NetSim™ Standard Version - Technical Specifications

INTERNETWORKS
(ETHERNET, WIRELESS LAN: 802.11 a / b / g / e / n/ ac, ROUTING: RIP, OSPF, TCP and UDP)

Fast and Gigabit Ethernet

1. Basics – explanation through animation

Spanning tree implementation in switch (as per IEEE 802.1d)
Understanding different switch architecture
Types of transmission in switch
Switch Vs Hub
Different switching Techniques

2. Simulation

Create scenario, simulate and study the performance of switch connected network. Store and forward, cut thru and fragment free switching techniques
Facility to conduct various experiments for differing input parameters.

Input	*Output*
Protocol	Utilization
Frames	Effective Utilization
Data size	Overhead
Error probability rate	Loss
Switching Techniques	Delay
Data Rate	Transmission Time
	Medium Access Time
	Queuing Delay
	User level Throughput
	Probability of success
	Average Attempt

Experimental combination parameters:
- Protocol Vs. Utilization
- Protocol Vs Delay
- Protocol Vs User level Throughput
- Protocol Vs Probability of Success
- Error probability Vs Utilization
- Error probability Vs Frames Discarded etc
- Switching Techniques Vs Utilization

3. Network Programming

Lab exercises:
Design, develop and code fundamental concepts of network during a typical 3 hr lab session.
- Minimum Cost Spanning Tree algorithm
  - Kruskal
  - Prims
  - Boruvska
- Frame sorting techniques
- Scheduling techniques – FIFO, Min-Max Fair

Wireless LAN 802.11 a, b, g, n and ac. IEEE 802.11 e QoS

1. Basics – explanation through animation

Wireless LAN standards
Advantages and Disadvantages of Wireless LAN

802.11 MAC
- Understand working of WLAN components – Access point, Basic service set
- System architecture and Layered architecture

802.11 PHY
- Channel model
- Receiver performance

Working of *CSMA/CA*

Privacy Algorithm
- WEP

2. Simulation

Create scenario, simulate and observe the performance of network with WLAN protocol implementation per IEEE 802.11, a, b, g , n and ac standards. QoS enhancements to WLAN through IEEE 802.11e.

Facility to conduct various experiments for differing input parameters.

Input	*Output*
Protocol	Utilization
Frames	Effective Utilization
Data size	Overhead
Error probability rate	Loss
RTS Threshold	Delay
Retry Limit	Transmission Time
Channel Characteristics	Medium Access Time
Data Rate	Queuing Delay
	User level Throughput
	Probability of success
	RTS Collision count
	Average Attempt

Experimental combination parameters:
- Protocol Vs. Utilization
- Protocol Vs Delay
- Protocol Vs User level Throughput
- Protocol Vs Probability of Success.
- Error probability Vs Utilization
- Error probability Vs Frames Discarded etc
- Number of transmitting nodes Vs Utilization
- RTS method Vs Basic Access method

3. Network Programming

Lab exercises:

Design, develop and code fundamental concepts of network during a typical 3 hr lab session
- PC to PC Communication
  - Simplified WEP encryption / decryption
  - Encryption\ Decryption
- MLMA collision free protocol
- Dynamic Host Control Protocol (DHCP)
- Privacy technique
  - Substitution
  - Transposition
  - XOR, DES, RSA

ROUTING – RIP, OSPF, BGP

1. Basics – explanation through animation

Router Architecture
Working Principle of Router
Components of Routing

Routing methods and algorithms
IP Addressing
- Classful Addressing
- Classless Addressing

Subnetting
Routing Protocols
- RIP – Distance Vector Algorithm
- OSPF – Dijkstra Algorithm

Queuing Techniques
- FIFO
- Priority Queuing.

2. Simulation

Create scenario, simulate, and study the performance of routers running various protocols – Routing Information Protocol (RIP) implemented as per RFC 1058. Open shortest path First (OSPF), implemented as per RFC 2328,

Facility to conduct various experiments for differing input parameters.

Input	*Output*
Protocol	Utilization
Packets	Effective Utilization
Data size	Overhead
Error probability rate	Loss
Buffer size	Delay
Timer	Transmission Time
Data Rate	Propagation Delay
Link Distance	Queuing Delay
Link cost	User level Throughput
MED	Packets Errored
	Local Preference Packets Dropped

Experimental combination parameters:
- RIP Vs OSPF
- RIP Timers Vs Overhead
- Buffer Size Vs Loss
- Link Weight (OSPF) Vs Utilization
- BGP Table formation

3. Network Programming

Lab exercises:
- Distance vector routing algorithm
- Shortest path algorithm
- IPV4 Addressing
  - Address Mask
  - Binary Conversion
  - CIDR
  - Network Address
  - Special Addresses
  - Subnetting
- IPV6 Address
  - EUI 64 Interface Identifier
  - IPV6 Host Addresses
  - IPV6 Subnetting

Transmission Control Protocol (TCP) and User Datagram Protocol (UDP)

1. Basics – explanation through animation

TCP header format
Connection Oriented and Connectionless service
Reliable and Unreliable

Windowing
Congestion Control – Slow Start, Fast Retransmit, Fast Recovery
TCP Timers
TCP and UDP applications
Port Numbering
UDP protocol working

2. Simulation

TCP: Old Tahoe (Slow Start and Congestion Avoidance) as per RFC 2001, 2581, Tahoe (Fast Retransmit) as per RFC 2001, 2581
UDP: Create scenario, simulate and study the performance of UDP. Protocol implementation is as per RFC 768.
Variation of Bit error probability in Links – No error, 10^{-9}, 10^{-8}, 10^{-7}, 10^{-6}
Facility to conduct various experiments for differing input parameters.

Input	*Output*
Protocol	Utilization
Frames	Effective Utilization
Data size	Overhead
Error probability rate	Loss
Window Size	Delay
Congestion Control	Transmission Time
Data Rate	Propagation Delay
Link Distance	Queuing Delay
	User level Throughput
	Segments Errored
	Segments Dropped
	Segments Retransmitted Successfully

Experimental combination parameters:
Utilization Vs Congestion Method
Utilization Vs Error Rate
TCP Vs Routing

3. Network Programming

Lab exercises:
ARP Concept
Sliding Window Protocol

LEGACY NETWORKS
(ALOHA, SL. ALOHA, CSMA / CD, TOKEN RING, TOKEN BUS, ATM, X.25, FRAME RELAY)

Aloha (Pure/Slotted), CSMA / CD, Token Ring and Token Bus

1. Basics – explanation through animation

Network Application
Networking Architecture
Types of Network
Network Performance
Aloha
- Aloha Principle
- Working of Slotted Aloha
- Working of Pure Aloha

Ethernet
- Physical Layer
- Collision
- Frame Structure
- Back off Algorithm

Working of CSMA/CD

Token Ring
- Control Frames
- Working of Protocol
- FDDI

Token Bus
- Control Frames
- Working of Protocol

2. Simulation – Aloha (Pure/ Slotted), CSMA / CD, Token Bus, Token Ring

Create scenario, simulate and study the performance of network with Pure Aloha, Slotted Aloha, CSMA/CD (IEEE 802.3), Token bus (IEEE 802.4) and Token ring (IEEE 802.5) protocols Simulation allows creation of a network with 25 nodes.

Traffic Generator

Data is generated using an inbuilt traffic generator. The size of the data frame depends on the protocol selected for simulation. Inter arrival time can be constant, exponential, uniform and inter-arrival time can be constant, exponential, uniform.

Facility to conduct various experiments for differing input parameters.

Input	*Output*
Protocol	Utilization
Frames	Effective Utilization
Data size	Overhead
Error probability rate	Loss
Data Rate	Delay
Persistence in Ethernet	Transmission Time
	Medium Access Time
	Queuing Delay
	User level Throughput
	Probability of success
	Total Attempt
	Successful Attempt
	Average Attempt

Experimental combination parameters:
- Protocol Vs. Utilization
- Protocol Vs Delay
- Protocol Vs User level Throughput
- Protocol Vs Probability of Success.
- Error probability Vs Utilization
- Error probability Vs Frames Discarded etc
- Persistence Vs Medium Access Time
- Persistence Vs Loss

3. Network Programming

Lab exercises:

Design, develop and code fundamental concepts of network during a typical 3 hr lab session.

- Error detection code
  - Cyclic Redundancy Check –12
  - CCITT
  - Cyclic Redundancy Check –16
  - Cyclic Redundancy Check –32
  - Longitudinal redundancy check
- Error correcting code
  - Hamming code
- Assignments of sites

ATM

1. Basics – explanation through animation

Working of ATM protocol
Traffic Management Functions
Connection Set-up
ATM Cell

2. Simulation

Create scenario, simulate and study the performance of ATM in stand alone mode. Protocol implementation as per ATM forum guidelines. 25 CPEs and 15 ATM Switches can be used for the simulation.

Facility to conduct various experiments for differing input parameters.

Input	*Output*
Protocol	Utilization
Frames	Effective Utilization
Data size	Overhead
Error probability rate	Loss
PCR	Delay
CDVT	Transmission Time
GCRA type	Propagation Delay
Data Rate	Queuing Delay
Link Distance	User level Throughput
	Cells Errored
	Cells Dropped

Experimental combination parameters:

PCR Vs Queuing Delay
Traffic Vs Overhead

3. Network Programming

Leaky Bucket Algorithm
Virtual Scheduling algorithm

X.25

1. Basics – explanation through animation

Working of X.25 protocol
Setup and Working of SVC and PVC Connection
Flow Control protocol
- Stop & Wait
- Go Back N
- Selective Repeat

2. Simulation

Create scenario, simulate and study the performance of X.25 protocol in stand alone mode, link wise and network wise. 25 CPEs and 15 X.25 switches can be used for the simulation

Facility to conduct various experiments for differing input parameters.

Input	*Output*
Protocol	Utilization
Packets	Effective Utilization
Data size	Overhead
Error probability rate	Loss
ARQ	Delay
Modulo	Transmission Time

Data Rate	Propagation Delay
Link Distance	Queuing Delay
	User level Throughput
	Packets Errored
	Packets Dropped

Experimental combination parameters:

- SVC/PVC Vs Delay
- X.25 Vs Frame Relay
- Flow control protocols Vs performance
- Buffer size Vs Delay

3. Network Programming

Lab exercises:

- Flow control protocol
  - Stop and Wait
  - Go Back N
  - Selective repeat
- Framing
  - Bit Stuffing
  - Character Stuffing

Frame Relay

1. Basics – explanation through animation

- Working of Frame Relay
- Congestion principles
- Congestion avoidance
- Congestion Recovery algorithm
  - FECN Algorithm
  - BECN Algorithm

2. Simulation

Create scenario, simulate and study the performance of Frame Relay protocol in stand alone mode, link wise and network wise. 25 CPEs and 15 Frame Relay Switches can be used for the simulation.

Facility to conduct various experiments for differing input parameters.

Input	*Output*
Protocol	Utilization
Frames	Effective Utilization
Data size	Overhead
Error probability rate	Loss
CIR value	Delay
Data Rate	Transmission Time
	Propagation Delay
	Queuing Delay
	User level Throughput
	Packets Errored
	Packets Dropped

Experimental combination parameters:

- Traffic load Vs cllm messages/FECN
- CIR Vs cllm messages/FECN
- Link data rate Vs performance
- x.25 Vs Frame Relay

BGP and MPLS NETWORKS
(BORDER GATEWAY PROTOCOL and MULTI-PROTOCOL LABEL SWITCHING)

ROUTING – BGP

1. Basics – explanation through animation

Router Architecture
Working Principle of Router
Components of Routing
Routing methods and algorithms
BGP - Path Vector Routing, Routing Tables, Loop Prevention, BGP messages.

2. Simulation

Create scenario, simulate, and study the performance of routers in stand-alone mode.
Protocols –, Border Gateway Protocol (BGP), implemented as per RFC 1771. Queuing Techniques - FIFO and Priority, 25 CPEs, 15 Normal Routers, and 5 Border Routers can be used for the simulation.
Facility to conduct various experiments for differing input parameters.

Input	*Output*
Protocol	Utilization
Packets	Effective Utilization
Data size	Overhead
Error probability rate	Loss
Buffer size	Delay
Timer	Transmission Time
Data Rate	Propagation Delay
Link Distance	Queuing Delay
Link cost	User level Throughput
MED	Packets Errored
	Local Preference Packets Dropped

Experimental combination parameters:
BGP Table formation

3. Network Programming

Lab exercises:
Distance vector routing algorithm
Shortest path algorithm
IPV4 Addressing
Address Mask
Binary Conversion
CIDR
Network Address
Special Addresses
Subnetting
IPV6 Address
EUI 64 Interface Identifier
IPV6 Host Addresses
IPV6 Subnetting

MPLS

1. Basics – explanation through animation

MPLS Characteristics
Advantages and Disadvantages of MPLS
MPLS Key concepts
Packet Format

Architecture
MPLS Operation
Label Distribution Protocol
Label Distribution Types, Modes and Retention

2. Simulation

Create scenario, simulate and study the performance of MPLS in stand alone mode. Protocols – Label Distribution Protocol (LDP) implemented as per RFC3036. Constraint Based Routing Label Distribution Protocol (CR-LDP), implemented as per RFC 3212. 25 CPEs and 15 Routers can be used for the simulation.

Facility to conduct various experiments for differing input parameters.

Input	*Output*
Protocol	Utilization
Packets	Effective Utilization
Data size	Overhead
Error probability rate	Loss
Traffic Engineering	Delay
Data Rate	Transmission Time
Link Distance	Propagation Delay
Link Weight	Queuing Delay
	User level Throughput
	Packets Errored
	Packets Dropped
	LSP Rejection Ratio
	Rejected Bandwidth Quantity

Experimental combination parameters:
LDP Vs CR-LDP – LSP
LDP Vs CR-LDP – Queuing Delay
LDP Vs CR-LDP – Loss
LDP Vs CR-LDP – Number of Packets Dropped

4. Primitives Library

Network layer
Dijkstra Algorithm
MPLS layer
Constraint based routing
LDP request message forwarding
Label creation and assignment
LDP mapping message forwarding
LSP creation
IP packet forwarding
LIB formation
LFIB formation

ADVANCED WIRELESS NETWORKS (MOBILE ADHOC NETWORKS AND Wi-MAX)

MANET (Mobile Adhoc Network)

1. Basics – explanation through animation

Working of MANET
Characteristics of MANET
Advantages and Disadvantages of MANET
Dynamic Source Routing
Mobility

Independent Mobility
Group Mobility

2. Simulation

Create scenario, simulate and study the performance of Mobile Adhoc Network (MANET. Algorithm – Dynamic Source Routing (DSR) implemented as per RFC4278 and Adhoc on Demand Distance Vector Routing (AODV) per RFC 3561.

Mobility is via the Random waypoint model, which is designed to describe the movement pattern of mobile users, and how their location, velocity and acceleration change over time.

Facility to conduct various experiments for differing input parameters.

Input	*Output*
Protocol	Utilization
Frames	Effective Utilization
Data size	Overhead
Error probability rate	Loss
Velocity	Delay
Pause Time	Transmission Time
Channel Characteristics	Medium Access Time
Data Rate	Queuing Delay
	User level Throughput
	Frames Errored
	Frames Dropped
	Packet Delivery Ratio
	Collision count
	Average Attempt

Experimental combination parameters:
Pause time Vs Packet Delivery Ratio
Pause time Vs Routing Overheads

Wi-Max

1. Basics – explanation through animation

Wi-MAX standards
MAC Layer Specification
Convergence Sub layer
Common part Sub Layer
Security Sub Layer
PHY Layer Specification
Working of Wi-MAX

2. Simulation

Create scenario, simulate and observe the performance of network with Wi-MAX. Implementation is as per IEEE 802.16 d. One BS (Base Station) can be used for the scenario building. And 25 SS (Service Station) can be used for the simulation.

Facility to conduct various experiments for differing input parameters.

Input	*Output*
Protocol	Utilization
Frames	Effective Utilization
Data size	Overhead
Error probability rate	Loss
Modulation Techniques	Delay
Nominal Channel Bandwidth	Transmission Time
OFDM Frame Duration	Medium Access Time
	Queuing Delay

User level Throughput
Frames Errored
Frames Dropped
Call Drop Probability

Experimental combination parameters:

Number of Transmitting SS Vs Utilization
Number of Transmitting SS Vs Call Drop Probability

4. Network Programming

Lab exercises:

Orthogonal Frequency division multiplexing (OFDM)

CELLULAR NETWORKS (GSM AND CDMA)

Global System for Mobile Communication (GSM)

1. Simulation

Create scenario, simulate and observe the performance of network with GSM. Implementation is as per ETSI & ITU standards. Seven BTS (Base transceiver station) can be used for the scenario building. And 25 MS (Mobile Station) can be used for the simulation.

Facility to conduct various experiments for differing input parameters.

Input	*Output*
Protocol	Number of channel
Bandwidth	Max channel utilization
Packing function	Average channel utilization
Data size	Number of calls
Error probability rate	Call processed
Transmitter power	Call blocked
	Call Blocking Probability
	Handover attempt
	Successful Handover
	Unsuccessful Handover
	Call dropping probability
	User level Throughput
	Frames Errored
	Frames Dropped

Experimental combination parameters:

Number of Transmitting MS Vs Channel Utilization
Number of Transmitting MS Vs Call Blocking Probability
Mobility Vs Call dropping probability

2. Primitives Library

Data Link layer

Channel Formation
Channel Allocation
Cellular mobility and Mobility model

3. Network Programming

Lab exercises:

Time Division Multiple Access (TDMA)

Code Division Multiple Access (CDMA)

1. Simulation

Create scenario, simulate and observe the performance of network with CDMA. Implementation is as per Telecommunication Industry Association (TIA).standards. Seven BTS (Base transceiver station) can be used for the scenario building. And 25 MS (Mobile Station) can be used for the simulation.

Facility to conduct various experiments for differing input parameters.

Input	*Output*
Protocol	Number of channel
Bandwidth	Max channel utilization
Chip rate	Average channel utilization
Voice activity factor	Number of calls
Error probability rate	Call processed
Transmitter power	Call blocked
Packing function	Call Blocking Probability
Data size	Handover attempt
Channel characteristics	Successful Handover
	Unsuccessful Handover
	Call dropping probability
	User level Throughput
	Frames Errored
	Frames Dropped

Experimental combination parameters:

Number of Transmitting MS Vs Channel Utilization
Number of Transmitting MS Vs Call Blocking Probability

3. Network Programming

Lab exercises:

Code Division Multiple Access (CDMA)

WSN AND PAN
(WIRELESS SENSOR NETWORKS AND ZIGBEE)

Wireless Sensor Network (WSN)

1. Simulation

Create scenario, simulate and observe the performance of network with wireless sensor. Data link and physical layer implementation is as per IEEE 802.15.4 standards 100 Motes, 1 Sink node with 5 agents can be used for the scenario building and simulation.

This component works in conjunction with component 4 (MANET protocols) for network layer routing.

Facility to conduct various experiments for differing input parameters.

Input	*Output*
Beacon Order	Routing Overhead
Superframe Order	Delay
Backoff Exponent	Power Consumption
Battery life Extension	Lifetime of motes
CCA type	Packet Delivery ratio
Channel Number	Routing Time
Phy SHR Duration	Actual Vs Sensed path of agent
Receiver Sensitivity	
ED Threshold	
Channel Characteristics	

Zigbee

1. Simulation

Create scenario, simulate and observe the performance of network with data link and physical layer implementation is as per Zigbee 802.15.4 standards. Network layer implementation is DSR / AODV routing.

Facility to conduct various experiments for differing input parameters.

Input	*Output*
Beacon Order	Routing Overhead
Superframe Order	Delay
Backoff Exponent	Power Consumption
Channel Number	Routing Time
Phy SHR Duration	Receiver Sensitivity
ED Threshold	
Channel Characteristics	

COGNITIVE RADIO NETWORKS (WIRELESS REGIONAL AREA NETWORKS, IEEE 802.22)

1. Simulation

Create scenario, simulate and observe the performance of network with wireless sensor. Data link and physical layer implementation is as per IEEE 802.22 standards. In network layer, IPV4 is implemented. In transport layer TCP and UDP is implemented. 100 CPE, 1 Base station with 5 incumbent can be used for the scenario building and simulation.

Facility to conduct various experiments for differing input parameters.

Input	*Output*
Dsx request retries	FCH Sent/received
Back-off count	SCH sent/received
Channel availability check time	DSx sent/received
Num Sensing period	UCS sent
Sensing period duration	CHS req sent
Sensing period interval	Spectral efficiency
Sensing mode	Interference time with incumbent
Channel refresh time	Application throughput
False alarm probability	Packet sent/received
Quiet period bitmap	Link throughput
Quiet period duration	Packet sent in link
Quiet period cycle length	Packet error in link
DL/UL ratio	
DCD/UCD interval	
TTG	
CP Factor	
Modulation	
Sampling factor	
FFT size	
Multiple access	
Coding rate	
Frequency range	
Channel Bandwidth	
Tx power	
Incumbent model	

LONG TERM EVOLUTION NETWORKS (3GPP 36.XXX STANDARDS)

1. Simulation

Create scenario, simulate and observe the performance of network with LTE. Network layer, Data link and physical layer implementation is as per standards 3GPP 36.*** .100 UE, 25 eNB with 1 MME can be used for the scenario building and simulation.

Facility to conduct various experiments for differing input parameters.

Input	*Output*
Transmission Power	Packet transmitted
Transmission Mode	Packet Received
Tx antennas count	Handover count
Rx antennas count	Run time graph for UE downlink data rate Vs Time
Channel Bandwidth	
RB Size	
Modulation	
OFDM parameters	
Channel Characteristics	

ADVANCED FUNCTIONALITIES

New Traffic Generator (All components except legacy networks, Wi-Max and MPLS)

The following traffic models are available in NetSim

- File Transfer Protocol (FTP)
- Database Application
- Voice traffic
  - Voice codecs include G.711, G.713, G.729, GSM – FR, GSM EFR
  - CBR service
  - VBR services
    - Silence suppression via deterministic model
    - Silence suppression via Discrete Time Markov Chain (DTMC) model
- Video Traffic
  - Continuous Normal VBR
  - Continuous State Auto Regressive Markov Model
  - Quantized State Continous Time Markov Model
  - Simple IPB Composite Model
- Custom Model: Users can develop custom application model based on
  - Packet size and inter-arrival time available in the following probability distributions
  - Exponential
  - Constant
  - Uniform
  - Wiebull
  - Customized Distributions

Performance Metrics (All Components)

The following network performance metrics are reported:

- Utilization Report – Network
- Delay Report – Network
- Utilization Report – Link by Link
- Delay Report – Link by Link
- Network Statistics

Channel Models (For wireless protocols)

The following channel (propagation) models are available for wireless protocols:

- Free space path loss
- Lognormal shadowing
- Rayleigh fading

New Traffic Generator

- CLI mode of running for more concise and powerful means of control
- Facilitates use of automated scripts for running batch simulations
- Model network configurations using XML based configuration files

Packet Animation

- Animates packet flow over wired and wireless links, as well as node movement
- Color variation for data, control and error packets
- Animation settings via play, pause and time-slide