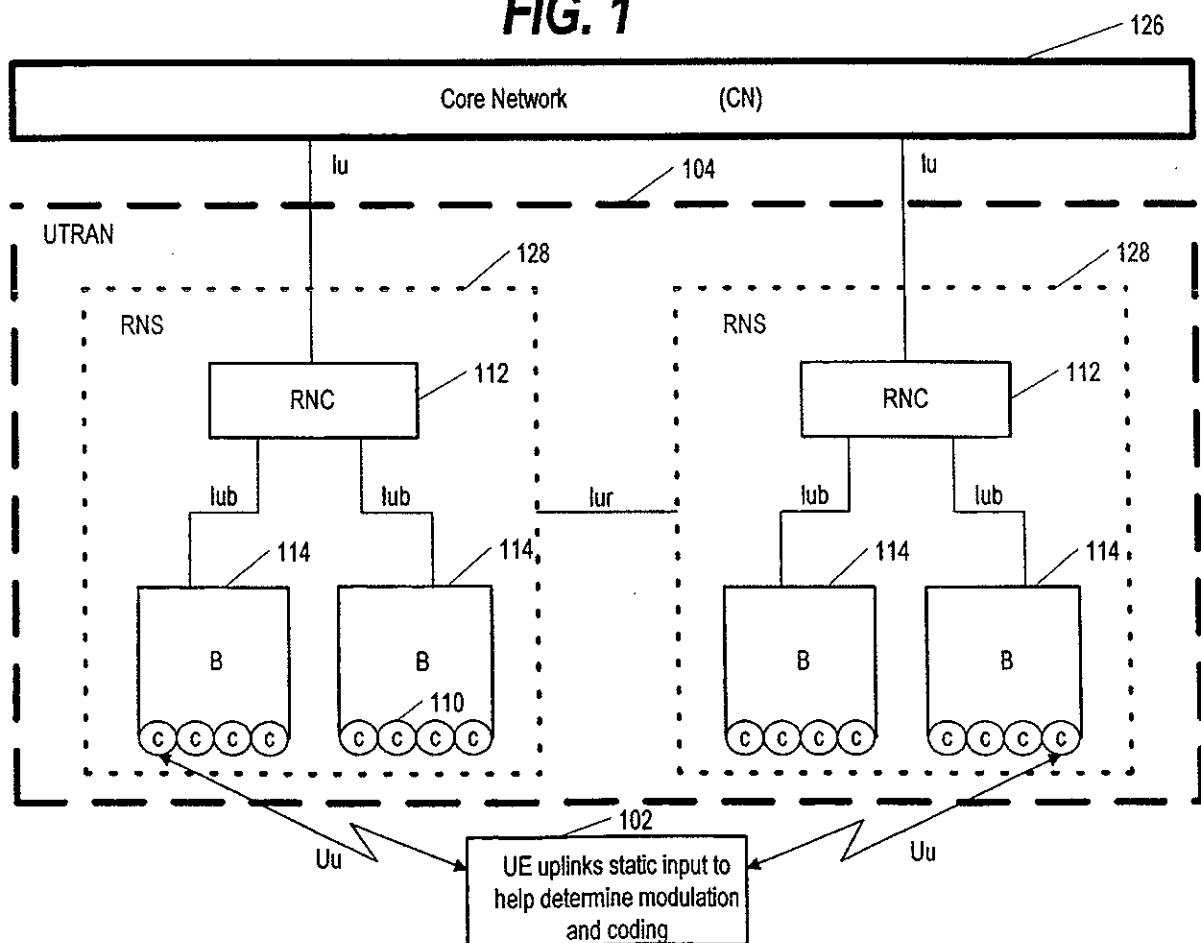


FIG. 1



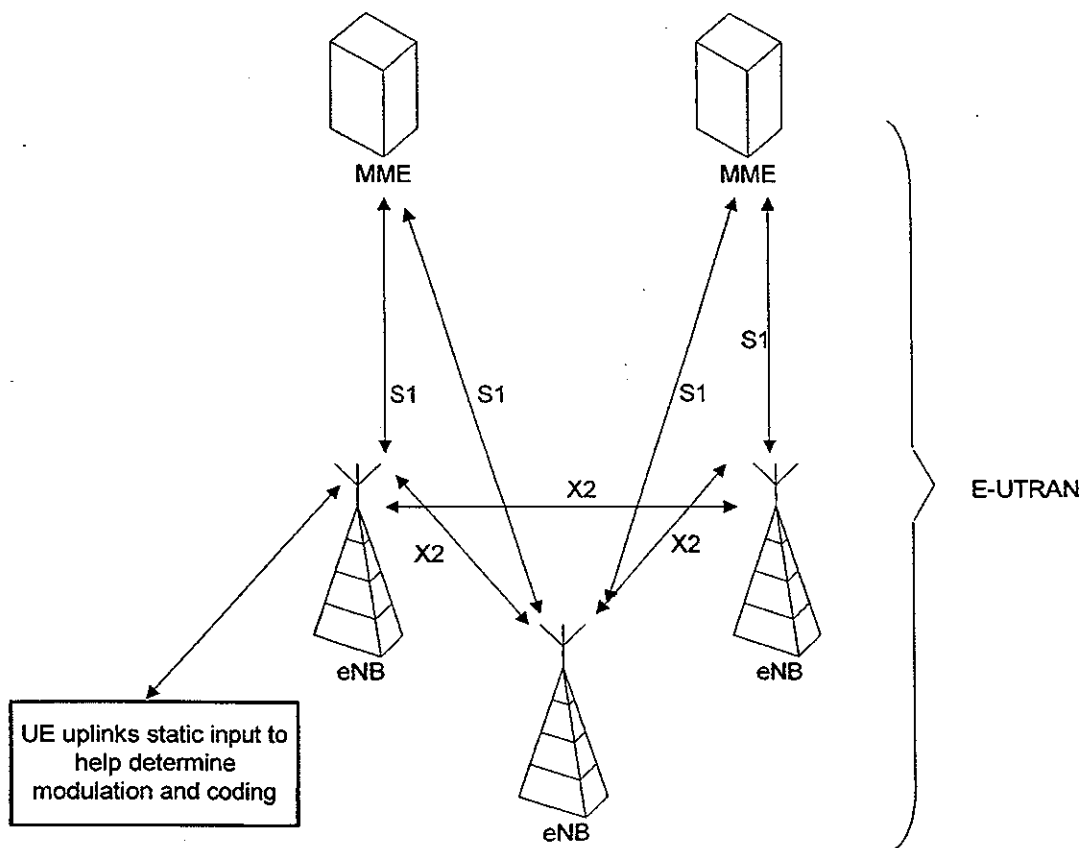


FIG. 2

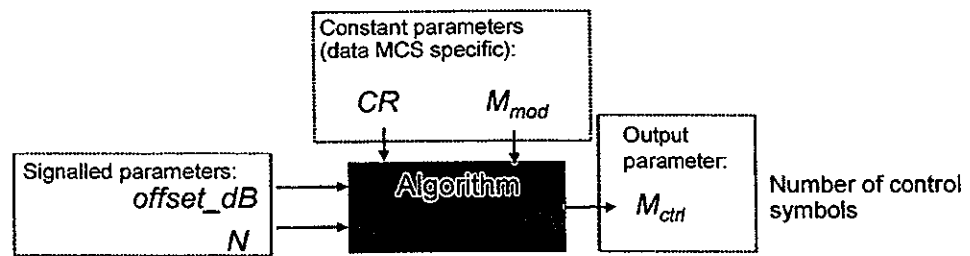


FIG. 3

symbol number	DTX	ACK/NACK
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		

FIG. 4A

symbol number	DTX	NACK	ACK
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			

FIG. 4B

symbol number	DTX	ACK/NACK
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		

FIG. 4C

symbol number	DTX/NACK	ACK
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		

FIG. 4D

Control channel performance

- CQI BLER = 10%
- A/N BER = 0.1%

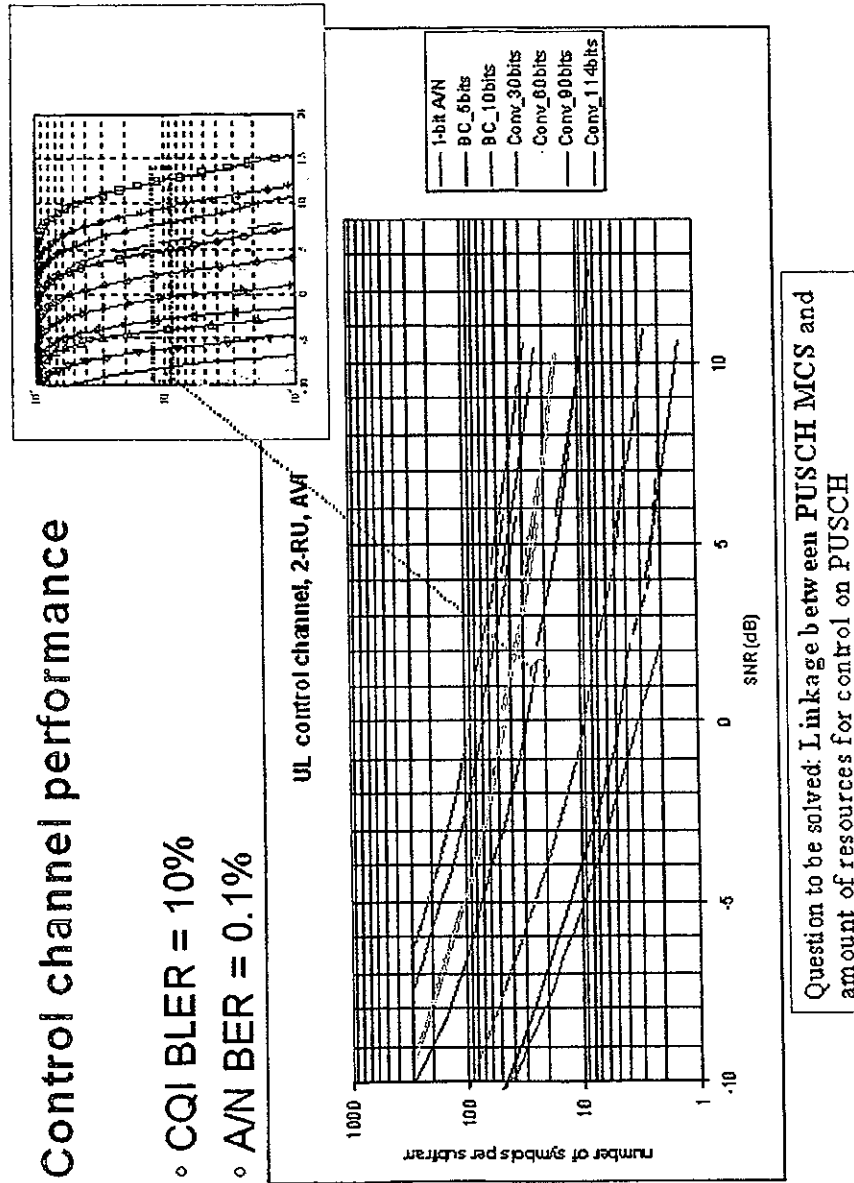


FIG 5

Control channel performance

- CQI BLER = 5%
- A/N BER = 0.1%

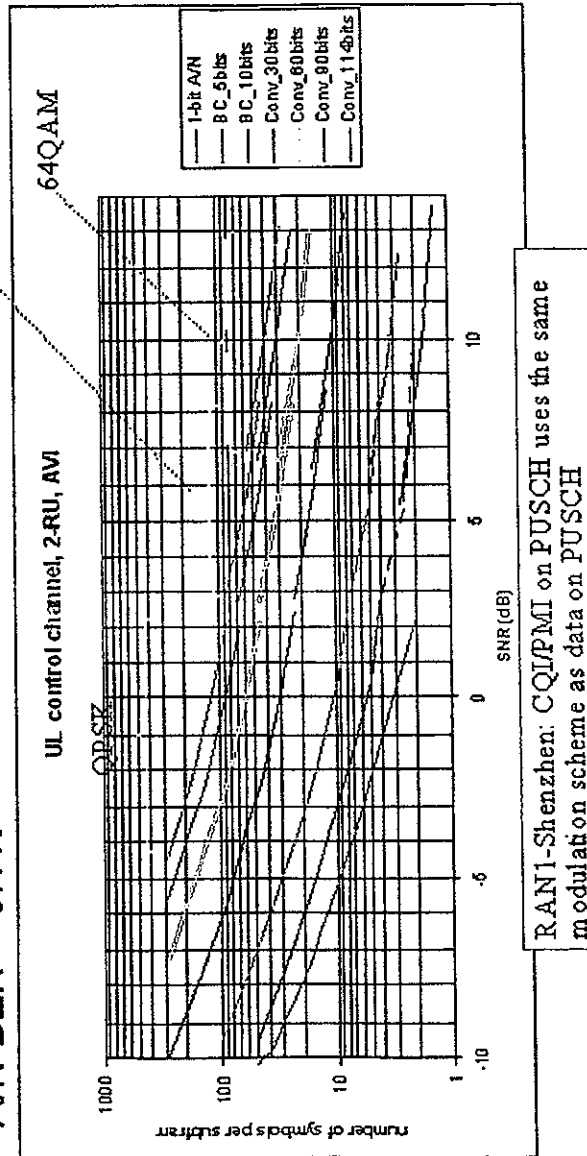


FIG 6

Control channel performance

- CQI BLER = 1% (QPSK, 16QAM, 64QAM)
- AN BER = 0.1%

The entire sub frame
(2RUs=288 symbols)
used for CQI

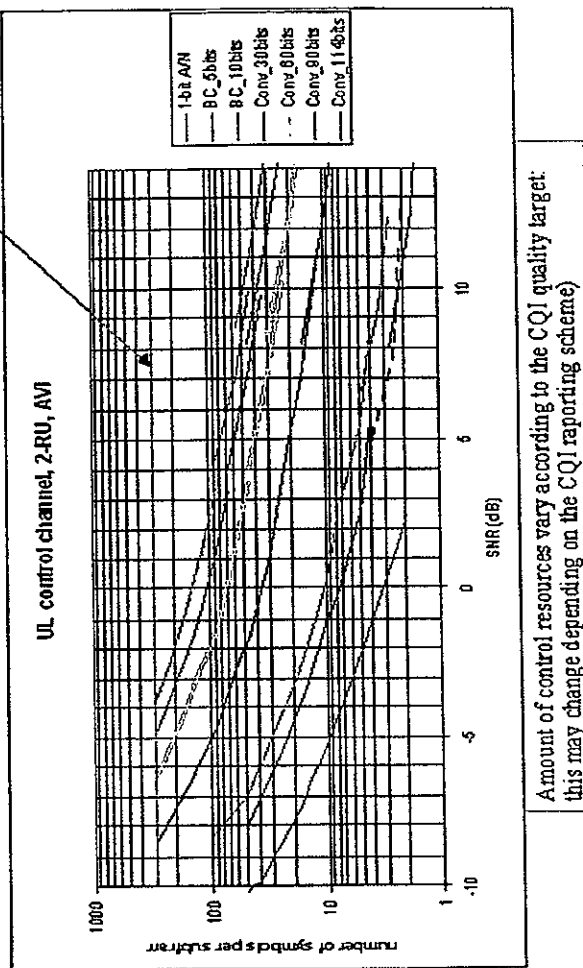
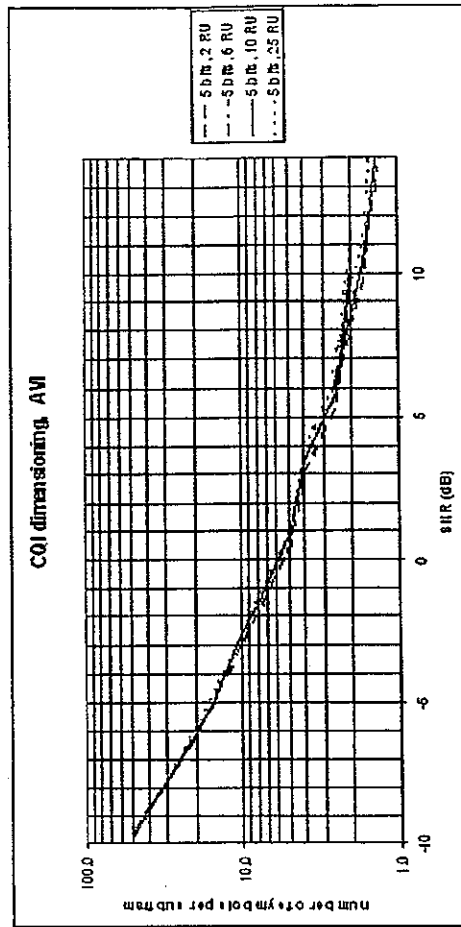


FIG 7

Control channel performance

- Comparison of different PUSCH BW options
- 5-bits CQI, block code
- Dynamic (non-persistent) scheduling -> AVI approach

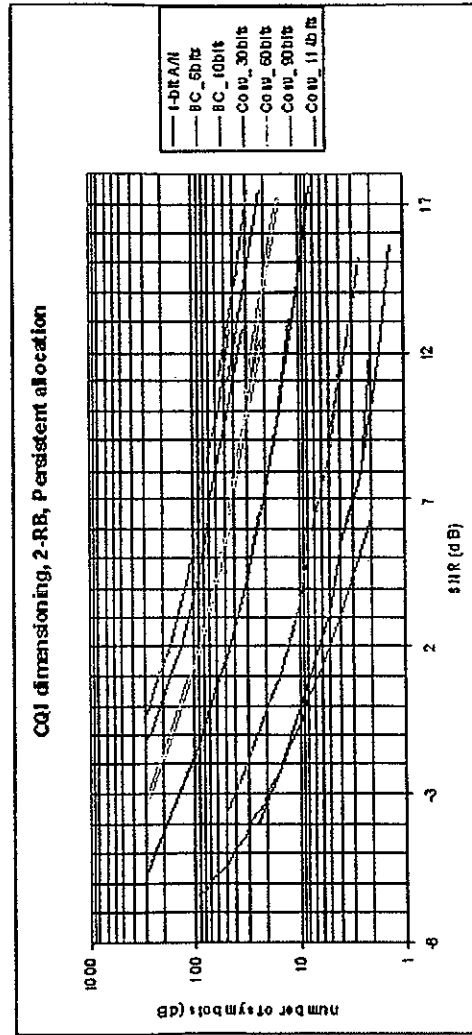


Different BW options perform almost equally, in terms of CQI BLER

FIG 8

Persistent Allocation, 2 RBs

- 2 RBs
- CQI BLER=5%, AN BER=0.1%, FH OFF



2 RB is the most important case with persistent allocation

FIG 9

Shenzhen decisions

- **Control signaling on PUSCH**
 - Modulation scheme
 - CQI/PMI on PUSCH uses the same modulation scheme as data on PUSCH
 - Code rate for control
 - Continue discussion until next meeting.
 - Offset
 - Semi-statically configured offset between the data MCS and the code rate of the control signaling (AN and CQI)
 - Next steps: Define the offset values. Discuss whether multiple offsets are needed e.g. when multiple services with different QoS are time multiplexed
- **Open Issues**
 - Linkage between PUSCH MCS and amount of resources for control on PUSCH (i.e., offset values)
 - UE procedure
 - NB procedure
 - Signalling support

FIG 10

Proposed scheme

- N : Number of control signalling bits (for given control type)
- M_{ctrl} : Number of control symbols for a certain control type
- $BPRE$: bits/resource element (symbol) for given data MCS
 - $BPRE = CR / M_{mod}$ $M_{mod} \in \{2, 4, 6\}$, $CR \in \{..., 4, 3, 2, 4/3, ... \}$
- $offset_dB$: quality difference between given control type and PUSCH data, configured via RRC
 - S(1)NR requirement for control – S(1)NR requirement for data
 - Configured/signalled via RRC
 - Common for all data MCS?

$$\lceil \cdot \rceil : \text{ceil operation } M_{ctrl} = \left\lceil \frac{N \cdot BPRE}{10^{\frac{-offset_dB}{10}}} \right\rceil$$

This equation locates at both UE and NB

FIG 11

Offset_dB (cont')

- **Offset_dB**: Compensates the performance difference between control and data channel
 - Different BLER operation point (data & control)
 - Different Packet size (coding gain)
 - No coding (A/N)
 - BW allocation (persistent allocation)

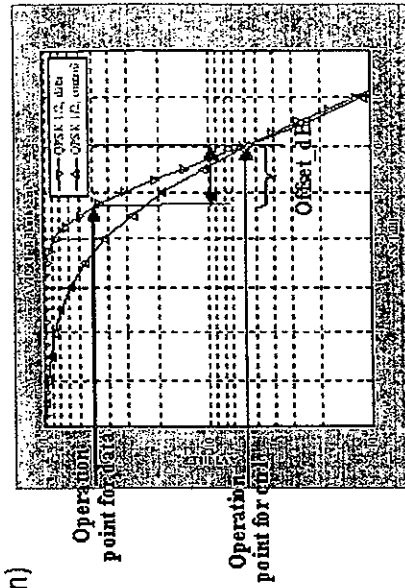


FIG 12

Example

- BLER_data < 30%
- BLER_CQI < 5%
- Offset_dB = 1.1 dB

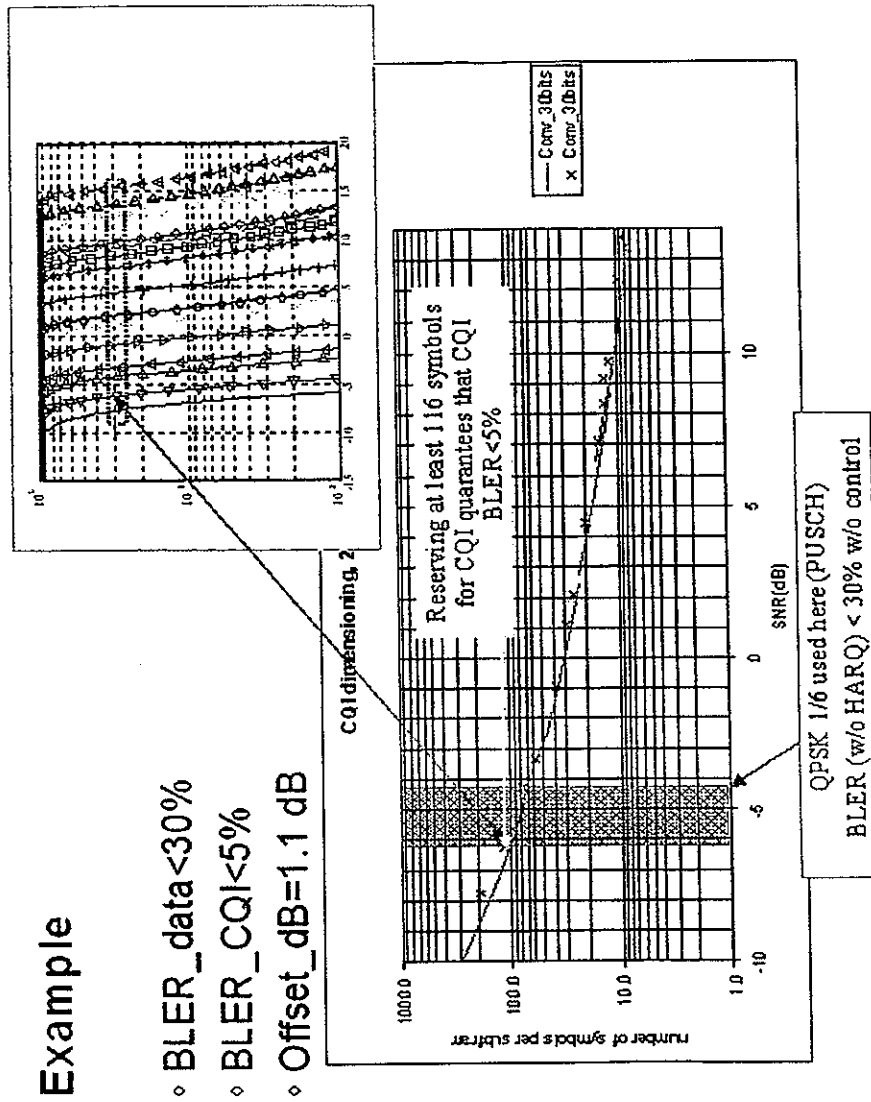


FIG 13

Numerical values for offset

- BLER_data<40%
- BLER_CQI<5%

N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
Offset_dB	0.8	1.1	1.3	1.5	1.7	1.9	2.1	2.3	2.5	2.7	2.9	3.1	3.3	3.5	3.7	3.9	4.1	4.3	4.5	4.7	4.9	5.1	5.3	5.5	5.7	5.9	6.1	6.3	6.5	6.7	6.9	7.1	7.3	7.5	7.7	7.9	8.1	8.3	8.5	8.7	8.9	9.1	9.3	9.5	9.7	9.9	10.1	10.3	10.5	10.7	10.9	11.1	11.3	11.5	11.7	11.9	12.1	12.3	12.5	12.7	12.9	13.1	13.3	13.5	13.7	13.9	14.1	14.3	14.5	14.7	14.9	15.1	15.3	15.5	15.7	15.9	16.1	16.3	16.5	16.7	16.9	17.1	17.3	17.5	17.7	17.9	18.1	18.3	18.5	18.7	18.9	19.1	19.3	19.5	19.7	19.9	20.1	20.3	20.5	20.7	20.9	21.1	21.3	21.5	21.7	21.9	22.1	22.3	22.5	22.7	22.9	23.1	23.3	23.5	23.7	23.9	24.1	24.3	24.5	24.7	24.9	25.1	25.3	25.5	25.7	25.9	26.1	26.3	26.5	26.7	26.9	27.1	27.3	27.5	27.7	27.9	28.1	28.3	28.5	28.7	28.9	29.1	29.3	29.5	29.7	29.9	30.1	30.3	30.5	30.7	30.9	31.1	31.3	31.5	31.7	31.9	32.1	32.3	32.5	32.7	32.9	33.1	33.3	33.5	33.7	33.9	34.1	34.3	34.5	34.7	34.9	35.1	35.3	35.5	35.7	35.9	36.1	36.3	36.5	36.7	36.9	37.1	37.3	37.5	37.7	37.9	38.1	38.3	38.5	38.7	38.9	39.1	39.3	39.5	39.7	39.9	40.1	40.3	40.5	40.7	40.9	41.1	41.3	41.5	41.7	41.9	42.1	42.3	42.5	42.7	42.9	43.1	43.3	43.5	43.7	43.9	44.1	44.3	44.5	44.7	44.9	45.1	45.3	45.5	45.7	45.9	46.1	46.3	46.5	46.7	46.9	47.1	47.3	47.5	47.7	47.9	48.1	48.3	48.5	48.7	48.9	49.1	49.3	49.5	49.7	49.9	50.1	50.3	50.5	50.7	50.9	51.1	51.3	51.5	51.7	51.9	52.1	52.3	52.5	52.7	52.9	53.1	53.3	53.5	53.7	53.9	54.1	54.3	54.5	54.7	54.9	55.1	55.3	55.5	55.7	55.9	56.1	56.3	56.5	56.7	56.9	57.1	57.3	57.5	57.7	57.9	58.1	58.3	58.5	58.7	58.9	59.1	59.3	59.5	59.7	59.9	60.1	60.3	60.5	60.7	60.9	61.1	61.3	61.5	61.7	61.9	62.1	62.3	62.5	62.7	62.9	63.1	63.3	63.5	63.7	63.9	64.1	64.3	64.5	64.7	64.9	65.1	65.3	65.5	65.7	65.9	66.1	66.3	66.5	66.7	66.9	67.1	67.3	67.5	67.7	67.9	68.1	68.3	68.5	68.7	68.9	69.1	69.3	69.5	69.7	69.9	70.1	70.3	70.5	70.7	70.9	71.1	71.3	71.5	71.7	71.9	72.1	72.3	72.5	72.7	72.9	73.1	73.3	73.5	73.7	73.9	74.1	74.3	74.5	74.7	74.9	75.1	75.3	75.5	75.7	75.9	76.1	76.3	76.5	76.7	76.9	77.1	77.3	77.5	77.7	77.9	78.1	78.3	78.5	78.7	78.9	79.1	79.3	79.5	79.7	79.9	80.1	80.3	80.5	80.7	80.9	81.1	81.3	81.5	81.7	81.9	82.1	82.3	82.5	82.7	82.9	83.1	83.3	83.5	83.7	83.9	84.1	84.3	84.5	84.7	84.9	85.1	85.3	85.5	85.7	85.9	86.1	86.3	86.5	86.7	86.9	87.1	87.3	87.5	87.7	87.9	88.1	88.3	88.5	88.7	88.9	89.1	89.3	89.5	89.7	89.9	90.1	90.3	90.5	90.7	90.9	91.1	91.3	91.5	91.7	91.9	92.1	92.3	92.5	92.7	92.9	93.1	93.3	93.5	93.7	93.9	94.1	94.3	94.5	94.7	94.9	95.1	95.3	95.5	95.7	95.9	96.1	96.3	96.5	96.7	96.9	97.1	97.3	97.5	97.7	97.9	98.1	98.3	98.5	98.7	98.9	99.1	99.3	99.5	99.7	99.9	100.1	100.3	100.5	100.7	100.9	101.1	101.3	101.5	101.7	101.9	102.1	102.3	102.5	102.7	102.9	103.1	103.3	103.5	103.7	103.9	104.1	104.3	104.5	104.7	104.9	105.1	105.3	105.5	105.7	105.9	106.1	106.3	106.5	106.7	106.9	107.1	107.3	107.5	107.7	107.9	108.1	108.3	108.5	108.7	108.9	109.1	109.3	109.5	109.7	109.9	110.1	110.3	110.5	110.7	110.9	111.1	111.3	111.5	111.7	111.9	112.1	112.3	112.5	112.7	112.9	113.1	113.3	113.5	113.7	113.9	114.1	114.3	114.5	114.7	114.9	115.1	115.3	115.5	115.7	115.9	116.1	116.3	116.5	116.7	116.9	117.1	117.3	117.5	117.7	117.9	118.1	118.3	118.5	118.7	118.9	119.1	119.3	119.5	119.7	119.9	120.1	120.3	120.5	120.7	120.9	121.1	121.3	121.5	121.7	121.9	122.1	122.3	122.5	122.7	122.9	123.1	123.3	123.5	123.7	123.9	124.1	124.3	124.5	124.7	124.9	125.1	125.3	125.5	125.7	125.9	126.1	126.3	126.5	126.7	126.9	127.1	127.3	127.5	127.7	127.9	128.1	128.3	128.5	128.7	128.9	129.1	129.3	129.5	129.7	129.9	130.1	130.3	130.5	130.7	130.9	131.1	131.3	131.5	131.7	131.9	132.1	132.3	132.5	132.7	132.9	133.1	133.3	133.5	133.7	133.9	134.1	134.3	134.5	134.7	134.9	135.1	135.3	135.5	135.7	135.9	136.1	136.3	136.5	136.7	136.9	137.1	137.3	137.5	137.7	137.9	138.1	138.3	138.5	138.7	138.9	139.1	139.3	139.5	139.7	139.9	140.1	140.3	140.5	140.7	140.9	141.1	141.3	141.5	141.7	141.9	142.1	142.3	142.5	142.7	142.9	143.1	143.3	143.5	143.7	143.9	144.1	144.3	144.5	144.7	144.9	145.1	145.3	145.5	145.7	145.9	146.1	146.3	146.5	146.7	146.9	147.1	147.3	147.5	147.7	147.9	148.1	148.3	148.5	148.7	148.9	149.1	149.3	149.5	149.7	149.9	150.1	150.3	150.5	150.7	150.9	151.1	151.3	151.5	151.7	151.9	152.1	152.3	152.5	152.7	152.9	153.1	153.3	153.5	153.7	153.9	154.1	154.3	154.5	154.7	154.9	155.1	155.3	155.5	155.7	155.9	156.1	156.3	156.5	156.7	156.9	157.1	157.3	157.5	157.7	157.9	158.1	158.3	158.5	158.7	158.9	159.1	159.3	159.5	159.7	159.9	160.1	160.3	160.5	160.7	160.9	161.1	161.3	161.5	161.7	161.9	162.1	162.3	162.5	162.7	162.9	163.1	163.3	163.5	163.7	163.9	164.1	164.3	164.5	164.7	164.9	165.1	165.3	165.5	165.7	165.9	166.1	166.3	166.5	166.7	166.9	167.1	167.3	167.5	167.7	167.9	168.1	168.3	168.5	168.7	168.9	169.1	169.3	169.5	169.7	169.9	170.1	170.3	170.5	170.7	170.9	171.1	171.3	171.5	171.7	171.9	172.1	172.3	172.5	172.7	172.9	173.1	173.3	173.5	173.7	173.9	174.1	174.3	174.5	174.7	174.9	175.1	175.3	175.5	175.7	175.9	176.1	176.3	176.5	176.7	176.9	177.1	177.3	177.5	177.7	177.9	178.1	178.3	178.5	178.7	178.9	179.1	179.3	179.5	179.7	179.9	180.1	180.3	180.5	180.7	180.9	181.1	181.3	181.5	181.7	181.9	182.1	182.3	182.5	182.7	182.9	183.1	183.3	183.5	183.7	183.9	184.1	184.3	184.5	184.7	184.9	185.1	185.3	185.5	185.7	185.9	186.1	186.3	186.5	186.7	186.9	187.1	187.3	187.5	187.7	187.9	188.1	188.3	188.5	188.7	188.9	189.1	189.3	189.5	189.7	189.9	190.1	190.3	190.5	190.7	190.9	191.1	191.3	191.5	191.7	191.9	192.1	192.3	192.5	192.7	192.9	193.1	193.3	193.5	193.7	193.9	194.1	194.3	194.5	194.7	194.9	195.1	195.3	195.5	195.7	195.9	196.1	196.3	196.5	196.7	196.9	197.1	197.3	197.5	197.7	197.9	198.1	198.3	198.5	198.7	198.9	199.1	199.3	199.5	199.7	199.9	200.1	200.3	200.5	200.7	200.9	201.1	201.3	201.5	201.7	201.9	202.1	202.3	202.5	202.7	202.9	203.1	203.3	203.5	203.7	203.9	204.1	204.3	204.5	204.7	204.9	205.1	205.3	205.5	205.7	205.9	206.1	206.3	206.5	206.7	206.9	207.1	207.3	207.5	207.7	207.9	208.1	208.3	208.5	208.7	208.9	209.1	209.3	209.5	209.7	209.9	210.1	210.3	210.5	210.7	210.9	211.1	211.3	211.5	211.7	211.9	212.1	212.3	212.5	212.7	212.9	213.1	213.3	213.5	213.7	213.9	214.1	214.3	214.5	214.7	214.9	215.1	215.3	215.5	215.7	215.9	216.1	216.3	216.5	216.7	216.9	217.1	217.3	217.5	217.7	217.9	218.1	218.3	218.5	218.7	218.9	219.1	219.3	219.5	219.7	219.9	220.1	220.3	220.5	220.7	220.9	221.1	221.3	221.5	221.7	221.9	222.1	222.3	222.5	222.7	222.9	223.1	223.3	223.5	223.7	223.9	224.1	224.3	224.5	224.7	224.9	225.1	225.3	225.5	225.7	225.9	226.1	226.3	226.5	226.7	226.9	227.1	227.3	227.5	227.7	227.9	228.1	228.3	228.5	228.7	228.9	229.1	229.3	229.5	229.7	229.9	230.1	230.3	230.5	230.7	230.9	231.1	231.3	231.5	231.7	231.9	232.1	232.3	232.5	232.7	232.9	233.1	233.3	233.5	233.7	233.9	234.1	234.3	234.5	234.7	234.9	235.1	235.3	235.5	235.7	235.9	236.1	236.3	236.5	236.7	236.9	237.1	237.3	237.5	237.7	237.9	238.1	238.3	238.5	238.7	238.9	239.1	239.3	239.5	239.7	239.9	240.1	240.3	240.5	240.7	240.9	241.1	241.3	241.5	241.7	241.9	2

Numerical values for offset

- BLER_data<50%
- BLER_CQI<5%

N	1	5	10	30	60	90	114
Offset, dB	7.0	2.0	1.9	1.4	1.3	1.3	1.3

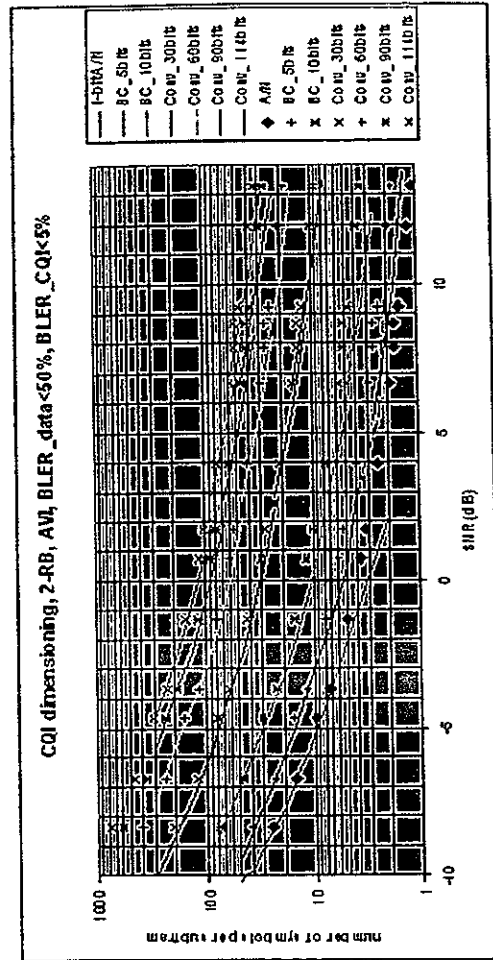


FIG 15

Numerical values for offset

- BLER_data<20%
- BLER_CQI<1%

N	1	5	10	30	60	114
Offset _{dB}	0.3	2.7	2.6	1.5	1.5	1.5

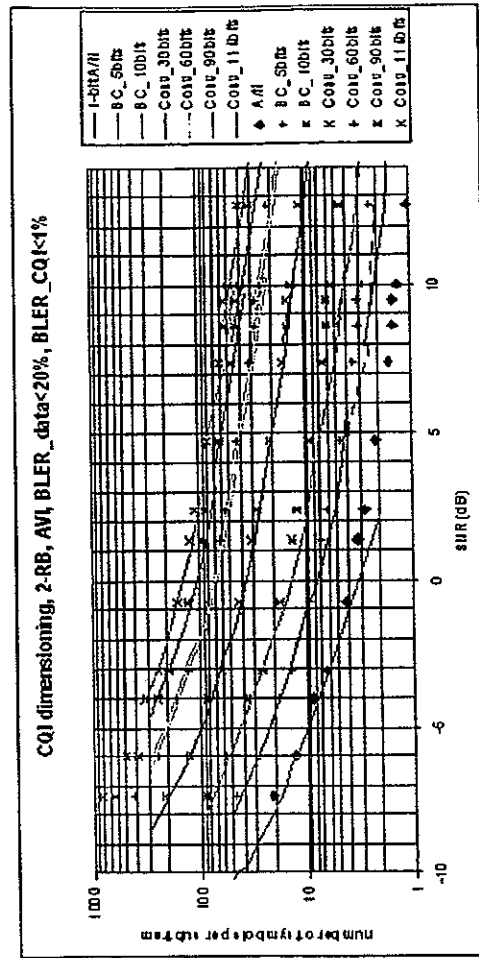


FIG 16

Numerical values for offset

BLER_data<20%

BLER_CQI<10%

N	1	5	10	30	60	90	114
Offset dB	0.3	0.5	0.5	0.4	0.4	0.4	0.4

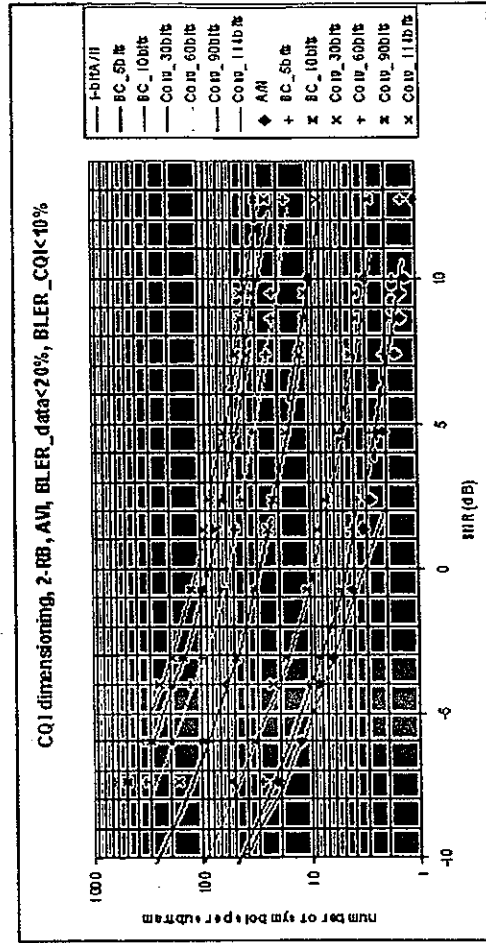


FIG 17

Summary of Numerical values (2RB)

•BLER

	Block codes				Conv. coding			
	1	6	10	30	60	90	114	114
	70	20	19	14	13	13	13	13
- Data<50%, CQI<5%	N	$Offset_{dB}$						
	1	6	10	30	60	90	114	114
	63	36	31	22	22	22	22	22
- Data<40%, CQI<1%	N	$Offset_{dB}$						
	1	6	10	30	60	90	114	114
	63	18	16	12	12	12	12	12
- Data<40%, CQI<5%	N	$Offset_{dB}$						
	1	6	10	30	60	90	114	114
	63	14	14	08	08	08	08	08
- Data<40%, CQI<10%	N	$Offset_{dB}$						
	1	6	10	30	60	90	114	114
	63	16	16	10	10	10	10	10
- Data<30%, CQI<5%	N	$Offset_{dB}$						
	1	6	10	30	60	90	114	114
	63	27	26	16	16	16	16	16
- Data<20%, CQI<1%	N	$Offset_{dB}$						
	1	6	10	30	60	90	114	114
	63	12	12	08	08	08	08	08
- Data<20%, CQI<5%	N	$Offset_{dB}$						
	1	6	10	30	60	90	114	114
	63	05	05	04	04	04	04	04
- Data<20%, CQI<10%	N	$Offset_{dB}$						

AN
63 9 70
(dB)

CQI
04 1 3.1 (dB)

FIG 18

Signalling

- ACK/NACK
 - Dynamic range: X dB?
 - DTX-to-ACK issue needs to be solved (these results assume explicit DTX signalling bit included in UL grant)
 - RRC signalling can be used
- Other control formats (CQI)
 - Dynamic range: Y dB
 - CQI size –specific (to some extent)
 - Signalled via RRC signalling
- Persistent A/N
 - Separate Offset_dB parameter

FIG 19

Observations

- In some cases, more than 1 different value (e.g.,) Offset_dB values can be considered
 - One applicable for low MCSs
 - Another applicable for high MCSs
- The same applies for different BW allocations for PUSCH
 - Offset_dB_1 for $BW < K$ RBs
 - Offset_dB_2 for $BW = K$ RBs
- If multiple services having different BLER operation point are applied simultaneously different (fixed) offset value can be applied

FIG 20

Improved DTX detection

- The preferred use case for improved DTX detection is the situation in which the UL grant is not present ($\rightarrow$ 1 bit included in UL grant cannot be used)
- In these cases, it is possible to always reserve M_{ctrl} symbols and transmit NACK or DTX using this symbol space. Problem is the excessive control overhead.
- The idea of improved DTX detection is to define the control signaling size in such that a certain number of ACK/NACK symbols are always reserved. The idea can be presented as follows:

$$M_{ctrl} = \max\left(\left\lceil \frac{N \cdot BPPE}{10^{\frac{-offset_{dB}}{10}}}, K \right\rceil\right)$$

- where K is a predetermined number, e.g., 8-10.
- This number is selected in such that it will provide sufficient DTX detection performance while maintaining reasonable control overhead.
- When ACK/NACK is present, then the number of A/N symbols is calculated based the equation above.
- In the case when ACK/NACK is absent, then K symbols are still reserved.
 - In these cases, UE can signal either NACK or DTX.
- Benefit of this arrangement is that control overhead is reduced and, at the same time DTX performance is always guaranteed.

FIG 21

Simulation assumptions

- Both short-term (non-persistent scheduling) and long-term performance (persistent scheduling) are considered
 - Frequency hopping OFF
- Bandwidth allocation: [2, 6, 10, 25] RBs
- TU channel, $v=3$ km/h, 2 receiving antennas
- Channel coding
 - Block coding (32, N) with $N=5$, $N=10$
 - Tail-biting convolutional codes (1/3)
 - Simple matching has been used to support variable code rates for CQI
 - Convolutional codes:
 - repetition of every N th bit
 - puncturing of parity bits only
 - Block codes:
 - Repetition/puncturing for every N th bit
- Practical receiver assumptions, realistic channel estimation

FIG 22

Control channel performance, 2RBs
(short-term)

- CQI BLER = 10%
- A/N BER = 0.1%

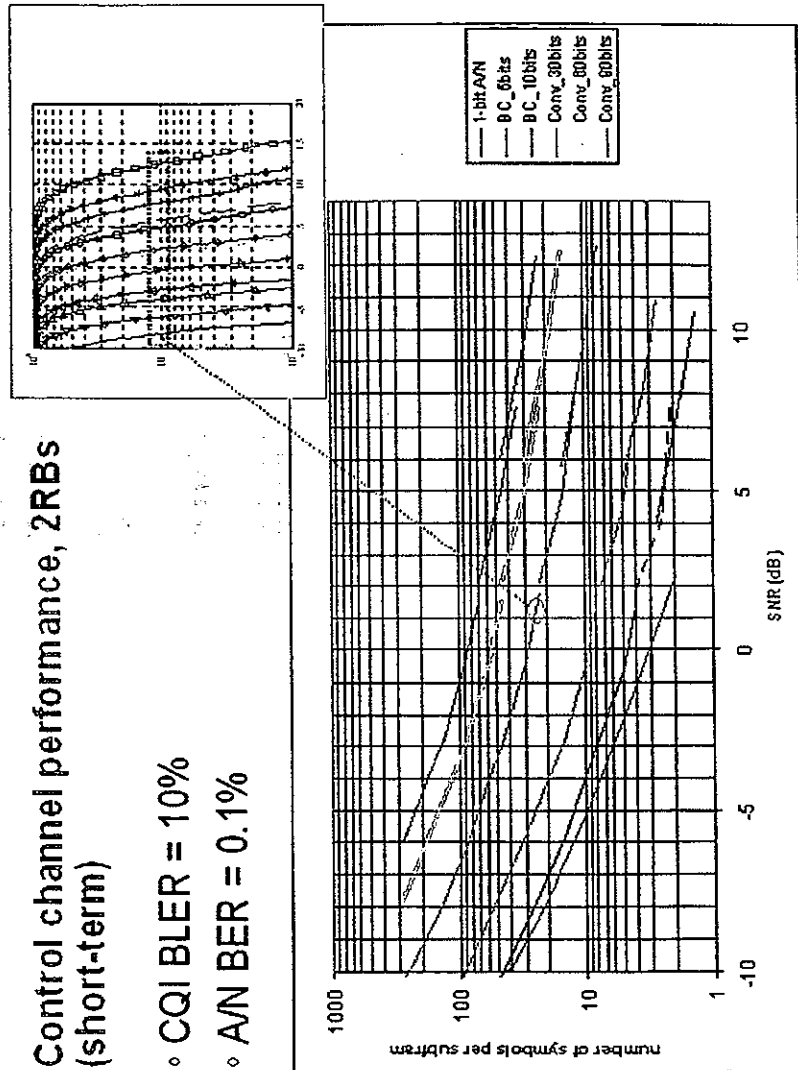


FIG 23

Control channel performance, 2RBs (short-term)

◦ RAN1-Shenzhen: CQ/PMI on PUSCH uses the same modulation scheme as data on PUSCH

- CQI BLER = 5%
- A/N BER = 0.1%

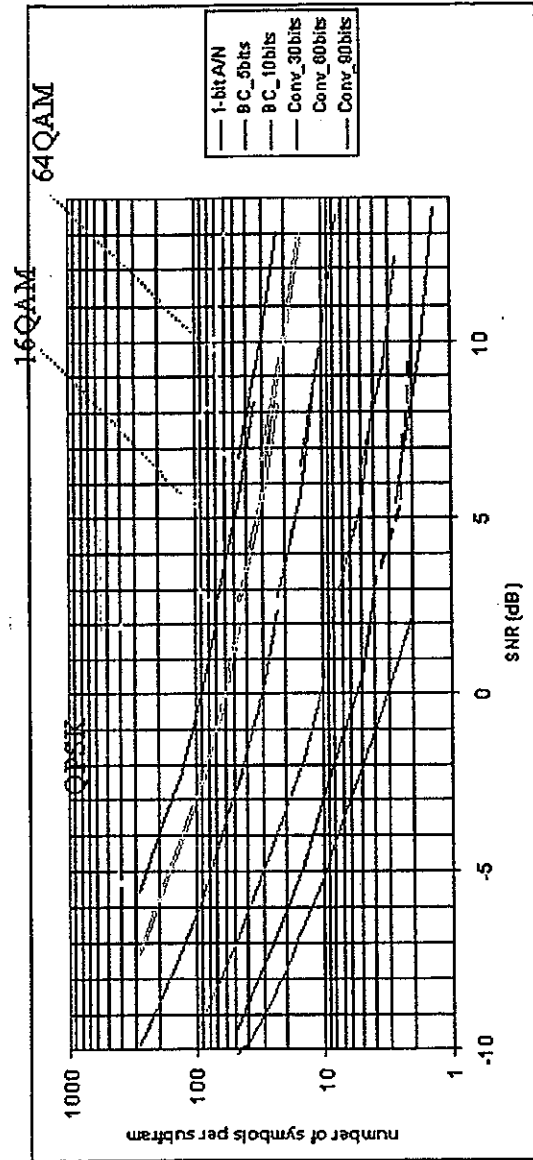


FIG 24

Control channel performance, 2RBs (short-term)

- CQI BLER = 1%
- A/N BER = 0.1%

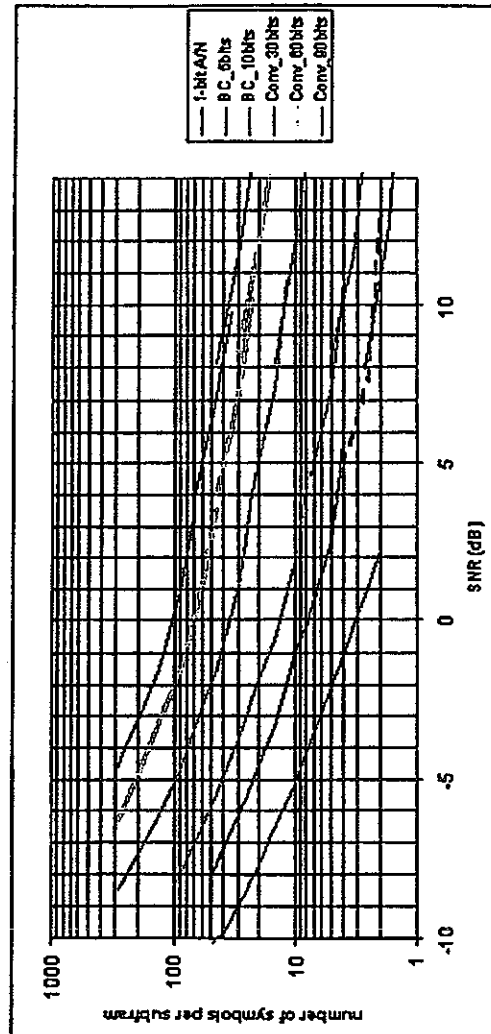


FIG 25

Control channel performance, (short-term)

- Performance comparison for different PUSCH BW options
 - 5-bits CQI, block code
- Different BW options perform almost equally, in terms of CQI BLER
 - The same applies for PUSCH data (short-term performance)

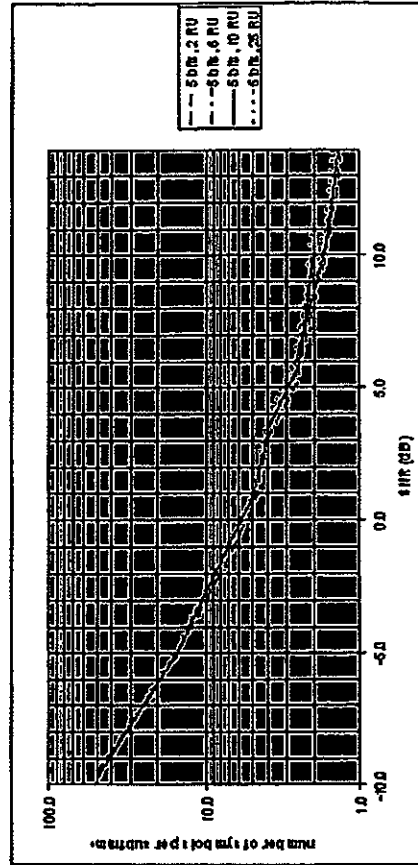


FIG 26

Control channel performance, (long-term)

- 2 RBs, FH OFF
- CQI BLER=5%,
- A/N BER=0.1%

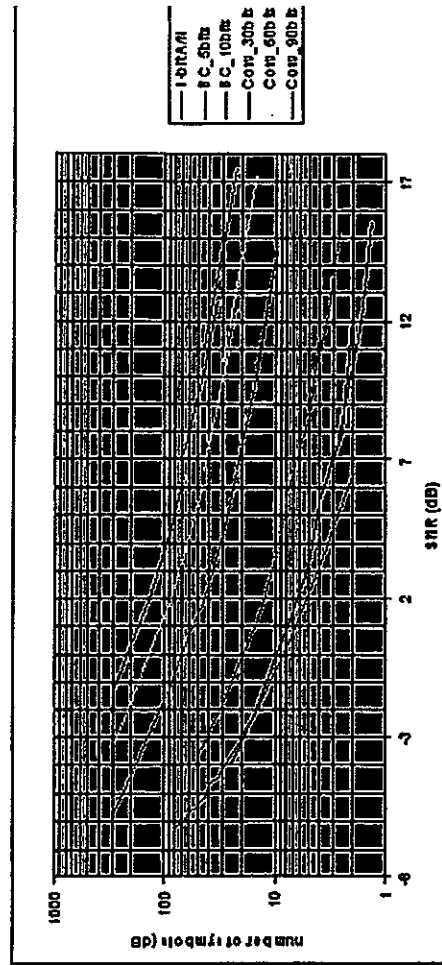


FIG 27

RAN1 Status

- **Control signaling on PUSCH**
 - **Modulation scheme**
 - CQI/PMI on PUSCH uses the same modulation scheme as data on PUSCH
 - **Offset**
 - Semi-statically configured offset between the data MCS and the code rate of the control signaling (AN and CQI)
 - Next steps: Define the offset values. Discuss whether multiple offsets are needed e.g. when multiple services with different QoS are time multiplexed
- **Open issues**
 - **Formula to determine the size of control region based on data MCS**
 - **Offset values**

FIG 28

Proposed formula to determine the size of control region based on data MCS

- M_{ctrl} : Number of control symbols for given control type
- N : Number of control signalling bits (for given control type)
- CR : coding rate of given PUSCH MCS, e.g., 3/1
- M_{mod} : number of (uncoded) bits/symbol $M_{mod} \in \{2, 4, 6\}$
- $offset_dB$: quality difference between given control type and PUSCH data
 - S(l)NR requirement for control – S(l)NR requirement for data
 - Configured/signalled via RRC
- $\lceil \cdot \rceil$: cell operation
 - rounds the control channel size to the nearest supported integer value, towards (plus) infinity.

$$M_{ctrl} = \left\lceil \frac{N \cdot \frac{CR}{M_{mod}}}{10^{\frac{offset_dB}{10}}} \right\rceil$$

FIG 29

offset_dB (cont')

- offset_dB: Compensates the performance difference between control and data channel
 - Different BLER operation point (data & control)
 - Different packet size & coding gain
 - No coding (A/N)

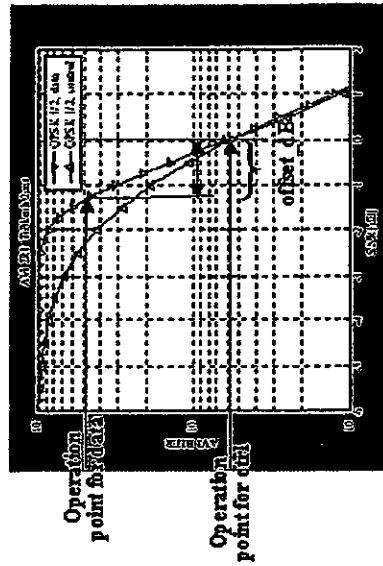


FIG 30

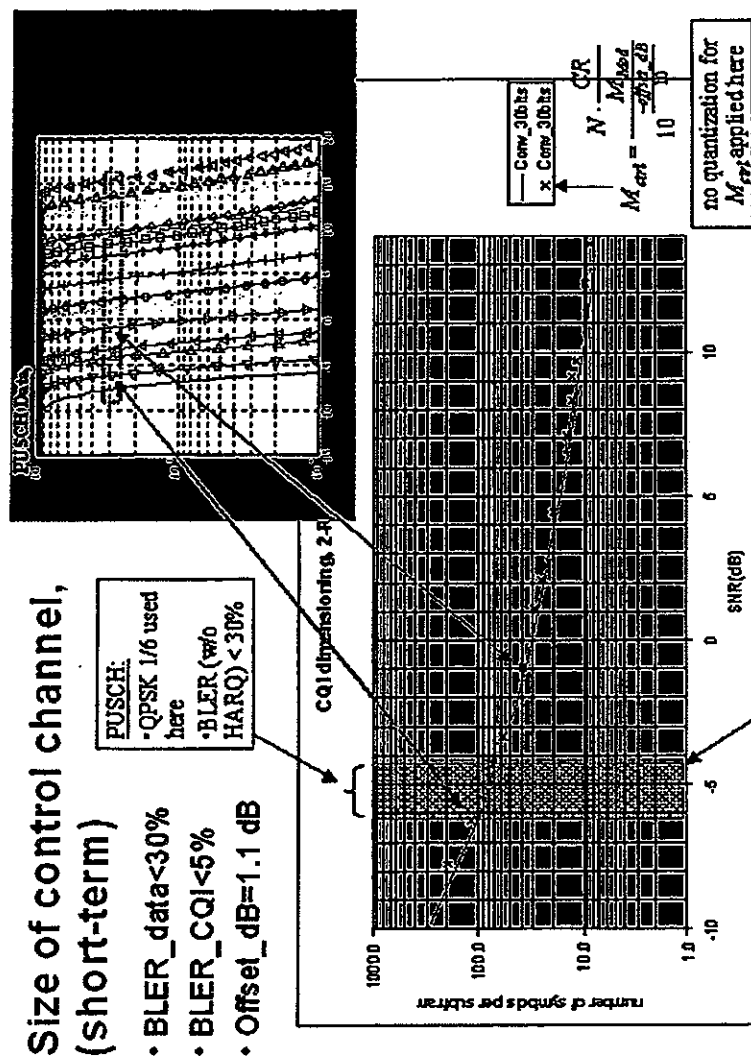


FIG 31

Numerical values for offset, (short term)

- BLER_data<20%
- BLER_CQI<10%

Offset dB	1	5	10	30	60	90
N_r	0.3	0.5	0.6	0.4	0.4	0.4

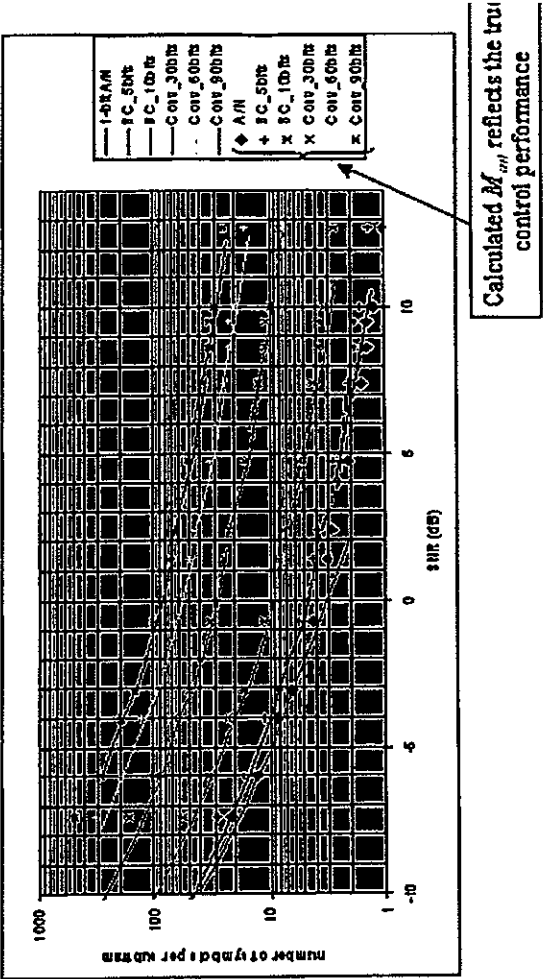


FIG 32

Numerical values for offset,
(short term)

- BLER_data<40%
- BLER_CQI<5%

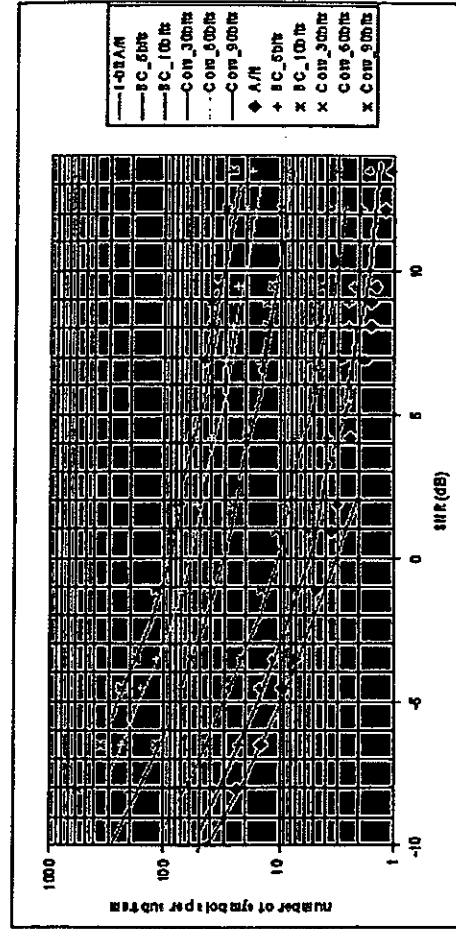


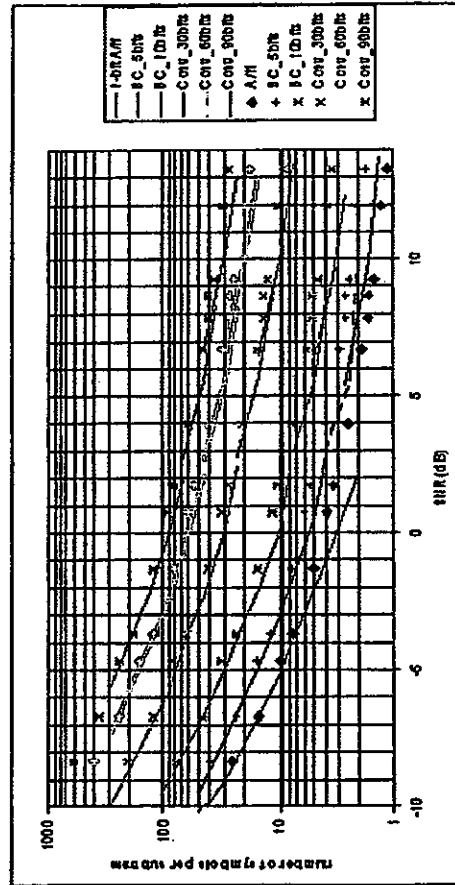
FIG 33

Numerical values for offset, (short term)

- BLER_data<50%
- BLER_CQI<5%

N	1	5	10	30	80	90
Offset_dB	7.0	2	1.9	1.4	1.2	1.2

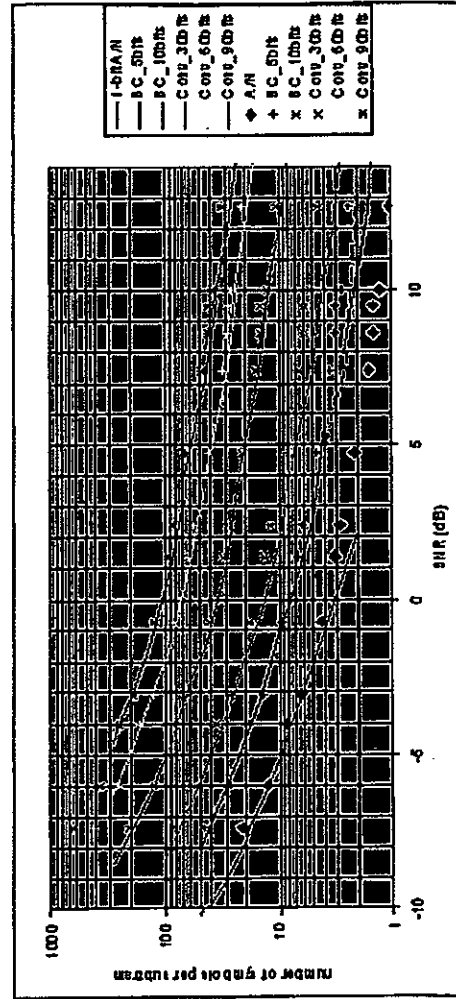
FIG 34



Numerical values for offset,
(short term)

- BLER_data<20%
- BLER_CQI<1%

N	1	5	10	30	60	90
Offset, dB	0.2	2.7	2.5	1.5	1.5	1.5



Summary of Numerical Offset values, 2RBs, (short term)

Offset (dB)		Block codes										Conv. coding			
		N													
QoS		1	5	10	30	60	90								
Data BLER															
50%	5%	7.0	2.0	1.9	1.4	1.3	1.3								
	0.1%														
40%	1%	6.8	2.5	3.1	2.2	2.2	2.2								
	0.1%														
40%	5%	6.8	1.8	1.6	1.2	1.2	1.2								
	0.1%														
30%	10%	6.8	1.1	1.1	0.8	0.8	0.8								
	0.1%														
20%	5%	6.5	1.5	1.5	1.0	1.0	1.0								
	0.1%														
20%	1%	6.3	2.7	2.5	1.5	1.5	1.5								
	0.1%														
20%	5%	6.3	1.2	1.2	0.8	0.8	0.8								
	0.1%														
20%	10%	6.3	0.6	0.6	0.4	0.4	0.4								
	0.1%														
10%	1%	5.9	2.4	2.2	1.3	1.3	1.3								

AN

38.7 7.0 (dB)

CQI

0.4 | 3.1 (dB)

AN
3.8 ? 7.0
(dB)

CQI
0.4 | 3.1 (dB)

FIG 36

Numerical values for offset, 2RBs,
(long term)

- BLER_data < 20%
- BLER_CQI < 5%



Conclusions

- We have presented a robust scheme to size the PUSCH control channel
 - Calculated control size reflects well the true control performance
- The proposed scheme is applicable for all situations
 - Both ACK/NACK and CQI
 - Both dynamically scheduled and persistently scheduled data
- We propose that the equation below is adopted as method to size the control channel on PUSCH

$$M_{CB} = \left\lceil \frac{N \cdot CR}{10} \frac{M_{HARQ}}{\frac{M_{HARQ}}{10} \cdot \frac{dR}{dR}} \right\rceil$$

FIG 38