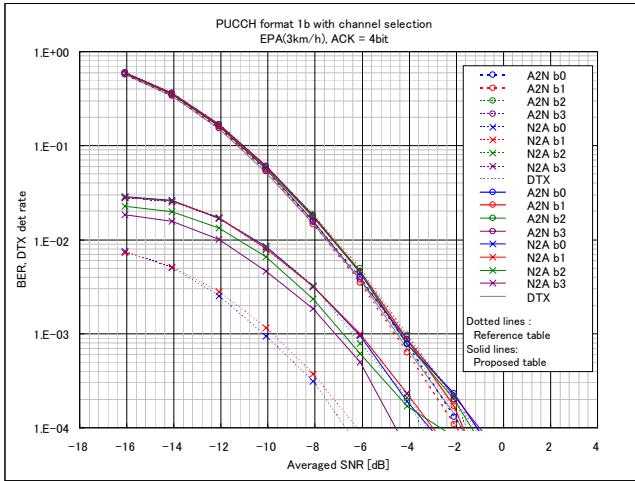
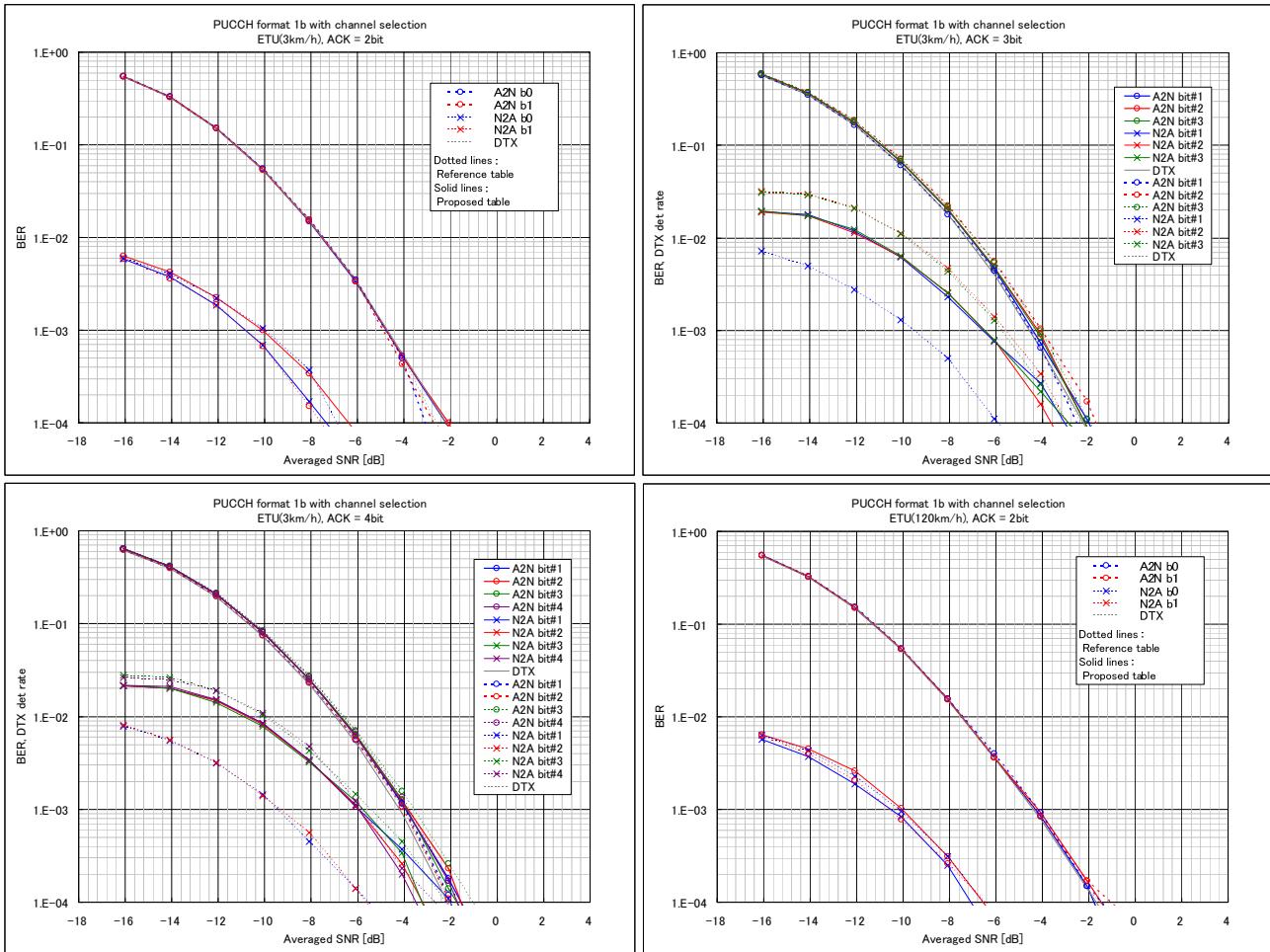


Figure 10 Simulation results of Qualcomm's tables

## Huawei



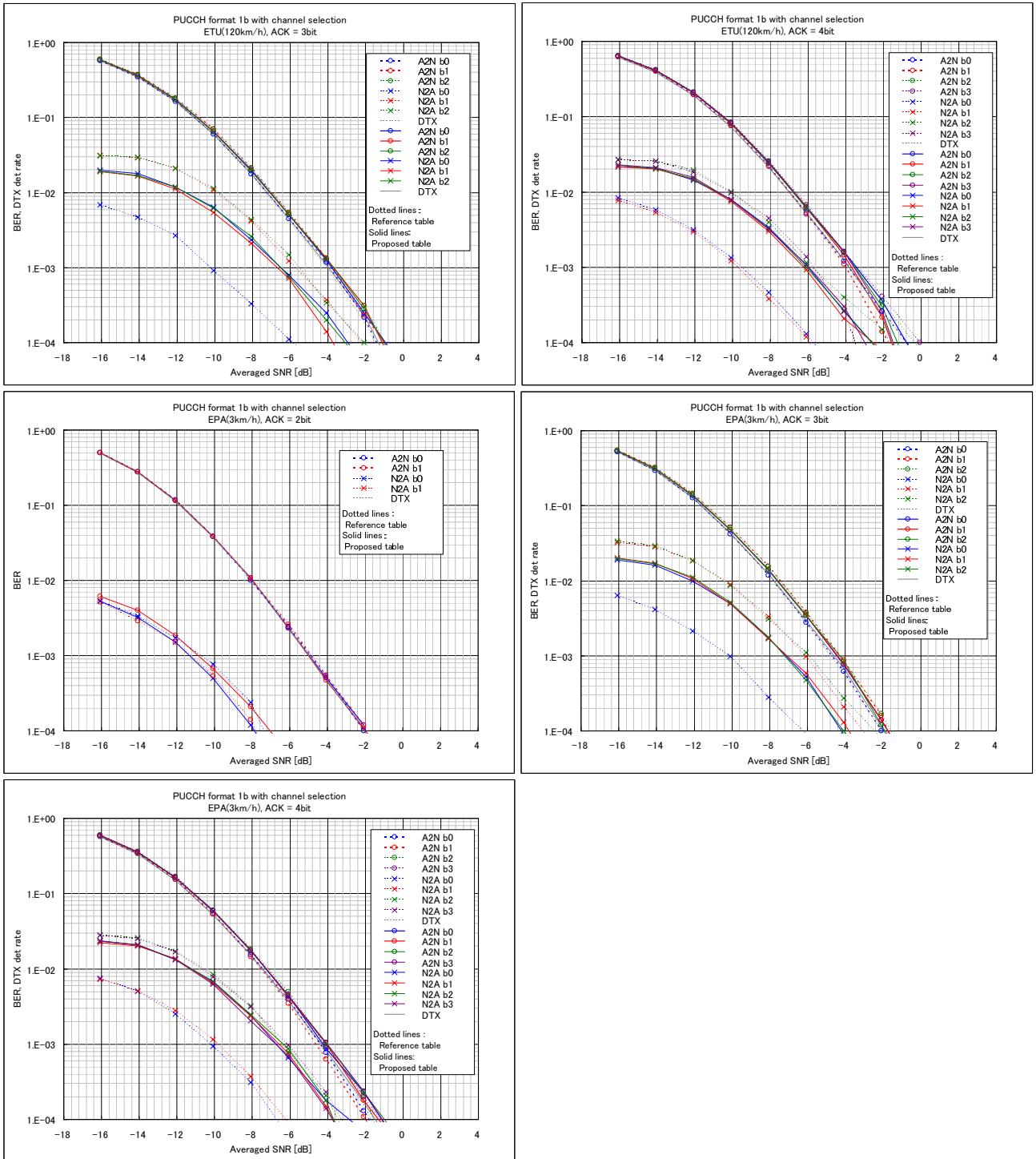
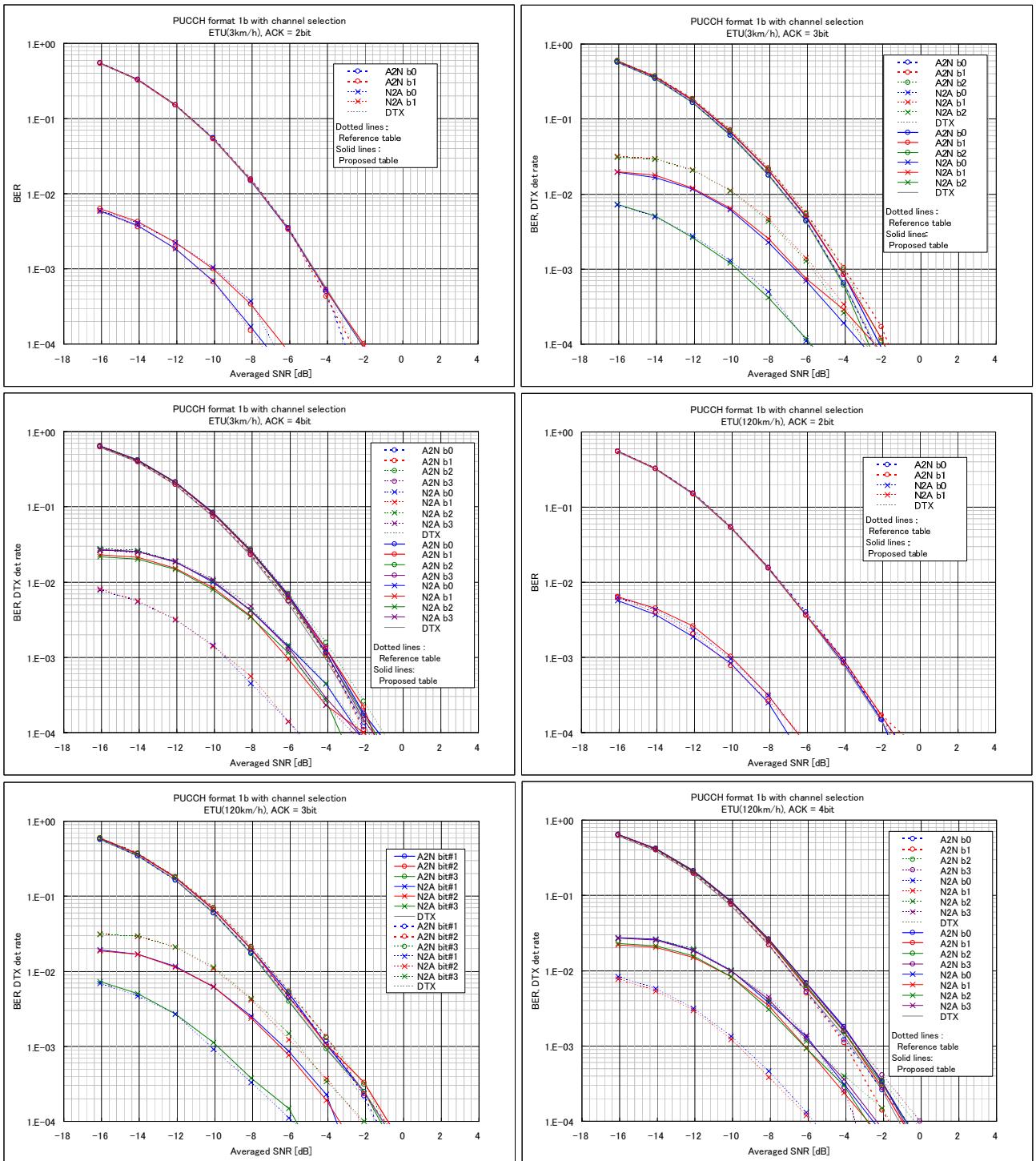


Figure 11 Simulation results of Huawei's tables

## Nokia



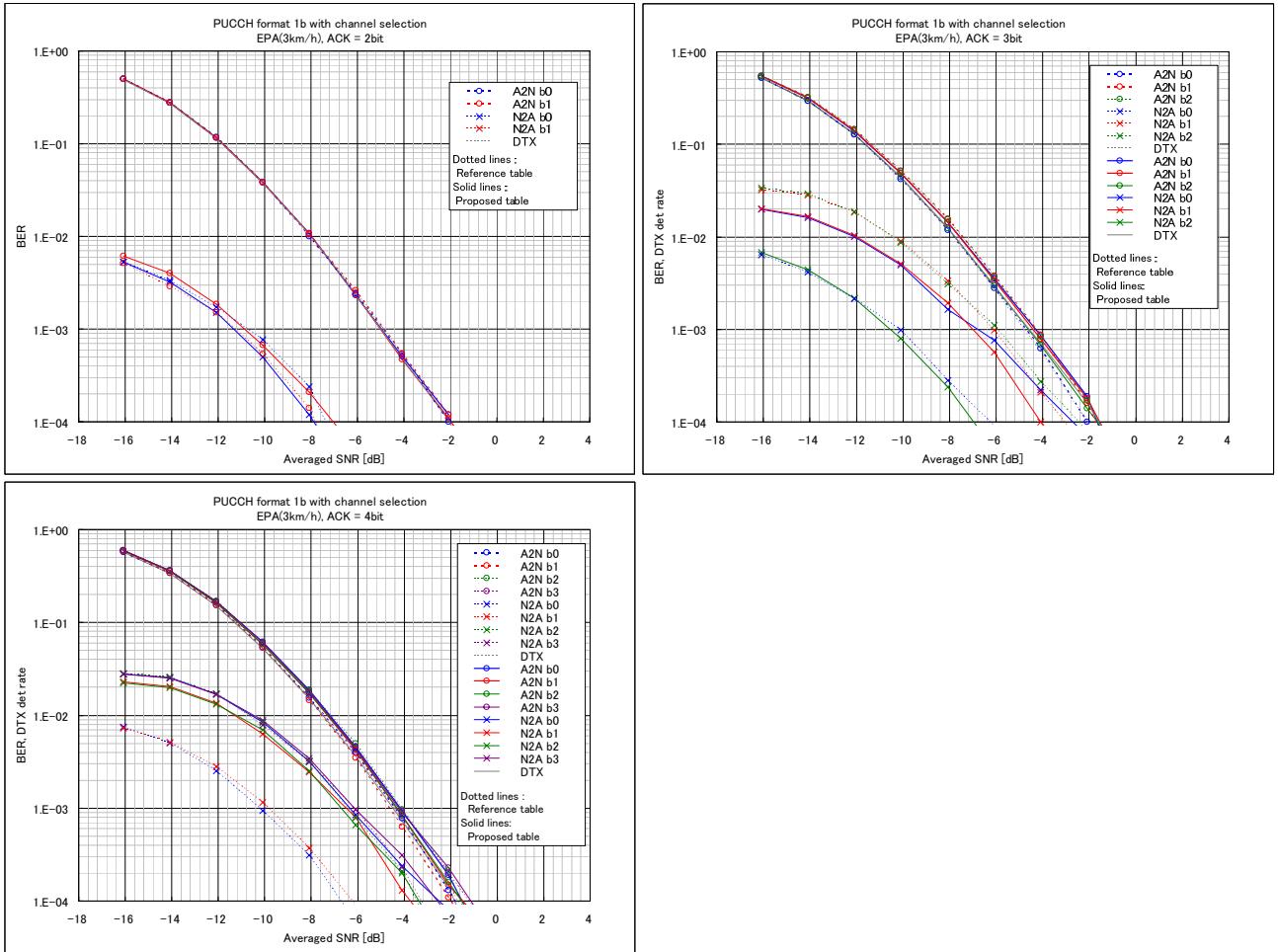
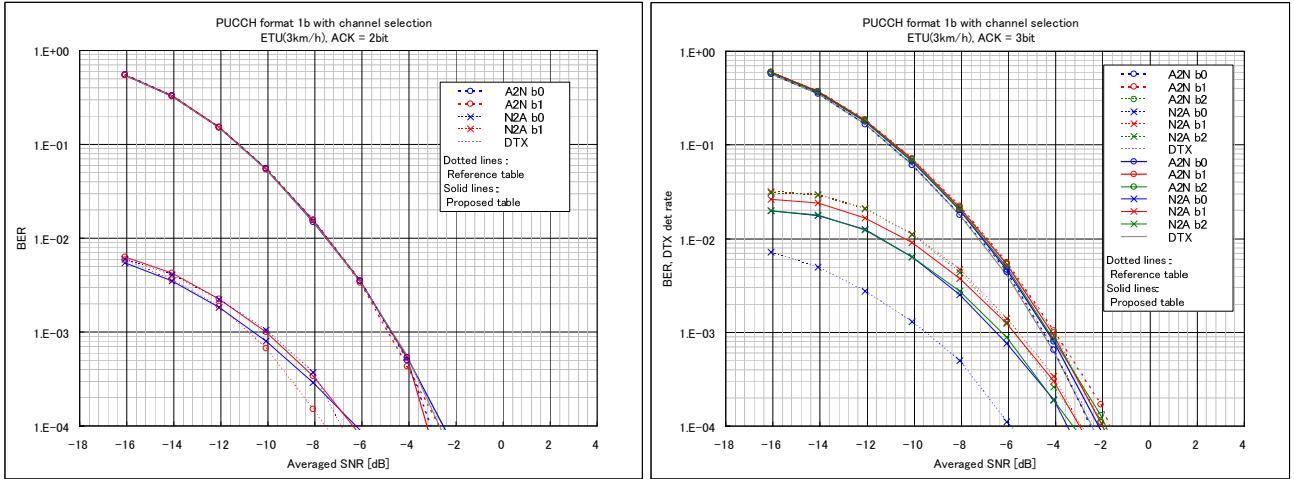
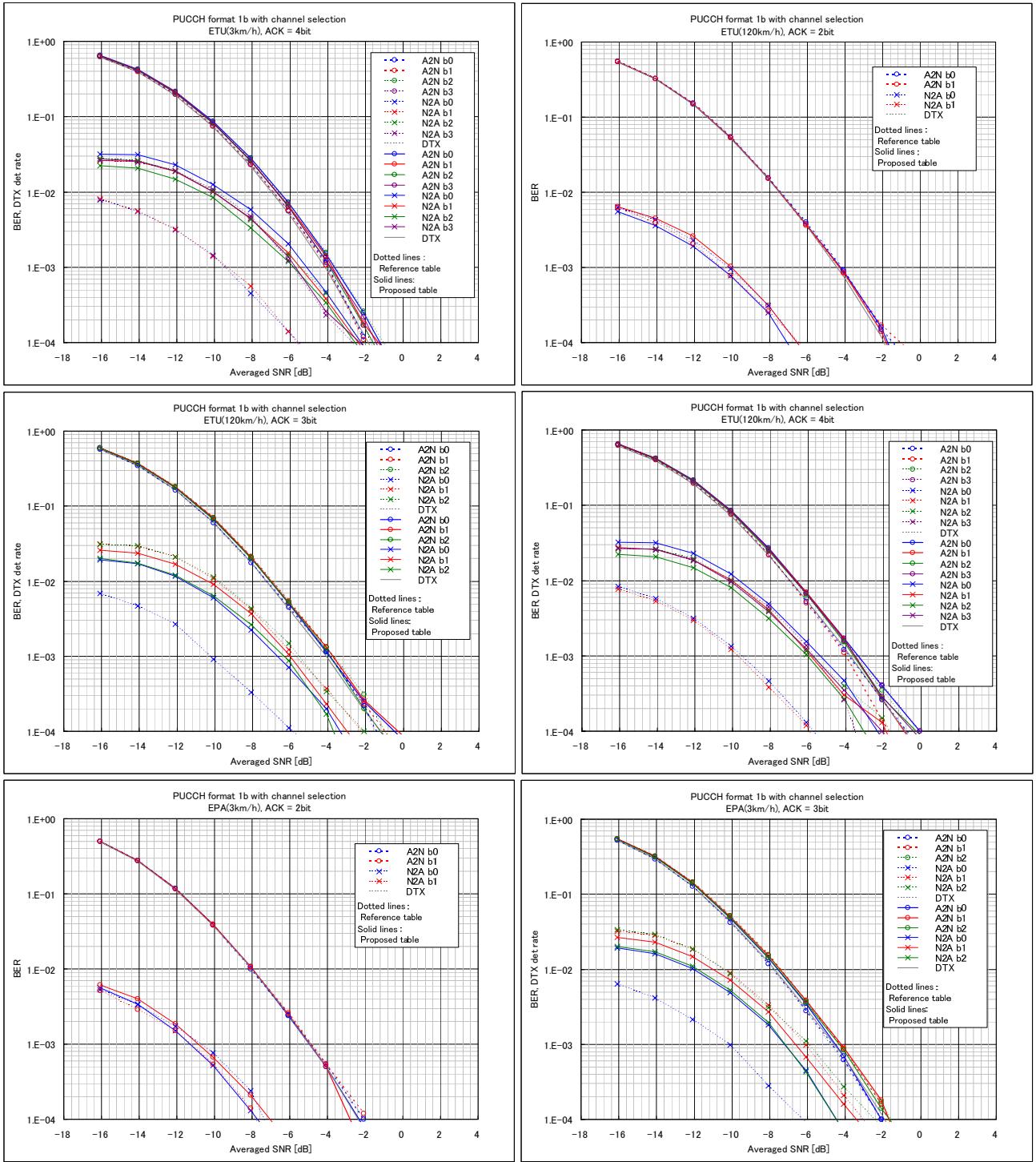


Figure 12 Simulation results of Nokia's tables

## Samsung





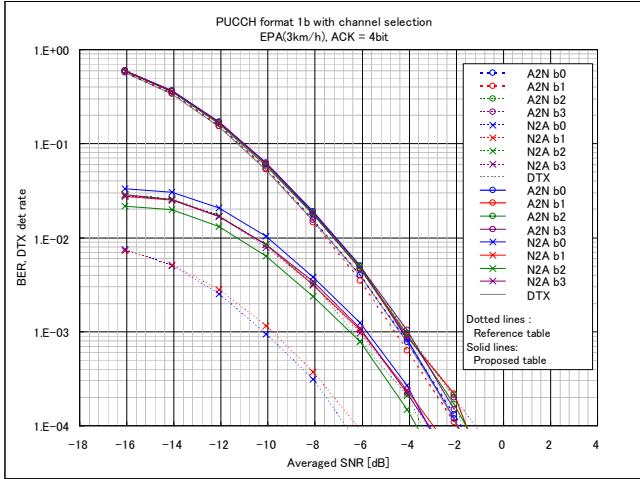
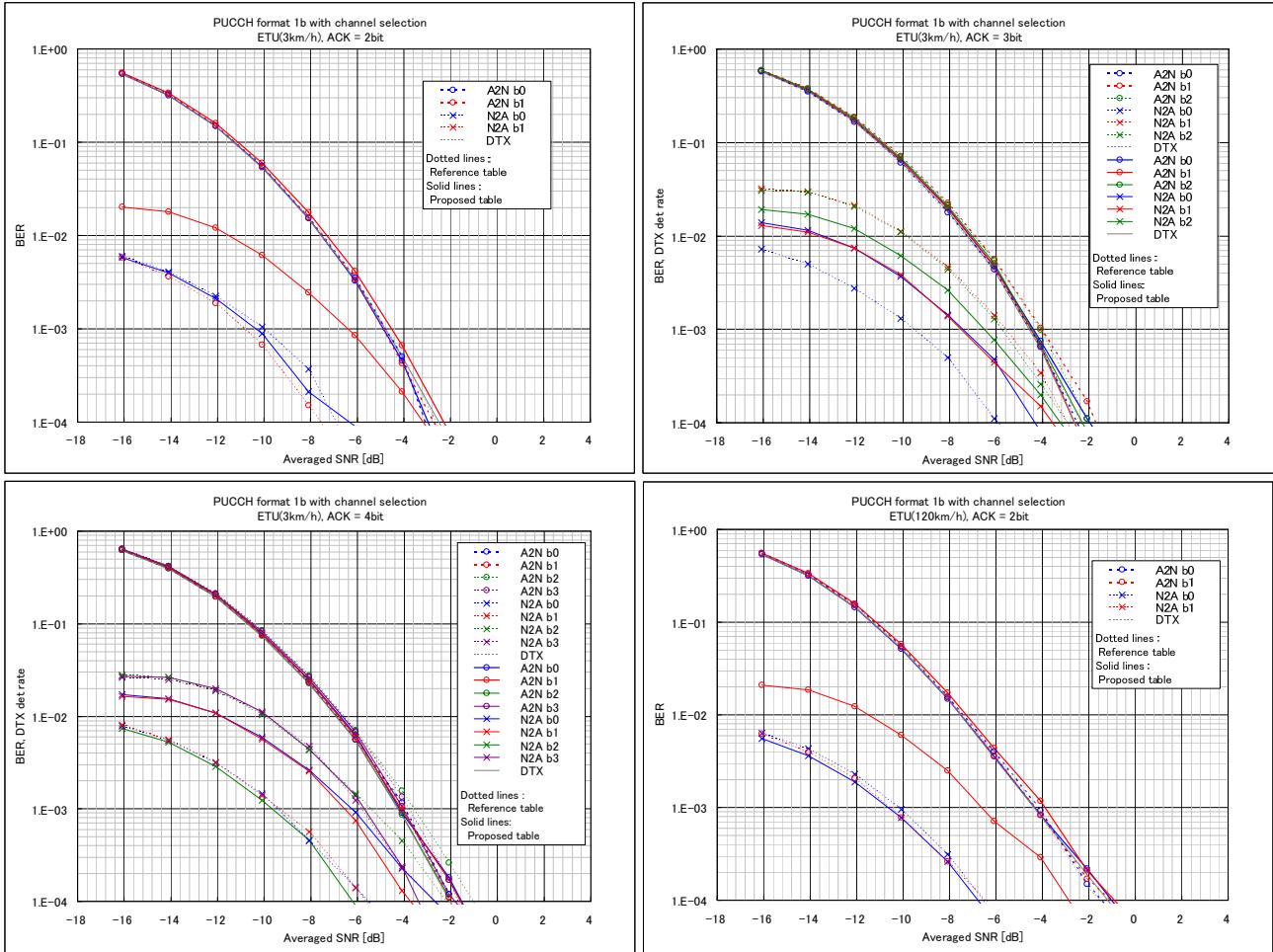


Figure 13 Simulation results of Samsung’s tables

CATT



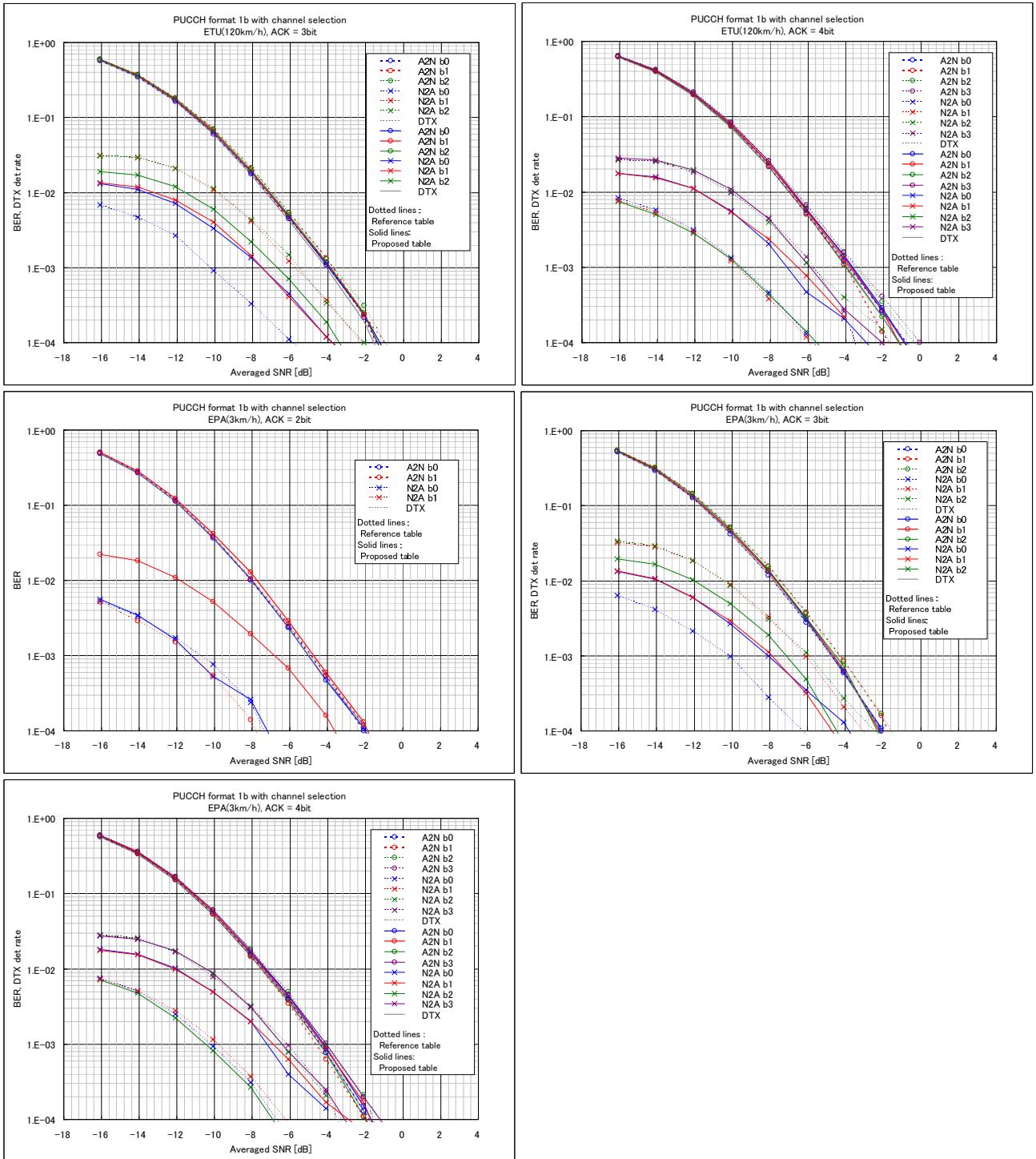
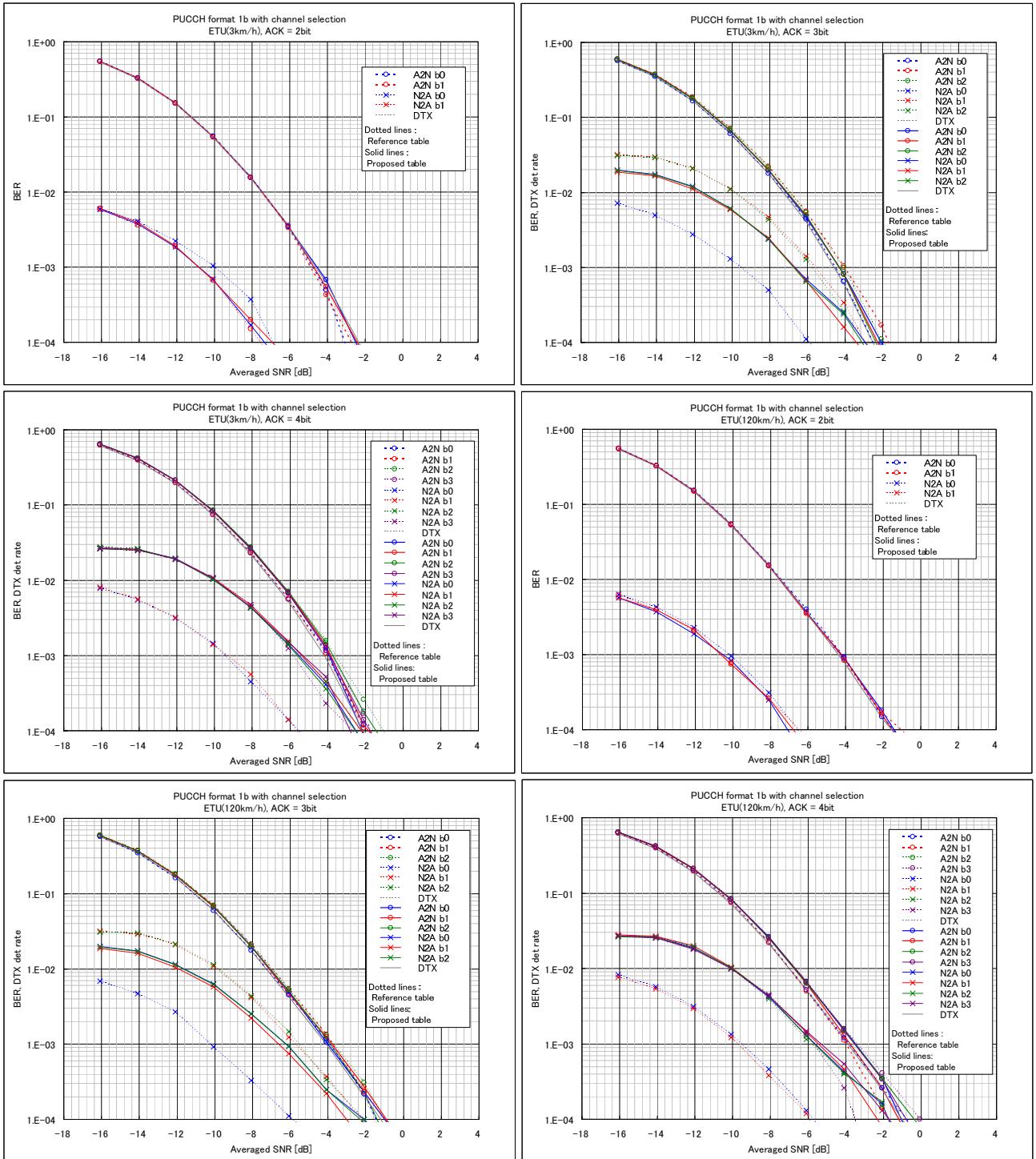


Figure 14 Simulation results of CATT's tables



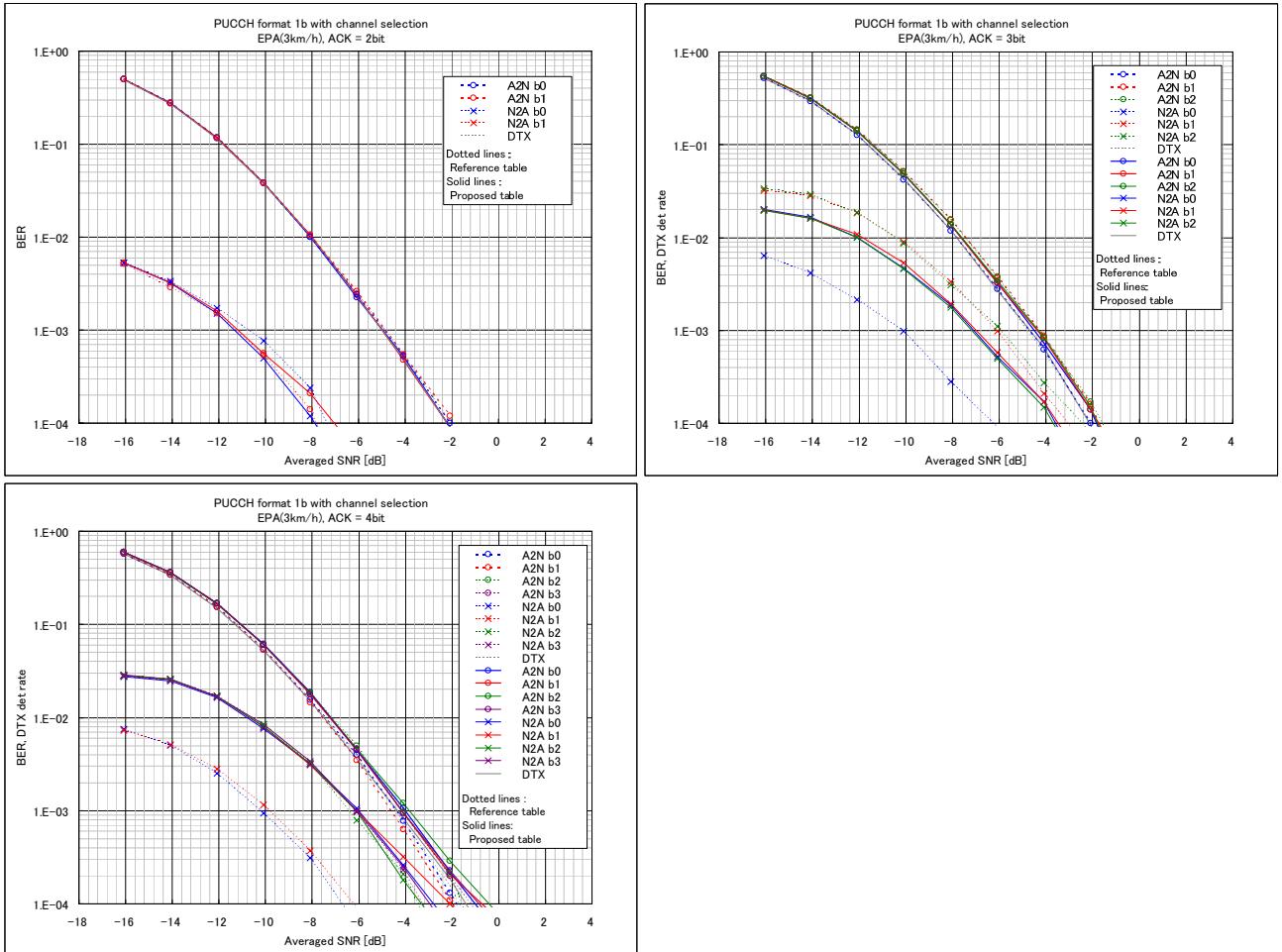


Figure 15 Simulation results of ZTE's tables

Table 5 Reference mapping tables for 2, 3 and 4 A/N bits

PUCCH resource		1	2
A,A		-1	
A,N	-1		
N,A		1	
N,N	1		

(a) 2 A/N mapping table

PUCCH resource		1	2
A,A,A		-1	
A,N,A		-j	
N,A,A	-1		
N,N,A	-j		
A,A,N		j	
A,N,N		1	
N,A,N	j		
N,N,N	1		

(b) 3 A/N mapping table

PUCCH resource		1	2	3	4
A,A,A,A				-1	
A,N,A,A				-1	
N,A,A,A			-1		
N,N,A,A	-1				
A,A,A,N				j	
A,N,A,N				j	
N,A,A,N		j			
N,N,A,N	j				
A,A,N,A				-j	
A,N,N,A				-j	
N,A,N,A		-j			
N,N,N,A	-j				
A,A,N,N				-j	1
A,N,N,N				1	
N,A,N,N		1			
N,N,N,N	1				

(c) 4 A/N mapping table