



## Network Simulation and Emulation Software

Trusted by 400+ Universities Across 25+ Countries for Network R&D and Lab Experimentation

**New!**



Satellite Communication

**New!**



5G NR mm Wave



Internet of Things



Software Defined Networks



Vehicular Adhoc Networks



Network Emulator



# WHAT IS NETSIM® AND HOW IS IT USED?

NetSim is the industry's leading network simulation software for protocol modelling and simulation, network R & D and defence applications.

It is an end-to-end, full stack, packet level network simulator and emulator, providing researchers with a technology development environment for protocol modelling and network R&D. The behaviour and performance of new protocols and devices can be investigated in an virtual network within NetSim at significantly lower cost and in less time than with hardware prototypes.



## Design the network

- Create network scenarios using NetSim's GUI or using XML config files
- Click and drop devices, links, application etc. into the environment using NetSim's GUI
- Set properties with just a click. Layer-wise parameters can be edited



## Run the simulation

- Run the Discrete Event Simulation (DES) through the GUI or CLI
- Log packet trace and event trace files
- Capture packets using Wireshark



## Visualize the simulation - packet animator

- Animate packet flow over wired and wireless links
- Colour variation for control packets, data packets and error packets
- Control animation with play, pause and simulation time-line



## Analyse the results

- Examine output performance metrics at multiple levels - network, sub network, link, queue, application etc.
- Study a variety of metrics such as throughput, delay, loss, packet error, link utilization etc.
- Interpret metrics using in-built plots and graphs
- Create pivot tables and charts for visualization



## Interface with external software

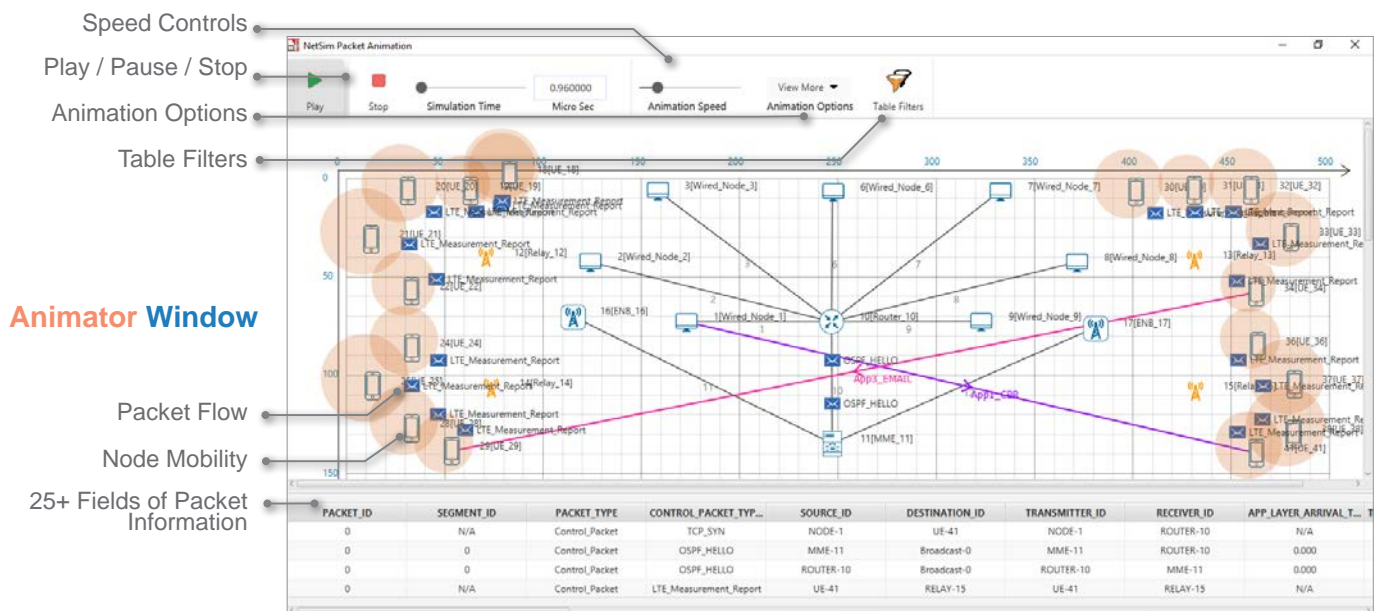
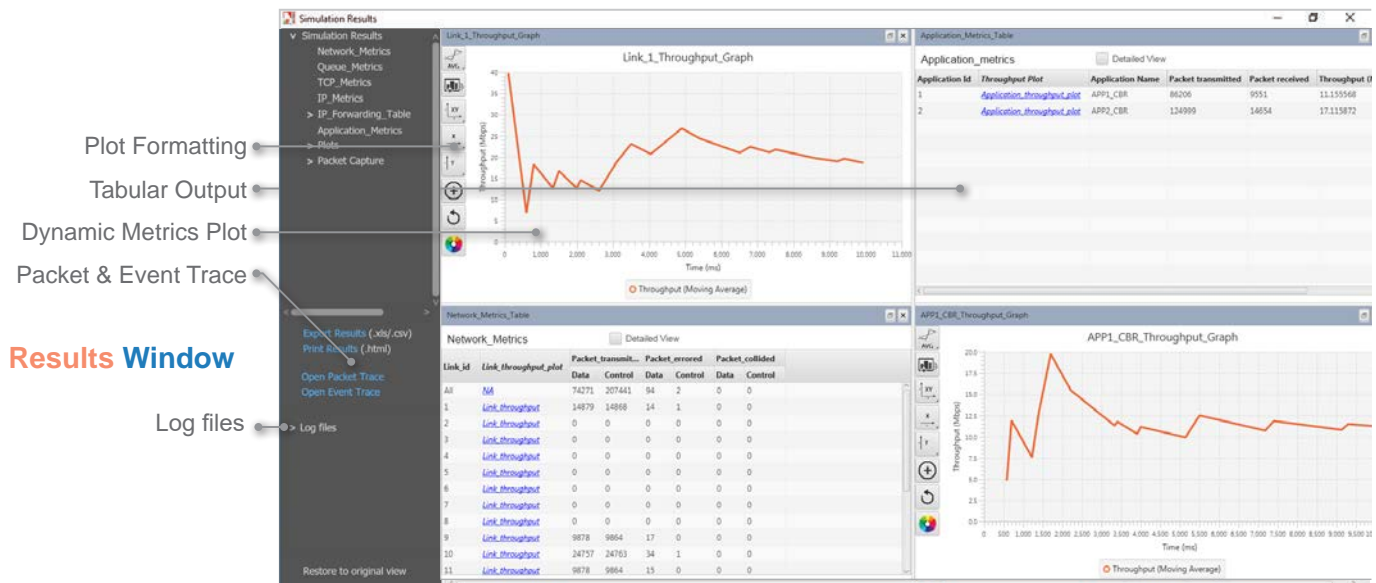
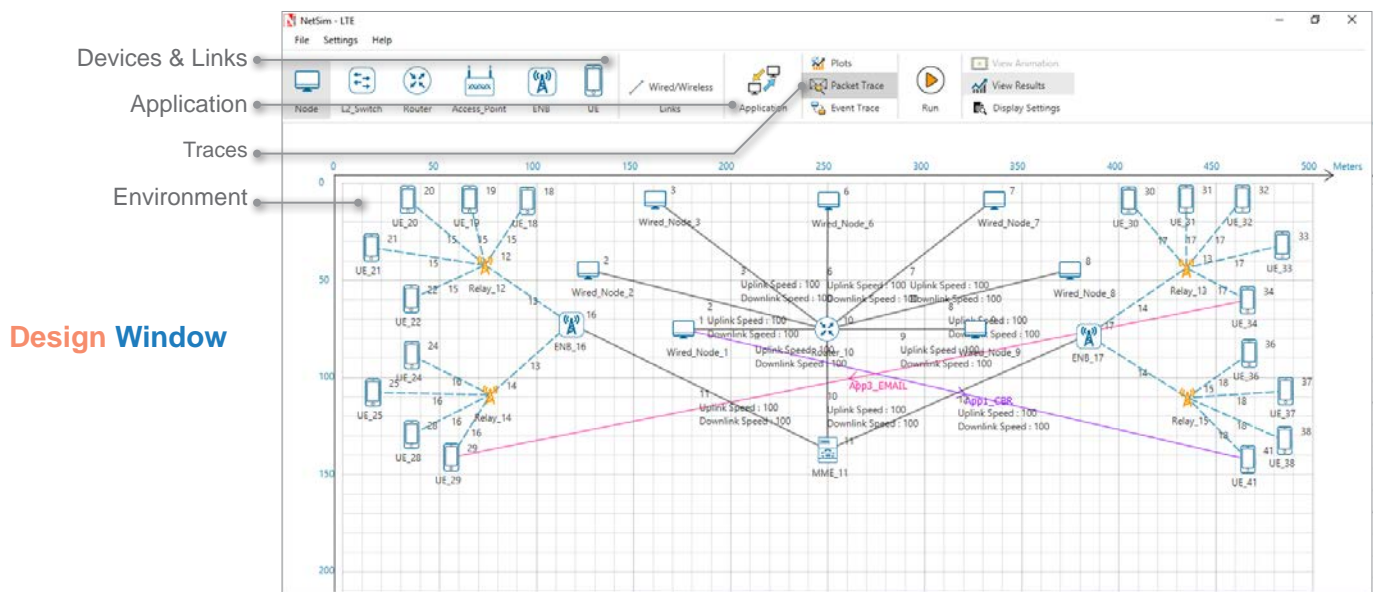
- MATLAB®
- SIMULINK®
- SUMO
- WIRESHARK
- Python



## Develop your own protocol / algorithm

- Extend existing algorithms by modifying NetSim's source C code
- Create custom protocols using NetSim's simulation API's
- Debug your code (step-in, step-out, step-over, continue) and watch your variables in sync with simulation

# WHAT DOES NETSIM'S USER INTERFACE LOOK LIKE ?



# WHAT ARE THE TECHNOLOGIES COVERED IN NETSIM®?

Libraries (Toolboxes)	Networks / Protocols
<b>Component 1</b> (Base. This is required for all other components to run)	<b>Internetworks:</b> Ethernet - Fast & Gigabit, ARP, Routing - RIP, OSPF, WLAN - 802.11 a / b / g / p / n / ac & e, Minstrel Rate Adaptation Algorithm Propagation models - HATA Urban / Suburban, COST 231 HATA urban / Suburban, Indoor Home / Office / Factory, Friis Free Space, Log Distance. Shadowing - Constant, Lognormal. Fading - Rayleigh, Nakagami IPv4, Firewalls, Queuing - Round Robin, FIFO, Priority, WFQ, TCP, - Old Tahoe, Tahoe, Reno, New Reno, BIC, CUBIC, Window Scaling, SACK UDP <b>Common Modules:</b> Traffic Generator: Voice, Video, FTP, Database, HTTP, Email, P2P, Custom, COAP Virtual Network Stack, Simulation Kernel, Command Line Interface, Metrics Engine with packet and event trace Plot Generator Packet Animator, Packet Encryption External Interfaces: MATLAB®, Wireshark, SUMO
<b>Component 2</b>	<b>Legacy &amp; Cellular Networks:</b> Pure Aloha & Slotted Aloha, GSM and CDMA
<b>Component 3</b>	<b>Advanced Routing and Switching:</b> VLAN, Multicast Routing - IGMP, PIM, Layer 3 Switch, Access Control Lists, NAT
<b>Component 4</b>	<b>Mobile Adhoc Networks:</b> MANET - DSR, AODV, OLSR, ZRP. Single and Multiple MANETs
<b>Component 5</b>	<b>Software Defined Networks:</b> Based on Openflow v1.3
<b>Component 6</b> (Component 4 required)	<b>Internet of things:</b> IOT with RPL protocol Wireless Sensor Networks (WSN) LR-WPAN 802.15.4
<b>Component 7</b>	<b>Cognitive Radio Networks:</b> WRAN IEEE 802.22
<b>Component 8</b>	<b>Long-Term Evolution Networks:</b> LTE, LTE - Advanced, LTE Device to Device (LTE D2D), LTE Femto Cell
<b>Component 9</b> (Component 4 required)	<b>Vehicular Adhoc Networks:</b> IEEE 1609 WAVE, Basic Safety Message (BSM) protocol per J2735 DSRC, Interface with SUMO for road traffic simulation
<b>New!</b> <b>Component 10</b>	<b>5G NR mmWave Networks:</b> 3GPP 38 Series. Full Stack covering SDAP, PDCP, RLC - UM, TM, MAC, PHY - FR1 and FR2, mmWave propagation
<b>New!</b> <b>Component 11</b>	<b>Satellite Communication Networks:</b> Geo Stationary Satellite. Forward link TDMA in Ku Band and Return link MF-TDMA in Ka band per DVB S2. Markov Loo Fading model. Device models for Satellite, Satellite Gateway, and Satellite User Terminals
<b>Network Emulator</b> Add On	<b>Network Emulator:</b> Connect real hardware running live applications to NetSim Simulator. Interface with Raspberry Pi



## HOW DO I WRITE MY OWN CODE/ALGORITHM ?



### Protocol Libraries

provided in source C code form with necessary API's and documentation



### User Generated Libraries

can be created by modifying protocol source C code



### Development Environment

in NetSim enables you to call into NetSim user generated libraries to run network scenarios



### Detailed Simulation Report

of user generated libraries covering millions of packets and events are available for detailed analysis

## WHAT ARE SOME RESEARCH AREAS WHERE NETSIM IS USED ?

List of R&D projects with code and documentation is available at [www.tetcos.com/file-exchange](http://www.tetcos.com/file-exchange)

### Internet Of Things (IOT)

- » IOT security
- » Energy management and sustainable operation
- » 6LoWPAN based IOT design

### 5G NR mmWave Networks

- » End to End simulation of 5G NR
- » Radio numerology and impact on latency
- » Channel models for FR1 and FR2

### Cognitive Radio Networks (WRAN)

- » Spectrum sensing and incumbent detection
- » Spectrum allocation
- » Interference analysis, spectrum usage

### Vehicular Adhoc Networks(VANETs)

- » v2v and v2i communication
- » Mobility models and connectivity
- » Clustering and routing

### Mobile Ad hoc Networks (MANET)

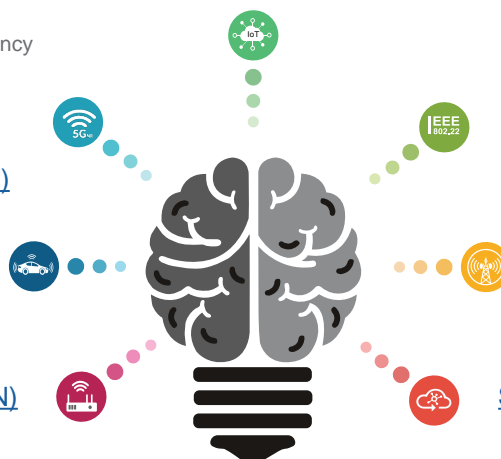
- » Location based, Power aware routing
- » Sinkhole attack
- » Intrusion detection systems

### Wireless Sensor Networks (WSN)

- » Energy efficiency
- » Routing, Clustering and LEACH
- » Localization

### Software Defined Networks (SDN)

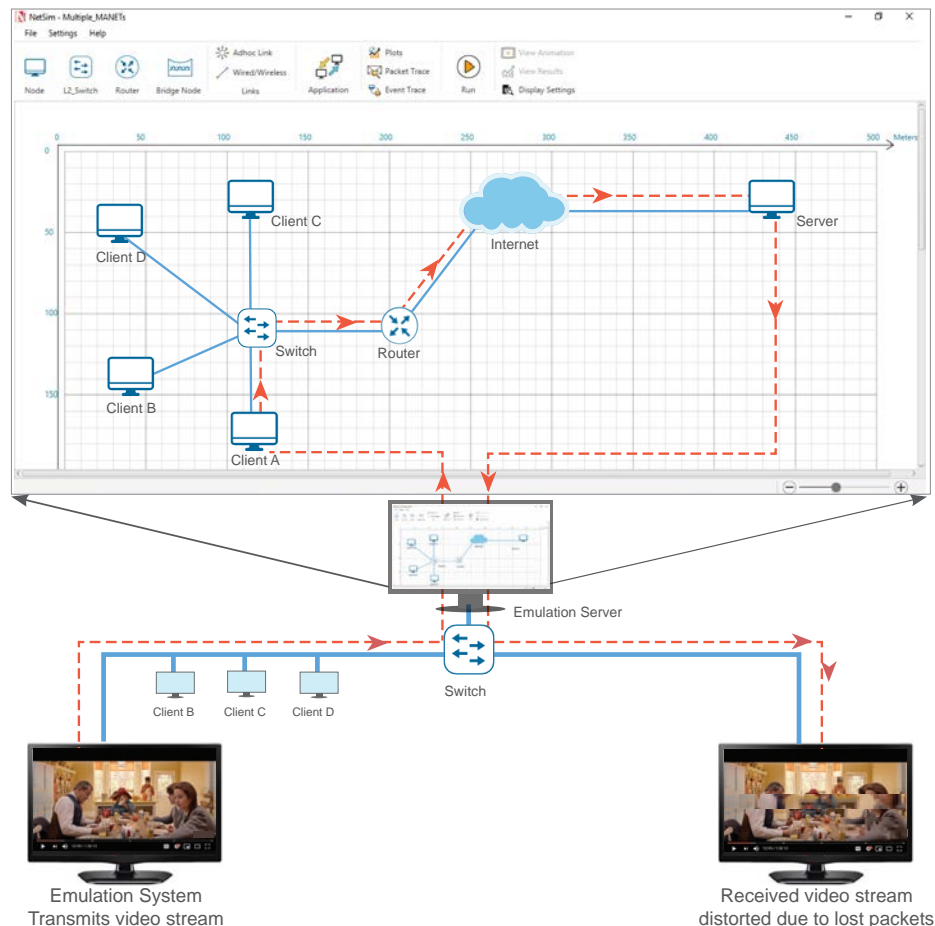
- » SDN based Wired/Wireless/MANETs/VANETs
- » Performance evaluation
- » SDN based traffic engineering and QoS



# HOW DO I CONNECT REAL DEVICES TO NETSIM FOR EMULATION ?

NetSim emulator provides critical insights into application performance by enabling user to run their live application over an equivalent virtual network and see how the application is performing in real time.

NetSim is an IP based, data plane, flow-through network emulator; NetSim emulates the network for the data flowing between the client(s) and server(s)



## What is Emulation?

- » NetSim Emulator enables users to connect NetSim simulator to real hardware and interact with live applications
- » Users can test the performance of real applications over a virtual network.
- » If you are designing a new network or expanding an existing network then NetSim emulator will enable you to run your live application over an equivalent virtual network and see how the application is performing in real time

## Where can it be used?

- » Military radio networks
- » Satellite link analysis
- » Metro rail networks
- » R&D in new protocol design

## How does it work?

- » Create the desired network in the Emulation server using NetSim GUI
- » Route traffic from the PC's/VM's where your application runs, to NetSim emulation server
- » Each live PC/VM corresponds to a node in the simulated network. In the simulated network map the device IP addresses per the real PC/VM
- » Run your application & Measure various parameters such as throughput, delay, loss etc. for your live application using Wireshark

## What are the benefits?

- » Can be used to emulate a wide range of technologies
- » Switching, Routing, MANETs, 4G-LTE networks etc.,
- » NetSim Emulator is a cost effective alternative to hardware emulators that have high costs, complicated configuration requirements and limited scale

# NETSIM EXAMPLE EXPERIMENTS

NetSim comes with a set of example experiments, to aid in the learning of networking concepts through simulation.

## List of Experiments

With structured documentation covering Objective, Theory, Network Set-up, Results and Inference

- Introduction to network modeling and analysis using NetSim
- Understand working of ARP, and IP forwarding within a LAN and across a router
- Simulate and study the spanning tree protocol
- Study the working and routing table formation of Interior routing protocols, i.e. Routing Information Protocol (RIP) and Open Shortest Path First (OSPF)
- Understand the working of “Connection Establishment” in TCP
- Appreciate the mathematical modelling of TCP and understand the fundamental relationship between packet loss probability and TCP performance
- Understand the working of TCP BIC Congestion control algorithm, simulate and plot the TCP congestion window
- Understand the working of Slow start and Congestion Avoidance (Old Tahoe), Fast Retransmit (Tahoe) and Fast Recovery (Reno) Congestion Control Algorithms in TCP
- Study how throughput and error of a Wireless LAN network changes as the distance between the Access Point and the wireless nodes is varied
- How many downloads can a WiFi access point simultaneously handle?
- Understand how channel selection can improve performance of a Wi-Fi network
- Study the Quality of Service (QoS) in 802.11e based WLANs
- Study the hidden node problem in WLAN
- Plot the characteristic curve of throughput versus offered traffic for a Pure and Slotted ALOHA system
- Understand the events involved in NetSim DES (Discrete Event Simulator) in simulating the flow of one packet from a Wired node to a Wireless node
- Simulate M/D/1 Queuing
- Analyze the performance of FIFO, Priority and WFQ Queuing Disciplines
- Study how call blocking probability varies as the load on a GSM network is continuously increased
- Study the 802.15.4 SuperFrame Structure and analyze the effect of SuperFrame order on throughput
- Introduction and working of Internet of Things (IoT)
- Understand the working of OSPF
- Analyze how the allocation of frequency spectrum to the Incumbent (Primary) and CR CPE (Secondary User) affects throughput
- Study how the throughput of LTE network varies as the distance between the ENB and UE (User Equipment) is increased
- Study how the throughput of LTE network varies as the Channel bandwidth changes in the ENB (Evolved node)
- Simulate and study LTE Handover procedure
- Understand the working of LTE Device to Device Communication
- Understanding VLAN operation in L2 and L3 Switches
- Understanding Access and Trunk Links in VLANs
- Understanding Public IP Address & NAT
- Understand the working of basic networking commands (Ping, Route Add/Delete/Print, ACL)

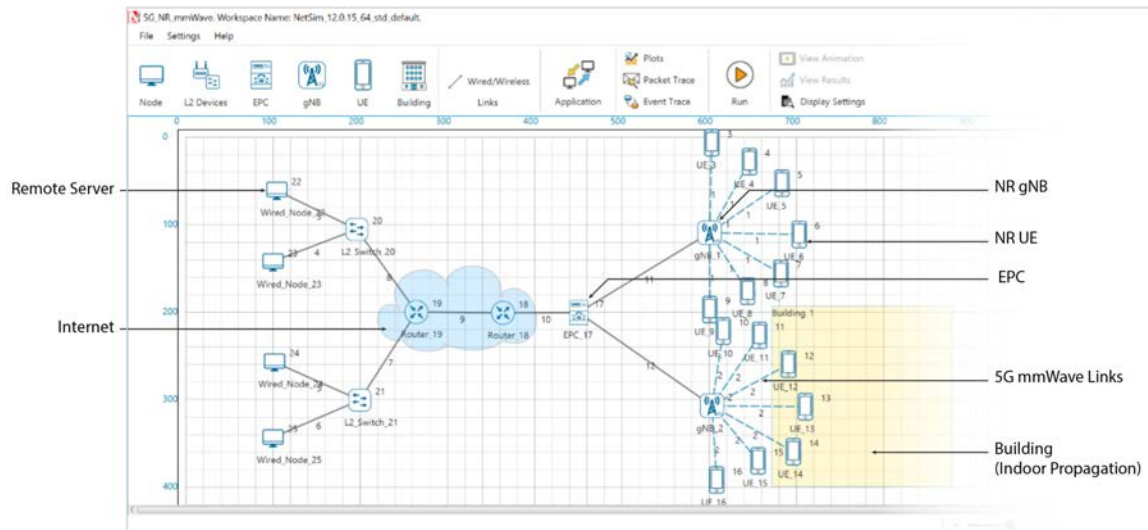
Download the complete experiment manual from

[http://www.tetcos.com/downloads/v12.1/NetSim\\_Experiment\\_Manual.pdf](http://www.tetcos.com/downloads/v12.1/NetSim_Experiment_Manual.pdf)



## Overview

- End-to-End simulation of 5G networks
- Devices: UE, gNB, EPC, Router, Switch, Server
- GUI based with Drag and Drop, Packet Animator and Results Dashboard
- Interfaces with NetSim's proprietary TCP/IP stack providing simulation capability across all layers of the stack
- Discrete Event Simulation (DES) with event level debugging to inspect and control the simulation
- Application Models - FTP, HTTP, Voice, Video, Email, DB, Custom and more
- Packet level simulation with detailed packet trace, event trace and NR log file
- Standalone architecture and based on 3GPP38 series



## Specifications

- SDAP based on specification: 37.324
- RLC based on specification 38.322
- PDCP based on specification 38.323
- MAC Layer based on specification 38.321
  - MAC Scheduler featuring Round Robin, Proportional Fair, Max Throughput and Strictly fair algorithms
  - Link Adaptation to change MCS based on CQI
- PHY Layer
  - Flexible sub-carrier spacing in the NR frame structure using multiple numerologies  $\mu = 0, 1, 2, 3$
  - Carrier aggregation
  - CQI - MCS - TBS
  - PHY layer modulations supported - BPSK, QPSK, 16QAM, 64QAM, 256QAM
- RF propagation
  - mmWave Propagation models (Based on 3GPP TR 38.900 Channel Model) - Rural Macrocell, Urban Macrocell, Urban Microcell, Indoor Office – Mixed office, Open office. LOS States. Outdoor to indoor model

## Featured Examples

- Understand 5G simulation flow through LTE-NR log file
- Effect of distance on pathloss for different channel models - Rural-Macro, Urban-Macro, Urban-Micro
- Effect of UE distance on throughput in FR1 and FR2
- Impact of MAC Scheduling algorithms on throughput, in a Multi UE scenario
- Max Throughput for various bandwidth and  $\mu$  configurations
- Outdoor vs. Indoor Propagation
- 4G vs. 5G: Capacity analysis for video downloads

## HOW DOES NETSIM COMPARE WITH COMMERCIAL SIMULATORS ?

	Commercial Simulators	NetSim™ Standard
<b>Modeling and Simulation</b>		
5G NR mmWave	×	✓
Internet of Things (IoT)	×	✓
Software Defined Networks	×	✓
Vehicular Adhoc Networks	×	✓
Cognitive Radio Networks	×	✓
LTE-Advanced, LTE D2D	×	✓
Special modules for LEACH, Node Failure, Intrusion detection and Sink hole attacks	×	✓
Results dashboard with plots of simulation parameters over time	×	✓
<b>Core Architecture</b>		
Protocol Source Code	C++	C
Writing and building custom code	Re-build entire tool every time	Build only your primitives code
De-bugging custom code	Off line debug. No visibility of protocol variables	Simulation-in-the-loop debug, visibility of protocol variables
Packet Animation	Available, but no packet information provided	Available with packet information
Workspaces	×	✓
<b>Licensing</b>		
License validity	Annual	Annual/Perpetual
<b>Documents and Projects</b>		
Sample Projects based on referenced IEEE papers	×	✓
Project Source Code	×	✓
Lab Experiment manual	×	Per international university syllabi
<b>External Interfaces</b>		
MATLAB® Interface	×	✓
SUMO Interfacing for VANETs	×	✓
Wireshark interface	×	✓
<b>Support and Training</b>		
E-mail & Phone Support	Internet Forum only. E-mail / Telephone extra	✓
On-site Support & Training	On site support from OEM not available	✓

+ per publicly available information at time of print

## HOW DOES NETSIM COMPARE WITH OPEN SOURCE SIMULATORS ?

	Open Source Simulators	NetSim™ Standard
<b>Install</b>	Complicated installation process. Requires knowledge of various compilers and support packages for Python, QT, Doxygen, Mercurial, TCP Dump, and more	Two minute click-through installation
<b>OS/Compiler Support</b>	Linux gcc / g++	Windows Visual Studio (community Edition)
<b>Ease of Use</b>	Write hundreds of lines of script code to create network scenarios. Need to know various scripting and programming languages	Easy to use GUI allows users to simply drag and drop devices, links and applications
<b>Simulation Output</b>	Analyse and write code to extract performance results from multi megabyte files	Results dashboard provides appealing simulation performance reports with tables & graphs
<b>Data Visualization</b>	Fragmented tools with each requiring users to write programs for visualization	Inbuilt graphing with extensive formatting (axes, colours, zoom, titles etc)
<b>Technologies</b>	Limited technologies Stand alone	Wide range of technologies including the latest in IOT, WSN, MANET, VANET, SDN, LTE-Adv Cognitive Radio, 802.11 n / ac.. and more. Libraries work together
<b>Lab Experimentation</b>	Unsure of the quality of the build / patch you have used and if the results are even valid at the end	Comes with a pre-built set of 30-experiments covering important networking concepts
<b>External Interface</b>	Spend many days researching how to link to external software	Inbuilt interfaces to external software like MATLAB®, SUMO and Wireshark
<b>Easy Debug</b>	Code tens of printf statements to debug your code	Online debug capability and ability to 'watch' all variables. Run animation in parallel for immediate visual feedback
<b>Support</b>	No personalized ontime support Users dependent on online resources which require advanced programming knowledge	Professional support via email, helpdesk, remote desktop and phone

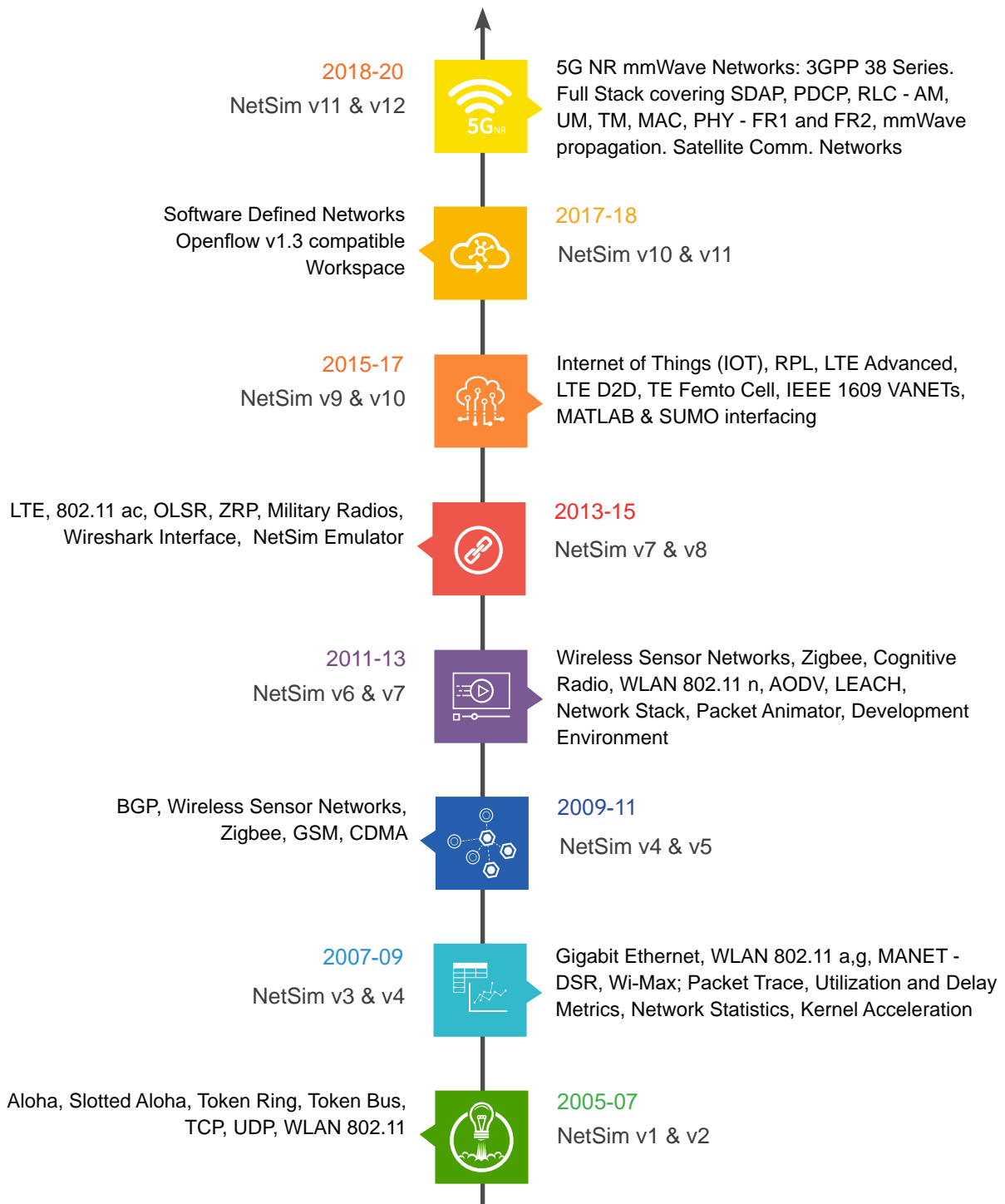
## HOW DO THE DIFFERENT VERSIONS OF NETSIM COMPARE ?

NetSim Standard and NetSim Academic are targeted at educational institutions. NetSim Pro is supplied to Defence and Industry. Please visit [www.tetcos.com](http://www.tetcos.com) for more information on NetSim Pro.

	NetSim® Academic	NetSim® Standard
<b>Technology Coverage</b>		
Internetworks	●	●
Legacy Networks	●	●
SDN	●	●
MANETs	●	●
Cellular Networks	●	●
Wireless Sensor Networks	●	●
Internet Of Things	●	●
Cognitive Radio Networks	●	●
LTE/LTE-A Networks	●	●
VANETs	×	●
5G NR mmWave Networks	×	●
Satellite Communication Networks	×	●
<b>Performance Reporting</b>	●	●
Performance metrics available for Network and Sub-network		
<b>Packet Animator</b>	●	●
Used to animate packet flow in network		
<b>Packet Trace</b>	●	●
Available in csv format for easy post processing		
<b>Protocol Library Source Codes with Documentation</b>	×	●
Protocol C source codes with extensive documentation		
<b>External Interfacing</b>	×	●
Interfacing with SUMO, MATLAB and WireShark		
<b>Integrated Debugging</b>	×	●
Write and link code to NetSim and debug using Visual Studio		
<b>Event Trace</b>	×	●
Logs every event processed by NetSim's discrete event engine		
<b>Dynamic Metrics</b>	●	●
Allows users to graph the values of parameter over simulation time		
<b>Simulation Scale</b>	100 Nodes	500 Nodes
<b>Target Users and Segment</b>	Educational (Lab use)	Educational (Research)
<b>Emulator(Add on)</b>	×	●
Connect to real hardware running live applications		

## OUR JOURNEY

Our customers benefit from our 15+ years of experience in the field of network simulation.



## SUPPORT ECOSYSTEM



**Support Portal**



**Monthly Webinars**



**Videos**



**NetSim File Exchange**



**Knowledgebase/FAQ**



**GitHub Repo**

# SELECT LIST OF EDUCATION CUSTOMERS



## Education - India

AC College of Technology, Karaikudi	IEST, Shibpur	NIT, Delhi
Agra Engg. College, Agra	IIIT, Allahabad	NIT, Durgapur
Aligarh Muslim University, Aligarh	IIIT, Bangalore	NIT, Jalandhar
Anna University College of Engg., Chennai	IIIT, Guwahati	NIT, Kurukshetra
Army Institute of Technology, Pune	IIIT, Gwalior	NIT, Manipur
Assam University, Silchar	IIIT, Raipur	NIT, Meghalaya
AU College of Engg. Vizag	IIST, Trivandrum	NIT, Nagaland
B.C.Roy Engg. College, West Bengal	IIT, Bhubaneswar	NIT, Nagpur
B.G.S Inst of Technology, Mandya	IIT, Delhi	NIT, Rourkela
Basaveshwar College of Engg., Karnataka	IIT, Dhanbad	NIT, Sikkim
Bhilai Institute of Technology, Chattisgarh	IIT, Kanpur	NIT, Silchar
BIT, Mesra	IIT, Kharagpur	NIT, Surat
BITS, Pilani, Goa Campus	IIT, Patna	NIT, Suratkal
BITS, Pilani, Hyderabad Campus	IIT, Roorkee	NIT, Trichy
BITS, Pilani, Pilani Campus	Institute of Tech & Management, Gwalior	NIT, Yupia
BVCOEP, Pune	Integral University, Lucknow	Pondicherry Engg. College, Puducherry
Central Institute of Technology, Kokrajhar	Jabalpur Engineering College, Jabalpur	PSG College of Technology, Coimbatore
CIT, Coimbatore	JNTU College of Engg., Ananthapur	Punjab College of Engineering, Chandigarh
College of Engg. and Tech, Bhubaneswar	JNTU College of Engg., Hyderabad	RGPV, Bhopal
College of Engg., Pune	JNTU College of Engg., Kakinada	R.V. College of Engg., Bangalore
DAIICT, Ahmedabad	K.K Wagh College of Engineering, Nashik	Sant Longowal Inst of Technology, Punjab
Delhi Technical University (Formerly, DCE)	Kalyani Govt Engg. College, West Bengal	Sastra University, Thanjavur, TN
Dibrugarh University, Assam	Kongu Engg.. College, Erode	Shivaji University, Kolhapur
Dr. D.Y Patil Inst of Engg. and Tech, Pune	Kumaon Engineering College, Uttarakhand	Sinhgad College of Engineering, Pune
FGIET, Bariely	M.M.M College of Engineering, Gorakhpur	SMVDU, Katra
GNDEC, Ludhiana	Malnad College of Engg., Hassan	SPIT, Mumbai
Gokaraju Rangaraju Inst of Engg,Hyderabad	MEPCO Engg. College, Sivakasi	Tech Teacher Training Institute, Chennai
Govt College of Technology, Coimbatore	MIT, Pune	Thanthai Periyar Govt Inst of Tech, TN
Govt Engineering College, Farmagudi, Goa	Mizoram University, Aizawl	Thapar University, Patiala
Govt Engineering College, Idukki, Kerala Govt	Motihari College of Engineering, Bihar	TIT, Tripura
Engineering College, Kannur, Kerala	MS University, Tirunelveli	UIET, Chandigarh
Govt Engineering College, Raipur	Mukesh Patel College of Engg., Mumbai	VES Institute of Technology Mumbai
Guru Nanak Dev University, Amritsar	NEC, Kovilpatti	VIT Chennai
Gwalior Engg. College, Gwalior	NERIST, Itanagar	VIT, Vellore
Haldia Institute of Technology, Kolkata	NIT, Agartala	VJTI, Mumbai
IFTM University, Moradabad	NIT, Bhopal	VNR VJIET, Hyderabad
IGIT, Dhenkanal, Orissa	NIT, Calicut	Walchand College of Engineering, Sangli

## Education - International

UNISA, Australia	Asia Pacific University, Malaysia	Sabancı University, Turkey
KUET, Bangladesh	INTI, Malaysia	Core Intl Inst. Higher Edu, UAE
Alberta University, Canada	UTHM, Malaysia	De Montfort Univ, UK
Fleming College, Canada	Oslo and Akerhus University, Norway	Kent University, UK
BITS Pilani, Dubai	Sohar University, Oman	Leeds Beckett Univ, UK
Military Technical College, Egypt	Bayamon Central University, Puerto Rico	Salford University, UK
LAAS-CNRS, France	Szczecin University of Tech, Poland	Sheffield University, UK
Ingolstadt University, Germany	Dar Al Hekma College, Saudi Arabia	Staffordshire University, UK
Education University of HK, Hong Kong	Taif University, Saudi Arabia	University of Wales, UK
Al Nahrain University, Iraq	NUS, Singapore	Barry University, USA
University of Udine, Italy	SIT, Singapore	Florida Gulf Coast University, USA
FREA, Japan	North West University, South Africa	Ontarget Enterprises, USA
GIST, Korea	UKZN, South Africa	Pearson Education, USA
Transport & Telecom. Inst, Latvia	UCLM, Spain	Sonoma State University, USA
Holy Spirit University, Lebanon	University of Vigo, Spain	Stone Hill College, USA
Klaipeda University, Lithuania	Allepo University, Syria	Univ of Wisconsin Eau Claire, USA



OVER 400+ CUSTOMERS ACROSS 25+ COUNTRIES



NetSim is exhibiting at :



**IEEE International Conference on Communications**  
7-11 June 2020 // Dublin, Ireland  
Communications Enabling Shared Understanding



**IEEE Global Communications Conference**  
7-11 December 2020 // Taipei, Taiwan  
Communications for Human and Machine Intelligence



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