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DEPARTMENT OF ELECTRONICS & TELECOMMUNICATION ENGINEERING

Academic Year 2023-24

Activity Report

On

"VISUALIZATION OF RESOURCE ELEMENT ALLOCATION USING LTE VISUALIZATION TOOL"

Date:27/4/2024

Submitted by:

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Signature of faculty		

Course: Advanced Cellular Communication **Course Code:18TE81**

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LTE VISUALIZATION TOOL

This tool models the allocation of downlink Resource elements to the set of signals and physical channels.

The following parameters can be configured by the user:

1. Channel Bandwidth: Determines the number of subcarriers and resource blocks available to transfer data. High channel bandwidths correspond to high throughputs.
2. Number of Antenna: Determines whether MIMO is used. Single antenna corresponds to no MIMO and relatively low throughputs.2x2 MIMO corresponds to 2 transmit antenna and 2 receive antenna, allowing throughputs to approximately double relative to the single antenna case. 4x4 MIMO corresponds to 4 transmit antenna and 4 receive antenna, all allowing throughputs to approximately quadruple relative to the single antenna case.
3. Cell Identity: The physical cell layer identity impacts the position of the cell specific reference signal in the frequency domain the i.e. vertical position within the grid generated by this application. The position of the cell specific reference signal cycles every 6 values of the PCI. It also impacts the position of each of the physical channels in the frequency domain.
4. PDCCH Quadruplets: The number of PDCCH quadruplets determines the number symbols used by the PDCCH. Higher channel bandwidths can accommodate increased numbers of PDCCH quadruplets. A maximum of 3 symbols can be used to accommodate the PDCCH so there is an upper limit upon the number of PDCCH quadruplets for each channel bandwidth.
5. PHICH Group Scaling Factor: The PHICH Group Scaling Factor, combined with the channel bandwidth, determines the number of PHICH groups (shown to the right). Each PHICH group occupies 12 Resource Elements.
6. PHICH Duration: Determines whether the PHICH is broadcast within a single symbol, or distributed across 3 symbols (normal => single symbol, extended => 3 symbols). The extended duration should only be used when the number of PDCCH quadruplets is relatively high otherwise the number of symbols available to the PDSCH will be reduced unnecessarily.

Steps To Allocate Resource Elements:

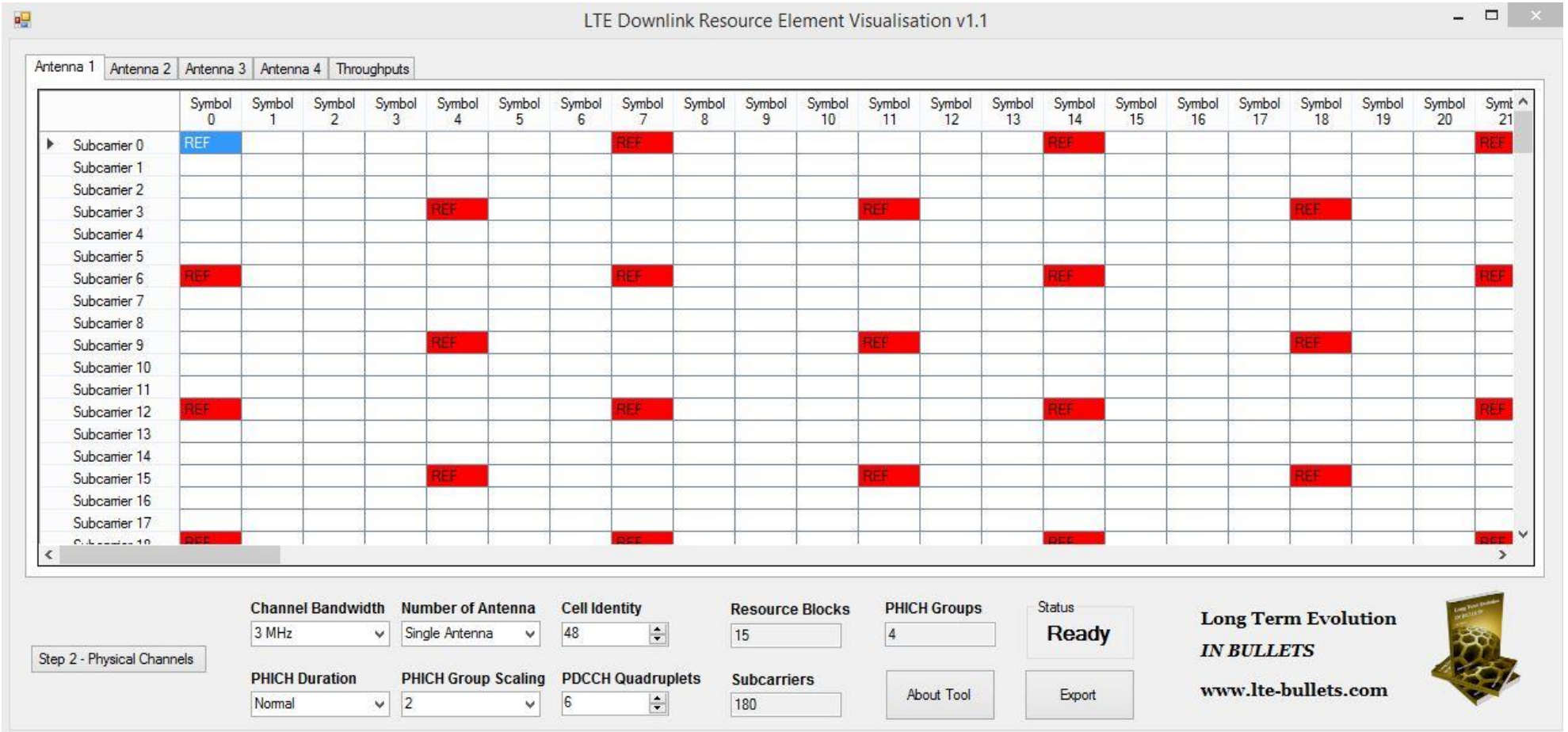
Step 1: Constructs Resource Element grid, then allocates Resource elements for the cell specific reference signal primary synchronization signal and secondary synchronization signal.

Step 2: Allocates resource elements for PBCH, PCFICH, PCICH, PDCCH, PDSCH.

Step 3: Calculates the PDSCH throughput for each modulation scheme and a range of coding rates.

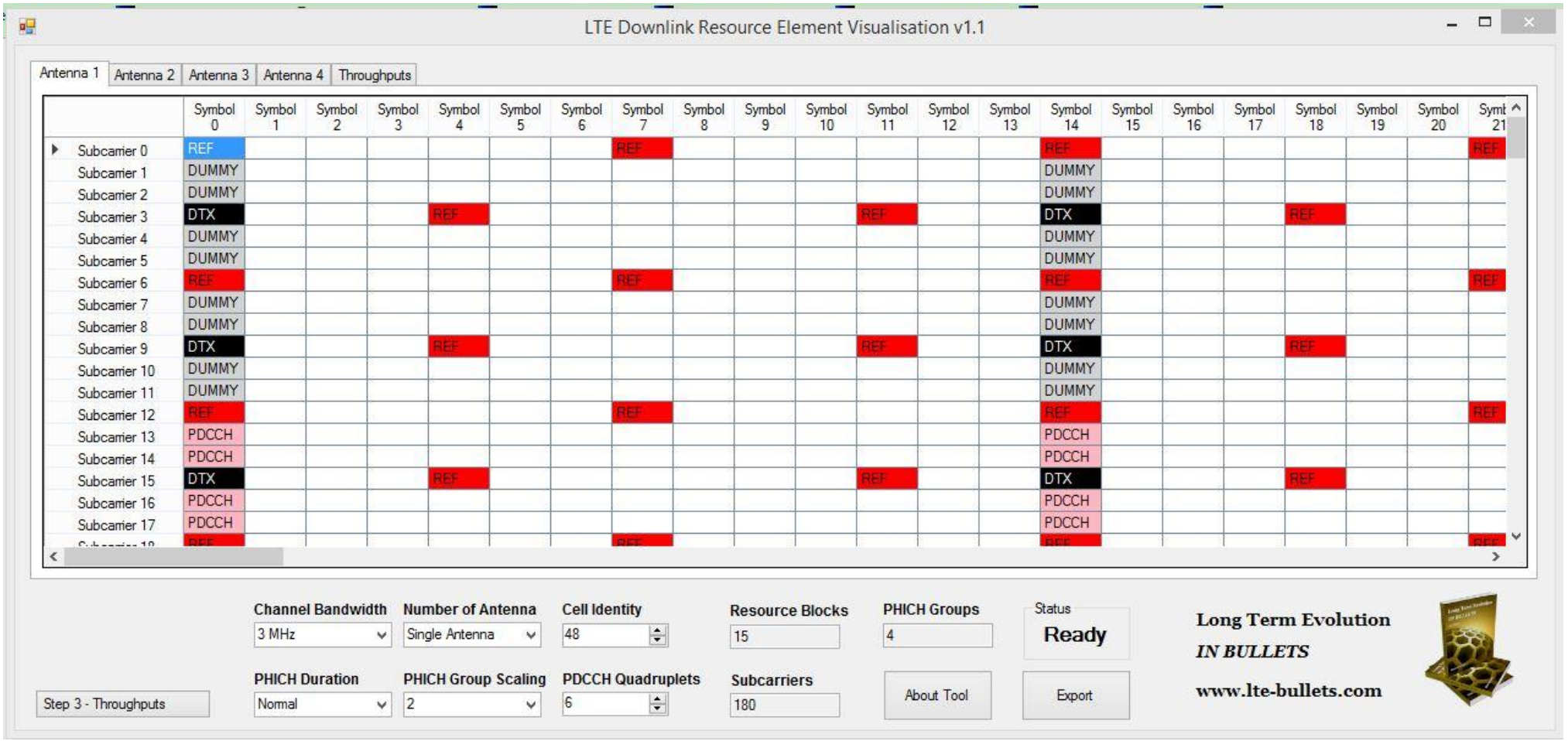
STEP I

1. Channel Bandwidth: 3 MHz
2. Number of antenna: Single antenna
3. Cell Identity: 48
4. PHICH Duration: Normal
5. PHICH Group Scaling: 2
6. PDCCH Quadruplets: 6
7. Resource Blocks: 15
8. Subcarriers: 180
9. PHICH groups: 4



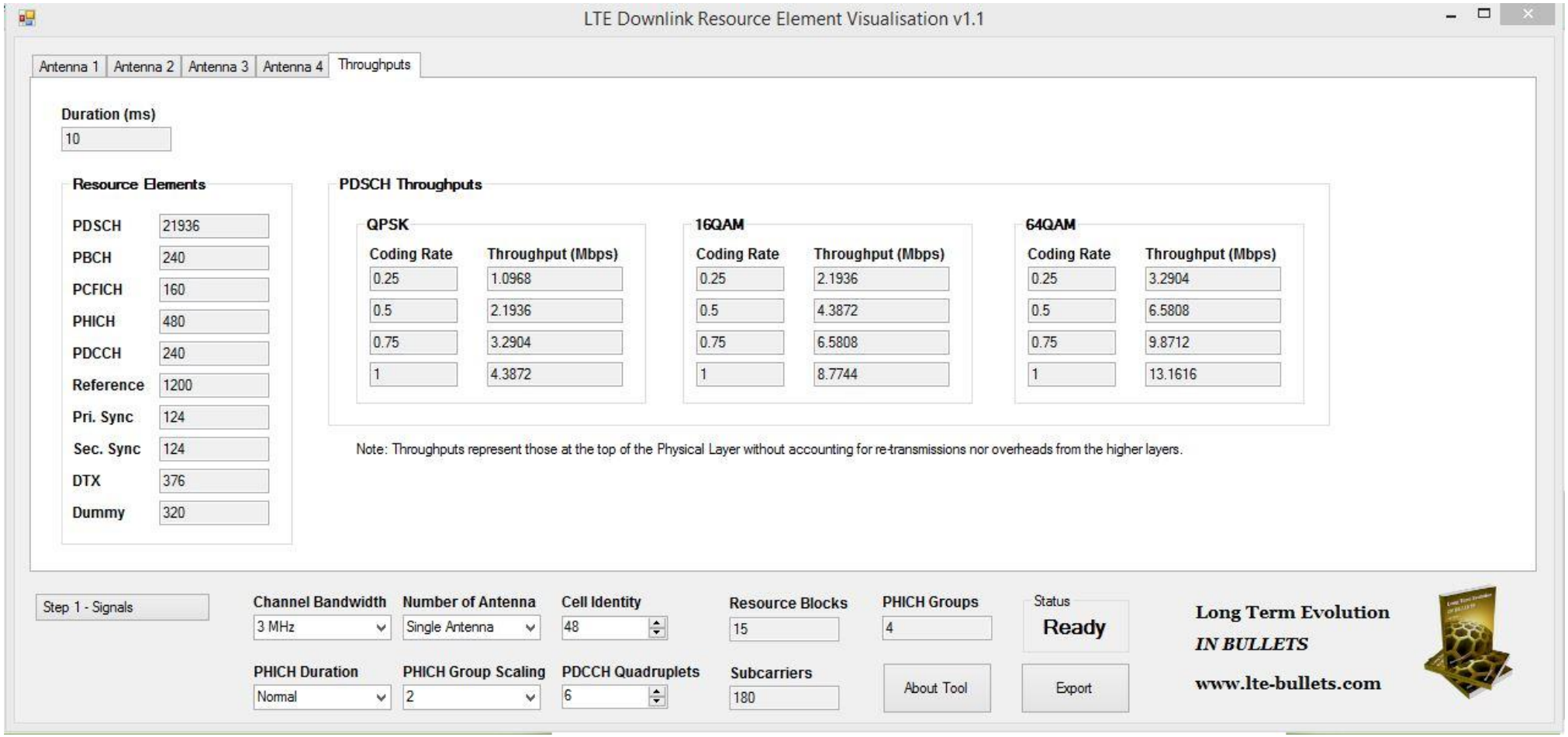
STEP 2

1. Channel Bandwidth: 3 MHz
2. Number of antenna: Single antenna
3. Cell Identity: 48
4. PHICH Duration: Normal
5. PHICH Group Scaling: 2
6. PDCCH Quadruplets: 6
7. Resource Blocks: 15
8. Subcarriers: 180
9. PHICH groups: 4



STEP 3

1. Channel Bandwidth: 3 MHz
2. Number of antenna: Single antenna
3. Cell Identity: 48
4. PHICH Duration: Normal
5. PHICH Group Scaling: 2
6. PDCCH Quadruplets: 6
7. Resource Blocks: 15
8. Subcarriers: 180
9. PHICH groups: 4



THROUGHPUT INFORMATION

Duration: 10 ms

Resource Element Allocations

Reference Signal: 1200

Primary Synchronization Signal: 124

Secondary Synchronization Signal: 124

PBCH: 240

PCFICH: 160

PHICH: 480

PDCCH: 240

PDSCH: 21936

DTX: 376

DUMMY: 320

TOTAL: 25200

Throughputs with QPSK

Coding Rate of 0.25 leads to 1.0968 Mbps

Coding Rate of 0.50 leads to 2.1936 Mbps

Coding Rate of 0.75 leads to 3.2904 Mbps

Coding Rate of 1.00 leads to 4.3872 Mbps

Throughputs with 16QAM

Coding Rate of 0.25 leads to 2.1936 Mbps

Coding Rate of 0.50 leads to 4.3872 Mbps

Coding Rate of 0.75 leads to 6.5808 Mbps

Coding Rate of 1.00 leads to 8.7744 Mbps

Throughputs with 64QAM

Coding Rate of 0.25 leads to 3.2904 Mbps

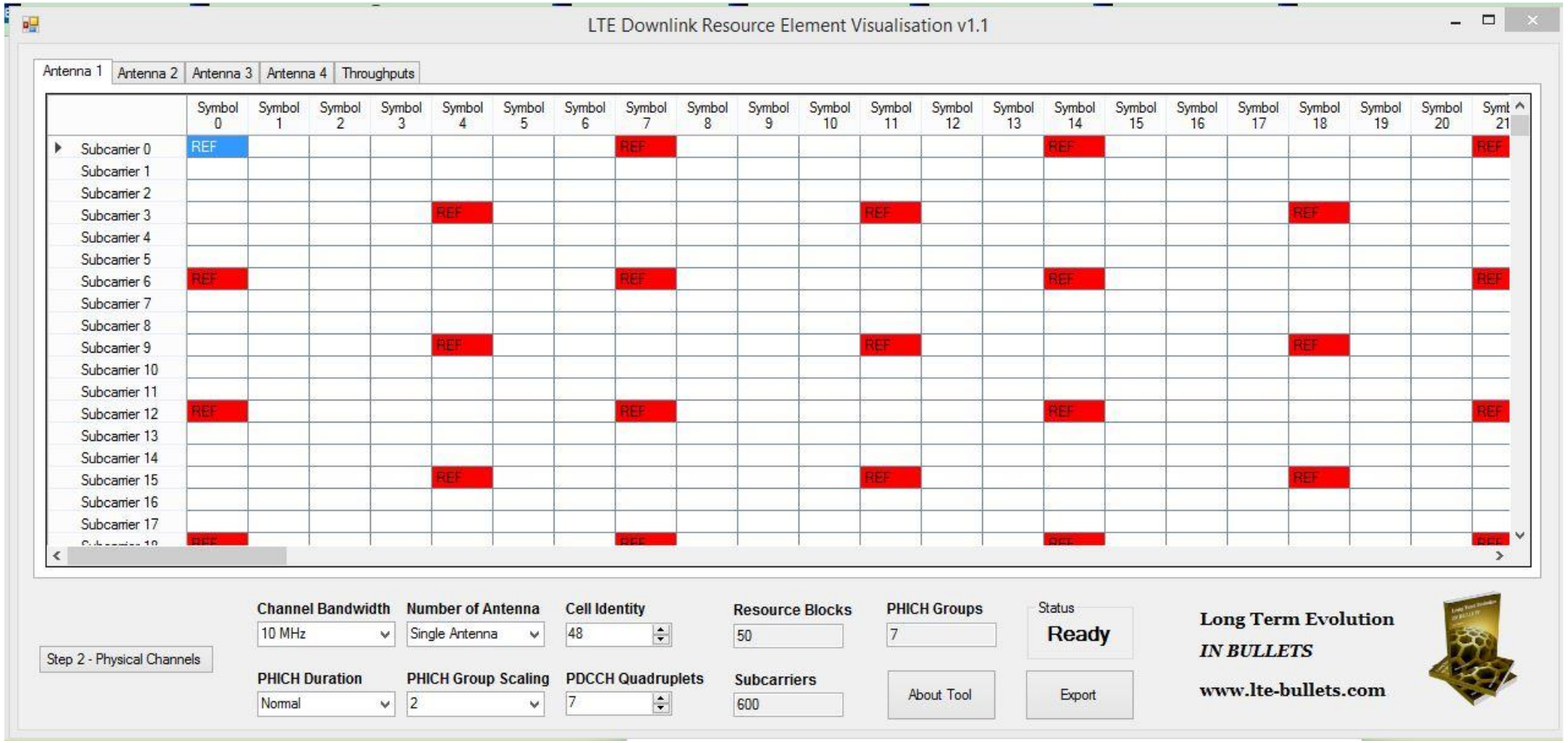
Coding Rate of 0.50 leads to 6.5808 Mbps

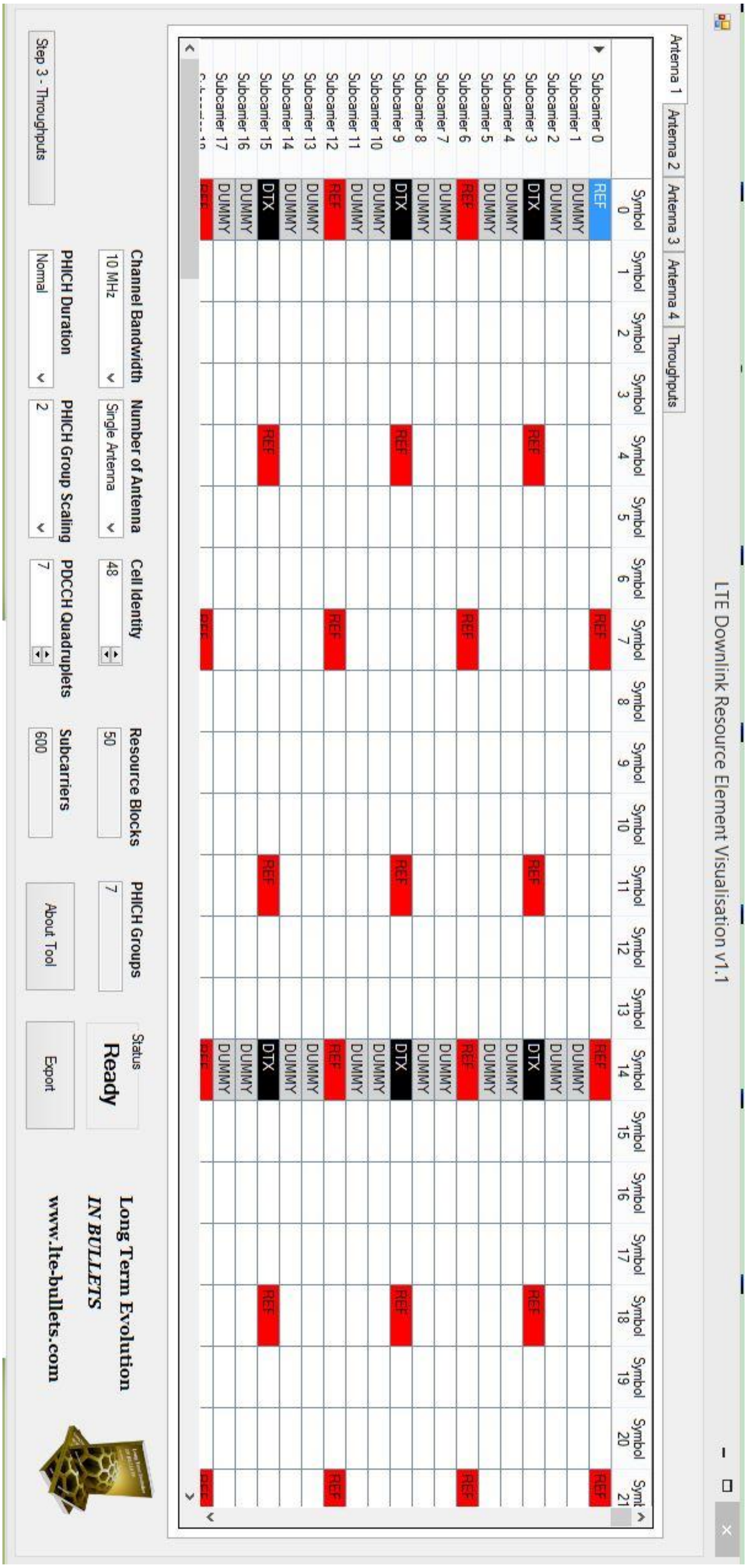
Coding Rate of 0.75 leads to 9.8712 Mbps

Coding Rate of 1.00 leads to 13.1616 Mbps

STEP I

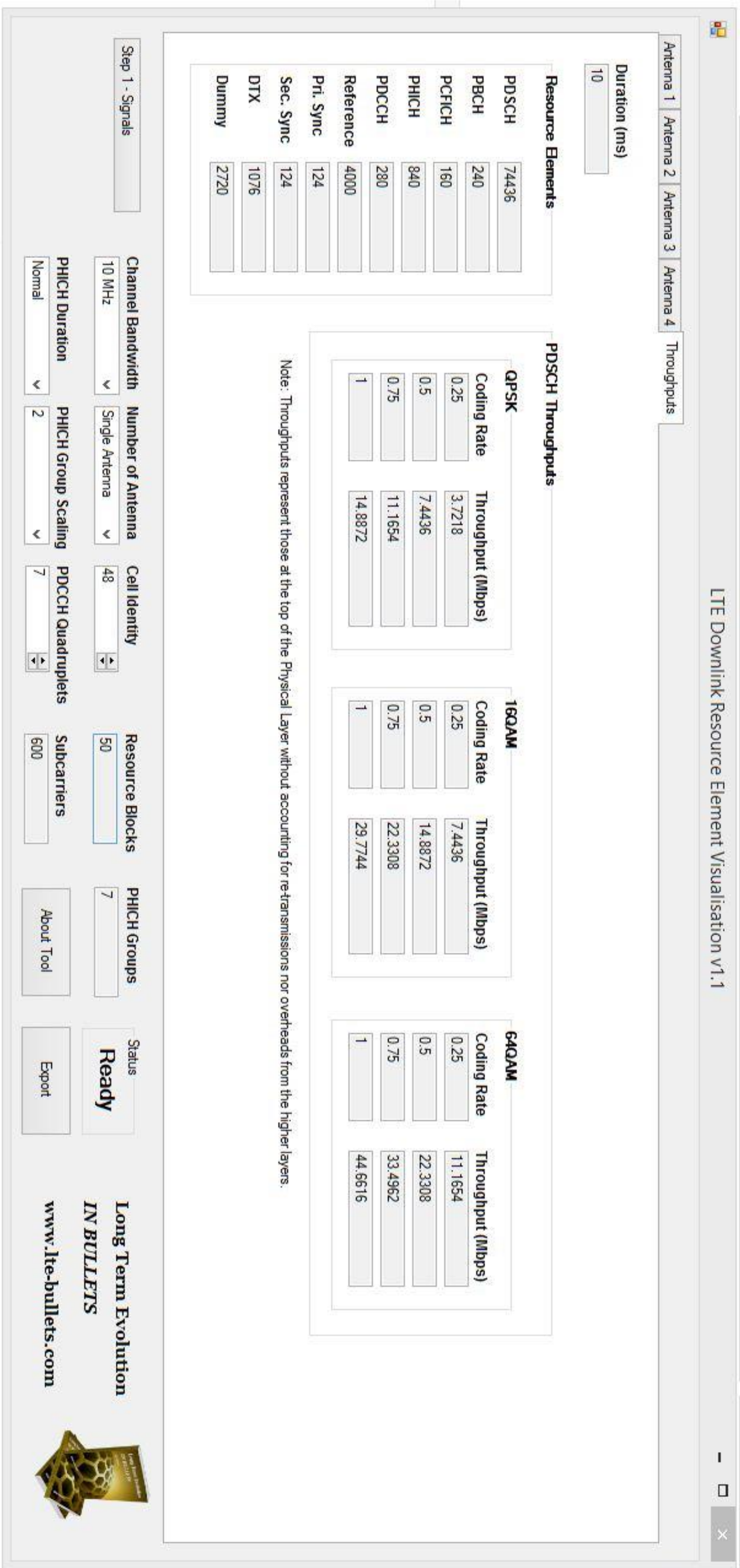
1. Channel Bandwidth: 10 MHz
2. Number of antenna: Single antenna
3. Cell Identity: 48
4. PHICH Duration: Normal
5. PHICH Group Scaling: 2
6. PDCCH Quadruplets: 7
7. Resource Blocks: 50
8. Subcarriers: 600
9. PHICH groups: 7





STEP 2

1. Channel Bandwidth: 10 MHz
2. Number of antenna: Single antenna
3. Cell Identity: 48
4. PHICH Duration: Normal
5. PHICH Group Scaling: 2
6. PDCCH Quadruplets: 7
7. Resource Blocks: 50
8. Subcarriers: 600
9. PHICH groups: 7



STEP 3

1. Channel Bandwidth: 10 MHz
2. Number of antenna: Single antenna
3. Cell Identity: 48
4. PHICH Duration: Normal
5. PHICH Group Scaling: 2
6. PDCCH Quadruplets: 7
7. Resource Blocks: 50
8. Subcarriers: 600
9. PHICH groups: 7

THROUGHPUT INFORMATION

Duration: 10 ms

Resource Element Allocations

Reference Signal: 4000

Primary Synchronization Signal: 124

Secondary Synchronization Signal: 124

PBCH: 240

PCFICH: 160

PHICH: 1560

PDCCH: 280

PDSCH: 74436

DTX: 1076

DUMMY: 2000

TOTAL: 84000

Throughputs with QPSK

Coding Rate of 0.25 leads to 3.7218 Mbps

Coding Rate of 0.50 leads to 7.4436 Mbps

Coding Rate of 0.75 leads to 11.1654 Mbps

Coding Rate of 1.00 leads to 14.8872 Mbps

Throughputs with 16QAM

Coding Rate of 0.25 leads to 7.4436 Mbps

Coding Rate of 0.50 leads to 14.8872 Mbps

Coding Rate of 0.75 leads to 22.3308 Mbps

Coding Rate of 1.00 leads to 29.7744 Mbps

Throughputs with 64QAM

Coding Rate of 0.25 leads to 11.1654 Mbps

Coding Rate of 0.50 leads to 22.3308 Mbps

Coding Rate of 0.75 leads to 33.4962 Mbps

Coding Rate of 1.00 leads to 44.6616 Mbps

INFERENCE

In this tool, different parameters affecting resource element allocation were varied. A Resource Element grid was constructed for the given channel bandwidth, then Resource elements were allocated for the cell specific reference signal primary synchronization signal and secondary synchronization signal. Resource elements were allocated for PBCH, PCFICH, PCICH, PDCCH, PDSCH. The PDSCH throughput was calculated for each modulation scheme and a range of coding rates. There are many other factors like Channel Bandwidth, Number of antennae, Cell Identity, PDCCH Quadruplets, PHICH Group Scaling Factor, PHICH duration which can be varied by the user. The modelling was performed for two bandwidths with the same PCI. The Throughputs with QPSK, 16QAM, 64QAM were calculated for different coding rates for a duration of 10 ms.