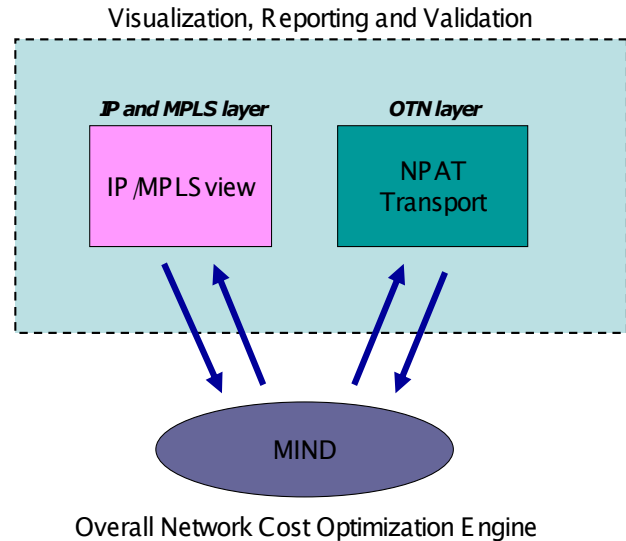


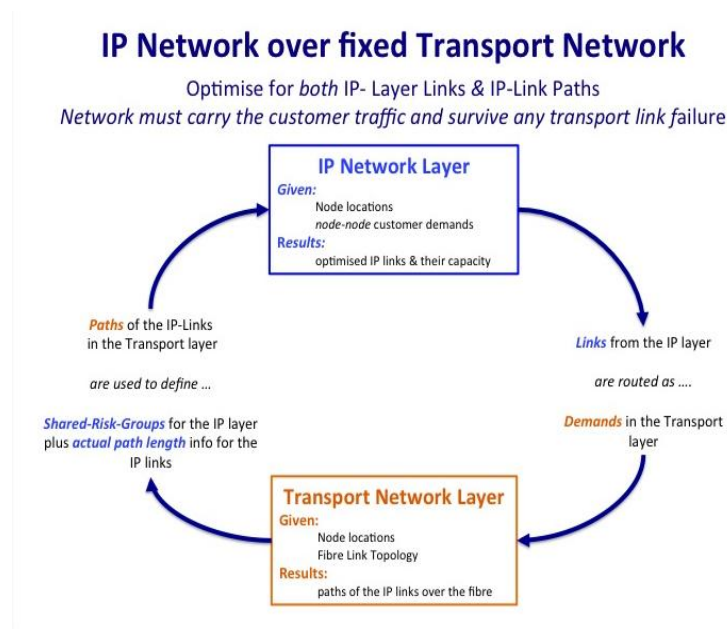
## 1 Introduction

MIND stands for Multilayer IP-over-transport Network Design. This planning software has been specifically developed by WANDL to perform multilayer design. It aims at minimizing the overall transmission and equipment costs for multilayer networks (up to 4 layers are supported).

The software runs alongside two other programs from WANDL called IP/MPLSView and NPAT Transport. Its outputs can be visualized using the GUI of either IP/MPLSView or NPAT Transport. The following chart depicts the relationships between the software components.



## 2 Objectives and Optimization Criteria



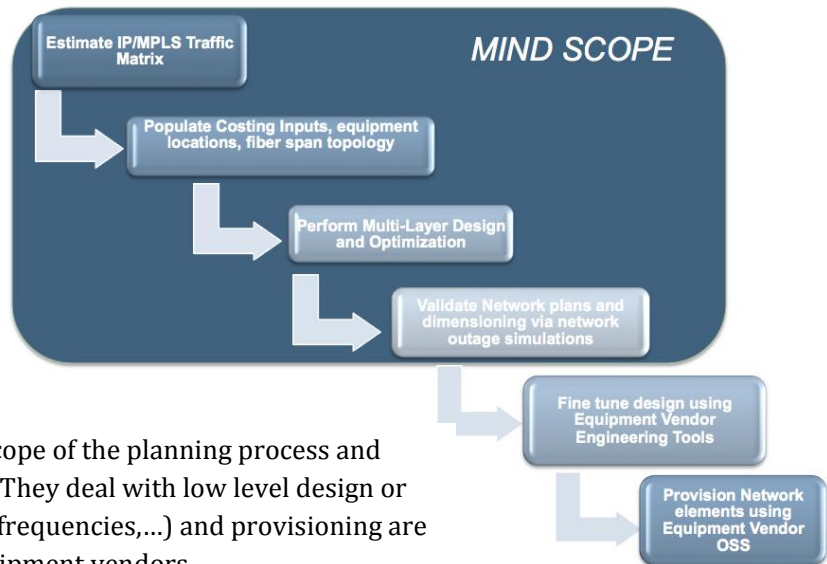
The multilayer design program aims at automating the planning of a multilayer topology that minimizes total network costs. This task can be very time consuming when manually performed. A typical use would be to design an IP or TP layer running over a fixed fiber network so that the IP/TP layer link topology has minimum cost, can carry all the traffic, and can survive any single fiber cut. The program can also be run in a single layer if required to optimize a single-layer network topology or can be used for much more complex network layer structures.

## 3 Multi Layer Planning Workflow

The following chart describes the various steps involved when designing a multi-layer infrastructure:

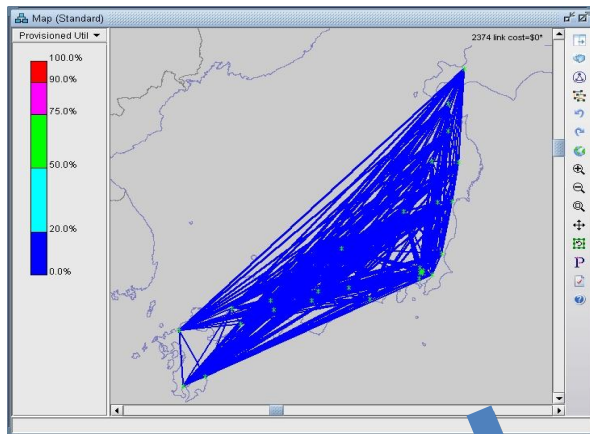
The first step is non trivial as it is quite challenging to estimate the end to end traffic matrix (e.g. PE to PE). At this stage the input process is completed and the optimization program can be run. The design outputs diversity can be validated using IP/MPLSview network outage simulation module.

Further steps are not part of the scope of the planning process and therefore not addressed by MIND. They deal with low level design or engineering issues (e.g. card type, frequencies,...) and provisioning are best handled with proprietary equipment vendors.

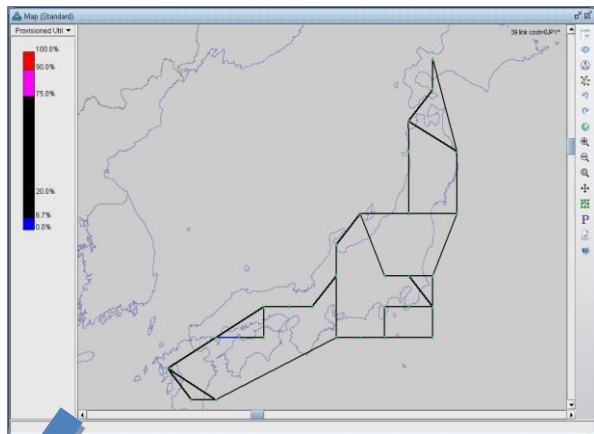


## 4 Case Study

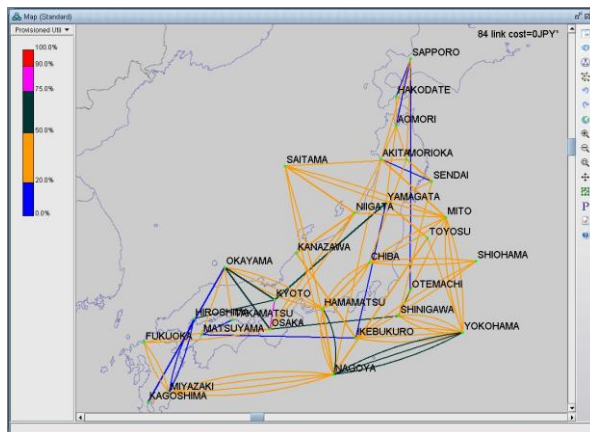
### Demand Distribution



### Fiber Paths (schematic)



### IP Network design solution: Links Diverse Routing



- The Sites and Links were abstracted from internet published materials
- The IP flows were created from the population of the greater area around the node sites.
- The costs used were meant to be relative costs and not current costs for hardware or transmission routes.
- In all cases, these networks are not actual network examples, but meant to be realistic examples.