

# Demonstrating the PlaNet-PTN Module: a Single Layer Design Tool for Packet Transport Networks

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**Abstract**—PlaNet is a multilayer network planning tool developed at the University of Texas at Dallas. This demo will illustrate some of the features of *PlaNet-PTN*, one of the modules available in the PlaNet tool. *PlaNet-PTN* can be used to design and plan a single layer packet transport network (PTN). Quality of protection, routing constraints, minimization of the network equipment cost, and user’s desired run time of the tool are just some examples of the features available in PlaNet. As shown in the demo, the *PlaNet-PTN* planning module is able to provide, among others, optimization of LSP-tunnel routes, link capacity placement, node and link equipment configuration.

## I. SHORT DESCRIPTION

Both number of traffic demands (or LSPs) and number of distinct types of service supported by today’s networks are continuously growing. Point to point (P2P) and point to multi-point (P2MP) traffic demands may coexist in the same network. Some LSPs are bidirectional, others are unidirectional. Some require end-to-end path protections, others require link protection (fast reroute). Network standards are also allowing loose definition of routing, for example by requiring that one or more network elements are included in the route of the LSP [1]. *Affinities* can also be used to match the LSP’s required level of service with the performance offered by the available equipment in the network [2].

These requirements, along with thousands of LSPs jointly carried by the same network must be accounted for when planning the network and provisioning the right amount of network resources while containing the overall network equipment cost. Computer aided tools that are required to plan and design networks are therefore becoming increasingly more complex, as new features must be continuously added and integrated with the already existing ones. Such tools must also be able to design multilayer networks, dealing with physical fiber/cable layer, optical/WDM layer, optical transport network (OTN) layer, and PTN layer, e.g., MPLS-TE.

A number of planning tools has been developed commercially. Some tools are designed and maintained by network equipment vendors to support design and marketing of their

products, e.g., [3]. Some are commercially available, e.g., OPNET [4].

PlaNet is a multilayer network planning tool recently developed at the University of Texas at Dallas. PlaNet is a collection of software modules that can be combined to achieve design and planning of multilayer networks. Layers that can be optimized and designed with the help of PlaNet include: the physical fiber layer, the wavelength division multiplexing (WDM) layer [5], the optical transport network (OTN) layer [6], and the packet transport network (PTN) layer [2]. The tool modules can handle the design of metro, as well as core networks.

This demo will present PlaNet-PTN, one of the modules in the PlaNet suite. PlaNet-PTN can be used to optimize the PTN layer in the network. One example of PTN layer is MPLS-TE [2]. Given the input traffic demands, node locations, physical connectivity between nodes, input constraints, and available hardware, PlaNet-PTN can design the network by:

- allocating node hardware, i.e., MPLS-TE chassis (switching fabric) and MPLS-TE line cards,
- providing a basic configuration for the node hardware,
- associating interfaces with a physical connection between nodes,
- computing routes for LSPs,
- assigning routes to LSPs based on QoS,
- assigning routes to LSPs based on input routing constraints, and
- adding redundancy in the network in order to provide reliability to the LSPs, which require it.

The objective of the design is to minimize CAPEX, i.e., the cost associated with the provisioning of all the hardware required to build (or update) the network.

## II. PLANET-PTN DEMONSTRATION

The following functionalities will be demonstrated.

**Multi-phase Optimization.** The user must be able to define a sequence of optimization steps to be applied sequentially to the network under optimization. The result found at the end

of each step may be saved (option selected by the user), and used as the input for the next step.

**Incremental Traffic Demands.** The user must be able to define multiple matrices of traffic demands. Each matrix defines a group of traffic demands that are handled as a whole by the tool. It is possible to run PlaNet-PTN using one group at a time, or multiple groups all together. It is possible to run PlaNet-PTN using a sequence of groups, to study the evolution of the network over time with incremental traffic demands.

**Objects to Optimize and Their Constraints.** For each optimization step, the user must be able to specify what objects (e.g., equipment at a node, routing of LSPs) can be optimized, and what objects are final, i.e., they cannot be changed. Objects include backplanes (switch fabrics) chosen for a node, line cards chosen for a backplane, and routing for an LSP.

**Network Descriptor.** The user must describe various key aspects of the network under optimization. The topology must be defined (e.g., using a graphical interface), specifying which spans (node pairs) are available, and for each span how many links are possible, and what set of transmission rates are available for that span. For each node, it may be necessary to indicate the product models (backplanes and cards) that are allowed to be used. Cost values must be provided for each network component.

**LSP Descriptor.** The user can address an individual LSP, or a group of LSPs. For the LSP (individual or group), the user must specify whether it is P2P or P2MP, the desired maximum hop count, nominal bandwidth, class type, affinity, etc.

**Optimization Algorithm and Parameters.** The user must specify the desired run time, or desired goodness of the optimized result.

**Optimization Mode.** The user must specify if the optimization must start from scratch, or must build upon the previously obtained results (resume of an existing planning session).

**Optimizer Output.** At the end of an optimization step, the solution is made available to the user for analysis and saved to files. The solution includes the specific description of the node hardware, paths of the demands, their reserved bandwidth, etc.

**Graphical User Interface.** A graphical user interface allows the user to interact with the optimizer and specify all the above functions. The interface allows the user to save optimization configurations, and make them the user default configuration. The planning tool provides a default configuration for every parameter, thus making it simple for the inexperienced user to run the optimizer the first time with some meaningful setup. Fig. 1 shows the GUI with the output topology. Each link is color coded to visually identify the percent load on each link. The thresholds for the different colors can be changed on the fly from the GUI.

In the demo it will be shown how the PlaNet-PTN module may be used to design a single layer packet transport network, either starting from a clean slate (no existing equipment in the field), or adding equipment incrementally to an already existing network. It will also be illustrated how the PlaNet-PTN module minimizes the cost of the equipment that is required in the network to support a given set of traffic demands (up

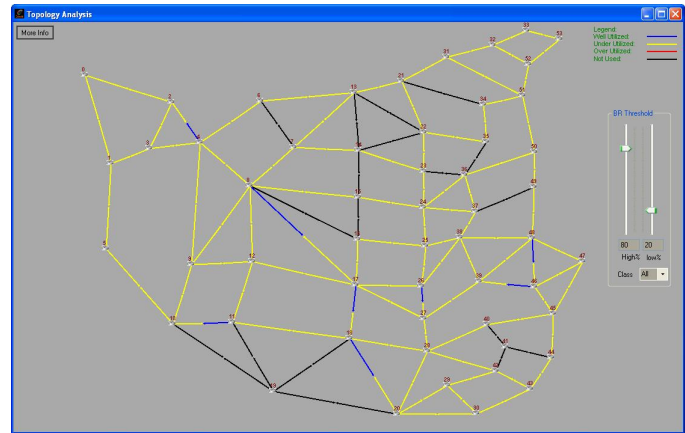


Fig. 1. Output topology

to tens of thousand), while taking into account a number of factors: (a) a realistic set of traffic demand types, including P2P and P2MP traffic, directional and bidirectional flows, end-to-end path protection and fast reroute link protection, multiple classes of priority, (b) the network equipment type, capacity, and cost, which the network designer provides as part of the tool input, (c) a number of routing constraints, e.g., requesting the include or exclude of multiple network elements along the route of special traffic demands, affinity between traffic demands and equipments, disjoint (link, node, and SRLG) routing for diversity purpose, (d) a pragmatic approach to designing networks, whereby the network designer may wish to trade the optimization run time of the module for the optimality level of the solution found.

The PlaNet tool was designed, developed and extensively tested by a team that includes both graduate and undergraduate students at the University of Texas at Dallas. The tool consists of about 170,000 lines of C++ code, which can be compiled on both Windows and Linux operating system. The challenge of designing, implementing, and integrating all the features available in the PlaNet tool offered this student team a unique opportunity to experience and understand the R&D type of environment, where loose specifications are given at the beginning of the project and must be turned into concrete requirements that can be met in the limited time frame given for development. One of these students will run the demo and explain what challenges had to be overcome to successfully complete the project.

## REFERENCES

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