NOKIA

NB-IoT 物理层过程

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NPRACH上行功控

对于所配置的最低重复等级以外的其他重复等级，P_{NPRACH} 设置为 $P_{CMAX,c}(i)$

对于所配置的最低重复等级，P_{NPRACH} 根据以下公式确定

$$P_{NPRACH} = \min\{ P_{CMAX,c}(i),\ NARROWBAND\_PREAMBLE\_RECEIVED\_TARGET\_POWER + PL_C \}\_[dBm]$$

其中：

① NARROWBAND_PREAMBLE_RECEIVED_TARGET_POWER= preambleInitialReceivedTargetPower + DELTA_PREAMBLE + (PREAMBLE_TRANSMISSION_COUNTER – 1) * powerRampingStep – 10 * log10(numRepetitionPerPreambleAttempt)

② preambleInitialReceivedTargetPower/ powerRampingStep重用LTE系统的取值

③ NB-IOT中，DELTA_PREAMBLE固定为0

Table 7.6-1: DELTA_PREAMBLE values.

Preamble Format	DELTA_PREAMBLE value
0	0 dB
1	0 dB
2	-3 dB
3	-3 dB
4	8 dB

***RACH-ConfigCommon-NB* information element**

```
-- ASN1START

RACH-ConfigCommon-NB-r13 ::=        SEQUENCE {
    preambleTransMax-CE-r13             PreambleTransMax,
    powerRampingParameters-r13          PowerRampingParameters,
    rach-InfoList-r13                   RACH-InfoList-NB-r13,
    connEstFailOffset-r13               INTEGER (0..15)                 OPTIONAL,   -- Need OP
    ...
}

PowerRampingParameters ::=          SEQUENCE {
    powerRampingStep                    ENUMERATED {dB0, dB2,dB4, dB6},
    preambleInitialReceivedTargetPower  ENUMERATED {
                                            dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,
                                            dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,
                                            dBm-100, dBm-98, dBm-96, dBm-94,
                                            dBm-92, dBm-90}
}
```

***NPRACH-ConfigSIB-NB* information elements**

```
NPRACH-Parameters-NB-r13::=     SEQUENCE {
    nprach-Periodicity-r13                  ENUMERATED {ms40, ms80, ms160, ms240,
                                                        ms320, ms640, ms1280, ms2560},
    nprach-StartTime-r13                    ENUMERATED {ms8, ms16, ms32, ms64,
                                                        ms128, ms256, ms512, ms1024},
    nprach-SubcarrierOffset-r13             ENUMERATED {n0, n12, n24, n36, n2, n18, n34, spare1},
    nprach-NumSubcarriers-r13               ENUMERATED {n12, n24, n36, n48},
    nprach-SubcarrierMSG3-RangeStart-r13    ENUMERATED {zero, oneThird, twoThird, one},
    maxNumPreambleAttemptCE-r13             ENUMERATED {n3, n4, n5, n6, n7, n8, n10, spare1},
    numRepetitionsPerPreambleAttempt-r13    ENUMERATED {n1, n2, n4, n8, n16, n32, n64, n128},
    npdcch-NumRepetitions-RA-r13            ENUMERATED {r1, r2, r4, r8, r16, r32, r64, r128,
```

NPUSCH上行功控

不支持闭环功控

当重复传输次数大于2时，**满功率发射**，否则为

$$P_{\mathrm{NPUSCH},c}(i)=\min\begin{Bmatrix}P_{\mathrm{CMAX},c}(i),\\ 10\log_{10}(M_{\mathrm{NPUSCH},c}(i))+P_{\mathrm{O\_NPUSCH},c}(j)+\alpha_c(j)\cdot PL_c\end{Bmatrix}$$

其中

$P_{\mathrm{CMAX},c}(i)$ ：min { $P_{EMAX,c}$ ， $P_{PowerClass}$ } ， $P_{EMAX,c}$ 为p-Max ， $P_{PowerClass}$ 为23dBm（Class 3）或20dBm （Class 5）

$M_{\mathrm{NPUSCH},c}(i)$：当子载波间隔为3.75kHz时，为1/4；当子载波间隔为15kHz时，为{1、3、6、12}

$P_{\mathrm{O\_NPUSCH},c}(j)$ ：$P_{\mathrm{O\_NOMINAL\_NPUSCH},c}(j)$ + $P_{\mathrm{O\_UE\_NPUSCH},c}(j)$

当 j=1时，用于动态调度， $P_{\mathrm{O\_NOMINAL\_NPUSCH},c}(j)$ 为p0-NominalNPUSCH，$P_{\mathrm{O\_UE\_NPUSCH},c}(j)$ 为p0-UE-NPUSCH

当 j=2时，用于RAR，$P_{\mathrm{O\_NORMINAL\_NPUSCH},c}(2)=P_{\mathrm{O\_PRE}}+\Delta_{\mathrm{PREAMBLE\_Msg3}}$ ， $P_{\mathrm{O\_UE\_NPUSCH},c}(2)=0$

$P_{\mathrm{O\_PRE}}$ 为preambleInitialReceivedTargetPower ，$\Delta_{\mathrm{PREAMBLE\_Msg3}}$ 为deltaPreambleMsg3

$\alpha_c(j)$：当 j=1（NPUSCH Format2）或 j=2时，为1；当 j=1（NPUSCH Format1），为alpha

PL_c ： nrs-Power + nrs-PowerOffsetNonAnchor – higher layer filtered NRSRP

***SystemInformationBlockType1-NB* message**

```
-- ASN1START

SystemInformationBlockType1-NB ::=  SEQUENCE {
    ...
    p-Max-r13                           P-Max                       OPTIONAL,
    freqBandIndicator-r13               FreqBandIndicator-NB-r13,
```

***UplinkPowerControl-NB* information elements**

```
-- ASN1START

UplinkPowerControlCommon-NB-r13 ::= SEQUENCE {
    p0-NominalNPUSCH-r13                INTEGER (-126..24),
    alpha-r13                           ENUMERATED {al0, al04, al05, al06, al07, al08, al09, al1},
    deltaPreambleMsg3-r13               INTEGER (-1..6)
}

UplinkPowerControlDedicated-NB-r13 ::=  SEQUENCE {
    p0-UE-NPUSCH-r13                        INTEGER (-8..7)
}
```

***NPDSCH-ConfigCommon-NB* information element**

```
-- ASN1START


NPDSCH-ConfigCommon-NB-r13 ::=  SEQUENCE {
    nrs-Power-r13                       INTEGER (-60..50)
}
```

***CarrierConfigDedicated-NB* information elements**

```
    ...,
    [[  nrs-PowerOffsetNonAnchor-v1330      ENUMERATED {dB-12, dB-10, dB-8, dB-6,
                                                        dB-4, dB-2, dB0, dB3}
                                    OPTIONAL    -- Need ON
    ]]
```

下行功率分配

不支持PA、PB

NRS EPRE由高层参数确定：

NRS EPRE=nrs-Power + nrs-PowerOffsetNonAnchor/0

NPDSCH-ConfigCommon-NB **information element**

```
-- ASN1START

NPDSCH-ConfigCommon-NB-r13 ::=   SEQUENCE {
    nrs-Power-r13                    INTEGER (-60..50)
}
```

CarrierConfigDedicated-NB **information elements**

```
    ...,
    [[  nrs-PowerOffsetNonAnchor-v1330       ENUMERATED {dB-12, dB-10, dB-8, dB-6,
                                                         dB-4, dB-2, dB0, dB3}
                                     OPTIONAL     -- Need ON
    ]]
```

当单天线端口时，UE假设：

NPDSCH EPRE/NRS EPRE=NPBCH EPRE/NRS EPRE=NPDCCH EPRE/NRS EPRE=0

当双天线端口时，UE假设：

NPDSCH EPRE/NRS EPRE=NPBCH EPRE/NRS EPRE=NPDCCH EPRE/NRS EPRE=-3

当操作模式为Inband-SamePCI 时：

NRS EPRE/CRS EPRE=nrs-CRS-PowerOffset/0

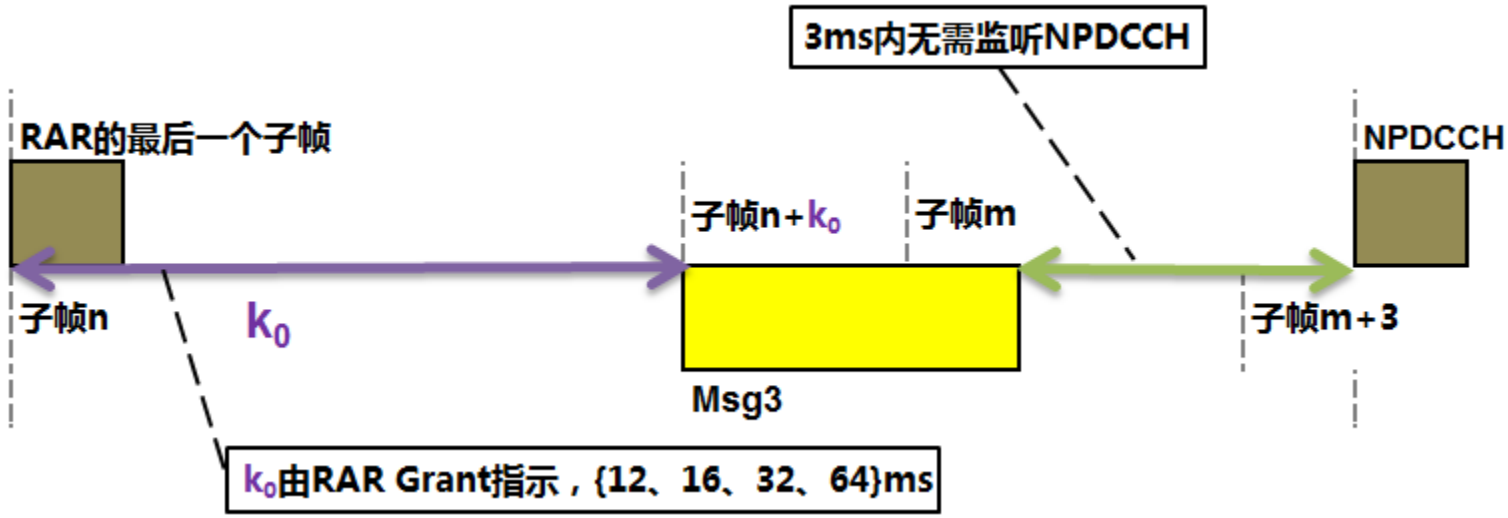
SystemInformationBlockType1-NB **message**

```
-- ASN1START

SystemInformationBlockType1-NB ::=  SEQUENCE {

   nrs-CRS-PowerOffset-r13             ENUMERATED {dB-6,       dB-4dot77, dB-3,
                                                   dB-1dot77,  dB0,       dB1,
                                                   dB1dot23,   dB2,       dB3,
                                                   dB4,        dB4dot23,  dB5,
                                                   dB6,        dB7,       dB8,
                                                   dB9}         OPTIONAL,    -- Cond inband-SamePCI
```

NPRACH时序关系



RAR Grant	
Field	Size (bits)
Uplink subcarrier spacing	1
Subcarrier indication field	6
Scheduling delay field	**2**
Msg3 repetition number	3
MCS index indicating TBS, modulation, and number of RUs for Msg3	3
Total	15

Table 16.5.1-1: k_0 for DCI format N0.

I_{Delay}	k_0
0	~~8~~ =12
1	16
2	32
3	64

NPRACH时序关系

NPDCCH order触发的随机接入：

- 当UE在子帧n收到NPDCCH order（DCI Format N1中），在子帧$n+k_2$（k_2>=8）可发起随机接入（在可用的NPRACH子帧中）
- 子载波索引为 $n_{sc} = I_{sc}$ ，其中 I_{sc} 为DCI中的“Subcarrier indication of NPRACH”
- 重复次数 N_{Rep} ，由 I_{Rep} 即DCI中的“Starting number of NPRACH repetition”决定，其中R_1、R_2、R_3为NPRACH资源组参数中的“numRepetitionsPerPreambleAttempt”

Table 16.3.2-1: Number of repetitions (N_{Rep}) for NPRACH following a “PDCCH order”

I_{Rep}	N_{Rep}
0	R_1
1	R_2
2	R_3
3	Reserved

N1 (PDSCH scheduling and NPDCCH order)		
Field		Size (bits)
Flag for format N0/format N1 differentiation		1
NPDCCH order indicator		1
NPDCCH order indicator=1	**Starting number of NPRACH repetition**	**2**
	Subcarrier indication of NPRACH	**6**
	All the remaining bits are set to one	13
NPDCCH order indicator=0	Scheduling delay	3
	Resource assignment	3
	Modulation and coding scheme	4
	Repetition number	4
	New data indicator	1
	HARQ-ACK resource	4
	DCI subframe repetition number	2
CRC		16
Total		39

NPUSCH时序关系

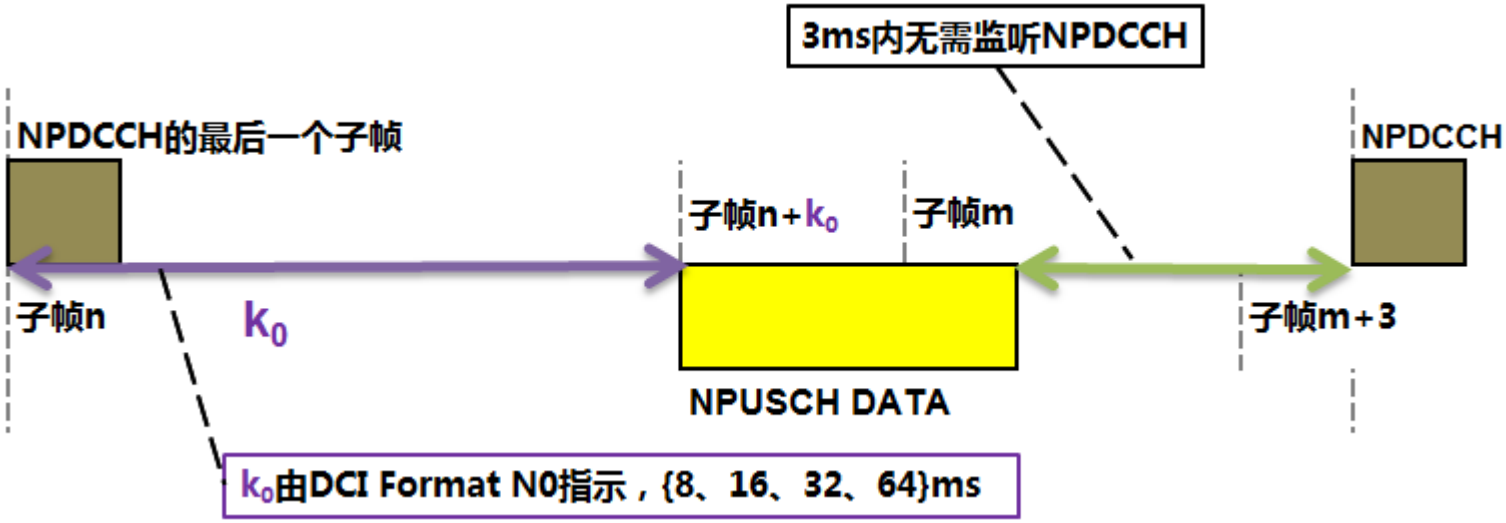
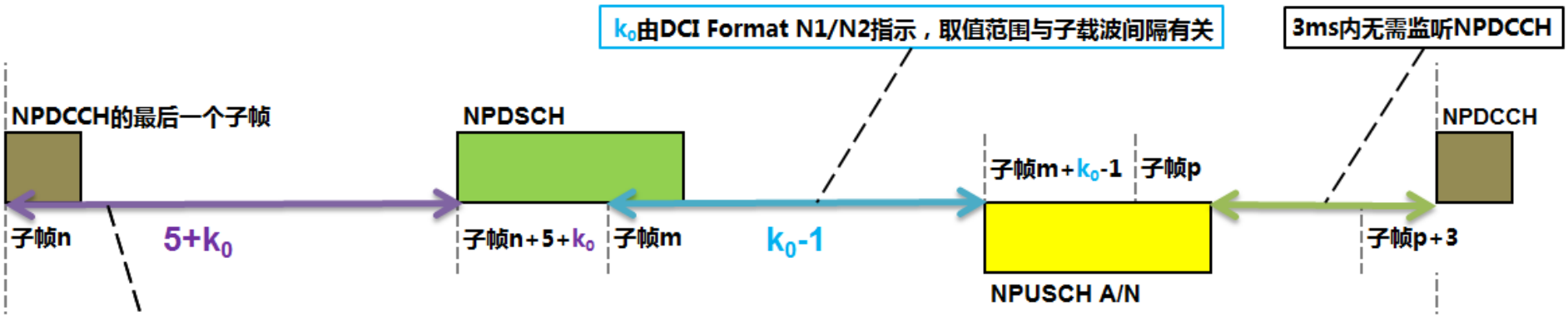


Table 16.5.1-1: k_0 for DCI format N0.

I_{Delay}	k_0
0	8
1	16
2	32
3	64

N0 (PUSCH scheduling)	
Field	Size (bits)
Flag for format N0/format N1 differentiation	1
Subcarrier indication	6
Resource assignment	3
Scheduling delay	**2**
Modulation and coding scheme	4
Redundancy version	1
Repetition number	3
New data indicator	1
DCI subframe repetition number	2
CRC	16
Total	39

NPDSCH时序关系



N1 (PDSCH scheduling and NPDCCH order)		
Field		Size (bits)
Flag for format N0/format N1 differentiation		1
NPDCCH order indicator		1
NPDCCH order indicator=1	Starting number of NPRACH repetition	2
	Subcarrier indication of NPRACH	6
	All the remaining bits are set to one	13
NPDCCH order indicator=0	**Scheduling delay**	**3**
	Resource assignment	3
	Modulation and coding scheme	4
	Repetition number	4
	New data indicator	1
	HARQ-ACK resource	**4**
	DCI subframe repetition number	2
CRC		16
Total		39

Table 16.4.1-1: k_0 for DCI format N1.

I_{Delay}	k_0	
	$R_{max} < 128$	$R_{max} \geq 128$
0	0	0
1	4	16
2	8	32
3	12	64
4	16	128
5	32	256
6	64	512
7	128	1024

K_0=0 for DCI format N2

Table 16.4.2-1: ACK/NACK subcarrier and k_0 for NPUSCH with subcarrier spacing $\Delta f = 3.75$ kHz

ACK/NACK resource field	ACK/NACK subcarrier	k_0
0	38	13
1	39	13
2	40	13
3	41	13
4	42	13
5	43	13
6	44	13
7	45	13
8	38	21
9	39	21
10	40	21
11	41	21
12	42	21
13	43	21
14	44	21
15	45	21

Table 16.4.2-2: ACK/NACK subcarrier and k_0 for NPUSCH with subcarrier spacing $\Delta f = 15$ kHz

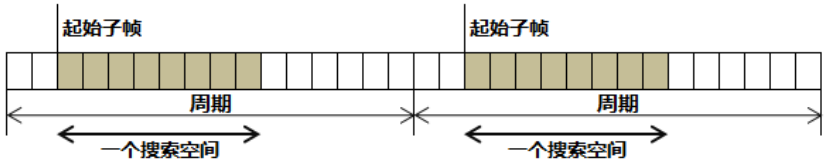
ACK/NACK resource field	ACK/NACK subcarrier	k_0
0	0	13
1	1	13
2	2	13
3	3	13
4	0	15
5	1	15
6	2	15
7	3	15
8	0	17
9	1	17
10	2	17
11	3	17
12	0	18
13	1	18
14	2	18
15	3	18

NPDCCH搜索空间

- DCI在NPDCCH搜索空间中下发，规范定义三种搜索空间，一个UE在同一时刻根据所处的状态只监听其中一种
  - Type-1公共搜索空间，用于Paging
  - Type-2公共搜索空间，用于RAR、Msg3重传、Msg4
  - UE专属搜索空间，用于其他上下行调度
- 搜索空间候选集：
  - NPDCCH搜索空间由聚合度 $L' \in \{1,2\}$ 和重复次数 $R \in \{1,2,4,8,16,32,64,128,256,512,1024,2048\}$ 组成
  - R 的最大值为 $R_{\max}$，由高层定义，搜索空间最多支持4或8种 R 取值
  - R 具体使用值通过DCI中“DCI subframe repetition number”指示
- 搜索空间起始位置：
  - Type-2公共搜索空间和UE专属搜索空间，满足如下公式，其中 G 和 α_{offset} 由高层定义

$$(10n_f + \lfloor n_s/2 \rfloor) \bmod T = \alpha_{offset} \cdot T$$

$$T = R_{\max} \cdot G$$



R_{max}=8
G=2
α_{offset}=1/8

- Type-1公共搜索空间，即为该UE PO时刻所对应的子帧

NPDCCH-ConfigDedicated-NB information element

UE专属搜索空间

```
-- ASN1START

NPDCCH-ConfigDedicated-NB-r13 ::=   SEQUENCE {
    npdcch-NumRepetitions-r13           ENUMERATED {r1, r2, r4, r8, r16, r32, r64, r128,
                                                    r256, r512, r1024, r2048,
                                                    spare4, spare3, spare2, spare1},
    npdcch-StartSF-USS-r13              ENUMERATED {v1dot5, v2, v4, v8, v16, v32, v48, v64},
    npdcch-Offset-USS-r13               ENUMERATED {zero, oneEighth, oneFourth, threeEighth}
}

-- ASN1STOP
```

NPRACH-ConfigSIB-NB information elements

Type-2公共搜索空间

```
-- ASN1START
    ...
    npdcch-NumRepetitions-RA-r13            ENUMERATED {r1, r2, r4, r8, r16, r32, r64, r128,
                                                        r256, r512, r1024, r2048,
                                                        spare4, spare3, spare2, spare1},
    npdcch-StartSF-CSS-RA-r13               ENUMERATED {v1dot5, v2, v4, v8, v16, v32, v48, v64},
    npdcch-Offset-RA-r13                    ENUMERATED {zero, oneEighth, oneFourth, threeEighth}
}
```

RadioResourceConfigCommonSIB-NB information element

Type-1公共搜索空间

```
ASN1START
..
PCCH-Config-NB-r13 ::=                  SEQUENCE {
    defaultPagingCycle-r13                  ENUMERATED {rf128, rf256, rf512, rf1024},
    nB-r13                                  ENUMERATED {
                                                fourT, twoT, oneT, halfT, quarterT, one8thT,
                                                one16thT, one32ndT, one64thT,
                                                one128thT, one256thT, one512thT, one1024thT,
                                                spare3, spare2, spare1},
    npdcch-NumRepetitionPaging-r13          ENUMERATED {
                                                r1, r2, r4, r8, r16, r32, r64, r128,
                                                r256, r512, r1024, r2048,
                                                spare4, spare3, spare2, spare1}
}
```

NPDCCH搜索空间

Table 16.6-1: NPDCCH UE- specific search space candidates

R_{max}	R	DCI subframe repetition number	NCCE indices of monitored NPDCCH candidates	
			L'=1	L'=2
1	1	00	{0},{1}	{0,1}
2	1	00	{0},{1}	{0,1}
	2	01	-	{0,1}
4	1	00	-	{0,1}
	2	01	-	{0,1}
	4	10	-	{0,1}
>=8	$R_{max}/8$	00	-	{0,1}
	$R_{max}/4$	01	-	{0,1}
	$R_{max}/2$	10	-	{0,1}
	R_{max}	11	-	{0,1}

Note 1: {x}, {y} denotes NPDCCH Format 0 candidate with NCCE index 'x', and NPDCCH Format 0 candidate with NCCE index 'y' are monitored

Note 2: {x,y} denotes NPDCCH Format1 candidate corresponding to NCCEs 'x' and 'y' is monitored.

Table 16.6-3: Type 2- NPDCCH common search space candidates

R_{max}	R	DCI subframe repetition number	NCCE indices of monitored NPDCCH candidates	
			L'=1	L'=2
1	1	00	-	{0,1}
2	1	00	-	{0,1}
	2	01	-	{0,1}
4	1	00	-	{0,1}
	2	01	-	{0,1}
	4	10	-	{0,1}
>=8	$R_{max}/8$	00	-	{0,1}
	$R_{max}/4$	01	-	{0,1}
	$R_{max}/2$	10	-	{0,1}
	R_{max}	11	-	{0,1}

Note 1: {x,y} denotes NPDCCH Format1 candidate corresponding to NCCEs 'x' and 'y' is monitored.

Table 16.6-2: Type 1- NPDCCH common search space candidates

R_{max}	R								NCCE indices of monitored NPDCCH candidates	
									L'=1	L'=2
1	1	-	-	-	-	-	-	-	-	{0,1}
2	1	2	-	-	-	-	-	-	-	{0,1}
4	1	2	4	-	-	-	-	-	-	{0,1}
8	1	2	4	8	-	-	-	-	-	{0,1}
16	1	2	4	8	16	-	-	-	--	{0,1}
32	1	2	4	8	16	32	-	-	-	{0,1}
64	1	2	4	8	16	32	64	-	-	{0,1}
128	1	2	4	8	16	32	64	128	-	{0,1}
256	1	4	8	16	32	64	128	256	-	{0,1}
512	1	4	16	32	64	128	256	512	-	{0,1}
1024	1	8	32	64	128	256	512	1024	-	{0,1}
2048	1	8	64	128	256	512	1024	2048	-	{0,1}
DCI subframe repetition number	000	001	010	011	100	101	110	111		

Note 1: {x,y} denotes NPDCCH Format1 candidate corresponding to NCCEs 'x' and 'y' is monitored.

- 盲检测候选集个数受限，最多支持4或8种 R 取值
- 当重复传输时，仅使用 $L'=2$

RAR

- 上行子载波间隔指示位，“0”为3.75kHz，“1”为15kHz

RAR Grant	
Field	Size (bits)
Uplink subcarrier spacing	1
Subcarrier indication field	6
Scheduling delay field	2
Msg3 repetition number	3
MCS index indicating TBS, modulation, and number of RUs for Msg3	3
Total	15

- Subcarrier indication字段定义一组连续的子载波：当使用3.75kHz时，$n_{sc} = I_{sc}$；当使用15kHz时，查询Table 16.5.1.1-1

Table 16.5.1.1-1: Allocated subcarriers for NPUSCH with $\Delta f = 15\,\text{kHz}$.

Subcarrier indication field (I_{sc})	Set of Allocated subcarriers (n_{sc})
0 – 11	I_{sc}
12-15	$3(I_{sc}-12)+\{0,1,2\}$
16-17	$6(I_{sc}-16)+\{0,1,2,3,4,5\}$
18	$\{0,1,2,3,4,5,6,7,8,9,10,11\}$
19-63	Reserved

- Scheduling delay field字段定义上行调度时延，即k_0

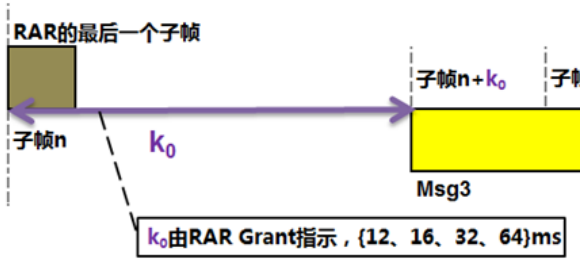


Table 16.5.1.1-1: k_0 for DCI format N0.

I_{Delay}	k_0
0	~~8~~
1	16
2	32
3	64

=12

- Msg3 repetition number字段定义Msg3初传的重复传输次数

Table 16.5.1.1-3: Number of repetitions (N_{Rep}) for NPUSCH.

I_{Rep}	N_{Rep}
0	1
1	2
2	4
3	8
4	16
5	32
6	64
7	128

- 该字段定义Msg3初传的TBS大小、调制方式、RU数量，冗余版本固定为RV0

Table 16.3.3-1: MCS index for Msg3 NPUSCH

MCS Index I_{MCS}	Modulation $\Delta f = 3.75$ kHz or $\Delta f = 15$ kHz and $I_{sc} = 0,1,\ldots,11$	Modulation $\Delta f = 15$ kHz and $I_{sc} > 11$	Number of RUs N_{RU}	TBS
‘000’	pi/2 BPSK	QPSK	4	88 bits
‘001’	pi/4 QPSK	QPSK	3	88 bits
‘010’	pi/4 QPSK	QPSK	1	88 bits
‘011’	reserved	reserved	reserved	reserved
‘100’	reserved	reserved	reserved	reserved
‘101’	reserved	reserved	reserved	reserved
‘110’	reserved	reserved	reserved	reserved
‘111’	reserved	reserved	reserved	reserved

DCI Format N0

- 格式N0/N1标识，因盲检时两者无法从长度上区分

N0 (PUSCH scheduling)	
Field	Size (bits)
Flag for format N0/format N1 differentiation	1
Subcarrier indication	6
Resource assignment	3
Scheduling delay	2
Modulation and coding scheme	4
Redundancy version	1
Repetition number	3
New data indicator	1
DCI subframe repetition number	2
CRC	16
Total	39

- Subcarrier indication字段定义一组连续的子载波：当使用3.75kHz时，$n_{sc} = I_{sc}$；当使用15kHz时，查询Table 16.5.1.1-1

Table 16.5.1.1-1: Allocated subcarriers for NPUSCH with $\Delta f = 15\,\text{kHz}$.

Subcarrier indication field (I_{sc})	Set of Allocated subcarriers (n_{sc})
0 – 11	I_{sc}
12-15	$3(I_{sc}-12)+\{0,1,2\}$
16-17	$6(I_{sc}-16)+\{0,1,2,3,4,5\}$
18	$\{0,1,2,3,4,5,6,7,8,9,10,11\}$
19-63	Reserved

- Resource assignment字段定义RU数量，为TBS大小的一个计算因子

Table 16.5.1.1-2: Number of resource units (N_{RU}) for NPUSCH.

I_{RU}	N_{RU}
0	1
1	2
2	3
3	4
4	5
5	6
6	8
7	10

- Modulation and coding scheme字段定义MCS，为TBS大小的一个计算因子

$N_{sc}^{RU} > 1, Q_m = 2, I_{TBS} = I_{MCS}$

$N_{sc}^{RU} = 1, Q_m = 1 \text{ or } 2, I_{TBS}$ is given in Table16.5.1.2.1-1

Table 16.5.1.2-1: Modulation and TBS index table for NPUSCH with $N_{sc}^{RU} = 1$.

MCS Index I_{MCS}	Modulation Order Q_m	TBS Index I_{TBS}
0	1	0
1	1	2
2	2	1
3	2	3
4	2	4
5	2	5
6	2	6
7	2	7
8	2	8
9	2	9
10	2	10

Table 16.5.1.2-2: Transport block size (TBS) table for NPUSCH.

I_{TBS}	I_{RU}							
	0	1	2	3	4	5	6	7
0	16	32	56	88	120	152	208	256
1	24	56	88	144	176	208	256	344
2	32	72	144	176	208	256	328	424
3	40	104	176	208	256	328	440	568
4	56	120	208	256	328	408	552	680
5	72	144	224	328	424	504	680	872
6	88	176	256	392	504	600	808	1000
7	104	224	328	472	584	712	1000	
8	120	256	392	536	680	808		
9	136	296	456	616	776	936		
10	144	328	504	680	872	1000		
11	176	376	584	776	1000			
12	208	440	680	1000				

DCI Format N0

N0 (PUSCH scheduling)	
Field	Size (bits)
Flag for format N0/format N1 differentiation	1
Subcarrier indication	6
Resource assignment	3
Scheduling delay	**2**
Modulation and coding scheme	4
Redundancy version	**1**
Repetition number	**3**
New data indicator	1
DCI subframe repetition number	**2**
CRC	16
Total	39

- **Scheduling delay字段定义上行调度时延，即k_0**

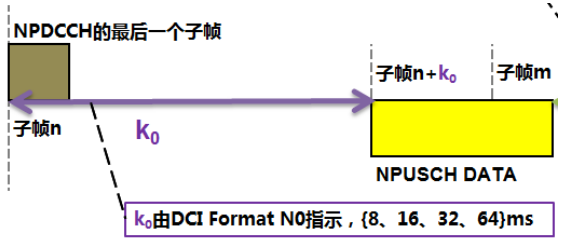


Table 16.5.1.1-1: k_0 for DCI format N0.

I_{Delay}	k_0
0	8
1	16
2	32
3	64

- **Redundancy version字段定义冗余版本，即RV0/RV2**

- **DCI subframe repetition number 字段定义该DCI使用的重复次数，即 R ，用于搜索空间的盲检测**

- **Repetition number字段定义NPUSCH重复传输次数**

Table 16.5.1.1-3: Number of repetitions (N_{Rep}) for NPUSCH.

I_{Rep}	N_{Rep}
0	1
1	2
2	4
3	8
4	16
5	32
6	64
7	128

DCI Format N1

- 格式N0/N1标识，因盲检时两者无法从长度上区分

N1 (PDSCH scheduling and NPDCCH order)		
Field		Size (bits)
Flag for format N0/format N1 differentiation		1
NPDCCH order indicator		1
NPDCCH order indicator=1	Starting number of NPRACH repetition	2
	Subcarrier indication of NPRACH	6
	All the remaining bits are set to one	13
NPDCCH order indicator=0	Scheduling delay	3
	Resource assignment	3
	Modulation and coding scheme	4
	Repetition number	4
	New data indicator	1
	HARQ-ACK resource	4
	DCI subframe repetition number	2
CRC		16
Total		39

- NPDCCH order标识

- Starting number of NPRACH repetition字段定义NPRACH重复次数，由Table 16.3.2-1指示，其中R_1、R_2、R_3为NPRACH资源组参数中的“numRepetitionsPerPreambleAttempt”

Table 16.3.2-1: Number of repetitions (N_{Rep}) for NPRACH following a “PDCCH order”

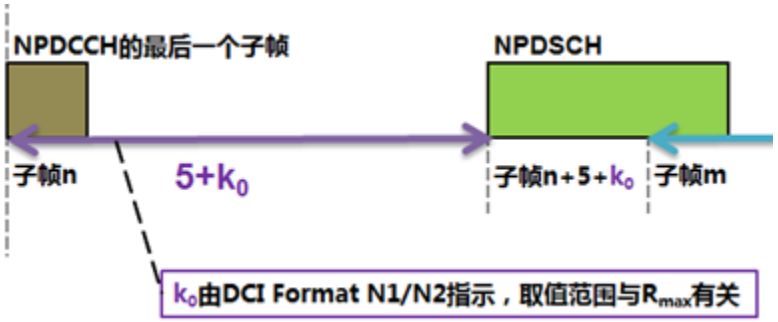
I_{Rep}	N_{Rep}
0	R_1
1	R_2
2	R_3
3	Reserved

- Subcarrier indication of NPRACH字段定义NPRACH子载波索引 I_{sc}，其中 $n_{sc} = I_{sc}$

- Scheduling delay字段定义上行调度时延，即k_0

Table 16.4.1-1: k_0 for DCI format N1.

I_{Delay}	k_0	
	$R_{max} < 128$	$R_{max} \geq 128$
0	0	0
1	4	16
2	8	32
3	12	64
4	16	128
5	32	256
6	64	512
7	128	1024



- DCI subframe repetition number 字段定义该DCI使用的重复次数，即 R ，用于搜索空间的盲检测

DCI Format N1

N1 (PDSCH scheduling and NPDCCH order)		
Field		Size (bits)
Flag for format N0/format N1 differentiation		1
NPDCCH order indicator		1
NPDCCH order indicator=1	Starting number of NPRACH repetition	2
	Subcarrier indication of NPRACH	6
	All the remaining bits are set to one	13
NPDCCH order indicator=0	Scheduling delay	3
	Resource assignment	**3**
	Modulation and coding scheme	**4**
	Repetition number	**4**
	New data indicator	1
	HARQ-ACK resource	**4**
	DCI subframe repetition number	2
CRC		16
Total		39

- **Resource assignment字段定义子帧数目，为TBS大小的一个计算因子**

Table 16.4.1.3-1: Number of subframes (N_{SF}) for NPDSCH.

I_{SF}	N_{SF}
0	1
1	2
2	3
3	4
4	5
5	6
6	8
7	10

Table 16.4.1.5.1-1: Transport block size (TBS) table.

I_{TBS}	I_{SF}							
	0	1	2	3	4	5	6	7
0	16	32	56	88	120	152	208	256
1	24	56	88	144	176	208	256	344
2	32	72	144	176	208	256	328	424
3	40	104	176	208	256	328	440	568
4	56	120	208	256	328	408	552	680
5	72	144	224	328	424	504	680	
6	88	176	256	392	504	600		
7	104	224	328	472	584	680		
8	120	256	392	536	680			
9	136	296	456	616				
10	144	328	504	680				
11	176	376	584					
12	208	440	680					

- **Modulation and coding scheme字段定义MCS，为TBS大小的一个计算因子，其中** $I_{TBS} = I_{MCS}$

- **Repetition number字段定义NPDSCH重复传输次数**

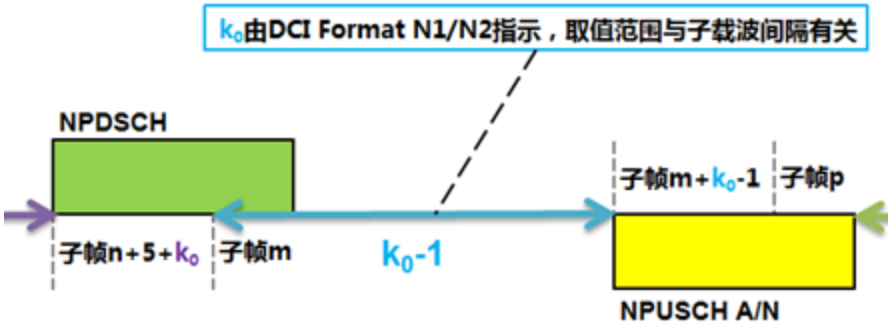
Table 16.4.1.3-3: Number of repetitions for NPDSCH carrying *SystemInformationBlockType1-NB*.

Value of *schedulingInfoSIB1*	Number of NPDSCH repetitions
0	4
1	8
2	16
3	4
4	8
5	16
6	4
7	8
8	16
9	4
10	8
11	16
12-15	Reserved

Table 16.4.1.3-2: Number of repetitions (N_{Rep}) for NPDSCH.

I_{Rep}	N_{Rep}
0	1
1	2
2	4
3	8
4	16
5	32
6	64
7	128
8	192
9	256
10	384
11	512
12	768
13	1024
14	1536
15	2048

- **HARQ-ACK resource字段定义NPUSCH A/N相对NPDSCH的时延（即k_0）及子载波索引**



6.4.2-1: ACK/NACK subcarrier and k_0 for NPUSCH with subcarrier spacing $\Delta f = 3.75$kHz.

ACK/NACK resource field	ACK/NACK subcarrier	k_0
0	38	13
1	39	13
2	40	13
3	41	13
4	42	13
5	43	13
6	44	13
7	45	13
8	38	21
9	39	21
10	40	21
11	41	21
12	42	21
13	43	21
14	44	21
15	45	21

Table 16.4.2-2: ACK/NACK subcarrier and k_0 for NPUSCH with subcarrier spacing $\Delta f = 15$kHz.

ACK/NACK resource field	ACK/NACK subcarrier	k_0
0	0	13
1	1	13
2	2	13
3	3	13
4	0	15
5	1	15
6	2	15
7	3	15
8	0	17
9	1	17
10	2	17
11	3	17
12	0	18
13	1	18
14	2	18
15	3	18

DCI Format N2

N2 (paging and direct indication)		
Field		Size (bits)
Flag for paging/direct indication differentiation		1
Flag=0 (direct indication)	Direct Indication information	8
	All the remaining bits	6
Flag=1 (paging)	Resource assignment	3
	Modulation and coding scheme	4
	Repetition number	4
	DCI subframe repetition number	3
CRC		16
Total		31

- paging/direct indication标识

Table 6.7.5-1: Direct Indication information

Bit	Field in *Direct Indication information*
1	*systemInfoModification*
2	*systemInfoModification-eDRX*
3, 4, 5, 6, 7, 8	Not used, and shall be ignored by UE if received

- Resource assignment字段定义子帧数目，为TBS大小的一个计算因子

Table 16.4.1.3-1: Number of subframes (N_{SF}) for NPDSCH.

I_{SF}	N_{SF}
0	1
1	2
2	3
3	4
4	5
5	6
6	8
7	10

- Repetition number字段定义Paging重复传输次数

Table 16.4.1.3-2: Number of repetitions (N_{Rep}) for NPDSCH.

I_{Rep}	N_{Rep}
0	1
1	2
2	4
3	8
4	16
5	32
6	64
7	128
8	192
9	256
10	384
11	512
12	768
13	1024
14	1536
15	2048

- Modulation and coding scheme字段定义MCS，为TBS大小的一个计算因子，其中 $I_{TBS} = I_{MCS}$

Table 16.4.1.5.1-1: Transport block size (TBS) table.

I_{TBS}	I_{SF}							
	0	1	2	3	4	5	6	7
0	16	32	56	88	120	152	208	256
1	24	56	88	144	176	208	256	344
2	32	72	144	176	208	256	328	424
3	40	104	176	208	256	328	440	568
4	56	120	208	256	328	408	552	680
5	72	144	224	328	424	504	680	
6	88	176	256	392	504	600		
7	104	224	328	472	584	680		
8	120	256	392	536	680			
9	136	296	456	616				
10	144	328	504	680				
11	176	376	584					
12	208	440	680					

- DCI subframe repetition number 字段定义该DCI使用的重复次数，即 R ，用于搜索空间的盲检测

eutra-CRS-SequenceInfo

当operationModeInfo= inband-SamePCI 时：

cell-specific reference signal sequence和raster offset由eutra-CRS-SequenceInfo解析获得

E-UTRA PRB index n'_{PRB} 由 $n'_{PRB} = n_{PRB} - \lfloor N_{RB}^{DL} / 2 \rfloor$ 定义

Table 16.8-1: Definition of *eutra-CRS-SequenceInfo*

eutra-CRS-SequenceInfo	E-UTRA PRB index n'_{PRB} for odd number of N_{RB}^{DL}	Raster offset	*eutra-CRS-SequenceInfo*	E-UTRA PRB index n'_{PRB} for even number of N_{RB}^{DL}	Raster offset
0	-35	-7.5 kHz	14	-46	+2.5 kHz
1	-30		15	-41	
2	-25		16	-36	
3	-20		17	-31	
4	-15		18	-26	
5	-10		19	-21	
6	-5		20	-16	
7	5	+7.5 kHz	21	-11	
8	10		22	-6	
9	15		23	5	-2.5 kHz
10	20		24	10	
11	25		25	15	
12	30		26	20	
13	35		27	25	
			28	30	
			29	35	
			30	40	
			31	45	

上行速率计算

计算公式 ：

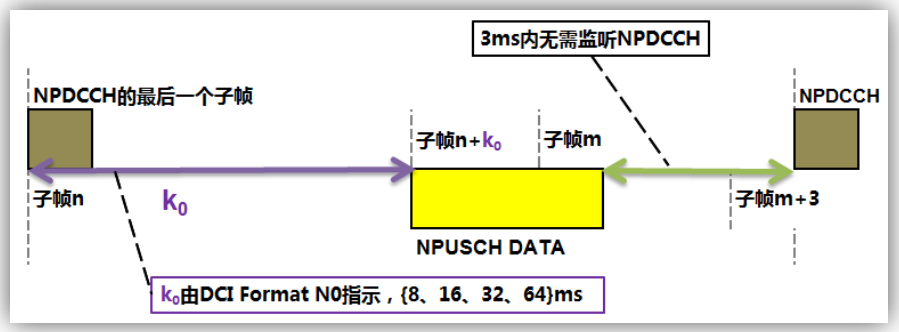
Transport Block Size for NPUSCH [bits]/ (NPDCCH transmission length [ms] + NPDCCH -> NPUSCH gap [ms] - 1 +TBS transmission time on NPUSCH [ms] + NPUSCH -> NPDCCH gap [ms]) × (1 – 1/NPRACH periodicity [ms]) × (1 - UL GAP [ms]/256)

Table 16.5.1.2-2: Transport block size (TBS) table for NPUSCH.

I_{TBS}	I_{RU}							
	0	1	2	3	4	5	6	7
0	16	32	56	88	120	152	208	256
1	24	56	88	144	176	208	256	344
2	32	72	144	176	208	256	328	424
3	40	104	176	208	256	328	440	568
4	56	120	208	256	328	408	552	680
5	72	144	224	328	424	504	680	872
6	88	176	256	392	504	600	808	1000
7	104	224	328	472	584	712	1000	
8	120	256	392	536	680	808		
9	136	296	456	616	776	936		
10	144	328	504	680	872	1000		
11	176	376	584	776	1000			
12	208	440	680	1000				

预设条件：

① Transport Block Size for NPUSCH [bits]=1000
② NPDCCH transmission length [ms]=1
③ NPDCCH -> NPUSCH gap [ms]=8
④ TBS transmission time on NPUSCH [ms]=4
⑤ NPUSCH -> NPDCCH gap [ms]=3
⑥ NPRACH periodicity [ms]=2560
⑦ UL GAP [ms]=40



最大上行速率：

1000/ (1+8-1+4+3) × (1-1/2560) × (1-40/256) =56.25kbps

下行速率计算

计算公式：

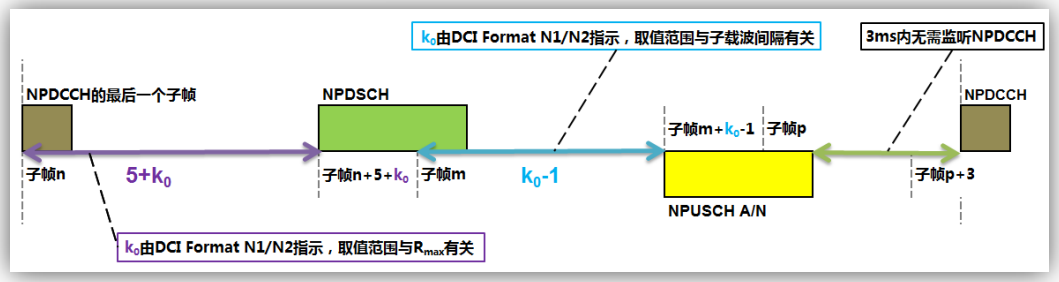
Transport Block Size for NPDSCH [bits]=/ (NPDCCH transmission length [ms] + NPDCCH -> NPDSCH gap [ms] - 1 +TBS transmission time on NPDSCH [ms] + NPDSCH -> NPUSCH (A/N) gap [ms] - 1 + NPUSCH (A/N) length [ms] + NPUSCH (A/N) / NPUSCH -> NPDCCH gap [ms]) × (1 – 1/ NPBCH periodicity [ms] – 1/NPSS periodicity [ms] – 1/ NSSS periodicity [ms] – 1/ SIB1-NB periodicity [ms])

预设条件：

① Transport Block Size for NPDSCH [bits]=680
② NPDCCH transmission length [ms]=1
③ NPDCCH -> NPDSCH gap [ms]=5
④ TBS transmission time on NPDSCH [ms]=3
⑤ NPDSCH -> NPUSCH (A/N) gap [ms]=12
⑥ NPUSCH (A/N) length [ms]=2
⑦ NPUSCH (A/N) / NPUSCH -> NPDCCH gap [ms]=3
⑧ NPBCH periodicity [ms]=NPSS periodicity [ms]=10
⑨ NSSS periodicity [ms]=20
⑩ SIB1-NB periodicity [ms]=80（等效）

Table 16.4.1.5.1-1: Transport block size (TBS) table.

I_{TBS}	I_{SF}							
	0	1	2	3	4	5	6	7
0	16	32	56	88	120	152	208	256
1	24	56	88	144	176	208	256	344
2	32	72	144	176	208	256	328	424
3	40	104	176	208	256	328	440	568
4	56	120	208	256	328	408	552	680
5	72	144	224	328	424	504	680	
6	88	176	256	392	504	600		
7	104	224	328	472	584	680		
8	120	256	392	536	680			
9	136	296	456	616				
10	144	328	504	680				
11	176	376	584					
12	208	440	680					



最大下行速率：

stand-alone=680/ (1+5-1+3+12-1+2+3) × (1-1/10-1/10-1/20-1/80) =20.90kbps