SEMINAR ON NETWORK PLANNING STRATEGY FOR EVOLVING NETWORK ARCHITECTURES FOR ASIA PACIFIC REGION

Session 5.2

Features, Inputs/outputs for most frequent tools: Exel, PLANITU

Live demo:

Exel, PLANITU

ITU, Bangkok, Thailand, 11-15 November 2002

Exel example:

The location problem from Session 4.2 Switching/Routing and Transmission planning :

0	0	81	326	81	0	0	0	***R1***
0	0	122	407	163	0	0	0	***R2***
0	0	81	366	204	0	0	0	***R3***
156	40	323	284	122	0	0	0	***R4***
391	236	323	323	326	41	43	43	***R5***
234	235	194	150	132	190	222	188	***R6***
38	208	326	310	240	283	317	317	***R7***

R1 = 81 + 326 + 81 = 488 **S1 = R1 = 488**

R2 = 122 + 407 + 163 = 692 **S2 = S1 + R2 = 1180**

R3 = 81 + 366 + 204 = 651 **S3 = S2 + R3 = 1183**

R4 = 156 + 40 + 323 + 284 + 122 = 925 **S4 = S3 + R4 = 2756**

R5 = 391 + 236 + 323 + 323 + 326 + 41 + 43 +43 = 1726
S5 = S4 + R5 = 4482

R6 = 234 +235 +194 +150 + 132 + 190 + 222 + 188 = 1545
S6 = S5 + R6 = 6027

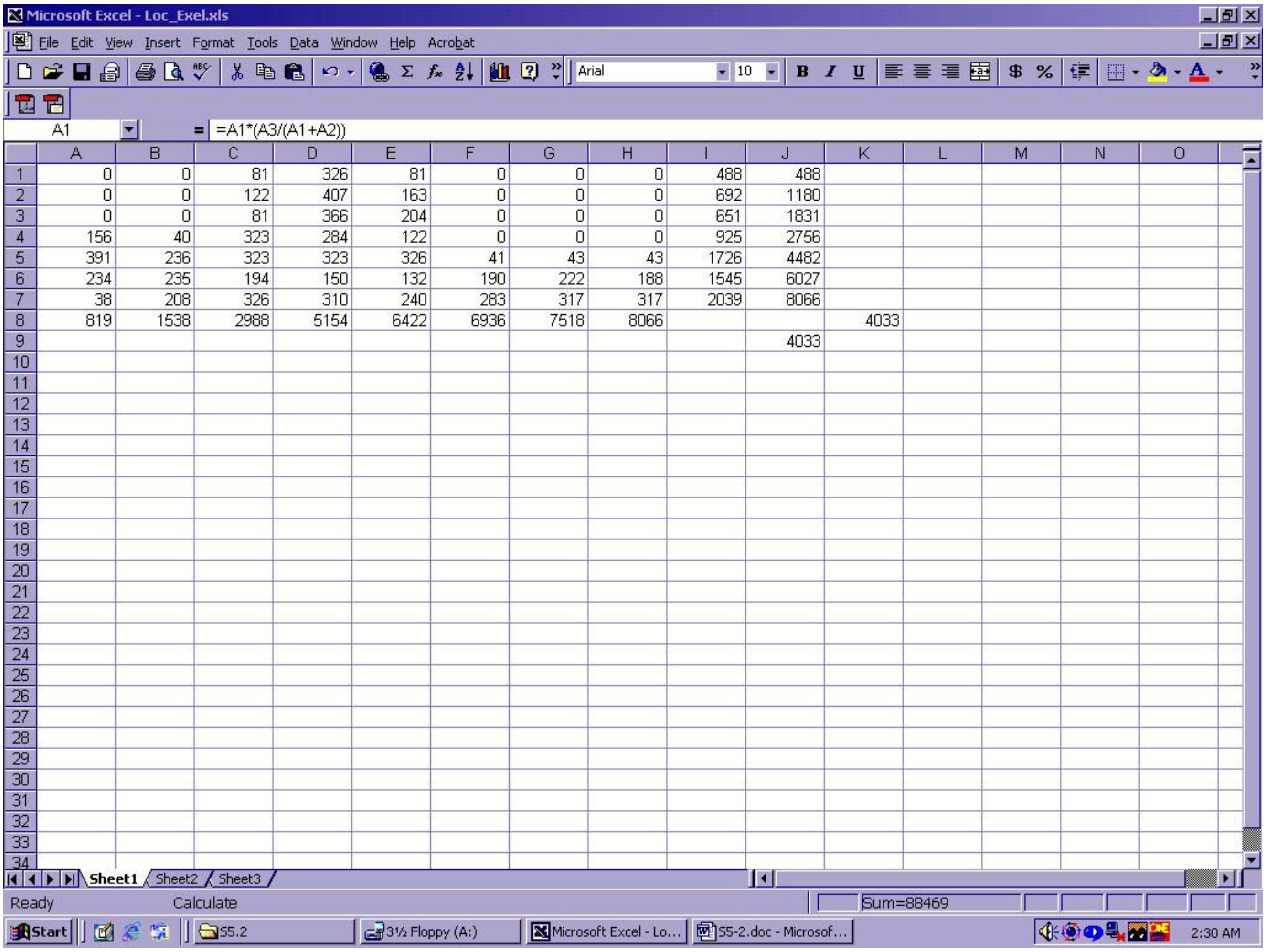
R7 = 38 + 208 + 326 + 310 + 240 + 283 + 317 + 317 = 2611
S7 = S6 + R7 = 8638

S_{TOT} = S7

$S_Y = S_{TOT}/2$ = 8638/2 = 4319

Exel example:

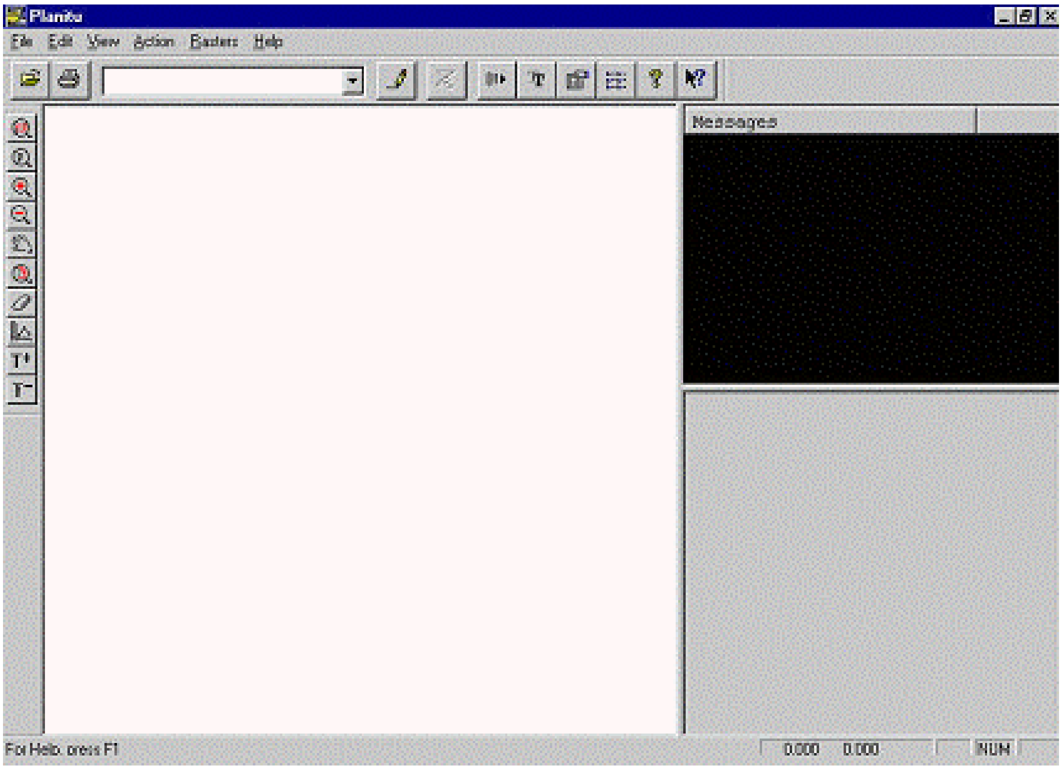
The location problem from Session 4.2 Switching/Routing and Transmission planning :

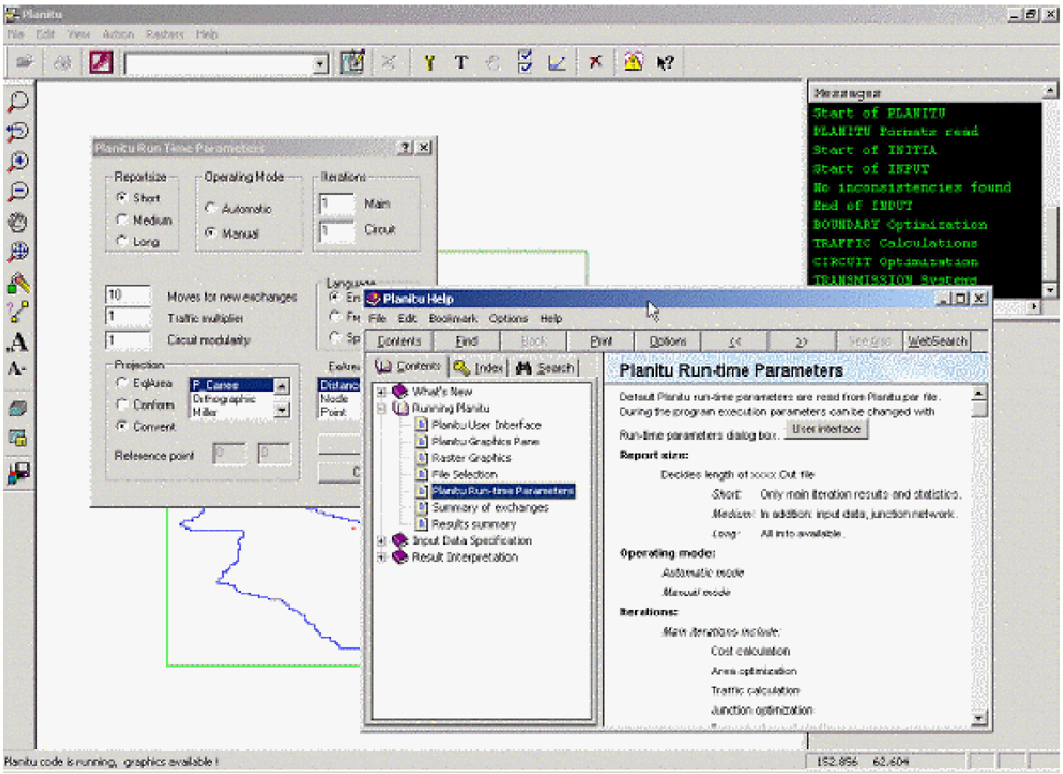


	A	B	C	D	E	F	G	H	I	J	K
1	0	0	81	326	81	0	0	0	488	488	
2	0	0	122	407	163	0	0	0	692	1180	
3	0	0	81	366	204	0	0	0	651	1831	
4	156	40	323	284	122	0	0	0	925	2756	
5	391	236	323	323	326	41	43	43	1726	4482	
6	234	235	194	150	132	190	222	188	1545	6027	
7	38	208	326	310	240	283	317	317	2039	8066	
8	819	1538	2988	5154	6422	6936	7518	8066			4033
9										4033	

New Features in Planitu 3.0

Planitu version number has gained one whole integer due to substantial amount of new features added and the extensive debugging undertaken in the field and during the current version software development.





Main additions to the program functionality are listed here.

- Access network optimization

    1. Dial-up Internet subscriber planning
    2. Broadband access planning
    3. Planning of cabinet areas

- Backbone network optimization

    1. Dual homing (load sharing)
    2. Design of nonhierarchical circuit-switched networks
    3. Optimization of the fixed part of mobile (GSM) networks
    4. Optimization of Ring/ Mesh SDH/ SONET transport networks
    5. Design of ATM, IP MPLS, WDM networks using equivalent bandwidth paradigm.

- Updated data handling and Planitu user interface

    1. Contemporary "flat" look and feel with redesigned toolbars.
    2. Integrated running cost chart for immediate hands-free cost trends inspection.
    3. Export Planitu graphics into industry standard CAD formats DWG/ DXF.
    4. Optimization results can be saved into Access database for post processing.
    5. Internet-aware Planitu help containing complete Planitu manual.
    6. New demo networks for quick hands-on experience training for new Planitu functionality
    7. New click and go installation on single CD.

Dial-up Internet Subscriber Planning

Method

To present dial-up access of Internet in an improved way a separate group of subscribers, consisting of subscribers with access to this service, is formed and presented as second subscriber layer. For better accuracy is possible to present one and the same subscriber in the layer of the ordinary voice subscribers and also in the group of the Internet subscribers.

A separate traffic matrix with the Internet traffic has to be prepared and presented in the data as complimentary data file to the ordinary traffic matrix.

Also, different type of transmission media for the dial-up Internet subscribers could be referenced in the input data.

Described method for presenting of dial-up Internet subscribers is applicable to Metropolitan networks only.

Input data

Dial-up Internet subscribers are presented as second layer (second file with subscribers data). Second traffic matrix corresponding to the dial-up Internet subscribers is referenced in the master input file (immediately after the usual traffic matrix).

In data block *General control* , section *Common parameters* on the line after **LCIRC** and **LAYERS** is added new parameter **Layers_IP** in format (I3) .

- **Layers_IP** = 1 is indication for second traffic matrix for the dial-up Internet traffic
- (**Layers_IP** = 0 for all other cases).

```
 1
Gyumri City Basic Plan
 6  2  1    MIN # OF CIRC./Layers + Dial-up Internet
--------
File:submatr.gym       subscriber matrix(first Layer)
File:submatr_IP.gym
 0                  nodes(first Layer)
 0
 0                  nodes(second Layer)
 0
 0                  runs
File:Traf5.gym        contains the traffic matrix
File:Traf5_IP.gym
 0  0  0               No profiles defined
```

In data block *Exchange specifications*, section *Specification of types REF2* after parameter **LevTr** is added new parameter **NCBLS_IP** in format (I2). Through this new parameter a different type of transmission media for the dial-up Internet subscribers could be referenced in data block *Definition of cables* (direct reference to *Specification of Cables* list).

```
2 EXCHANGES
Gym LD    0   4.5     7.4  3  2  4  2     0.0     0.0  1 2-5000.
Gym T&L   0   4.5     7.4  2  2  1  0     0.0     0.0
 4                       Ref1
 2  1  2  1  0  0  Loc
 3  2  3  2  1  0  Tan
 2  3  4  3  0  0  LD
 1  4  1  4  0 -1  RSU
 3                       Ref2
 2  1  1  1  1  1  1  1  1  0 0analog
 1  2  1  2  2  1  2  2  3  0 6dig (no RSU)
 1  3  1  2  3  1  2  3  3  0 6RSU
 4                       Ref3
 1  1  1         OpL/B:OO
 0  1  1         FxL/B:OO
 0  0  1         FxL/B:FO
 0  0  0         FxL/B:FF
```

Menus

There are no new menus.

Running of PLANITU is as for a typical Metropolitan network investigation.

Broadband Access Planning

Broadband access (xDSL, PON, WLL) is presented with the same method as dial-up Internet access, i.e. broadband subscribers are presented with separate subscriber layer and traffic matrix.

Specification of the costs of subscriber equipment has to describe corresponding equipment for broadband access (xDSL, PON, WLL).

As in the case of dial-up Internet subscribers described method is applicable to Metropolitan networks only.

Data Network Planning Module

Method

Optimization of the routing layer (ATM, IP, MPLS, WDM) as Data network planning module is additional feature in the PLANITU with extra input/output data

Input data for ATM and IP traffic are presented as traffic matrix with data in the form of equivalent bandwidth

The module allows planning of the data networks based on the ATM and IP/MPLS technologies. In general the underlying optimization task belongs to a class of topological design problems, where the set of demands and a list of potential locations for nodes and links is given.
The objective is to allocate all demands with the least cost, associated with the actual capacities of the links and the fixed installation costs of nodes and links.
We assume that network nodes are divided into the set of access nodes and the set of transport nodes.
Only the access nodes are demand generators and they are never used to transit the traffic flows.
Transport nodes do not generate demands and are only used to transit the end-to-end flows.
The selection of the actually installed transport nodes and of the links interconnecting all the network nodes (*i.e.* the actual network topology) is the major subject of optimization.

The general statement of the problem is given below.

Given:

- a set of access nodes with fixed geographical locations
- traffic demand between each access node pair.

Find:

- the number and locations of the transport nodes
- links connecting access nodes to transport nodes
- links interconnecting transport nodes

Objective:

- minimize the total network cost.

The total network cost is composed of

- the fixed installation cost of each link,
- the variable (capacity-dependent) cost of each link (which in general can be any function of the capacity and of the link length,
- the fixed installation cost of each transit node (currently unused).

In the context of an MPLS-capable IP network, the access nodes represent the Label Edge Routers (LER) and the transit nodes are the Label Switching Routers (LSR).

The simpler case of the presented problem (which is actually handled by the optimization code) is the topology design without node localization, where only the links are subject to optimization.

To allow the effective solving of this problem for large networks, the heuristic procedure is used. The procedure is based on the Simulated Allocation (SAL) method. The general idea of SAL consists in incrementally adding the required demand capacity units to the network, where demand routing is based on the shortest path procedure with properly selected cost and state-dependent link metrics. The diversification possibilities for the local search procedure applied in the allocation phase are provided by the possibility of retracting the already allocated demands during the whole progress of the algorithm.

The data network planning module allows planning of the ATM and IP/MPLS based networks. In case of the backbone networks the demand volumes can be interpreted as aggregated data streams, expressed in equivalent bandwidth (for example in Mbps). It is possible to later introduce the more sophisticated demand description, based on the number of sources with given traffic parameters, that will be converted by the module into aggregated streams on the base of equivalent bandwidth procedure and the given overbooking parameters.

In case of ATM networks the application of the algorithm is straightforward and one-phase. The algorithm searches for the sub-optimal link topology. The corresponding loads of the selected transport links and nodes, together with the paths used to route demands are determined and printed in the output file.

In case of the IP/ MPLS network the algorithm currently works in two phases. In the first phase the algorithm searches for the optimal aggregation of traffic in the transport network, based on the given link costs criteria. In the second phase the new aggregated demands are routed and the sub-optimal topology of LSP tunnels is determined.

Input data

To invoke optimization of Data network the parameter ***NPROG*** in data block *General control* is set to:

- ***NPROG*** = 4 for MPLS based network
- ***NPROG*** = 5 for ATM network
- ***NPROG*** = 6 for IP based network

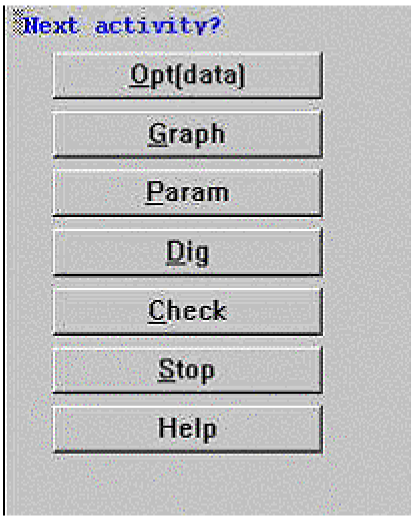
```
 4 for DATA - MPLS
DATA(MPLS) Network  -   T E S T
   6  1        Min Nb.Circ./Layers
```

Data network is set through input files *Definition of Nodes* and *Definition of Links*.
Demand matrix is presented in bandwidth (for example in Mbps) with file *Traffic Matrix*.
Cost of each link is set through costs values in input file *Definition of Cables*.

```
Cables
0.4   0.00280.00  0.00  1.55  0.00 17.4   1   150
0.6   0.00130.00  0.00  1.10  0.00 37.30  1    70
0.8   0.00 72.00  0.00  0.72  0.00 56.10  1    50
1.0   0.00 46.00  0.00  0.57  0.00 86.20  1    30
MPLS  0.00  0.00  0.00  0.00 5000.  1.0   2    30
----------------------
  1 cable dig-dig ( MPLS )
  5
```

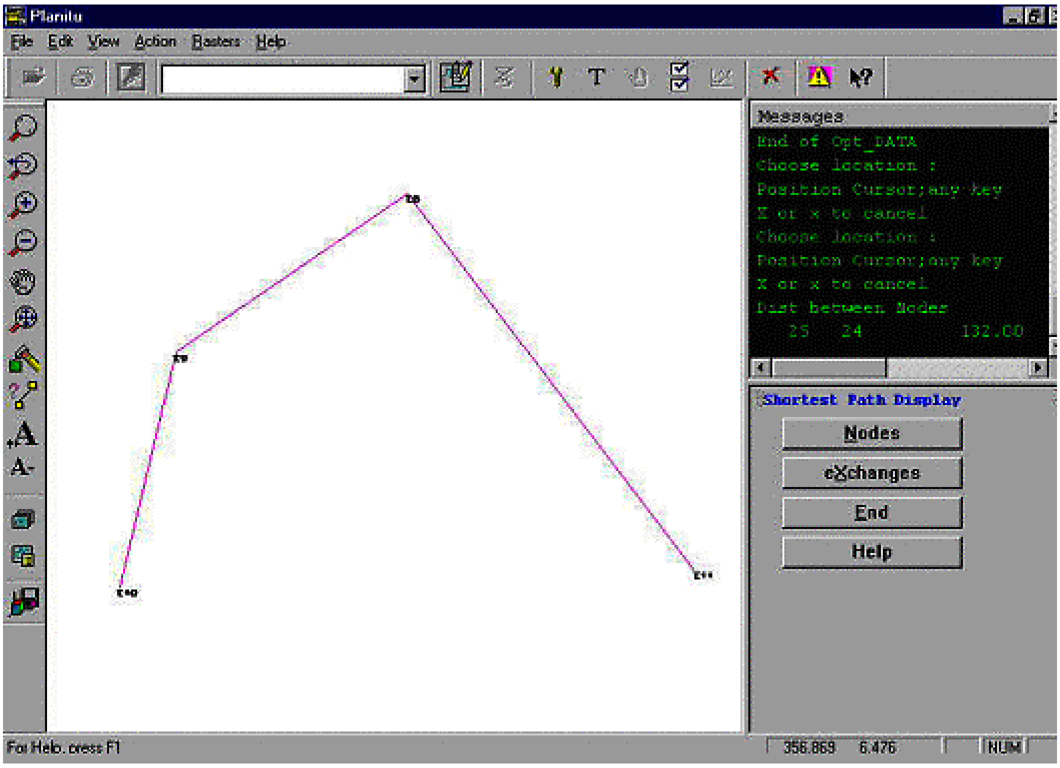
Menus

There is one new menu ***Opt(data)*** to control Data network optimization:



To see graphics presentation of the result use ***Graph*** menu.

To draw result of paths select ***Nodes/eXch*** and then select ***Paths***, ***Distance*** and ***Nodes*** and point the two end nodes by the cursor (to see node names activate ***text*** option in the main graphics menu):



Some times is difficult to read node names, as access nodes and transport nodes are in the same location (program will ask confirmation by prompting the nod name).

To finish the optimization process and exit the program ***Stop*** button has to be selected.

Result of the Data network optimization are presented in details in the PLANITU output file:

- Optimal path for each demand, e.g.:

```
    Demand:  T10     T11
     Path:
     T10    T9      T8      T11
```

- Nodes load:

```
    DATA: Nodes load:
        3     4248.
        4    11880.
        5     1944.
        7     2376.
        8    16584.
        9     9168.
```

- Links load:

```
     DATA: Links load:

       17   18     4248.
       18   19     1944.
       18   22     5688.
       21   22     2376.
       22   23     8520.
```