



NS2 Training

NS (version 2) is an object-oriented, discrete event driven network simulator developed at UC Berkely written in C++ and OTcl. NS is primarily useful for simulating local and wide area networks. Although NS is fairly easy to use once you get to know the simulator, it is quite difficult for a first time user, because there are few user-friendly manuals. Even though there is a lot of documentation written by the developers which has in depth explanation of the simulator, it is written with the depth of a skilled NS user. The purpose of this project is to give a new user some basic idea of how the simulator works, how to setup simulation networks, where to look for further information about network components in simulator codes, how to create new network components, etc., mainly by giving simple examples and brief explanations based on our experiences. NS2 Training includes following modules:

TRAINING DURATION 30 Hrs / 3 Weeks / Customized

TRAINING CHARGE 15,000+ Service Tax

Details of NS2 Training Modules:

1. Simulation of Computer Networks

- Computer Networks and Layering Concepts
 - Layering Concept
 - OSI and TCP/IP Reference Models
- System Modeling
 - Analytical Approach
 - Simulation Approach
- Basics of Computer Networks Simulation
 - Simulation Components
 - Simulation Performance
 - Confidence Interval
 - Choices for Network Simulation Tools
- Time Dependent Simulation

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- Time-Driven Simulation
- Event-Driven Simulation
- A Simulation Example: A Single-Channel Queuing System
 - Entities
 - State Global Variables
 - Resource
 - Events
 - Simulation Performance Measures
 - and Statistics Gatherers
 - Simulation Program

2. Introduction to Network Simulator 2 (NS2)

- Introduction
- Basic Architecture
- Installation
 - Installing an All-In-One NS2 Suite on Unix-Based Systems
 - Installing an All-In-One NS2 Suite on Windows-Based Systems
- Directories and Convention
- Running NS2 Simulation
 - NS2 Program Invocation
 - Main NS2 Simulation Steps

3. Linkage between OTcl and C++ in NS2

- The Two-Language Concept in NS2
 - The Natures of OTcl and CCC Programming Languages
 - CCC Programming Styles and Its Application in NS2
- Class Binding
 - Class Binding Process
 - Defining Your Own Class Binding
 - Naming Convention for Class TclClass
- Variable Binding
 - Variable Binding Methodology
 - Setting the Default Values



- NS2 Data Types
- Class Instvar
- Execution of C++ Statements from the OTcl Domain
 - OTcl Commands in a Nutshell
 - The Internal Mechanism of OTcl Commands
 - An Alternative for OTcl Command Invocation
 - Non-OOP Tcl Command
 - Invoking a TclCommand
- Shadow Object Construction Process
 - A Handle of a TclObject
 - TclObjects Construction Process
 - TclObjects Destruction Process
- Access the OTcl domain from the C++ domain
 - Obtain a Reference to the Tcl Interpreter
 - Execution of Tcl Statements
 - Pass or Receive Results to/from the Interpreter
 - TclObject Reference Retrieval
- Translation of TCL Code

4. Implementation of Discrete-Event Simulation in NS2

- NS2 Simulation concepts
- Events and Handlers
 - An Overview of Events and Handlers
 - Class NsObject: A Child Class of Class
 - Classes Packet and AtEvent: Child
 - Classes of Class Event
- The Scheduler
 - Main Components of the Scheduler
 - Data Encapsulation and Polymorphism Concepts
 - Main Functions of the Scheduler
 - Two Auxiliary Functions

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- Dynamics of the Unique ID of an Event
 - Scheduling–Dispatching Mechanism
 - Null Event and Dummy Event Scheduling
 - The Simulator
 - Main Components of a Simulation
 - Retrieving the Instance of the Simulator
 - Simulator Initialization
 - Running Simulation
 - Instprocs of OTcl Class Simulator
- 5. Network Objects: Creation, Configuration, and Packet Forwarding**
- Overview of NS2 Components
 - Functionality-Based Classification of NS2 Modules
 - CCC Class Hierarchy
 - NsObjects
 - Class NsObject
 - Packet Forwarding Mechanism of NsObjects
 - Connectors
 - Class Declaration
 - OTcl Configuration Commands
 - Packet Forwarding Mechanism of Connectors
- 6. Nodes as Routers or Computer Hosts**
- An Overview of Nodes in NS2
 - Routing Concept and Terminology
 - Architecture of a Node
 - Default Nodes and Node Configuration Interface
 - Classifiers: Multi-Target Packet Forwarders
 - Class Classifier and Its Main Components
 - Port Classifiers
 - Hash Classifiers



- Creating Your Own Classifiers
- Routing Modules
 - An Overview of Routing Modules
 - CCC Class RoutingModule
 - OTcl Class RtModule
 - Built-in Routing Modules
- Route Logic
 - CCC Implementation
 - OTcl Implementation
- Node Construction and Configuration
 - Key Variables of the OTcl Class Node and Their Relationship
 - Installing Classifiers in a Node
 - Bridging a Node to a Transport Layer Protocol
 - Adding/Deleting a Routing Rule
 - Node Construction and Configuration

7. Link and Buffer Management

- Introduction to SimpleLink Objects
 - Main Components of a SimpleLink
 - Instprocs for Configuring a SimpleLink Object
 - The Constructor of Class SimpleLink
- Modeling Packet Departure
 - Packet Departure Mechanism
 - CCC Class LinkDelay
- Buffer Management
 - Class PacketQueue: A Model for Packet Buffering
 - Queue Handler
 - Queue Blocking and Callback Mechanism
 - Class DropTail: A Child Class of Class Queue
- A sample Two-Node Network
 - Network Construction

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- Packet Flow Mechanism

8. Packets, Packets Headers, and Header Format

- An Overview of Packet Modeling Principle
 - Packet Architecture
 - A Packet as an Event: A Delayed Packet
 - Reception Event
 - A Link List of Packets
 - Free Packet List
- Packet Allocation and Deallocation
 - Packet Allocation
 - Packet Deallocation
- Packet Header
 - An Overview of First Level Packet
 - Composition: Offsetting Protocol-Specific
 - Header on the Packet Header
 - Common Packet Header
 - IP Packet Header
 - Payload Type
 - Protocol-Specific Headers
 - Packet Header Access Mechanism
 - Packet Header Manager
 - Protocol-Specific Header Composition and Packet Header Construction.
- Data Payload
- Customizing Packets
 - Creating Your Own Packet
 - Activate/Deactivate a Protocol-Specific Header



9. Transport Control Protocols Part 1:

An Overview and User Datagram Protocol Implementation

- UDP and TCP Basics
 - UDP Basics
 - TCP Basics
- Basic Agents
 - Applications, Agents, and a Low-Level Network
 - Agent Configuration
 - Internal Mechanism for Agents
 - Guidelines to Define a New Transport Layer Agent
- UDP and Null Agents
 - Null (Receiving) Agents
 - UDP (Sending) Agent
 - Setting Up a UDP Connection

10. Transport Control Protocols Part 2:

Transmission Control Protocol

- An Overview of TCP Agents in NS2
 - Setting Up a TCP Connection
 - Packet Transmission and Acknowledgment Mechanism
 - TCP Header
 - Defining TCP Sender and Receiver
- TCP Receiver
 - Class Acker
 - Class TcpSink
- TCP Sender
- TCP Packet Transmission Functions Function sendmsg(nbytes)
 - Function send much(force, reason, maxburst)
 - Function output(seqno,reason)
 - Function send one()
- ACK Processing Functions
 - Function rcv(p,h)
 - Function rcv newack helper(pkt)
 - Function newack(pkt)
 - Function dupack action()
- Timer-Related Functions
 - RTT Sample Collection

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- RTT Estimation
- Overview of State Variables
- Retransmission Timer
- Function Overview
- Function rtt update(tao)
- Function rtt timeout()
- Function rtt backoff()
- Function set rtx timer()and Function reset rtx timer(mild,backoff)
- Function newtimer(pkt)
- Function timeout(tno)
- Window Adjustment Functions
 - Function openwnd()
 - Function slowdown(how)

11. Application: User Demand Indicator

- Relationship Between an Application and a Transport Layer Agent
- Applications
 - Functions of Classes Application and Agent
 - Public Functions of Class Application
 - Related Public Functions of Class Agent
 - OTcl Commands of Class Application
- Traffic Generators
 - An Overview of Class TrafficGenerator
 - Main Mechanism of a Traffic Generator
 - Built-in Traffic Generators in NS2
 - Class CBR Traffic: An Example Traffic Generator
- Simulated Applications
 - File Transfer Protocol
 - Telnet

12. Wireless Mobile Ad Hoc Networks

- An Overview of Wireless Networking
 - Mobile Node
 - Architecture of Mobile Node
 - General Packet Flow in a Wireless Network Implementation
 - Mobile Node Configuration Process
- Network Layer: Routing Agents and Routing Protocols
 - Preliminaries for the AODV Routing Protocol
 - The Principles of AODV
 - An Overview of AODV Implementation in NS2
 - AODV Routing Agent Construction Process
 - General Packet Flow Mechanism in a Wireless Network
 - Packet Reception and Processing Function of AODV
 - AODV Time-Driven Actions

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- Data Link Layer: Link Layer Models, Address Resolution Protocols, and Interface Queues
 - Link Layer Objects
 - Address Resolution Protocol
 - Interface Queues
- Medium Access Control Layer: IEEE 802.11
 - Description of IEEE 802.11 MAC Protocol
 - NS2 Classes Mac and Mac802 11
 - Basic Functions of NS2 Classes Mac and Mac802 11
 - Timer Concepts for Implementation of IEEE 802.11
 - Packet Reception Mechanism of IEEE 802.11
 - Implementation of Packet Retransmission in NS2
 - Implementation of Carrier-Sensing, Backoff, and NAV
- Physical Layer: Physical Network Interfaces and Channel
 - Physical Network Interface
 - Wireless Channels
 - Sender Operations at the Physical Layer
 - Receiver Operations at the Physical Layer
- An Introduction to Node Mobility
 - Basic Mobility Configuration
 - General Operation Director
 - Random Mobility
 - Mobility and Traffic Generators: Standalone
 - Helper Utility

13. Developing New Modules for NS2

- Automatic Repeat reQuest
 - The Design
 - CCC Implementation
 - OTcl Implementation
 - ARQ Under a Delayed (Error-Free) Feedback Channel
- 13.2 Packet Scheduling for Multi-Flow Data Transmission
 - The Design
 - CCC Implementation
 - OTcl Implementation

14. Post simulation Processing: Debugging, Tracing, and Result Compilation

- Debugging: A Process to Remove Programming Errors
 - Types of Programming Errors
 - Debugging Guidelines
- Variable Tracing
 - Activation Process for Variable Tracing
 - Traceable Variable
 - Components and Architecture for Variable Tracing

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- Tracing in Action: An Example of Class TcpAgent
- Setting Up Variable Tracing
- Packet Tracing
 - OTcl Configuration Interfaces
 - CCC Main Packet Tracing Class Trace
 - CCC Helper Class BaseTrace
 - Various Types of Packet Tracing Objects
 - Format of Trace Strings for Packet Tracing
- Compilation of Simulation Results

15. Related Helper Classes

- Timers
 - Implementation Concept of Timer in NS2
 - OTcl Implementation
 - CCC Class Implementation
 - Guidelines for Implementing Timers in NS2
- Implementation of Random Numbers in NS2
 - Random Number Generation
 - Seeding a Random Number Generator
 - OTcl and CCC Implementation
 - Randomness in Simulation Scenarios
 - Random Variables
 - Guidelines for Random Number Generation in NS2
- Built-in Error Models
 - OTcl Implementation: Error Model Configuration
 - CCC Implementation: Error Model Simulation
 - Guidelines for Implementing a New Error Model in NS2
- Bit Operations in NS2
 - Bit Masking
 - Bit Shifting and Decimal Multiplication

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