

# WiMax Network Modeling with OpNet

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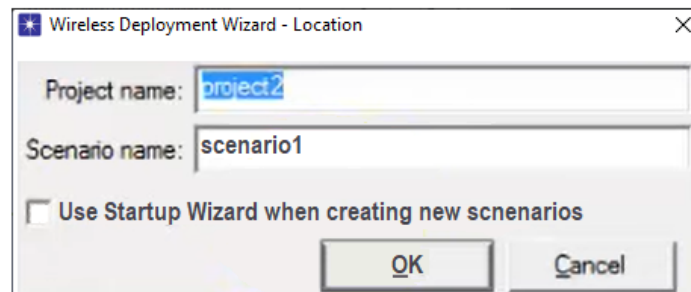
## The basic scenario

It consists of 4 BS (Base Stations), 4 SS (Subscriber Stations), 1 Gateway Router and the Server. The network will test the VOIP application and Handover performance

## Crearea unui nou proiect

Once we enter the OpNet program, creating a new project is done as follows:

File -> New -> Project (choose the name of the project and the name of the scenario) as in the figure below:



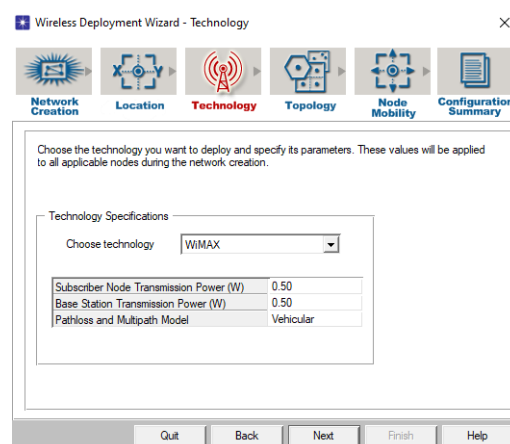
*Fig.1 Creating a new project*

After choosing the name, from the Topology -> Deploy Wireless Network -> Continue menu. This will open a new window, which can also be seen in the examples below.

Network Creation ( leave default )

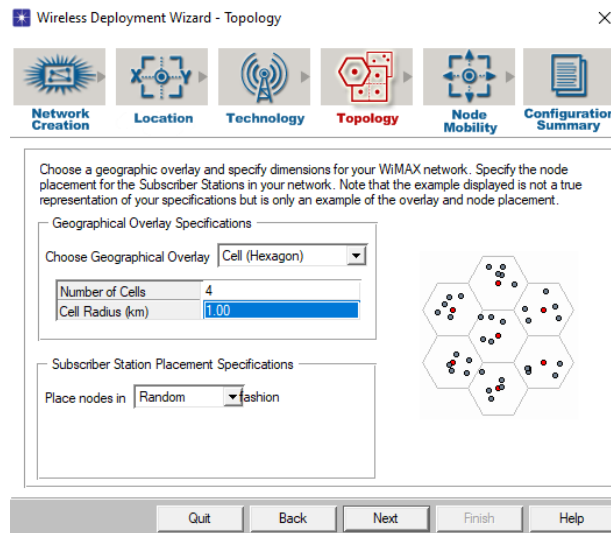
Location ( leave default ) -> here you can choose the coordinates ( latitude and longitude )

Technology -> choose WiMax technology

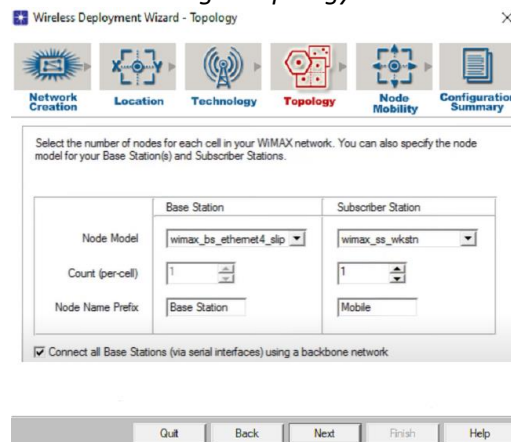


*Fig.2 Technology*

Topology -> choose cell type ( Hexagonal ), cell number ( 4 ) and cell radius of 1 km. Nodes remain "Random", to randomly scatter in the cell. Grid or Circular could also be chosen, but that would have meant that nodes would have to spread according to some rule in the cell. Also here the number of stations per cell is chosen.



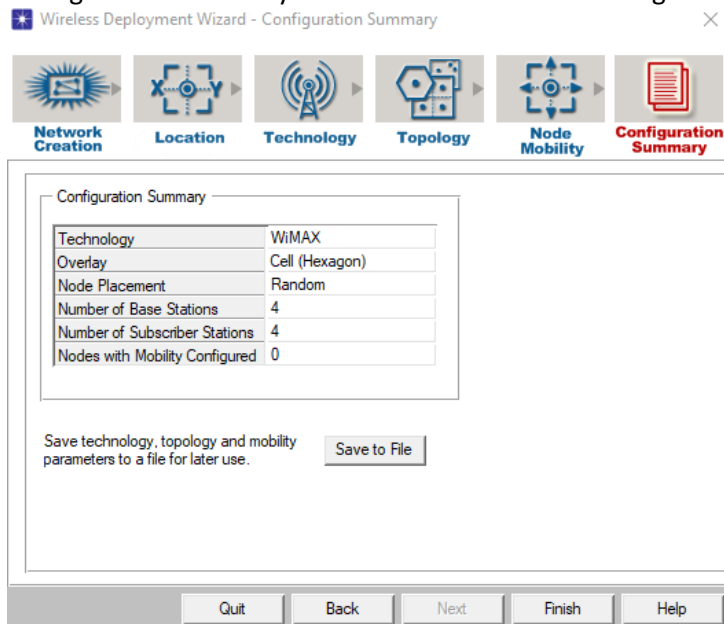
*Fig.3 Topology*



*Fig.4 Topology - count ( per cell )*

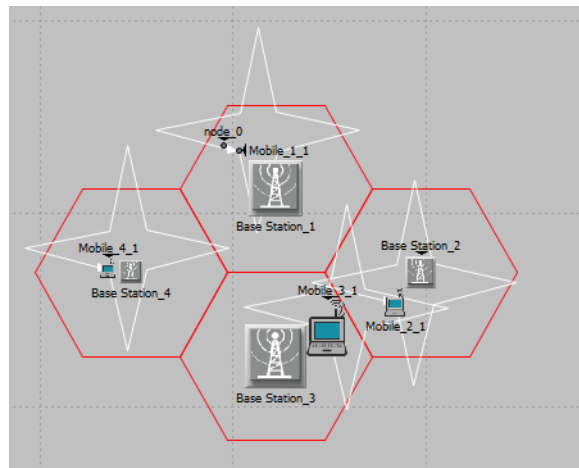
Node Mobility -> delete the trajectory information already set in the related table and continue to Configuration Summary.

Configuration Summary -> Here we show all the settings made, to be checked, and press Finish.



*Fig.5 Configuration Summary*

Next, the cell system will look exactly like the figure below:



*Fig.6 Cell system*

From the "Object Palette Tree" menu choose: WiMax -> Application Config + Profile Config and drag and drop them into the project as in figure 7.

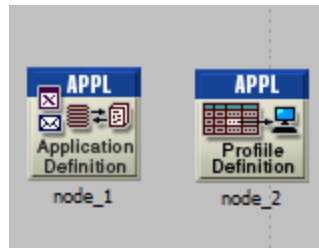


Fig.7 Application Definition + Profile Definition

## Application Config

Right click on Application Definition -> Edit Attributes and change the following:

- Number of Rows = 1
- Name = voice\_app
- Description -> Voice = PCM Quality Speech

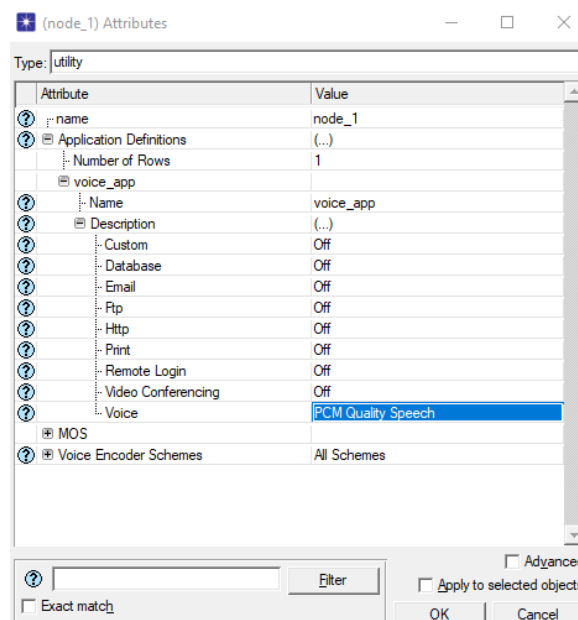


Fig.8 Application Definition

## Profile Config

Right click on Profile Definition -> Edit Attributes and change the following:

- Number of Rows = 1
- Profile Name = voice\_pro
- Applications -> Number of Rows = 1

- Applications -> Name = voice\_app

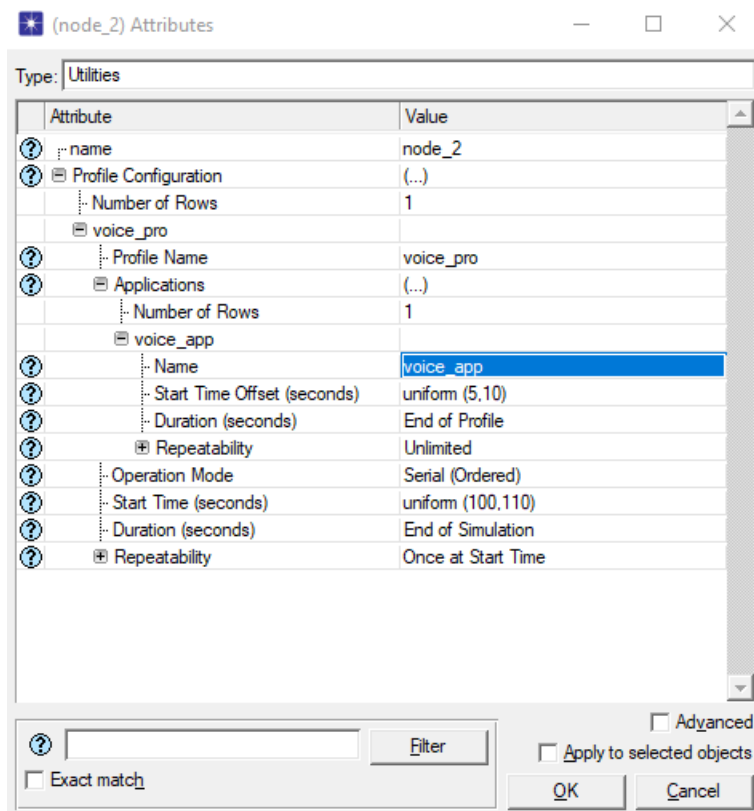


Fig.9 Profile Definition

## WiMax Config

From the "View" menu you get the WiMax configurator as follows:

View -> Show Network Browser -> WiMax\_config ( double click ) - the configurator will appear on the map, which is copied and inserted into our project as in figure 10.

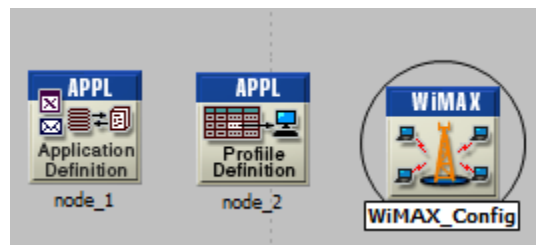


Fig.10 WiMax\_config

Right click on WiMax\_config -> Edit Attributes and from here change the following:

- MAC Service Class Def. -> Row -> Maximum Sustained Traffic Rate = 384 Kbps
- MAC Service Class Def. -> Row -> Maximum Reserved Traffic Rate = 384 Kbps

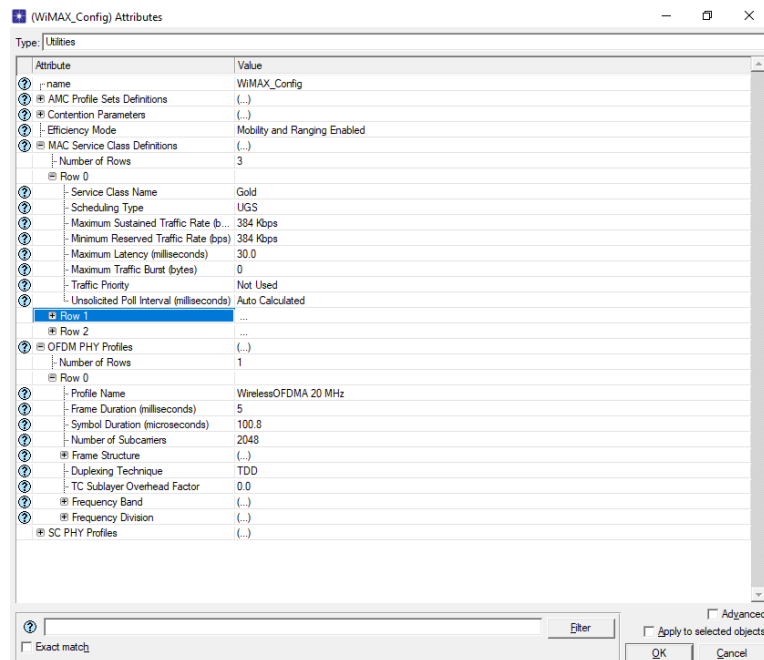


Fig.11 WiMax\_config

## Subscriber Station Config

Right click on one of the 4 SS ( Subscriber Station ) and select the option "Select Similar Nodes" to find all similar nodes. Then from the "Edit Attributes" option change the following:

### Subscriber Station 4

- Check "Apply to selected objects"
- Application: Supported Profiles -> Edit = a second window will open where you select Rows = 1 ( bottom left in figure 12 ), and in the table will appear to select the name of the profile. Click and select "voice\_pro".
- Application: Supported Services - do exactly the same as "Supported Profiles", only in the second window select the profile name = "voice\_app".

(Mobile\_4\_1) Attributes

Type: workstation

Attribute	Value
name	Mobile_4_1
trajectory	NONE
WiMAX Parameters	
Applications	
Application: ACE Tier Configuration	Unspecified
Application: Destination Preferences	None
Application: Supported Profiles	(...)
Application: Supported Services	None
H323	
CPU	
Client Address	Auto Assigned
IP	
TCP	

(Application: Supported Profiles) Table

	Profile Name	Traffic Type	Application Delay Tracking
voice_pro	voice_pro	All Discrete	Disabled

1 Rows   Delete   Insert   Duplicate   Move Up   Move Down

Details   Promote   ☒ Show row labels   OK   Cancel

Fig.12 Subscriber Station 4 Config



## Subscriber Station 1

- Check “Apply to selected objects”
- Trajectory = wimax\_example\_amc\_0

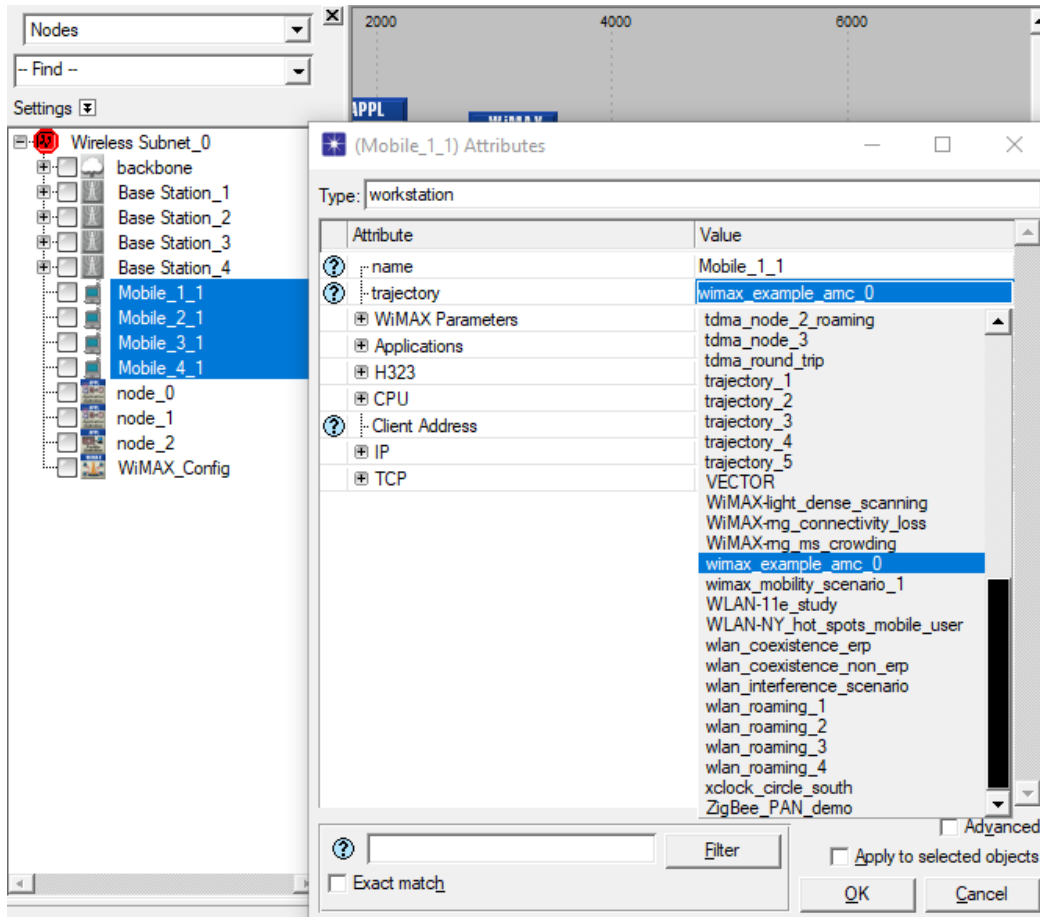


Fig.13 Subscriber Station 1 Config

## Subscriber Station 2

- WiMax Parameters -> Classifier Definitions -> Number of rows = 1
- Match Values = Interactive Voice ( 6 )

- Service Class Name = Gold
- Downlink Service Flows -> Number of rows = 1
- Service Class Name = Gold
- Uplink Service Flows -> Number of rows = 1
- Service Class Name = Gold
- Multipath Channel Model = ITU Pedestrian A

(Mobile\_2\_1) Attributes

Type: workstation

Attribute	Value
name	Mobile_2_1
trajectory	wimax_example_amc_0
WiMAX Parameters	
Antenna Gain (dBi)	-1 dBi
Classifier Definitions	(...)
Number of Rows	1
Row 0	
Type of SAP	IP
Traffic Characteristics	(...)
Match Property	IP ToS
Match Condition	Equals
Match Value	Interactive Voice (6)
Service Class Name	Gold
MAC Address	Auto Assigned
Maximum Transmission Power (W)	0.5
PHY Profile	WirelessOFDMA 20 MHz
PHY Profile Type	OFDM
SS Parameters	(...)
BS MAC Address	Distance Based
Downlink Service Flows	(...)
Number of Rows	1
Row 0	
Service Class Name	Gold
Modulation and Coding	Adaptive
Average SDU Size (bytes)	1500
Activity Idle Timer (seconds)	60
Buffer Size (bytes)	64 KB
ARQ Parameters	Disabled
PDU Dropping Probability	Disabled
CRC Overhead	Disabled
HARQ Enabled	Disabled
Uplink Service Flows	(...)
Number of Rows	1
Row 0	

Fig.14 Subscriber Station 2 Config

(Mobile\_2\_1) Attributes

Type: workstation

Attribute	Value
Row 0	
Service Class Name	Gold
Modulation and Coding	Adaptive
Average SDU Size (bytes)	1500
Activity Idle Timer (seconds)	60
Buffer Size (bytes)	64 KB
ARQ Parameters	Disabled
PDU Dropping Probability	Disabled
CRC Overhead	Disabled
HARQ Enabled	Disabled
Multipath Channel Model	ITU Pedestrian A
Pathloss Parameters	Vehicular
Ranging Power Step (mW)	0.25
Timers	Default
Contention Ranging Retries	16
Mobility Parameters	(...)
Scanning Parameters	Default
Handover Parameters	(...)
MS Handover Retransmission Timer (milliseconds)	30
Maximum Handover Request Retransmissions	6
Handover Threshold Hysteresis (dB)	0.4
Multitarget Handover Threshold Hysteresis (dB)	0.0
Maximum Handover Attempts per BS	3
HARQ Parameters	(...)
Piggyback BW Request	Enabled
CQICH Period	3
Contention-Based Reservation Timeout	16
Request Retries	16
Applications	
H323	
CPU	
Client Address	Auto Assigned
IP	
TCP	

Fig.14\_1 Subscriber Station 2 Config

## Base Station Config

Right click on one of the 4 BS ( Base Station ) and select the option "Select Similar Nodes" to find all similar nodes. Then from the "Edit Attributes" option change the following:

- Classifier Definitions -> Number of rows = 1
- Match Value = Interactive Voice ( 6 )
- Service Class Name = Gold

(Base Station\_4) Attributes

Type: router

Attribute	Value
Scanning Parameters	Default
Handover Parameters	(...)
Resource Retain Time (100 mi...)	2 (200 milliseconds)
Channel Quality Averaging Parameter	4/16
Number of Transmitters	SISO
ASN Gateway IP Address	Disabled
DL AMC Profile Set	Default DL Burst Profile Set
UL AMC Profile Set	Default UL Burst Profile Set
CQICH Period	Accept SS Configured Value
Reserved DL Subframe Capacity (%)	No Reservation
Reserved UL Subframe Capacity (%)	No Reservation
Classifier Definitions	(...)
Number of Rows	1
Row 0	
Type of SAP	IP
Traffic Characteristics	(...)
Match Property	IP ToS
Match Condition	Equals
Match Value	Interactive Voice (6)
Service Class Name	Gold
MAC Address	Auto Assigned
Maximum Transmission Power (W)	0.5
PHY Profile	WirelessOFDMA 20 MHz
PHY Profile Type	OFDM
PermBase	3
IP Routing Protocols	
Reports	
VPN	
IP	
Security	
L2TP	
MPLS	
RSVP	
System Management	

☐ Exact match
 ☐ Advanced
 ☐ Apply to selected objects

Fig.15 Base Station Config

From the Run menu, clicking will open a window with the run configuration parameters. Here you select the duration of 30 minutes and click on Run.

## Run Config

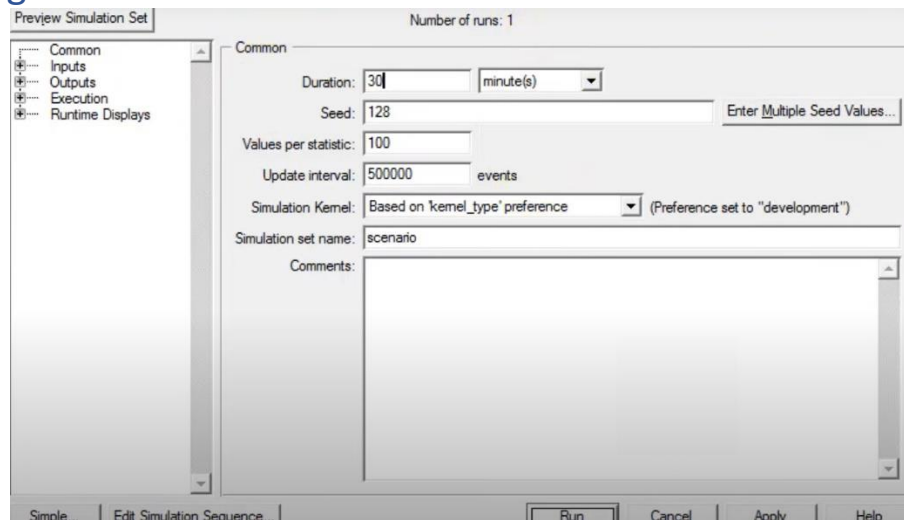


Fig.16 Run Config

## Simulation

Once the simulation has loaded, press "Close".

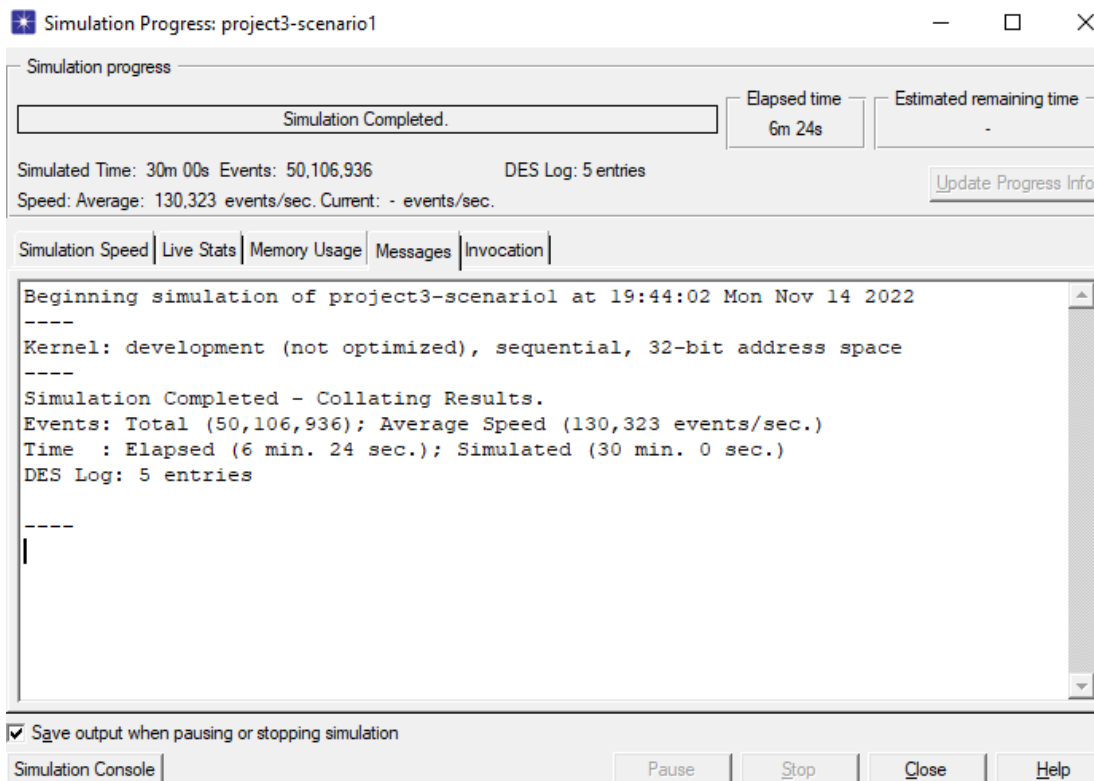


Fig.17 Simulation

Next, to see the results, right-click and select the "View Results" option. A window will open and in the top left under "Results for:" we select "Current Scenario".

At the bottom left will appear the two options "Voice" and "WiMax".

Results for Voice

### Jitter ( sec ) + MOS value

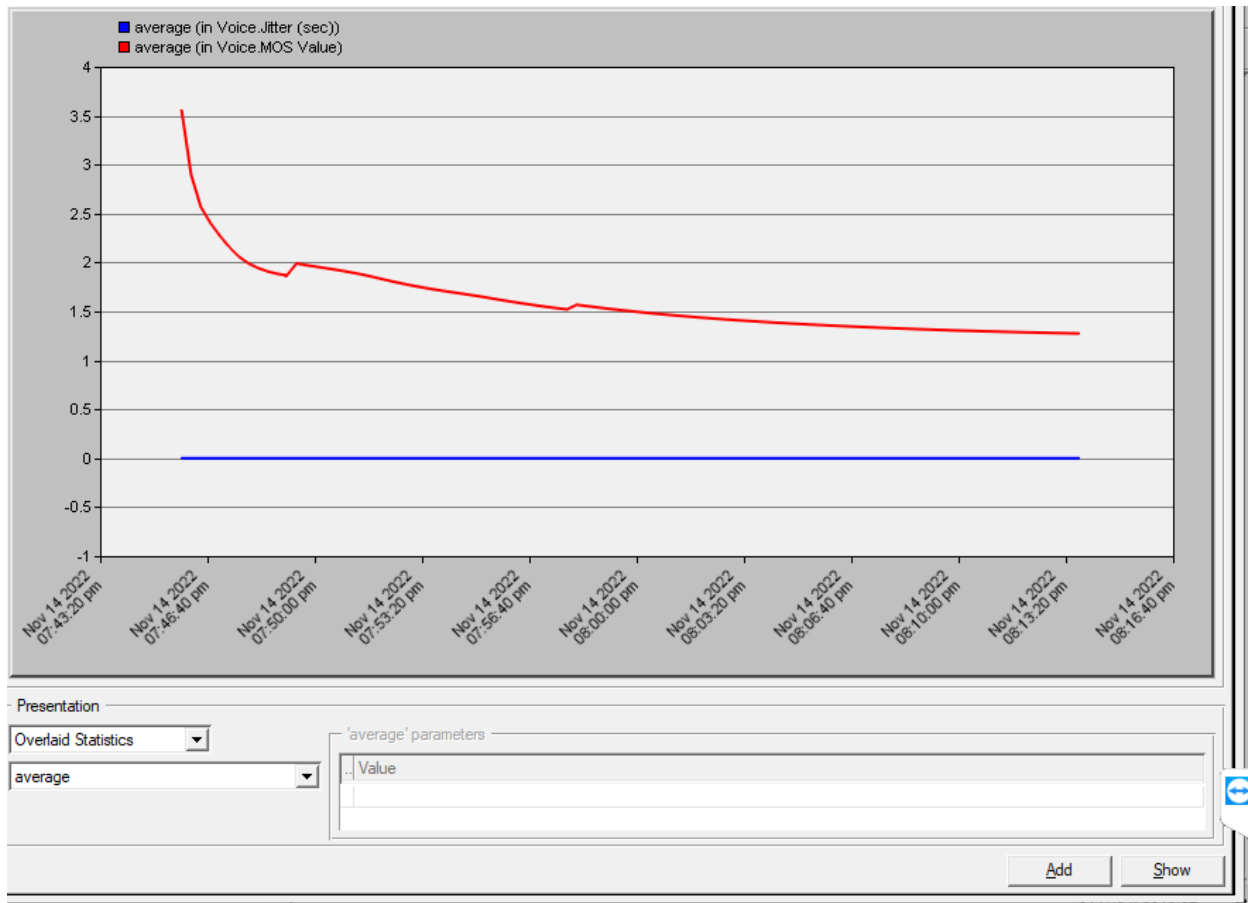
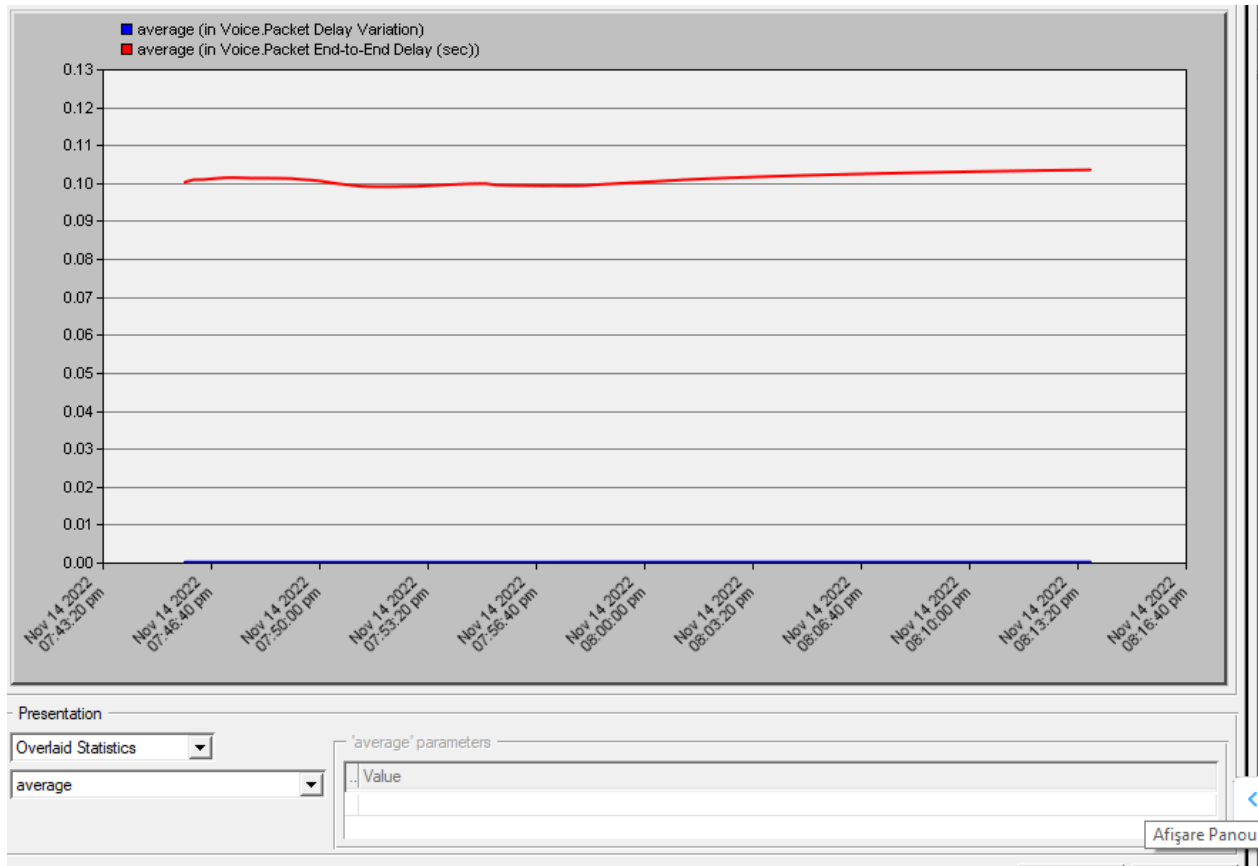


Fig.18 Jitter + MOS value

### Packet Delay Variation + Packet End-to-End Delay ( sec )



*Fig.19 Packet Delay Variation + Packet End-to-End Delay ( sec )*

**Traffic Received ( bytes/sec ) + Traffic Received ( packets/sec )**

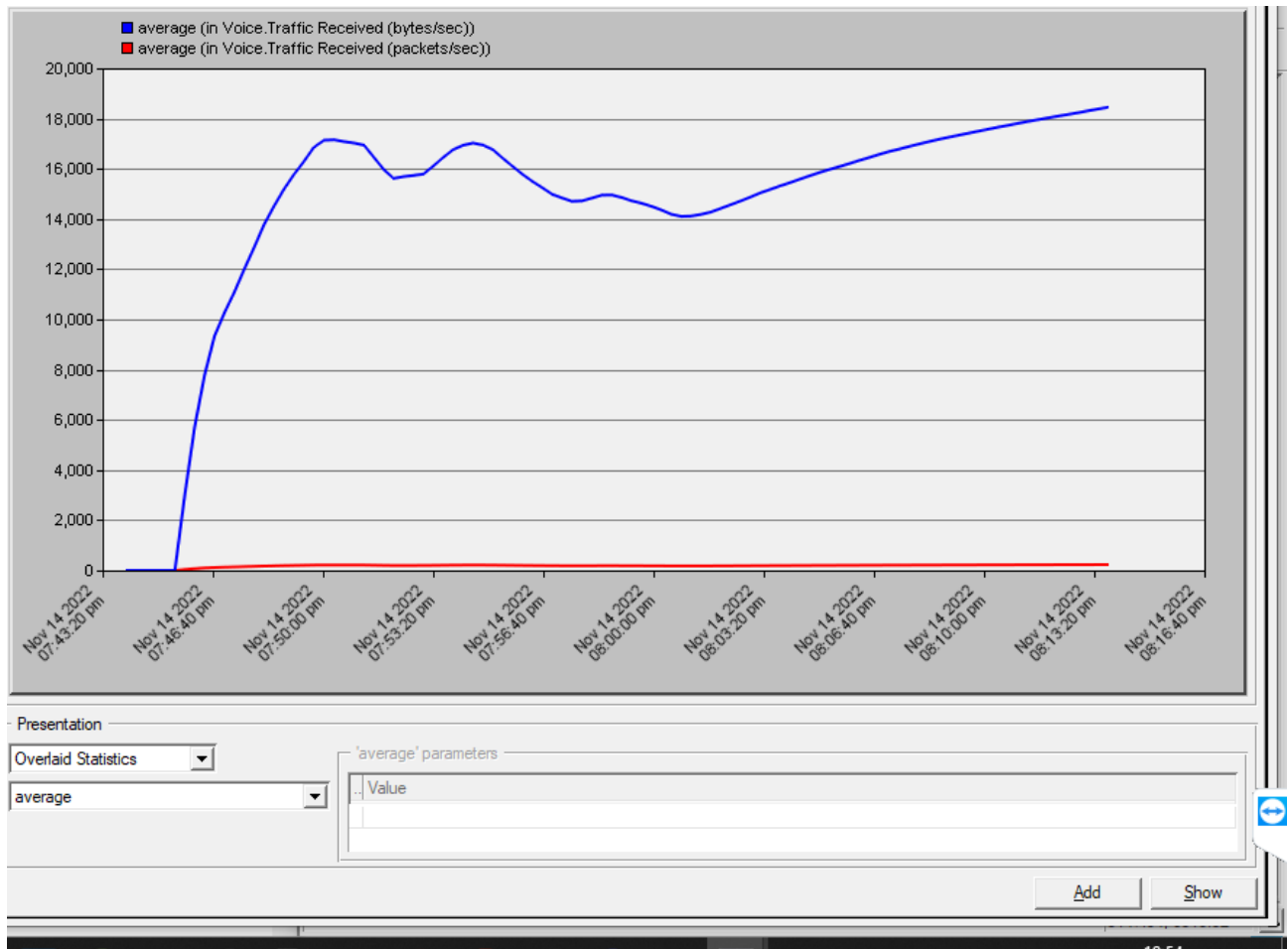


Fig.20 Traffic Received ( bytes/sec ) + Traffic Received ( packets/sec )

**Traffic Send ( bytes/sec ) + Traffic Send ( packets/sec )**



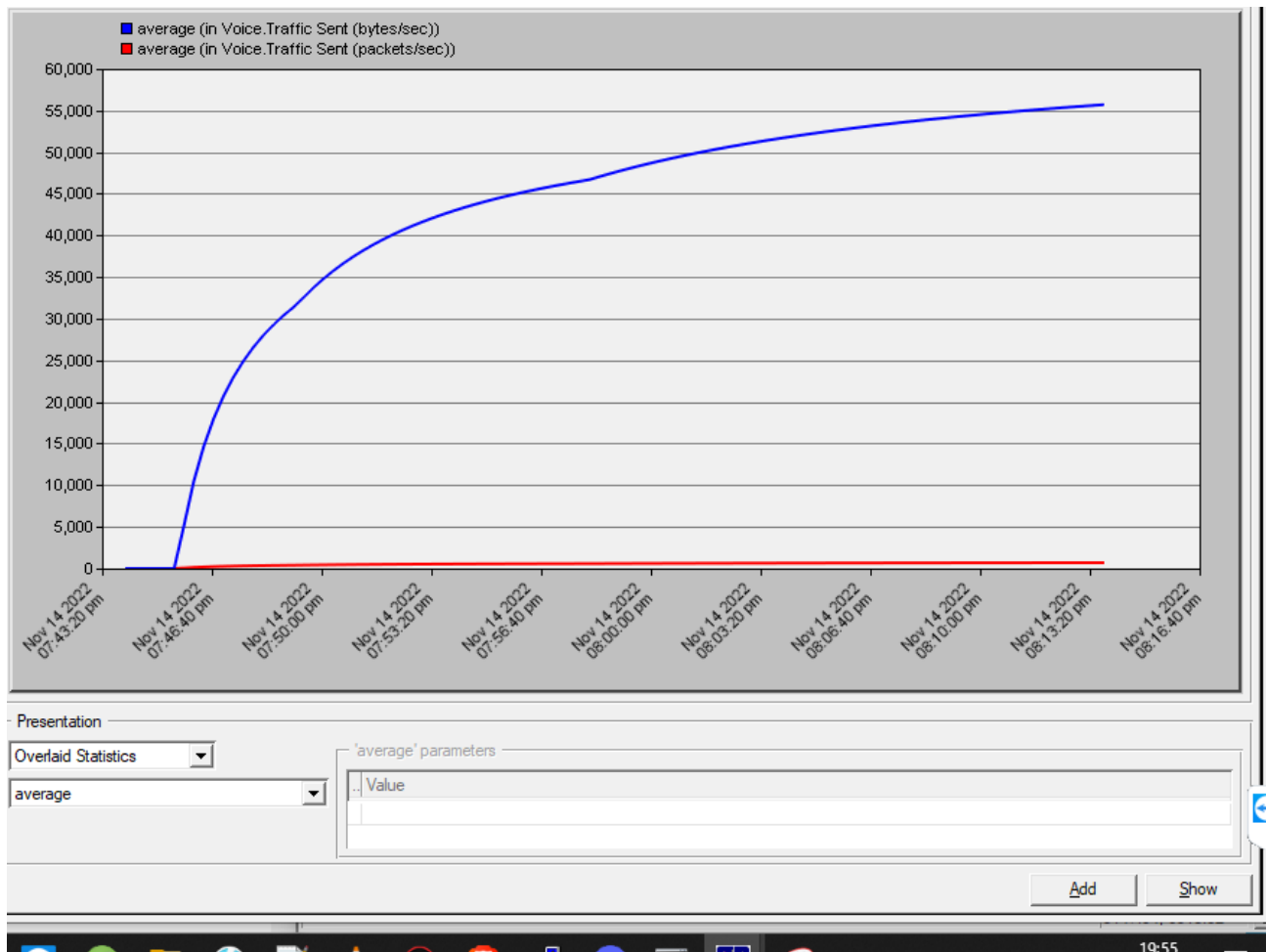
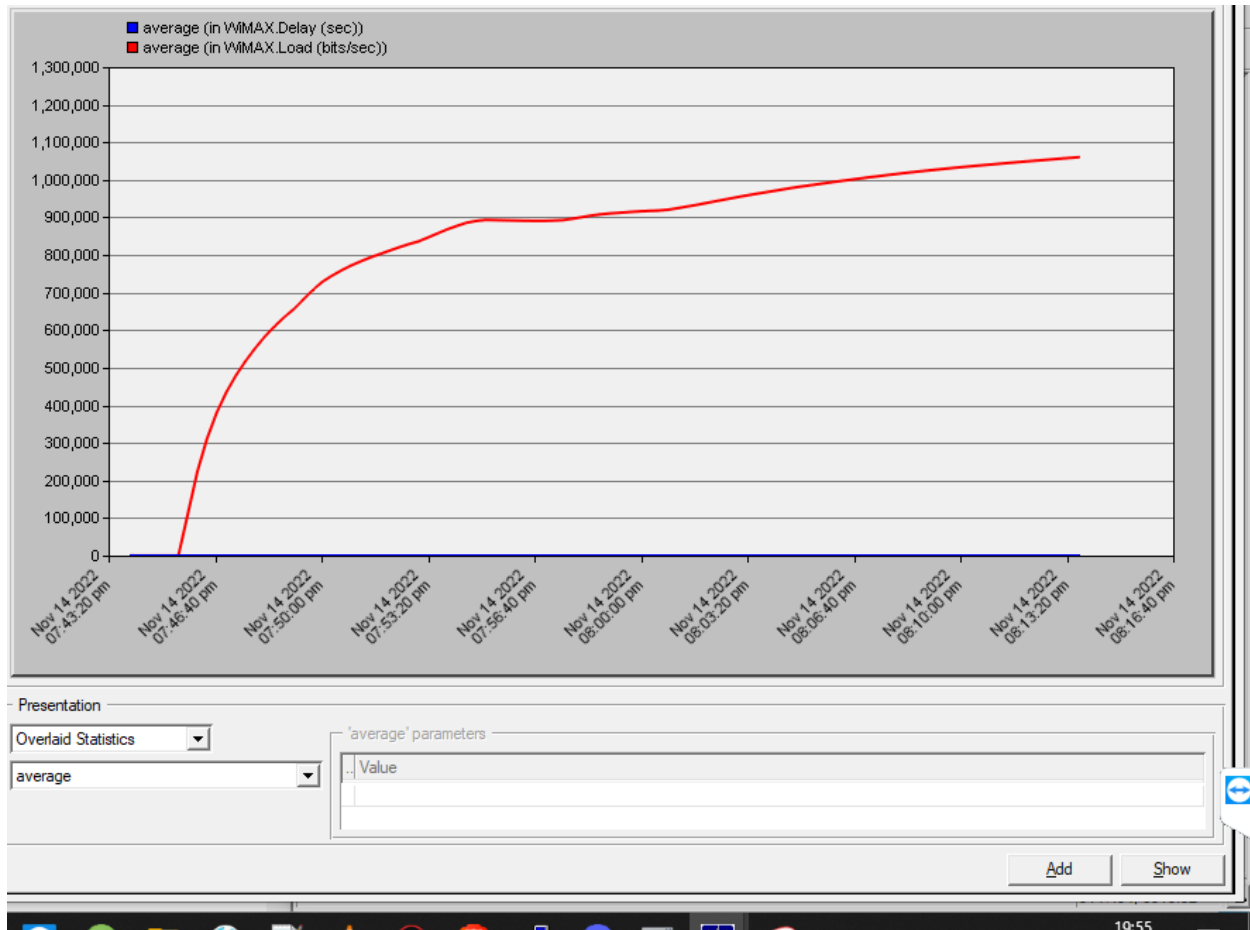


Fig.21 Traffic Send ( bytes/sec ) + Traffic Send ( packets/sec )

## Results for WiMax

**Delay ( sec ) + Load ( bits/sec )**



*Fig.22 Delay + Load ( bits/sec )*

## Load ( packets/sec ) + Throughput ( bits/sec )

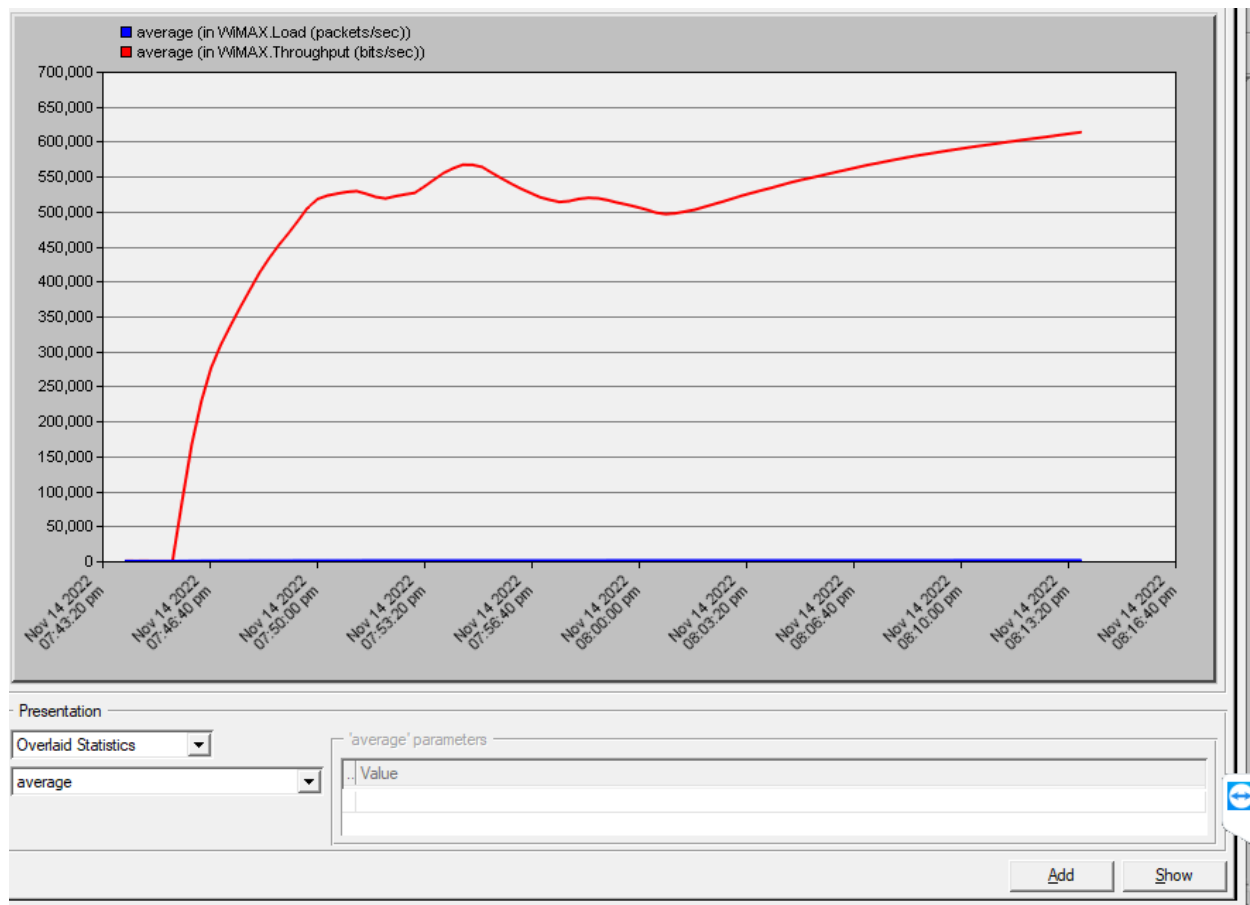


Fig.23 Load ( packets/sec ) + Throughput ( bits/sec )

## Throughput ( packets/sec )

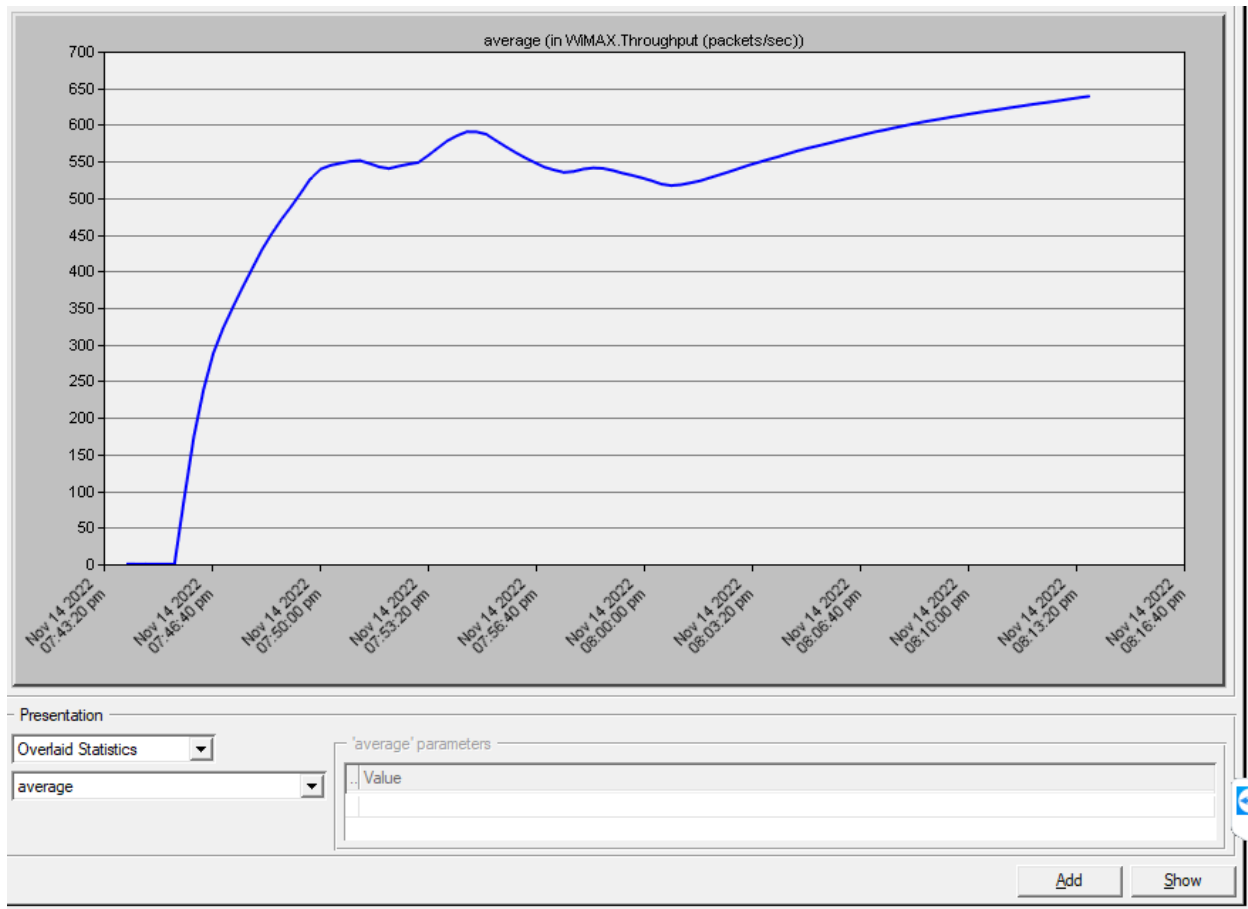


Fig.24 Throughput ( packets/sec )