TQ (Time Quanta) Mapping in EPoC

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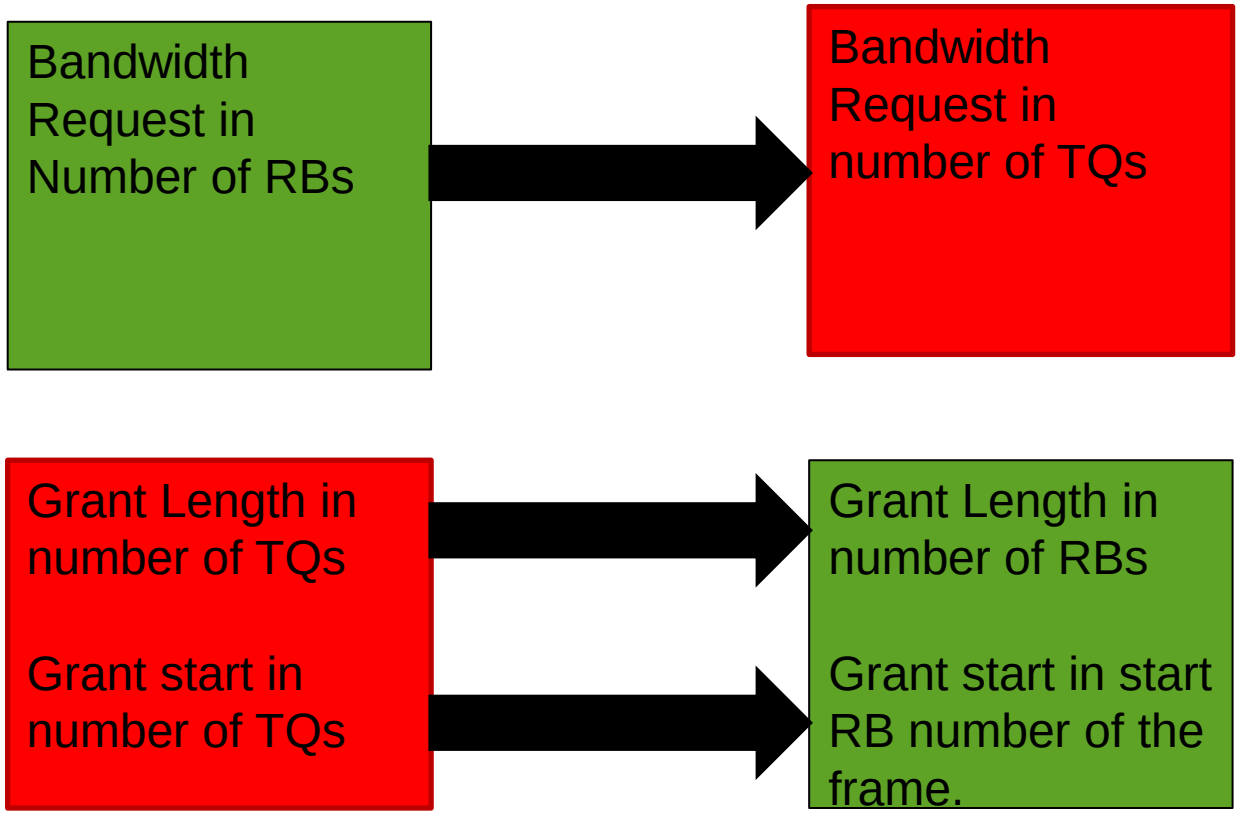
Introduction

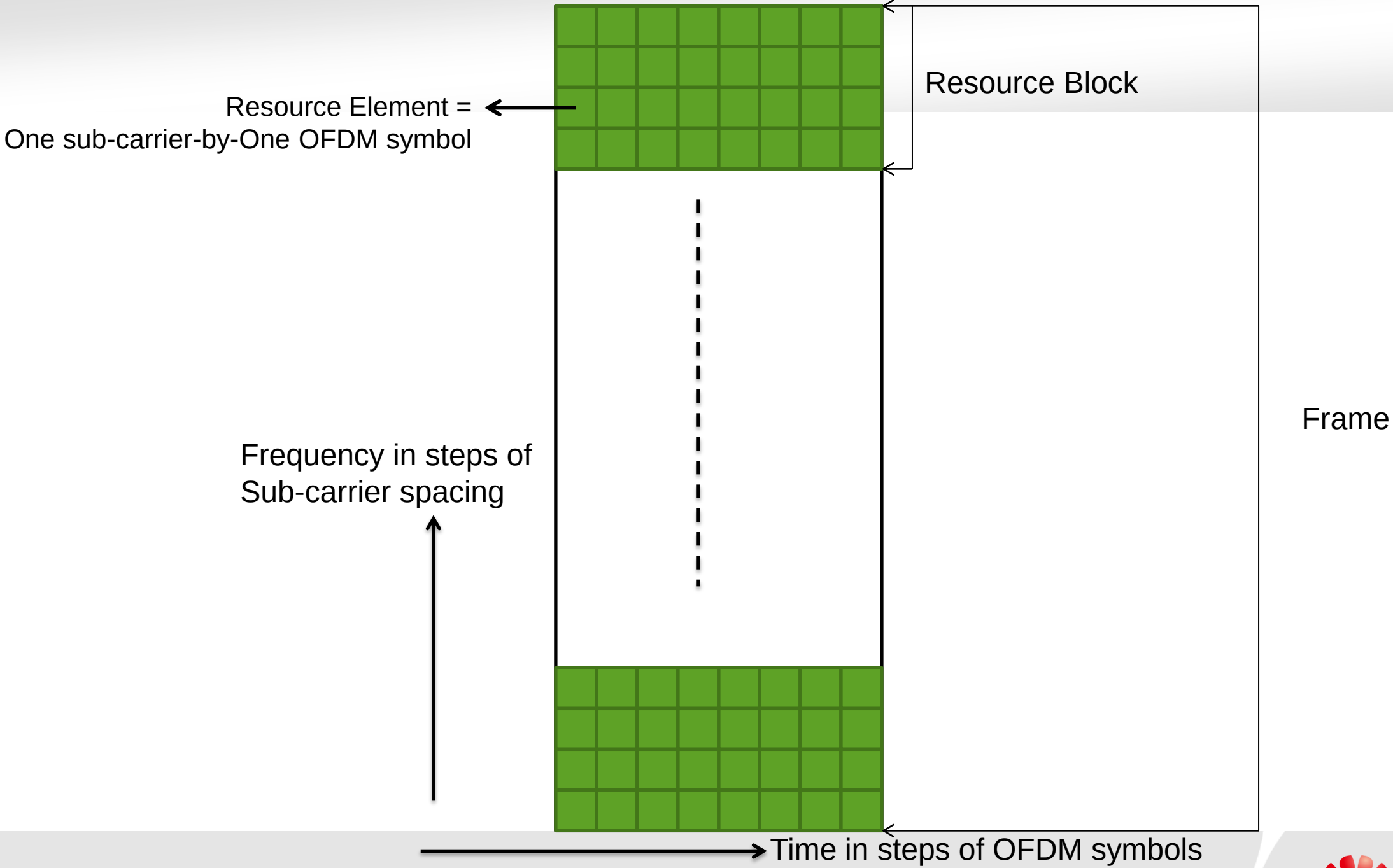
- The CNU maps the data in two dimensional (time and frequency) resource blocks.
- Both the bandwidth request and the bandwidth grant are in one dimensional units of time (TQs).
- This requires a mapping scheme to map the two dimensional resource blocks into one dimensional time quantas (TQs) and vice versa.

Two-Way Mapping Scheme



TQ = Time Quanta
= 16 nanoseconds

RB = Resource block


Resource Element =
One sub-carrier-by-One OFDM symbol
Resource Block
Frame
Frequency in steps of
Sub-carrier spacing
Time in steps of OFDM symbols

Define the following variables

- R = Number of resource elements in each resource block.
- N_b = Number of resource elements occupied by the burst markers.
- p = Number of pilots in each resource block
- N_d = Number of resource elements occupied by the data portion of the burst
- N_g = Number of resource elements used as Guard band.
- T_{symb_cp} = OFDM symbol plus cyclic prefix duration in seconds
- N_{RB} = Total number of resource blocks in a frame.
- C = Number of sub-carriers in each resource block.
- $N_{RE\_symb} = N_{RB} * C$ = Total number of resource elements in each OFDM symbol.
- $T_{RE} = \frac{T_{symb\_cp}}{N_{RE\_symb}}$ = Resource element representation in units of time (seconds)

Bandwidth Request in number of Resource Elements

- Using average bit loading per resource element and the FEC overhead compute the number of data resource elements, N_d
- Total number of resource elements for burst markers , data, and guard

$$N_{bdg} = N_b + N_d + N_g$$

- Number of available resource elements in a resource block : $A = R - p$
- Number of resource blocks needed to fit N_{bdg} resource elements

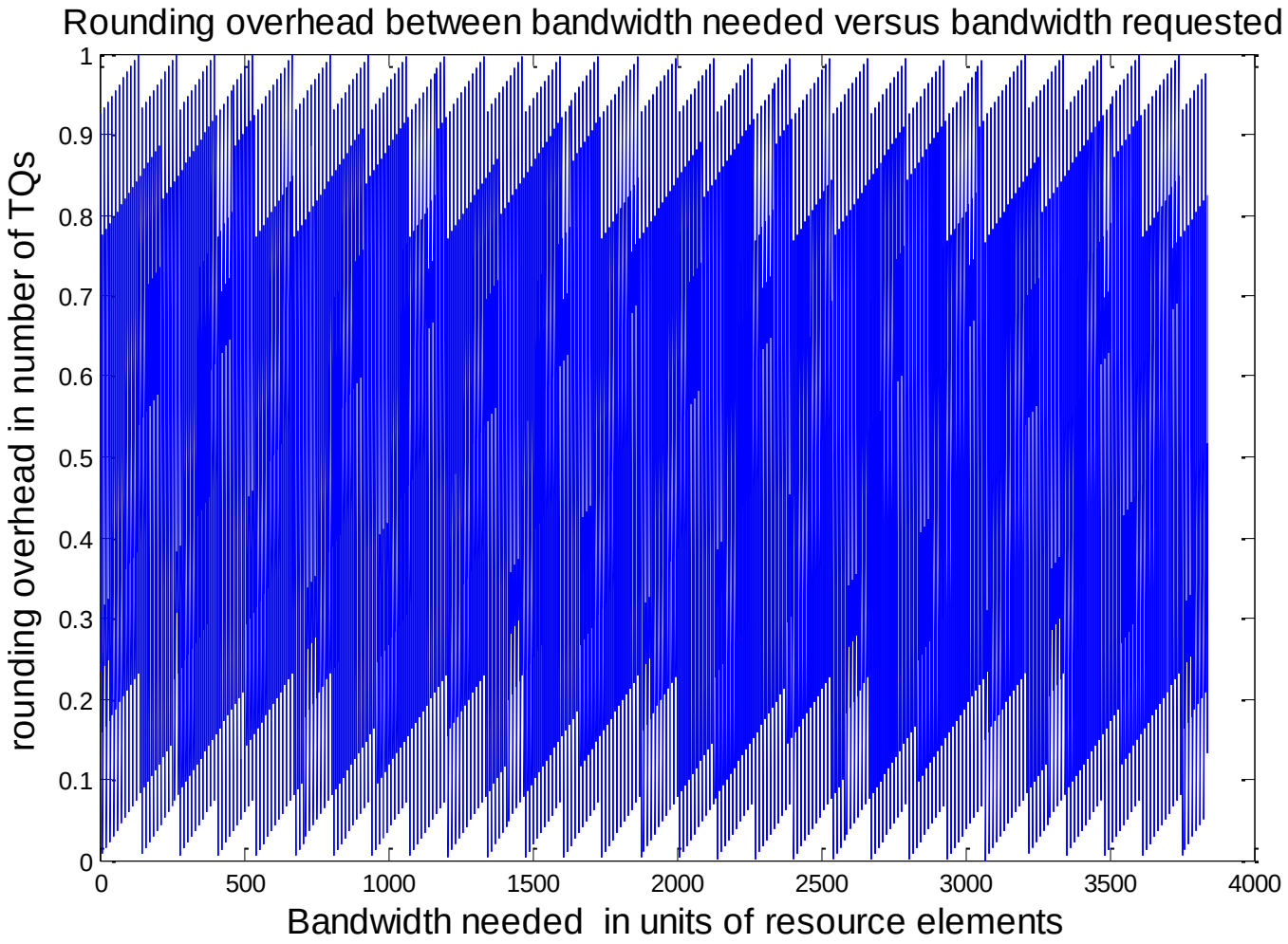
$$N = ceil\left(\frac{N_{bdg}}{A}\right)$$

- Bandwidth request in number of resource elements $N_{RE} = N * R$

Bandwidth Request in number of Time Quantas

- Bandwidth request in seconds = $T_{BW} = N_{RE} * T_{RE}$
- Bandwidth request in Time Quantas

$$N_{RTQ} = ceil\left(\frac{T_{BW}}{TQ}\right) = ceil\left(\frac{T_{BW}}{16E-9}\right)$$



Mean Overhead per burst = 0.5 TQ
Max Overhead per burst = 1 TQ

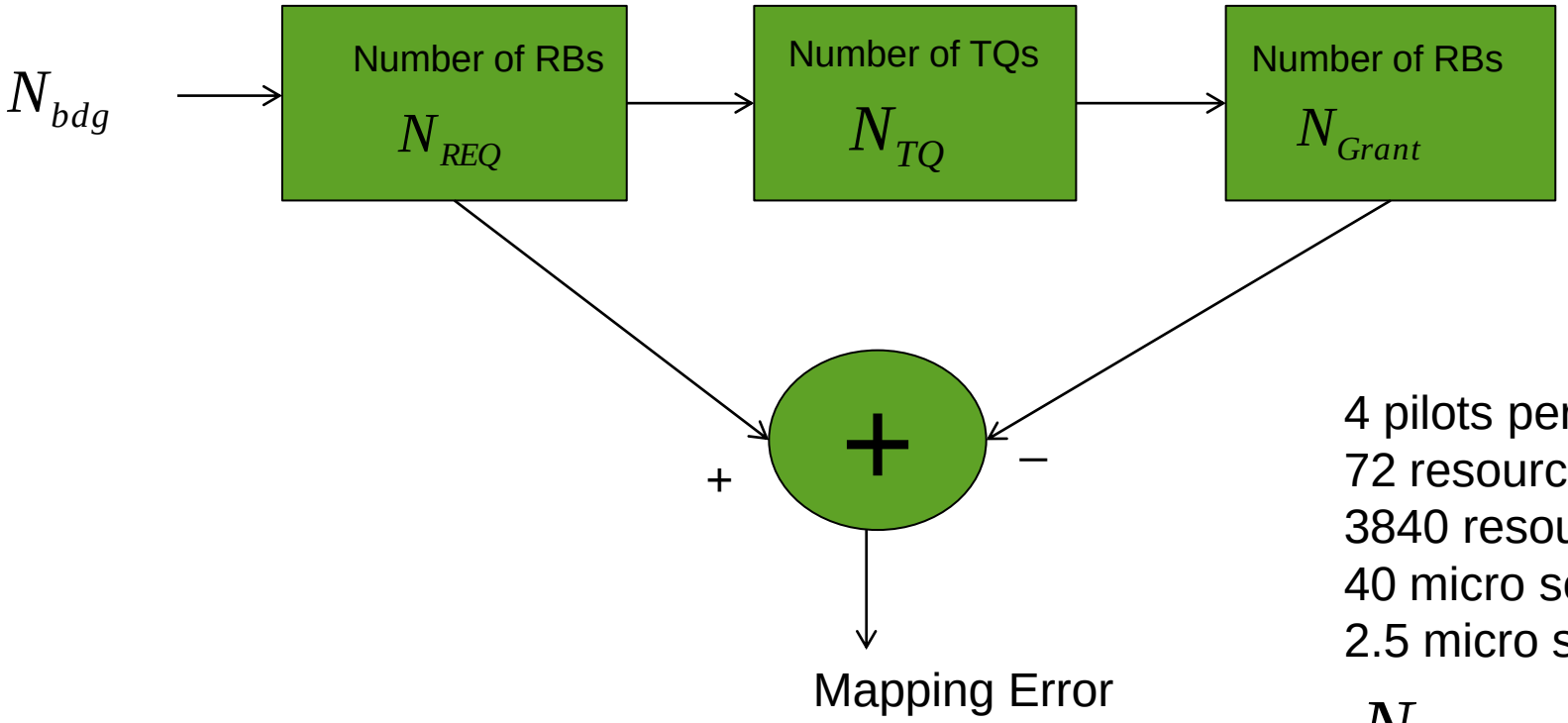
Bandwidth requested >= Bandwidth needed

Mapping Bandwidth Grant From TQs to RBs

- N_{GTQ} = Received bandwidth Grant in number of TQs
- Bandwidth Grant in seconds = $T_{BW} = N_{GTQ} * 16E-9$
- Bandwidth Grant in number of RBs

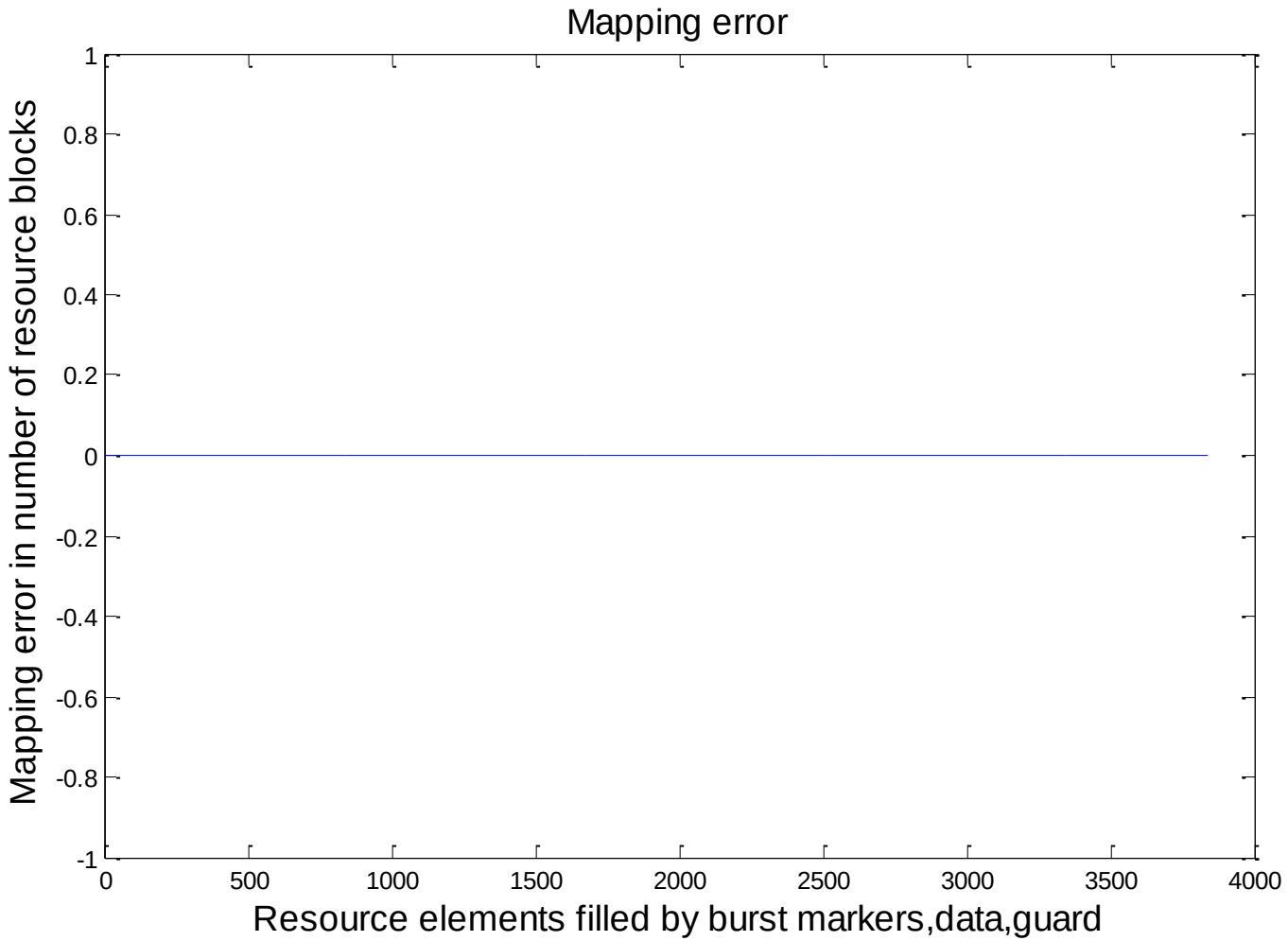
$$N = floor\left(\frac{T_{BW}}{R * T_{RE}}\right) = floor\left(\frac{T_{BW} * N_{RE\_symb}}{R * T_{symb\_cp}}\right)$$

Simulations



4 pilots per resource block
72 resource elements per resource block
3840 resource elements per OFDM symbol
40 micro second OFDM duration
2.5 micro second CP duration

$$N_{TQ} = N_{RTQ} = N_{GTQ}$$


Mapping error
Mapping error in number of resource blocks
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
500
1000
1500
2000
2500
3000
3500
4000
Resource elements filled by burst markers,data,guard

Mapping Grant Start, to start RB number

- During initial registration CNU synchronizes the OFDM frame start with the TQ counter. (details TBD)
- The CNU receives the Grant start , G_{start} in TQs

- Start resource element number $RE_{start} = round\left(\frac{G_{start} * 16E - 9}{T_{RE}}\right)$

- Start Resource block number $RB_{start} = \mathrm{mod}\left[round\left(\frac{RE_{start}}{R}\right), N_{RB}\right]$

Thank you

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