

# SIGNALING NETWORK PLANNING WITH THE CASCAD TOOL



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ITU/ITC Regional Seminar on Network Evolution  
to Next Generation Networks and Fixed Mobile Convergence  
for CEE, CIS and Baltic States

Network Evolution to NGN

April 27, 2004, Moscow, Russia



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- NGN signaling placement
- Tool overview
- Planning process
- Planning methodology
- Example
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## Interconnecting SS7 and NGN

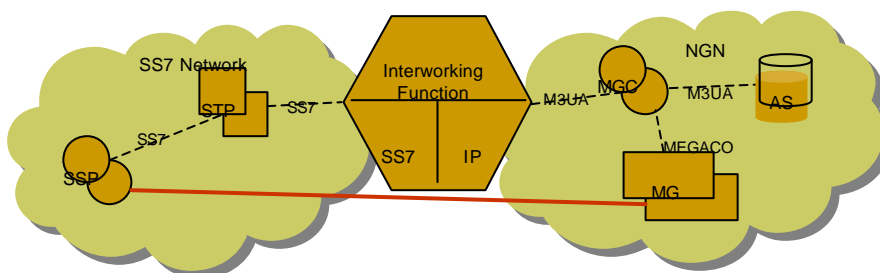
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- Sigtran
- SIP/SS7 Gateway
- H323/SS7 Gateway
- others

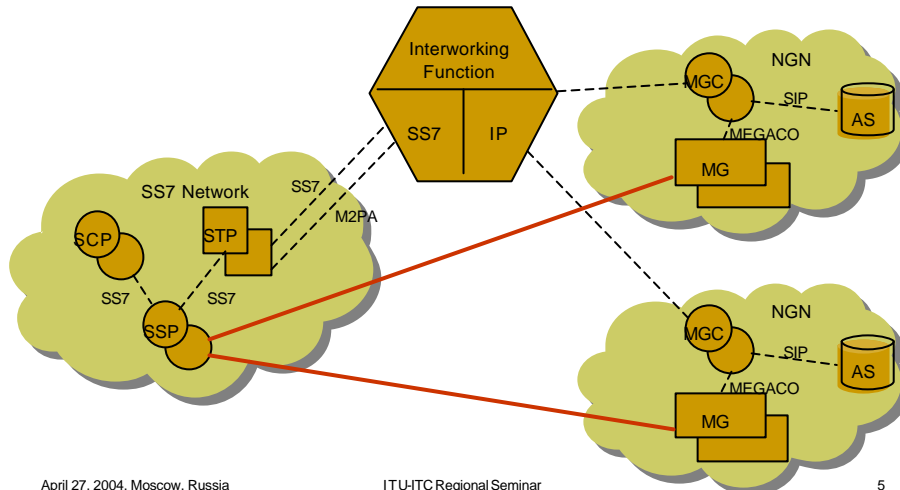
## Interconnecting SS7 and NGN Signaling Gateway/Sigtran

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## Interconnecting SS7 and NGN Signaling Gateway/SIP

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## SS7 Network Planning



- SS7 network supports reliable transport for all cooperating networks
- SS7 network planning plays significant role in future network development
- Large-scale signaling network planning needs for appropriate methodology and sophisticated computing tool

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## Tool Overview

### Common requirements

- All-purpose orientation (design, development, research)
- Flexibility and Scalability (specific project task implementation)
- Full modularity (interfaces to add the functions essential)

### System requirements

- Database interconnection mechanisms (import/export data)
- Optimized algorithms and programming solutions (performance)
- Simplicity of use (clear interfaces, logical process)



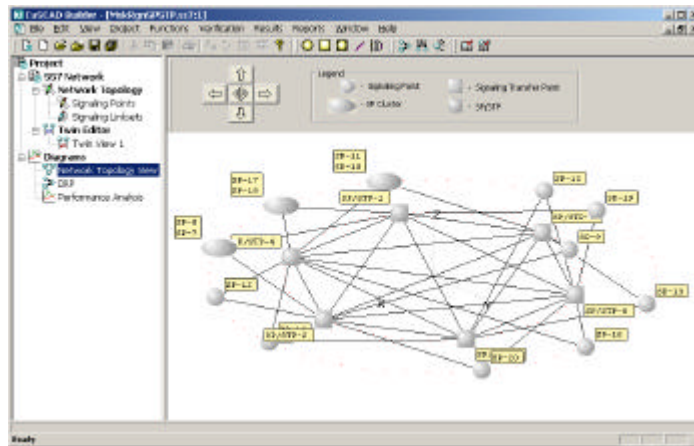
## Tool Overview

### Main tool features

- Loading and editing of the SS7 network data
- Routing plan calculation
- Signaling load and signaling linkset capacities calculation
- Signaling load sharing calculation
- Routing table generation
- Routing plan validation
- Performance analysis

## Tool Overview

### Example of the tool interface

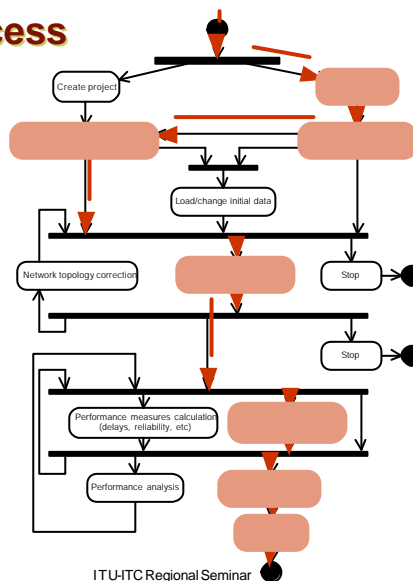


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## Planning Process



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## Planning Process

### Meta process

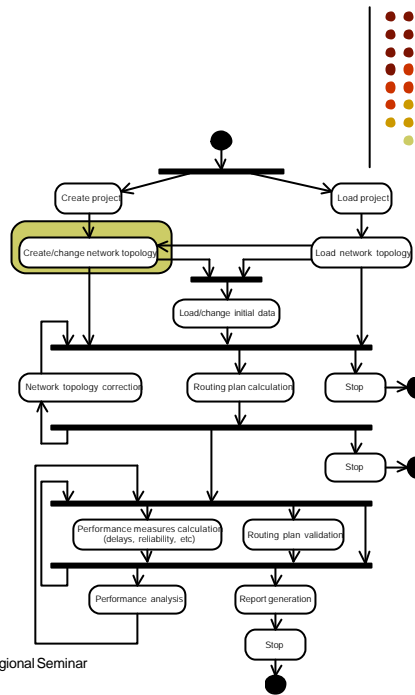
#### Create/change network topology

The SS7 network consists of signaling points to form the network topology. Within this topology, the routes have to be defined between the individual signaling points. When a planner creates or changes the network topology, the tool must provide the control of its correctness using the appropriate algorithms.

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## Planning Process

### Meta process

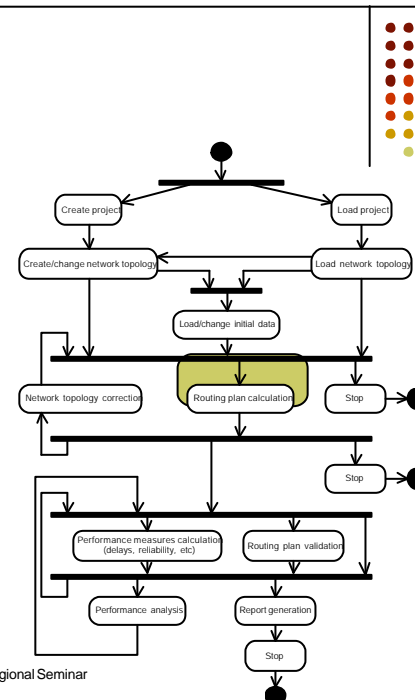
#### Routing plan calculation

This activity has been designed on the basis of the efficient numerical algorithms and therefore the process of the routing plan calculation is almost "transparent" for a planner. One should only answer a few simple questions concerning the planning restrictions in order to obtain the correct result.

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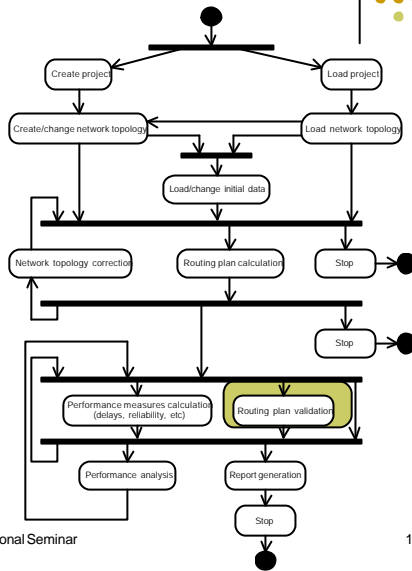


## Planning Process

### Meta process

#### Routing plan validation

The activity manages the key problem solution of the network planning. It includes a set of tests to verify the routing data such as the circle-free routing implementation, the availability of the signaling relations, the correctness of the SLS codes and the linkset priority allocation.



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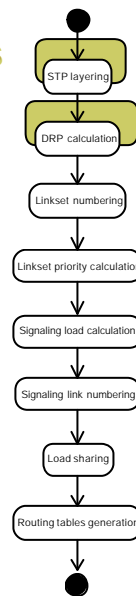
## Routing Plan Calculation Process

#### STP layering

We group the STPs into different layers taking into account their topological relationships with the SPs and other STPs. This action is necessary for the next stages of the routing plan calculation.

#### Destination routing plan calculation

DRP is defined as a set of routes destined to the concrete SP. The calculations include the route construction according to the predefined requirements.



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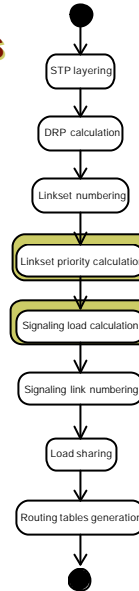
## Routing Plan Calculation Process

### Linkset priority calculation

Any linkset of the network must obtain a value of the priority for message routing to every destination SP. These priorities define the normal routing as well as the alternative routing in case of network failures.

### Signaling load calculation

The action provides the calculation of the load on every signaling relation between SPs and the load on every linkset of the signaling network.



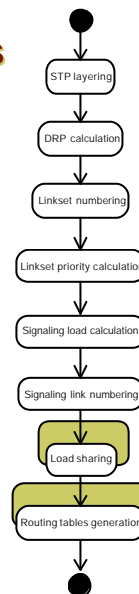
## Routing Plan Calculation Process

### Load sharing

The signaling load sharing action includes the algorithm for the SLS code calculation. The algorithm is based on the DRP multigraph edge colouring and provides the correct load sharing according to the ITU-T recommendations.

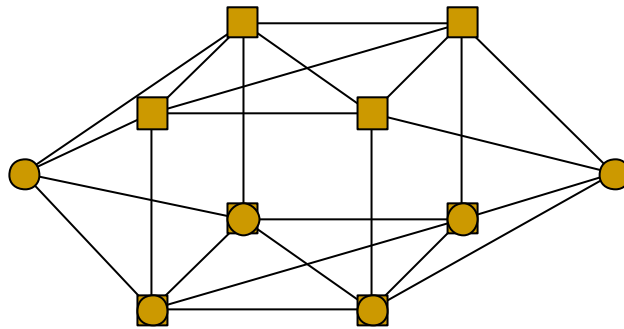
### Routing tables generation

The action provides calculation of the network routes and routing tables, which are constructed using the data acquired during the previous actions of the process.





## Example of Signaling Network Graph

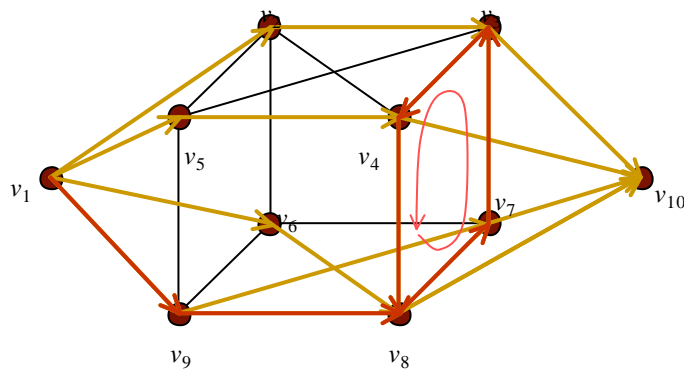


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## Example of the Routing in the Network Graph



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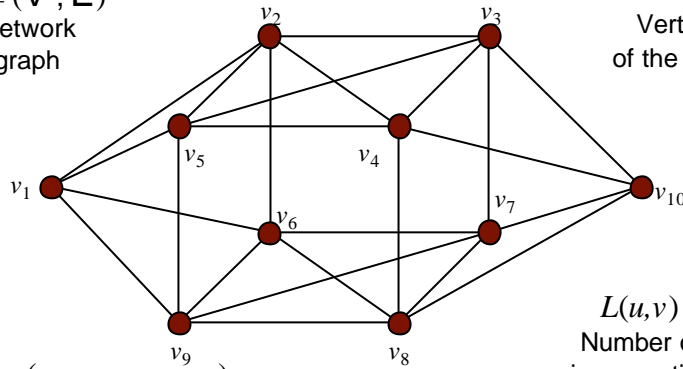
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## Notation



$G = (V, E)$   
Network graph

$V = V_1 \cup V_2$   
Vertex set of the graph  $G$



$l(u, v) = (u, x_1, \dots, x_t, v)$   
path

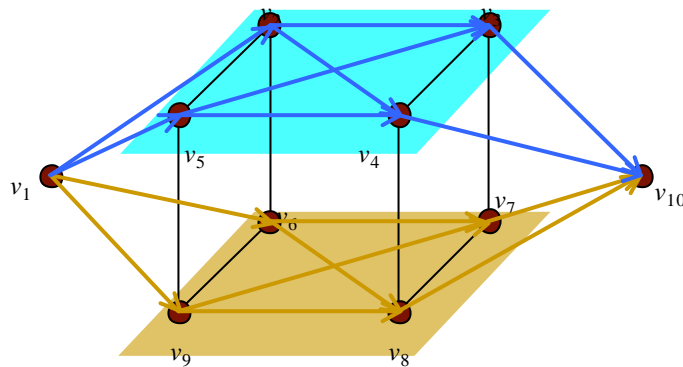
$L(u, v) = t$   
Number of the inner vertices of the path

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## Restrictions for the Set of Paths



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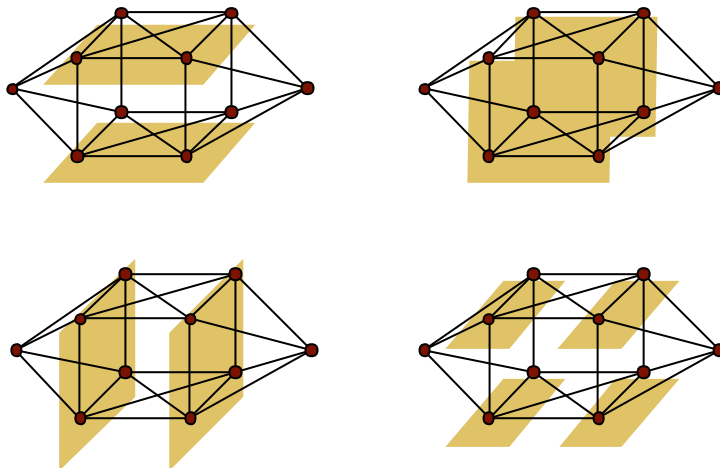


## Restrictions for the Set of Paths

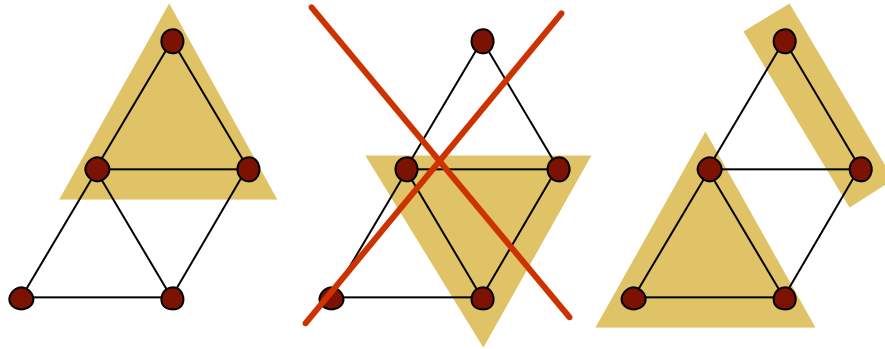
- (i) The number of the inner vertices of a path must not exceed the given value, i.e.  $0 = L(u, v) = T$
- (ii) A path must be a simple chain in the graph  $G$ , and its inner vertices (if they exist) should belong to the set  $V_2$



## Variants of the Vertex Set Decomposition



## Criteria 1 of the STP Network Decomposition



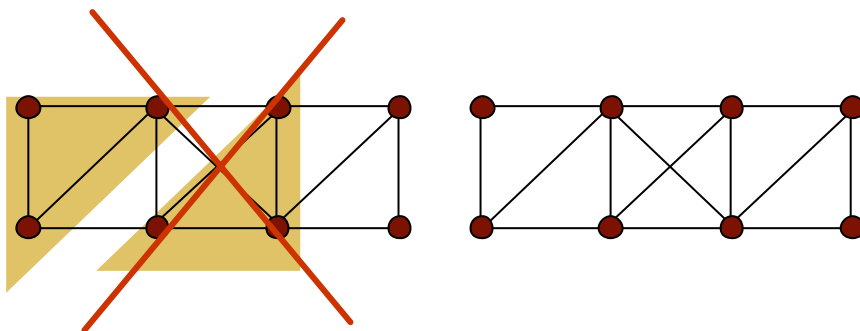
The number of bi-components should be minimal.

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## Criteria 2 of the STP Network Decomposition



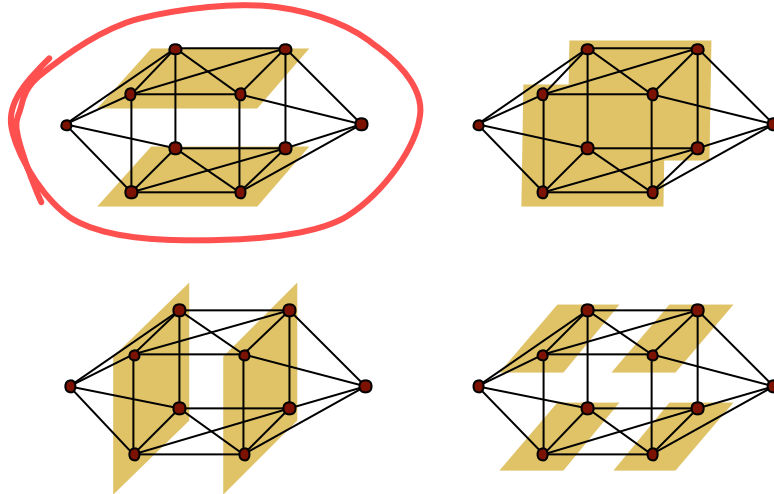
The number of vertices in the largest bi-component should be maximal from the all decompositions.

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## Variants of the Vertex Set Decomposition

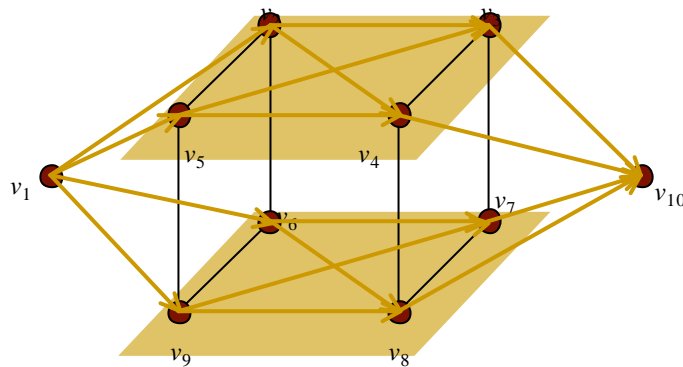


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## Example of the criteria application

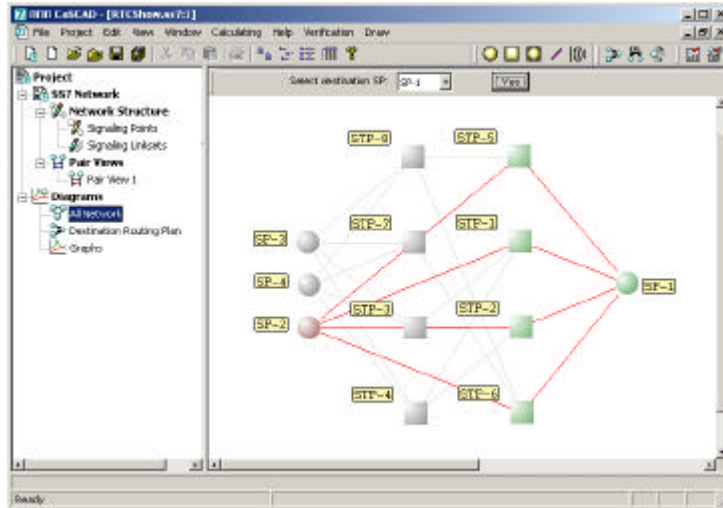


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## Example of the Destination Routing Plan



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## Example of the Routing Tables

SLS	SL	Priority	SLS Bits	Destination SP	Code 1	Code 2
0	0	1	000X	SP-2	2	2
0	0	1	100X	SP-4	4	2
0	0	1	100X	SP-3	3	2
1	0	2	100X	SP-2	2	2
1	0	1	010X	SP-4	4	2
1	0	1	010X	SP-3	3	2
2	0	1	100X	SP-2	2	2
2	0	1	110X	SP-4	4	2
2	0	1	110X	SP-3	3	2
3	0	2	000X	SP-2	2	2
3	0	1	000X	SP-4	4	2
3	0	1	000X	SP-3	3	2

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## Practical Results



### Russian SS7 Toll Network (Rostelecom, national level)

- 16 STPs divided in 2 layers, ~ 150 SPs
- ~ 25000 signaling routes

### SS7 Network of the Moscow Region (CentreTelecom, local level)

- 6 STPs, ~ 100 SPs
- ~ 10000 signaling routes

## Conclusions



### Results

- Methodology for the network planning at the MTP3 level
- Application of the tool and the methodology for the Russian large-scale signaling networks planning

### Future work

- Auxiliary planning aspects of NGN
- Algorithms for the SS7 network performance analysis