

# Model Of Owns An Optical Wavelength Division Multiplexing (Wdm) Network Simulator

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## **ABSTRACT**

With the tremendous bandwidth provided by optical fibre, optical wavelength division multiplexing (WDM) technology is a strong contender for harnessing it. When it comes to future wide-area network (WAN) environments like Next Generation Internet, where high bandwidth and low latency are required for seamless user experience, WDM networks are being seriously examined. To properly build these networks, an evaluation of the various switching and routing strategies in an optical wide-area network (OWAN) environment is required. However, there is currently no uniform simulator environment built to explicitly support WDM's network-layer functionalities. To that end, we've written this document to describe our work. Optical WDM network simulator (OWns) is described in full in the report, and this information could be crucial in helping us build a solid foundation for future routing performance studies. Network protocol performance studies employ the ns2 network simulator, which the simulator is constructed on top of. Multi-wavelength links, various switching systems, and routing algorithms will all be included in the simulator. When the paper is finished, there will be conversations regarding how OWns will be extended in the future.

**Keywords:** OWAN; WDM ; ns; OWns; MONET

## **1. Introduction**

Recently achieved improvements in optical Wavelength Division Multiplexing (WDM) technology, [1], have made optical networking feasible[2]. WDM divides the available bandwidth into a number of manageable, lesser capacity channels. According to some, WDM could serve as the foundation for Next-Generation Internet technologies[3]. One WDM test bed on the west coast, the National Transparent Optical Network Consortium (NTONC), is connected to a second WDM test bed on the east coast, the Multi-Wavelength Optical

Network (MONET). [4]

For optical WDM networks, both LANs and WANs (wide area networks) have been investigated (WAN). Local area networks have looked at the passive star architecture, as well as other media access control mechanisms and scheduling algorithms. Wide area networks using wavelength-routed networks have recently been studied[1]. Many interesting problems and issues arise when using wavelength-routed networks. There have been investigations into circuit, packet, and burst switching. Given present technological restrictions, circuit and burst switching appear to be the most promising alternatives. Light route determination based on physical topology and wavelength conversion has also been researched as related issues.[5]

All previous work has relied on mathematical analysis and simulation models to assess performance. For the models, each study makes use of a unique simulation platform and set of assumptions. An optical WDM network modelling framework is required to incorporate optical WDM network features. Thus, network performance can be analysed consistently, with no need to encode fundamental WDM ideas again.

## **2. Design Details of Simulator**

We must compare the performance of various switching and routing protocols in order to better understand the issue and features of optical WDM backbone routing. This is accomplished by analysing how these protocols behave in various traffic scenarios and optical WDM network topologies. We'll need a WDM network simulator to help with this research because multiple routing protocols and traffic patterns will be implemented on it. Optical WDM network simulator is the simulator we're showcasing today (OWns). The primary goal is to develop an optical WDM backbone network and compare its performance to that of traditional backbone networks using OWns as the foundation.[6]

### **2.1 OWns Design Objectives**

OWns was created with the following goals in mind: Modeling of WDM network properties, such as multi-wavelength links, to give a general framework. – Creation of network topologies – Creation of network traffic — Performance assessment based on optical WDM network-specific factors.

- To investigate IP's WDM performance.
- To investigate the interactions between current optical WDM networks and electronically switched networks.[7]

### **2.2 OWns Design Considerations**

Instead of creating OWns from the ground up as a standalone simulator, we attempted to utilise the resources already supplied by current network simulators. To begin, we looked at existing network simulator designs and features. The feasibility of these simulators for accomplishing our design objectives was assessed based on aspects including open source availability, extensibility, and ease of use. A number of simulators were taken into account throughout our analysis, including ns[4] (available from UCB/LBN), REAL (available from Cornell University), NEST (available from Columbia University), OPNET [8] (commercially available from MIL 3), and BONEs (commercially available from Cadence Design Systems). For our purposes, ns were the best choice. For example, ns offer features

like discrete-event simulation, TCP protocol stack, and GUI support. Below is a list of ns features. On this page you'll find information on how OWns components built on top of ns are designed.[8]

### 2.3 ns version 2

ns (network simulator) is a part of DARPA-funded research project, VINT, whose aim is to build a network simulator that will allow the study of scale and protocol interaction in the context of current and future network protocols. VINT is a collaborative project involving USC/ISI, Xerox PARC, LBNL, and UC Berkeley. ns is based on REAL (R Ealistic And Large), which in turn is based on NEST. A network simulator's main building elements are nodes, links, and traffic models, which will be discussed later. The glue comes in the form of a simulation description language, just like any other network simulator (SDL). Network simulators frequently run into the issue of uniformly implemented Building blocks and Glue in their code. It's impossible to meet both components' diverse needs using this uniform programming paradigm at the same time. Other common problem is the inflexibility of SDL when it comes to defining dynamic network simulation scenarios (e.g. REAL's NET Language which defines static configuration file and OPNET's schematic capture mechanism). Ns tries to avoid these problems by using different programming models for the implementation of these components. It uses C++ to implement efficient Building blocks. At the same time, it uses a scripting language OTcl, an object-oriented extension of Tcl (from David We therall at MIT/LCS) as a Glue. Key features of ns are listed below:

- C++ is used for building the simulation engine as well as implementing performance-intensive activities.
- The OTcl scripting language is used for protocol development and simulation settings.
- Divide the implementation of the object across the compiled and interpreted object hierarchies.
- Architecture for composing objects that allows many abstraction levels.
- Network animator separates visualization from simulation ( nam).
- Increasing the size of a system by using abstraction
- The class hierarchy of ns is depicted in Figure 1. ns supports following protocol modules

**Source Agents:** Among these are supports for Telnet, file transfer, and traffic generation depending on different distributions. In addition, UDP and CBR are available for usage.

**TCP:** Many flavors of TCP like Tahoe, Reno, Sack, Vegas, Two-way etc are supported

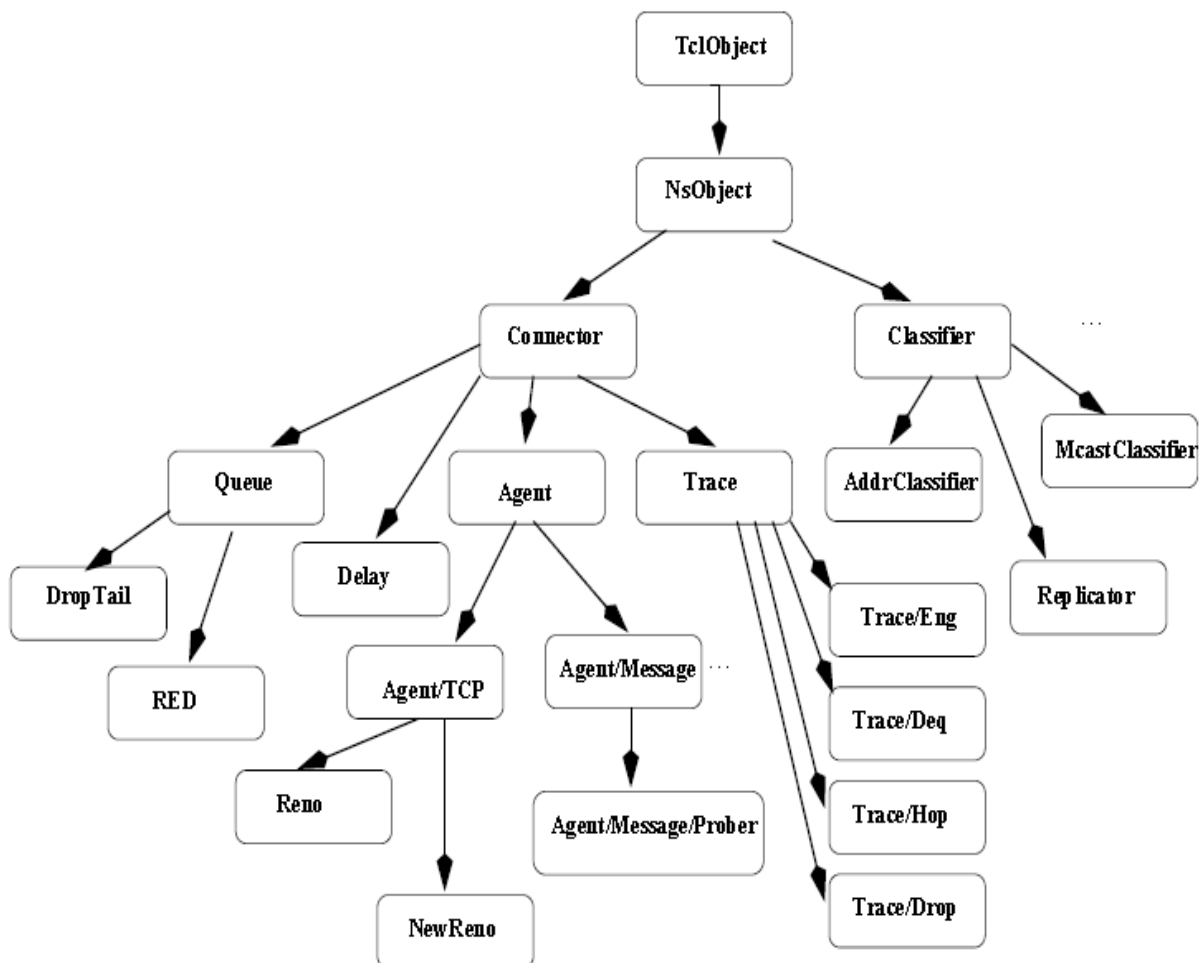
**Queuing/Scheduling:** You can use algorithms like Drop tail, FIFO/WFQ/Round-robin to

queue up packets as well as FIFO, CBQ, and WFQ/Round-robin to schedule packets. Tracing monitoring objects is supported.

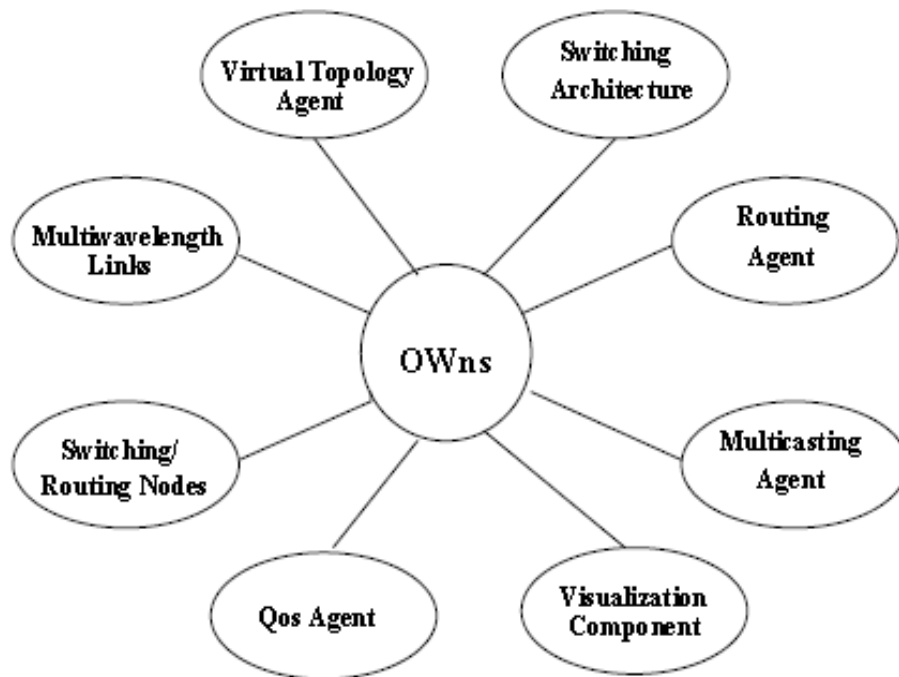
**Unicast routing:** In ns, pre-computed and dynamic unicast routing can both be used. There is also support for multi-path and asymmetric path routing, as well as link failures and other scenarios..

**Multicast routing:** ns supports broadcast and prune type of multicasting with static or dynamic topologies. Multicast tree computation is centralized. Support for multicast transport in terms of Reliable multicast (SRM-fixed and adaptive) and RTP/RTCP exists.

**MAC/LAN:** ns supports Multi-access LAN as well as wireless MAC protocols. Agents and Classifiers form the nucleus of a Node. Classifiers are packet de multiplexers, whereas Agents are protocol endpoints and related objects. Queue and delay objects are encapsulated in links. Network animations employ nam to show packet flows, protocol statuses and queueing in graphic form. It can also be used to create graphical scenarios. It's a lifesaver when it comes to creating and deciphering protocol dynamics and exchanges. It can also be used to troubleshoot software issues. the lines' capacity to transition between different forms of switching traffic using different wavelengths.



**Figure 1:** ns Class hierarchy[9]



**Figure 2:**OWns Components[9]

**Virtual Topology Design Schemes:** Virtual topology design methods based on heuristic must be implemented in optical WDM networks to support routing. Virtual topology Agents must be integrated into the framework in accordance with these algorithms.

**Routing Schemes:** Optical WDM networks require special routing algorithms. It is necessary to implement and incorporate virtual topology-based routing techniques into the framework.

**Multicasting Agents:** It is possible to implement various multicasting algorithms in optical WDM networks so that they can take use of fibre links' multi-wavelength characteristics. These multicasting algorithms necessitate the use of Multicasting Agents. There will be interaction between multicasting agents and the routing agents. for these multicasting algorithms. Multicasting Agents will interact with the routing Agents.

**Integrated services/QoS Agent:** The designs for providing integrated services over an optical WDM network, as well as QoS Agents, must be studied. Quantum Dot (QD) Agents can offer QoS in the optical realm by using algorithms tailored for WDM optical networks.

**Visualization Component:** Extension of nam is required in order to see optical WDM network simulations in real time. Visibility of network traffic is critical in understanding the relationship between regular network traffic and optical WDM backbone traffic. Optical WDM network engineering can be tested in a simulation environment by utilising these OWns components. There is a need for in-depth research on the interaction between optical

WDM network backbone and traditional networks in order to build and assess multiple optical WDM backbone architectures. In a high-speed optical WDM networking scenario, it will also help to clarify the differences between differentiated and integrated services.

## 2.5 Work-in-progress Modules

OWns are now in a state of flux, as described in this section. Node, link, and packet header are some of the ns components that have been enhanced for use in OWns. Below is a brief summary of the module design that is currently being implemented.

**Multi-wavelength Links:** A Multi-wavelength link is made from ns full-duplex full-duplex links (wdm link). Additionally, it contains features like the amount of wavelengths to imitate a WDM connection. For the link, the delay is calculated using a model that takes into account the buffering type (electronic, optical, or none at all).

**Switching architectures:** switching architecture, which is the most popular in optical networking test beds nowadays. Session generator is built to imitate the communication between the nodes. Arrangements have also been developed to keep track of times when connections have been lost. This is particularly helpful for figuring out how likely it is that a given path will be blocked.

**Virtual topology Agents:** a virtual topology that looks like the real one. Light routes are currently built before the simulation in the current version of OWns. Virtual topology construction algorithms, such as HDLA[9], are used to create these light routes. Throughout the simulation, these light paths will not change. The development of dynamic light path creation algorithms based on virtual topology construction methods is now underway.

**Routing Agents:** Currently, the virtual topology is built on light path virtual topology and a Routing Agent based on Dijkstra's all pairs Shortest-Path-First (SPF) method. Virtual Topology Agent interacts with Routing Agents to compute the network's paths. Routes are made up of a series of light routes that go from one node to another.

## 3 Simulation Configurations

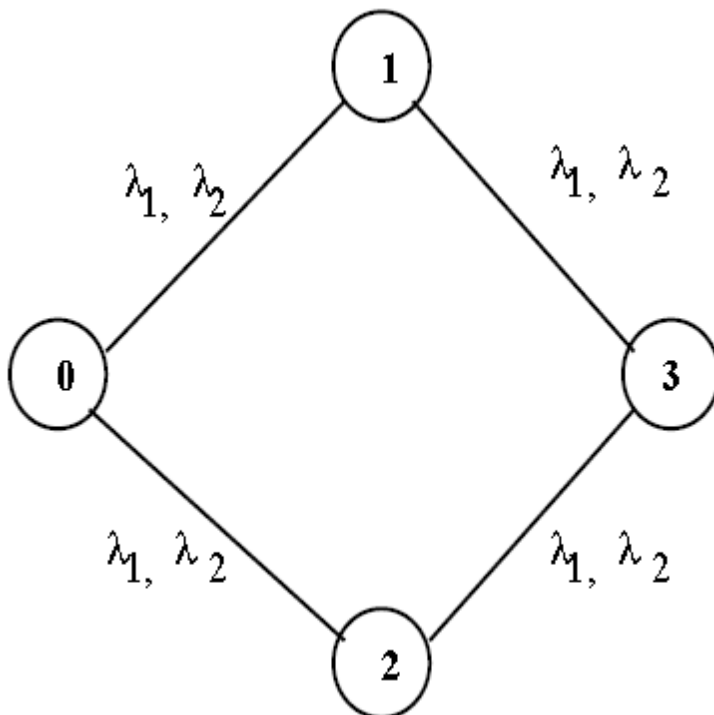
A hypothetical scenario informs the simulation. WDM routers serve as nodes in the network, and multiple-wavelength WDM links connect them. To receive incoming packets, WDM routers should be able to de-multiplex them based on the wavelength they come in at and then route to the correct output link and wavelength based on packet header information or control packets, depending on the application. Wavelength conversion isn't possible with all WDM routers, however it is possible with some of them.. This physical structure is used to build light routes. The nodes have traffic generators attached, and sessions are timed to match a simulation period.

If you want to use the simulator in a real-world WDM context, you'll need to play about with the parameters that are specific to that environment. Blocking probability, network congestion, and average packet latency are all important performance measures.

Take a look at Figure 3 for an example of a simple four-node network with a physical architecture. There are two 1 Gbps wavelengths in this network's WDM links, giving it a total bandwidth of 2 Gbps. Figure 4 shows the logical topology created by employing light routes. For example, a wavelength-based light channel connects nodes 0 and 3.

1. This is a viable path because it goes via a node physically. Nodes 3 and 2 have a logical connection through a wavelength.
2. The logical path and physical link are the same in this scenario. Notably, the logical connections are all going in the same direction only. When we tested the simulator, we used logical light routes that were fed into the programme. A well-known heuristic technique can be used to figure out the logical light routes.

a pair of File Transfer Protocol (FTP) traffic source-to-sink pairs is generated between the two nodes. To simulate traffic, the user interface triggers the traffic sources to produce it at predetermined periods.

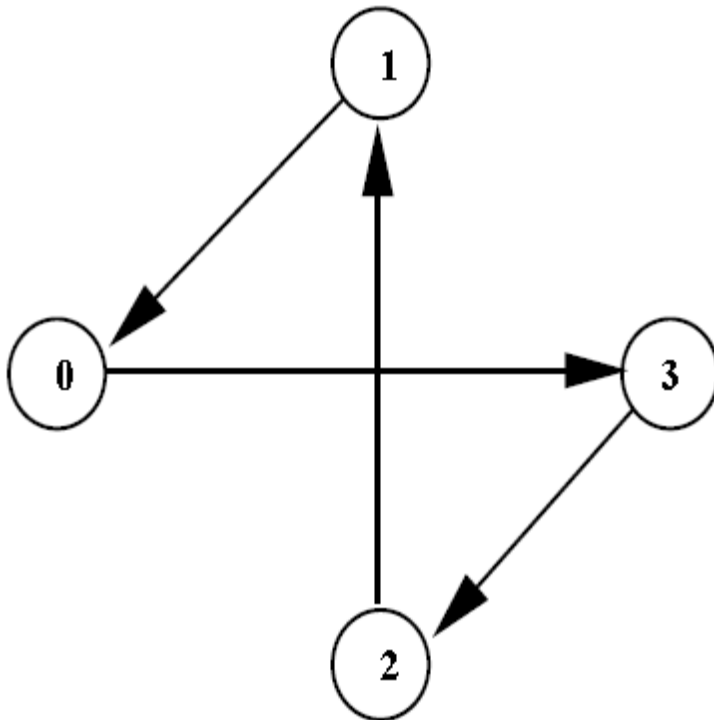


**Figure 3:**Physical Topology used in the example.[2]

Routes are determined by the logical topology and Dijkstra's all-pair shortest path algorithm..The initial state of the logical topology is shown in the first snapshot. Node 0 to node 1, routed by light routes 0→3, 3→2, and 2→1, is shown in the second snapshot. It is reasonable to suppose that node 0 initiates transmissions before node 1. Light pathways 0→3, 3→2, are used to get from node 0 to node 1 and from node 1 to node 2. That's because two sessions can't use the same light path at node 1, and that traffic is stopped.

#### 4 Summary and Future work

An optical WDM modelling environment based on ns was developed and is now being used in this research. A framework for evaluating OWAN switching and routing algorithms is provided by OWns (Open Web Networking Standard). The OWns framework must incorporate new switching strategies like burst-switching and IP-switching.. Optical WDM transmission functionality must be provided. Integrating solutions and value-added services such as QoS must be supported in the core OWns framework, which must also be improved. We're also looking into how optical WDM networks compare to electronic packet-switched networks.



**Figure 4** Logical Topology for physical topology of Fig 3.[2]

## References

- [1] P. E. Green, "Optical networking update," *IEEE J. Sel. areas Commun.*, vol. 14, no. 5, pp. 764–779, 1996.
- [2] R. Ramaswami and K. N. Sivarajan, "Optical Networks: A Practical Perspective." 2002.
- [3] B. Mukherjee, D. Banerjee, S. Ramamurthy, and A. Mukherjee, "Some principles for designing a wide-area WDM optical network," *IEEE/ACM Trans. Netw.*, vol. 4, no. 5, pp. 684–696, 1996.
- [4] N. M. Bhide and K. M. Sivalingam, "Design of OWns: optical wavelength division multiplexing (WDM) network simulator," in *proceedings of First SPIE Optical Networking Workshop*. Citeseer, 2000.
- [5] S. Ramamurthy and B. Mukherjee, "Fixed-alternate routing and wavelength conversion in wavelength-routed optical networks," in *IEEE GLOBECOM 1998 (Cat. NO. 98CH36250)*, 1998, vol. 4, pp. 2295–2302.



- [6] I. Chlamtac, A. Ganz, and G. Karmi, "Lightpath communications: An approach to high bandwidth optical WAN's," *IEEE Trans. Commun.*, vol. 40, no. 7, pp. 1171–1182, 1992.
- [7] A. G. Fayoumi and A. P. Jayasumana, "Performance evaluation of an all-optical ShuffleNet using optical buffering and deflection routing," *Photonic Netw. Commun.*, vol. 6, no. 1, pp. 43–50, 2003.
- [8] B. Wen, N. M. Bhide, R. K. Shenai, and K. M. Sivalingam, "Optical wavelength division multiplexing (WDM) network simulator (OWns): architecture and performance studies," *SPIE Opt. Networks Mag.*, vol. 2, no. 5, pp. 16–26, 2001.
- [9] R. Ramaswami and K. N. Sivarajan, "Design of logical topologies for wavelength-routed optical networks," *IEEE J. Sel. areas Commun.*, vol. 14, no. 5, pp. 840–851, 1996.