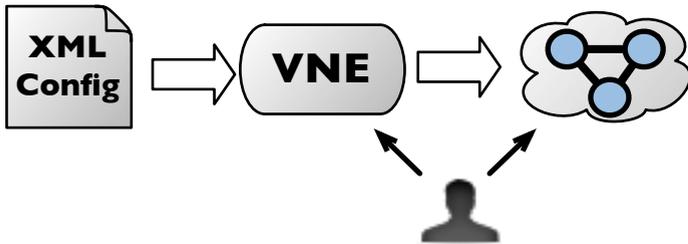


# Network Modeling and Emulation

An open-source GMPLS test-bed

## Virtual Network Experiments (VNE)

VNE is an application to manage a network experimentation session. VNE takes an XML topology description and emulates the network using User-Mode Linux.



The user can interact with VNE to start and stop machines, and interact with the machines to run experiments. By using DRAGON, it is possible to create a completely open-source GMPLS enabled test-bed.

## GMPLS

Generalized Multi-Protocol Label Switching (GMPLS) is a suite of protocols that allow users to request paths through the network which are then automatically provisioned. GMPLS is a generalisation of MPLS, adding abilities such as non packet-based forwarding planes, decoupling of control-plane and data-plane, and more.

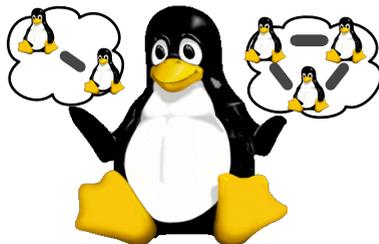
GMPLS builds upon the Traffic Engineering (TE) extensions that form the RSVP-TE and OSPF-TE protocols already used by MPLS, extending them to support multiple types of switching, i.e., Layer-2, TDM, lambda, and fiber. Additional constraints beyond bandwidth, such as framing or protection capability, can be incorporated by using a Constraint-based SPF (CSPF) algorithm.

## User-Mode Linux

User-Mode Linux allows multiple virtual Linux instances to run as application on a single machine. These emulated instances of Linux have the same capabilities as a normal machine.

Using User-Mode Linux networking utilities, the instances can be connected together in a virtual network testbed. This allows users to easily create complex networks and run tests.

The emulated Linux instances can run from dedicated or shared disk images.



## DRAGON

DRAGON stands for Dynamic Resource Allocation via GMPLS Optical Networks. A key achievement of DRAGON is the development of the Virtual Label Switch Router (VLSR), an open-source GMPLS control-plane. By using the VLSR, existing ethernet switches can be wrapped and made GMPLS enabled, to create a VLAN based control plane on ethernet networks. DRAGON has also implemented an open-source path computation engine (PCE) for constraint-based routing using a channel graph algorithm. Combined with the NARB – the Network Aware Resource-Broker, the DRAGON suite provides a way to enhance existing networks with a GMPLS control-plane, thus allowing automatic provisioning by clients.

## Education and Emulation

During the last few years Virtual Network Experiments has been successfully used in networking courses of the Master System- and Network Engineering at the University of Amsterdam. Using VNE students can easily emulate complex networks and study the behavior and traffic flows of different routing and switching protocols.

## Future Work

- **Using Multiple Nodes.** User-Mode Linux instances can be connected to the regular network. We plan to extend VNE to create emulations on multiple nodes.
- **Further DRAGON Integration.** Emulating GMPLS networks is an important goal. VNE will be further extended to allow better integration with DRAGON.

## Software Development Test-bed

VNE has helped the DRAGON team to reduce the number of hosts required for putting together a software development test-bed. It provides a full development suite within one easily maintainable disk image, allowing more developers to work in parallel while using less resources. The XML configuration syntax allows our team to quickly switch between a number of different scenarios for regression testing and debugging. The automation provided by VNE has helped us to remove the error-prone task of manual configuration by a human, allowing the developer to focus on the software instead of finding typos.

