ITU / BDT- COE workshop

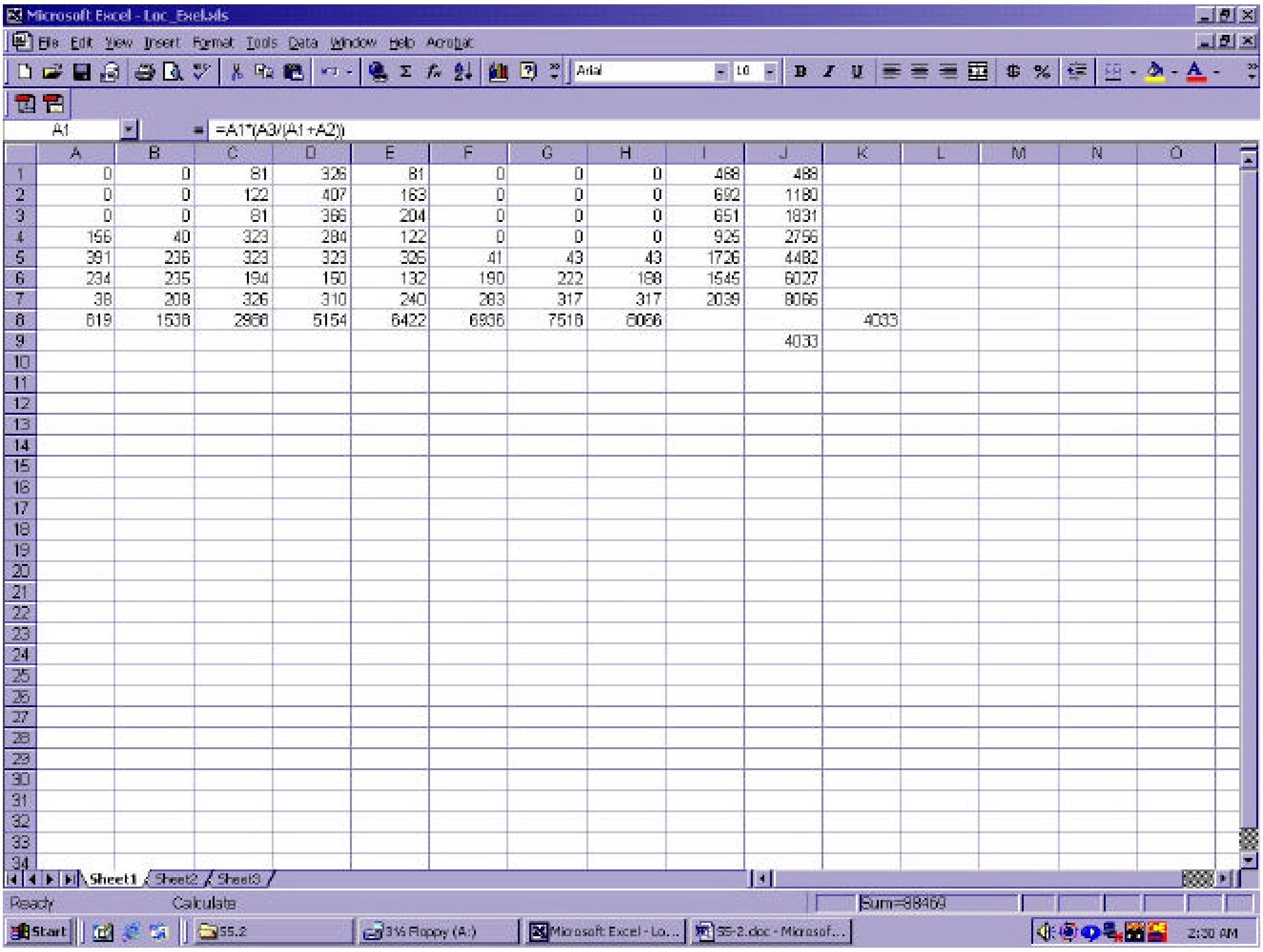
Nairobi, Kenya,
7 – 11 October 2002

Network Planning

Lecture NP-5.2

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

Exel example for the location problem from S4.2 Switching/routing 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	

Planitu 3.0 Manual

Planitu 3.0 Network planning system manual

March 2002

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 with password protection.

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

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.

Planning of Cabinet Areas

Method

Optimization of cabinet locations and service areas for copper and FO cabinets is performed through separate module, working per exchange area.

Method is very similar to the one for RSU optimization in Metropolitan areas.

Main difference is that in a cabinet there is no concentration of traffic. In an RSU on the outgoing direction we have already traffic stream and corresponding number of circuits, but in a cabinet we still have subscriber lines, i.e. in a cabinet we have the same number of inlets and outlets.

Optimization of cabinets is applicable to Metropolitan networks only.

Dual Homing (Load sharing)

Method

Dual homing (load sharing) routing is a case when exchanges could be connected to two different tandems.

Overflowing traffic is divided with predefined coefficient α :

- α * Overflowing traffic - traffic to the first tandem
- (1-α) * Overflowing traffic - traffic to the second tandem

Coefficient α is defined through input file with routing data.

Dual homing (load sharing) routing is applicable to all types of networks.

Design of Non-hierarchical Circuit-switched Networks

Method

Non-hierarchical routing is optional feature to the hierarchical routing .

The method optimizes routing and simultaneously optimally dimensions link capacities.

For each OD-pair a direct link and a number of two-link overflow paths are selected.

Three types of routing are included:

- FSR/OOC (Fixed Sequential Routing with Originating Office Control). This is routing with crank-back, i.e. the call blocked in a transit node is transferred back to the originating one and continues to try consecutive paths. All the overflow paths are tried before call is rejected;
- FSR/SOC (Fixed Sequential Routing with Successive Office Control). The call blocked in a transit node is rejected;

- DAR (Dynamic Alternative Routing). Direct path is tried first, as usual. Then there is one, single currently active overflow path. If the direct path is blocked the call is offered to the current overflow path, and if this is also blocked the call is rejected and new overflow path is selected at random.

In all cases Dynamic Circuit Reservation is used.

The main optimization loop starts with link dimensioning. A multivariable function gradient minimization method called Rosen Method is used. The link blockings serve as optimization variables. The GoS objective (Node-to-Node blocking for each OD pair should not exceed parameter beta) is taken into account with a penalty term in the objective function. After each execution of the main loop the penalty coefficient is increased, so the GoS objective is met better and better.

Optimization of the Fixed Part of GSM Networks

Method

Fixed part of GSM network is presented with the model of a national network.

There are two options for such a study:

- To start from Traffic matrix;

To enter directly Circuit matrix.

Optimization of Ring/ Mesh SDH/ SONET Transport Network

Method

Optimization of Ring/Mesh SDH/SONET transport network is additional feature in PLANITU with extra input/output data

The SDH module optimizes routing of 2 Mbps demands through the hybrid ring-mesh SDH network. The demands are expressed in multiples of 2 Mbps modules. The optimized network is structured into interconnected subnets that can have either ring or mesh topology. The ring structures provide models for protected SDH rings.

The following ring types are supported:

- bi-directional unprotected rings (two-fibers)
- bi-directional protected rings (four-fibers)
- bi-directional shared standby rings (two-fibers)

For multi-ring structures it is possible to use the dual homing protection scheme. The dual homing is based on the drop-and-continue functionality of the ADM-equipped nodes.

The mesh is a network structure of arbitrary topology (regular mesh etc.) that supports the following protection and restoration mechanisms:

- path protection
- link protection
- path diversity

The mesh can be also configured as unprotected.

The optimization method uses heuristic algorithm based on the shortest path approach. The following constrains can be applied during the dimensioning process:
edge capacity constraints – this options allows to specify the maximum capacity of the edge that cannot be exceeded during optimization.
line card constraints – this options allows to specify the maximum capacity of line card interface supported by the node (the edge capacity can be increased only in accordance with this constraints)
node capacity constraints – this options allows to specify the maximum number of cards that the node is able to support (not yet implemented).

Two types of nodes are distinguished in the optimized network:

- traffic access nodes – these nodes represent the abstract traffic entry points (e.g. telephone exchange etc.)
- transmission nodes – these nodes represent the actual SDH network nodes e.g. ADMs or DXCs. For these nodes it is possible to specify the number of slots (number of interface cards supported), the types of line cards supported (defined by the maximum capacity of the line card interface), the number of ports per card for each card type (line or tributary). Currently only 2 Mbps tributary cards are supported by the program.

The traffic matrix is expressed in 2 Mbps demands between the access nodes.

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.