



# ITU / BDT- COE workshop

Bangkok, Thailand,

11 – 15 November 2002

## Network Planning

Lecture NP- 5.3

### Supporting Network Planning Tools

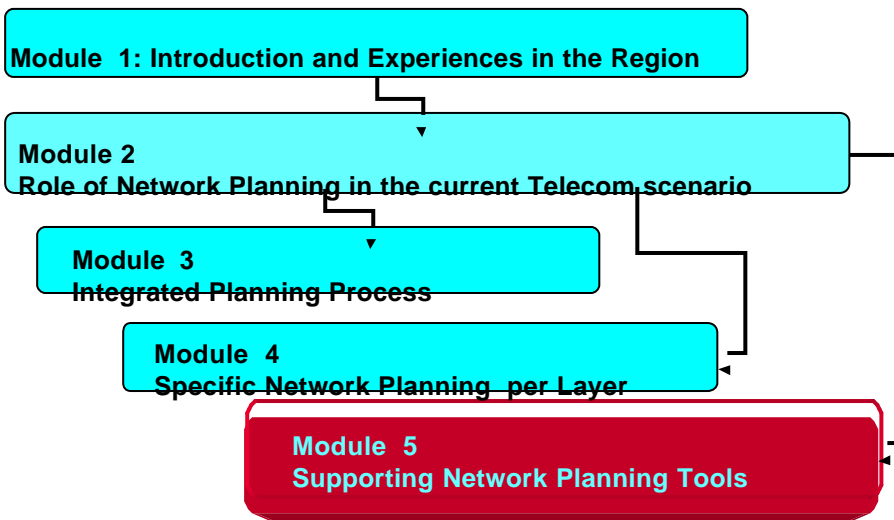
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Lecture NP - 5.3- slide 1



## BDT - COE workshop on Network Planning



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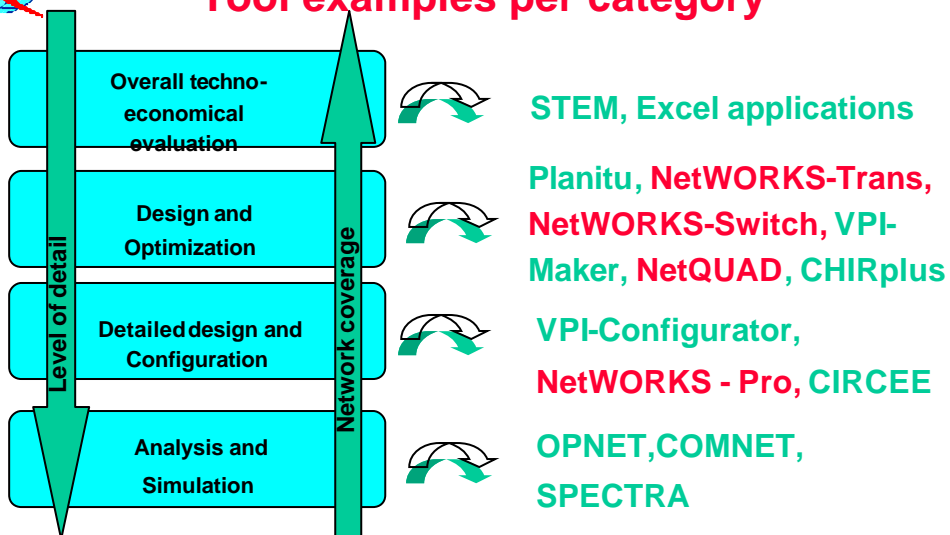


## Content Chapter 5.3 Network Planning Tools

- Objectives and classification for the different tool types
  - Overall techno-economical evaluation
  - Network design and optimization
  - Network evaluation and simulation
  - Tool mapping per class



## Network Planning Tools: Tool examples per category





## Network Planning Tools: NetWORKS

Telecom  
Network  
Planning



**Objective :** NetWORKS by  
Detecom (Germany) is a Telecom  
network planning tool to design,  
optimize and dimension several  
network layers as: Switching,  
Transmission, Cable, Mobile, etc.



## Network Planning Tools: NetWORKS

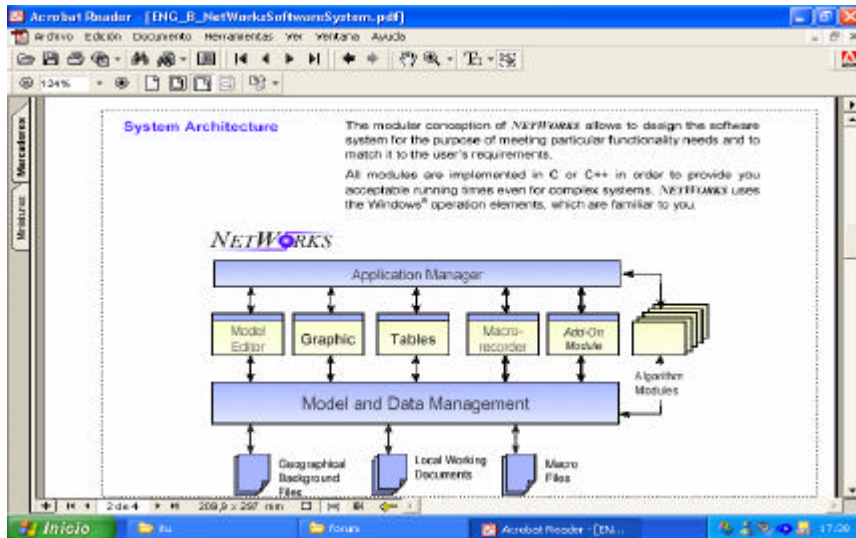
Telecom  
Network  
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**Objective :** NetWORKS is a  
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Switching, Transmission, Cable,  
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# Network Planning Tools: NetWORKS



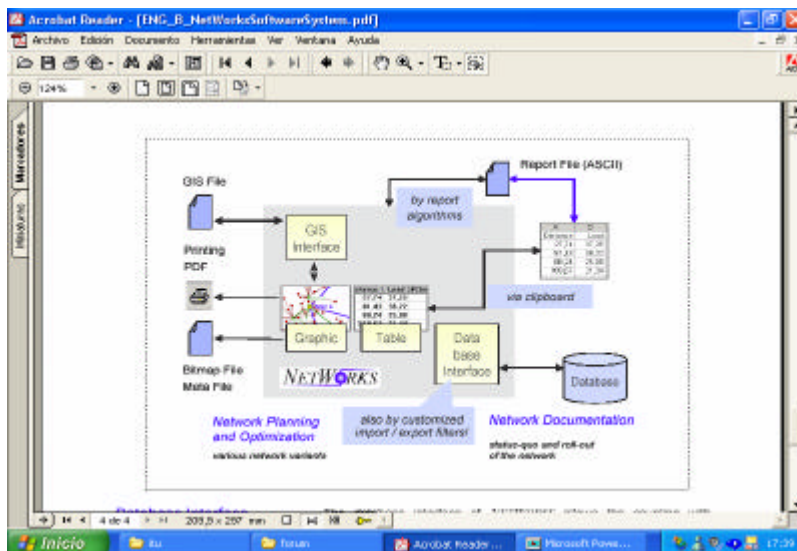
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# Network Planning Tools: NetWORKS



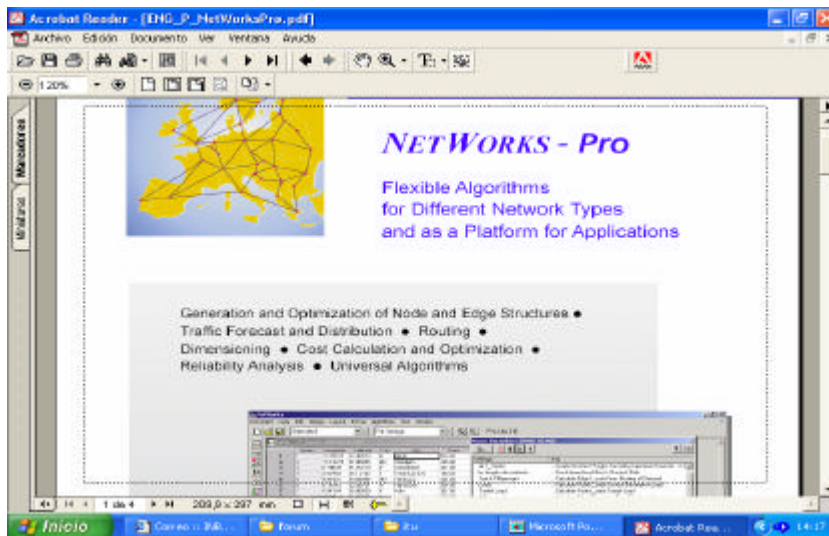
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# Network Planning Tools: NetWORKS



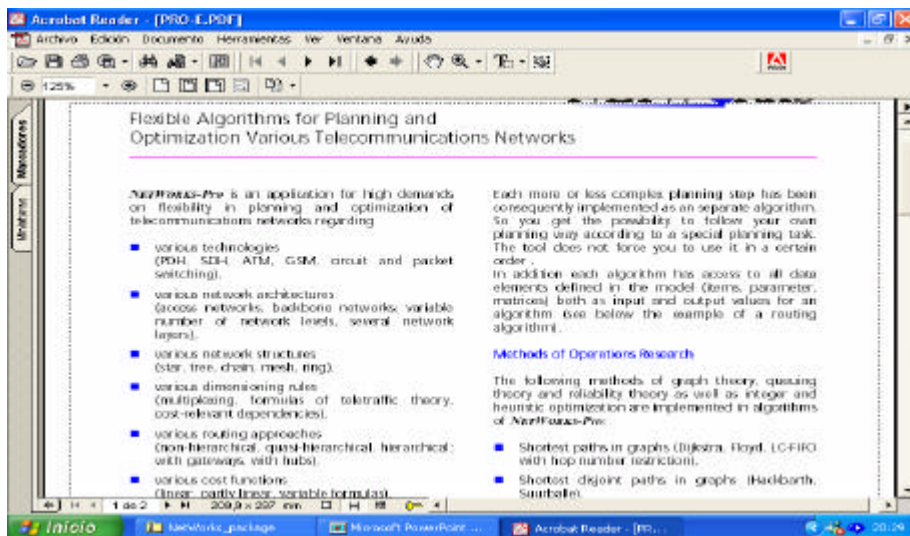
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# Network Planning Tools: NetWORKS



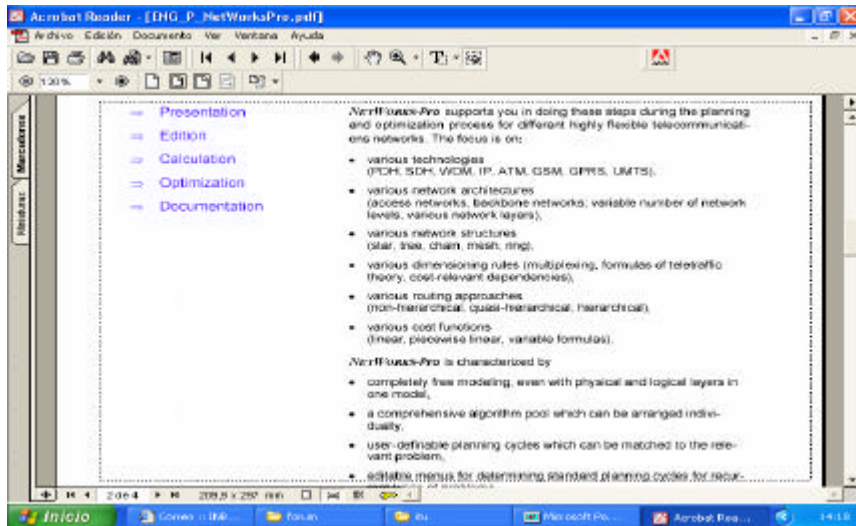
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# Network Planning Tools: NetWORKS



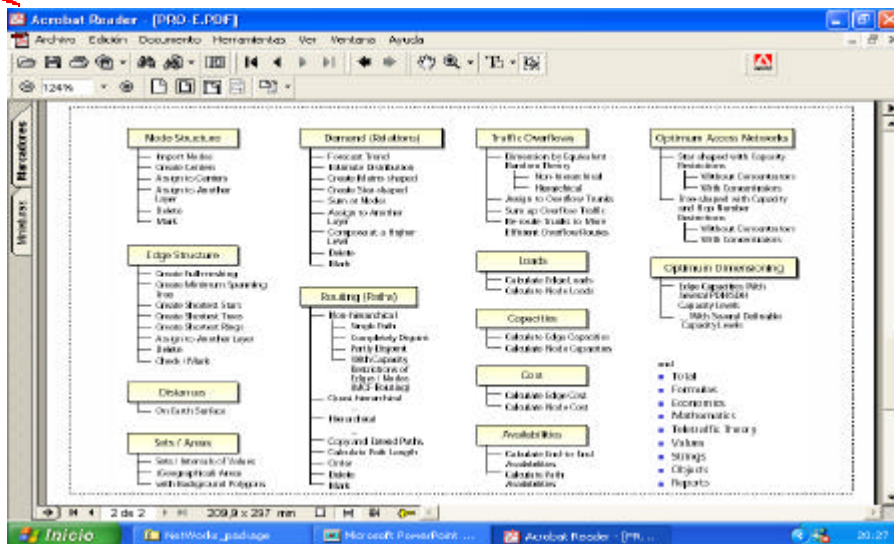
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# Network Planning Tools: NetWORKS



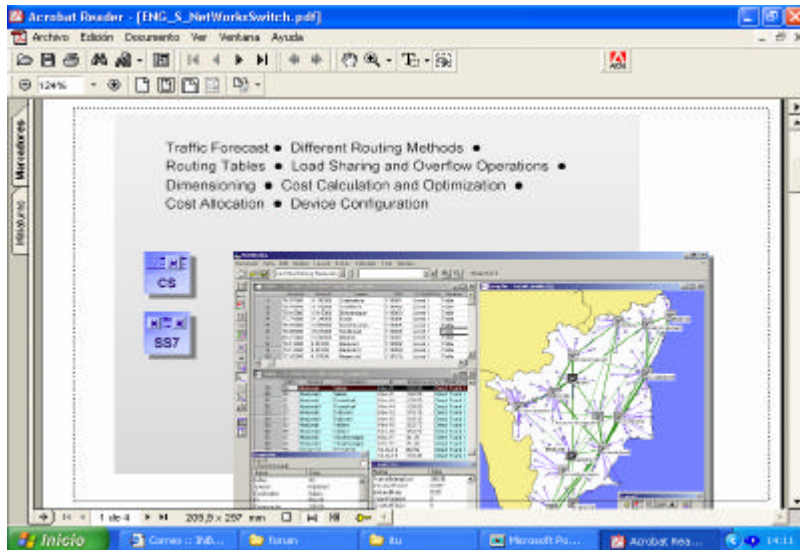
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## Network Planning Tools: NetWORKS



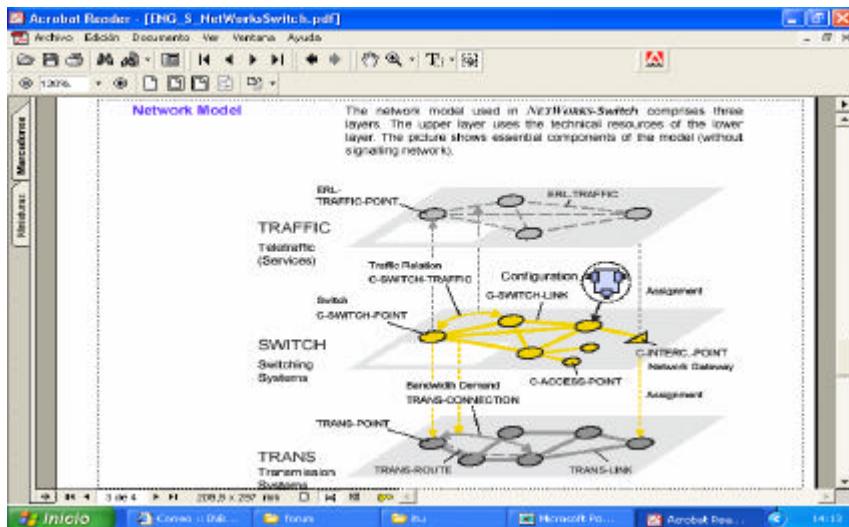
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## Network Planning Tools: NetWORKS



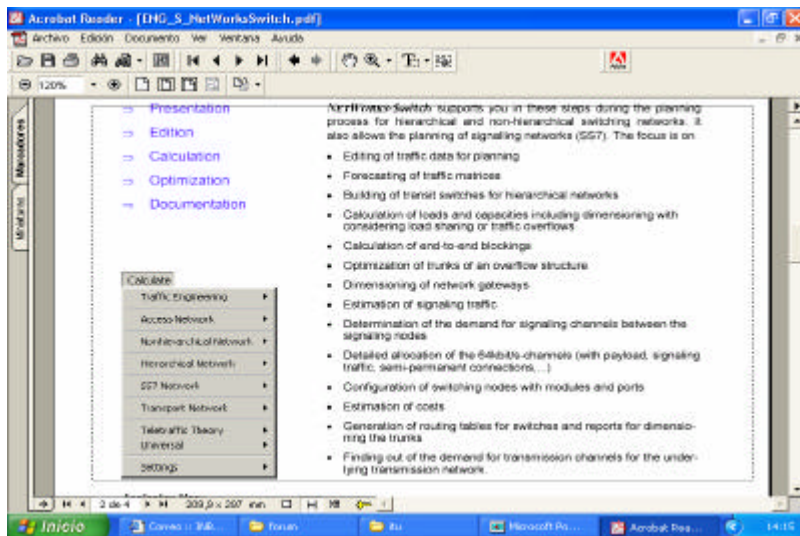
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# Network Planning Tools: NetWORKS



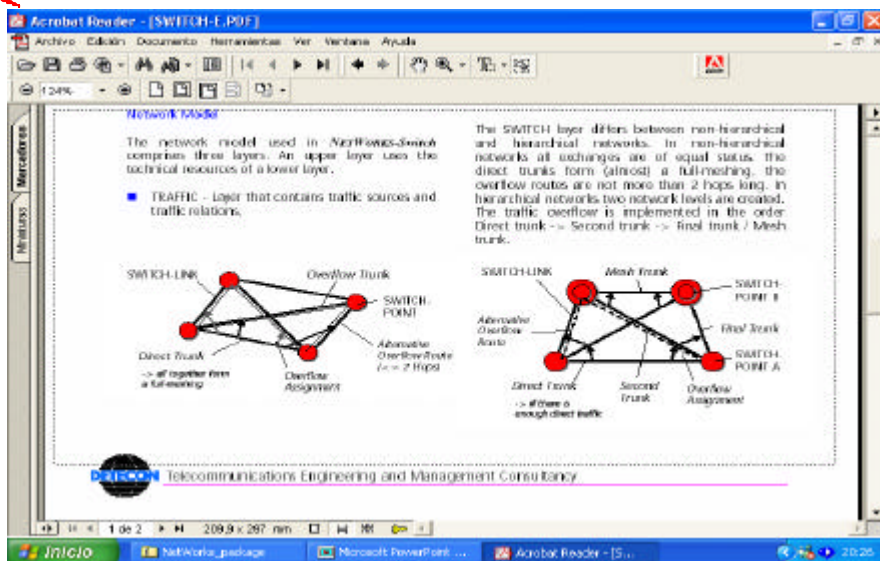
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# Network Planning Tools: NetWORKS



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# Network Planning Tools: NetWORKS

**Application Trans**

**NETWORKS**

Planning and Optimization of SDH and PDH Transmission Networks

NetFwaks-Trans is an application for specialists who are mainly confronted with PDH and SDH transport networks and who have to deal with complex problems regarding:

- Optimization of partly meshed and ring-like network structures.
- Consideration of a given infrastructure (fiber-optic cables, ducts).
- Routing of end-to-end connections by various criteria, with protection if required.
- Calculation of loads and capacities needed for protection facilities.
- Dimensioning of rings.

- **Design** - considering sites and links, demand (end-to-end relations), its path over sites and links, and the loads and capacities of sites and links (both cable points / links and duct points / links can be considered optionally)
- **Configuration** - considering devices, fibers/microwave channels, transmission systems at different mapping levels and splitted demand (end-to-end connections) and its path over devices and fibers / microwave channels

**Network Model**

The network model used in NetFwaks-Trans comprises three layers. An upper layer uses the technical resources of a lower layer.

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# Network Planning Tools: NetWORKS

**Application Trans**

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- **TRANS** - layer that contains devices, fibers,

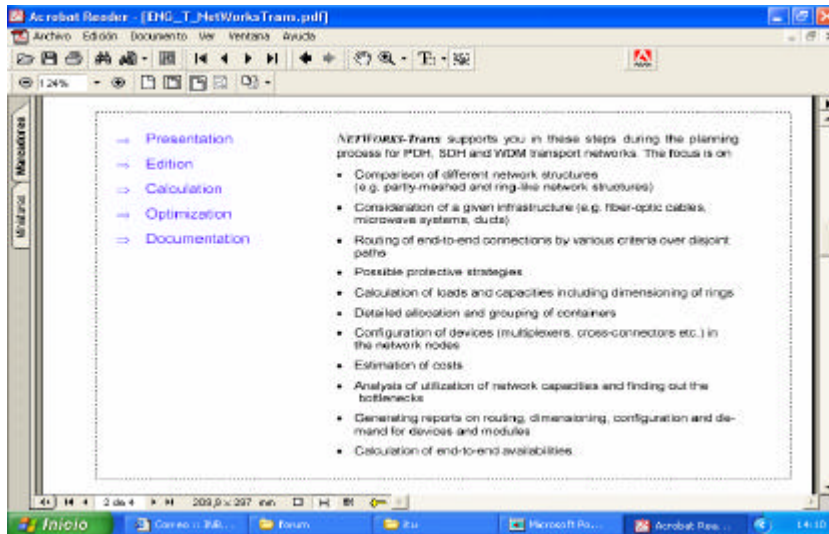
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# Network Planning Tools: NetWORKS



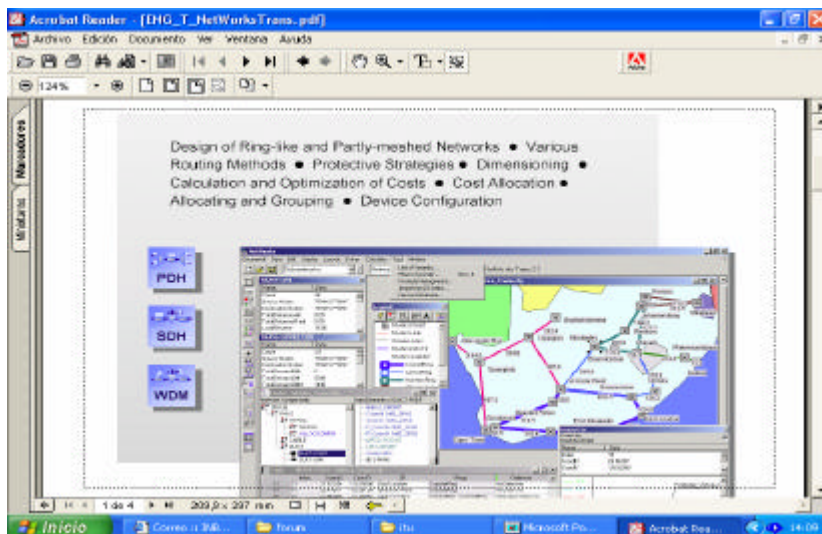
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# Network Planning Tools: NetWORKS



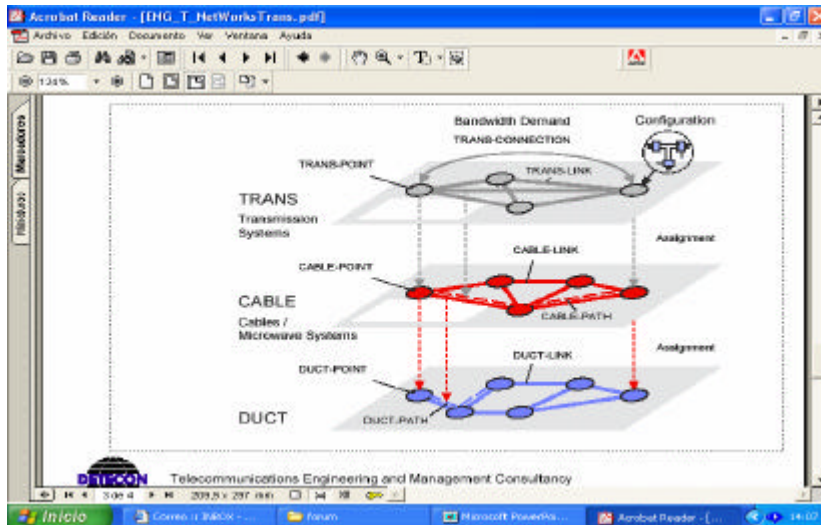
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## Network Planning Tools: NetWORKS



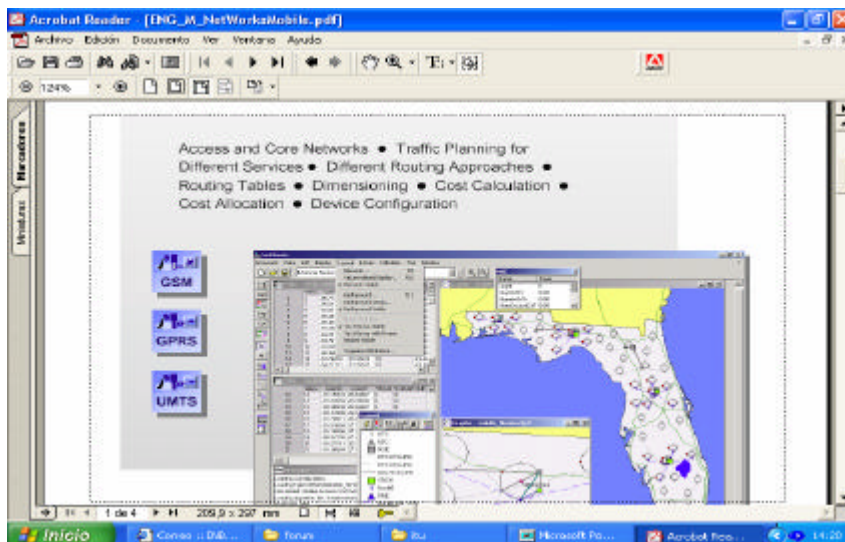
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## Network Planning Tools: NetWORKS



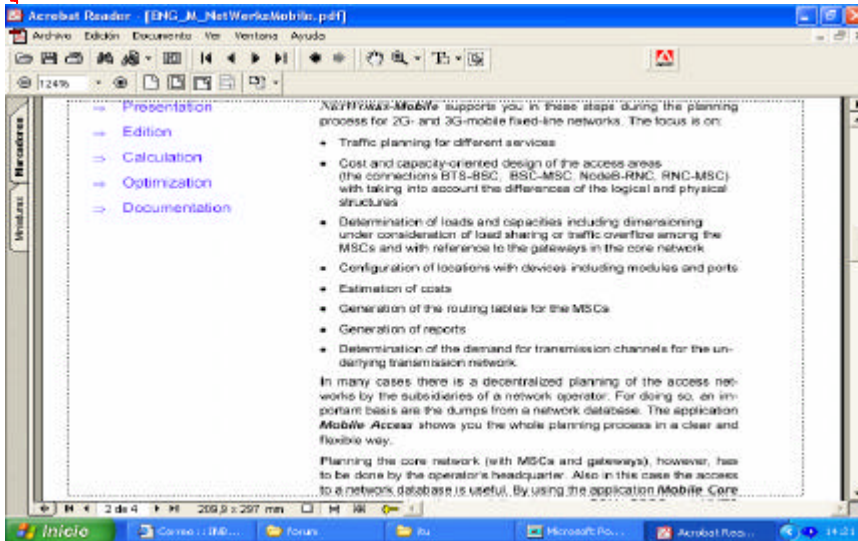
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# Network Planning Tools: NetWORKS



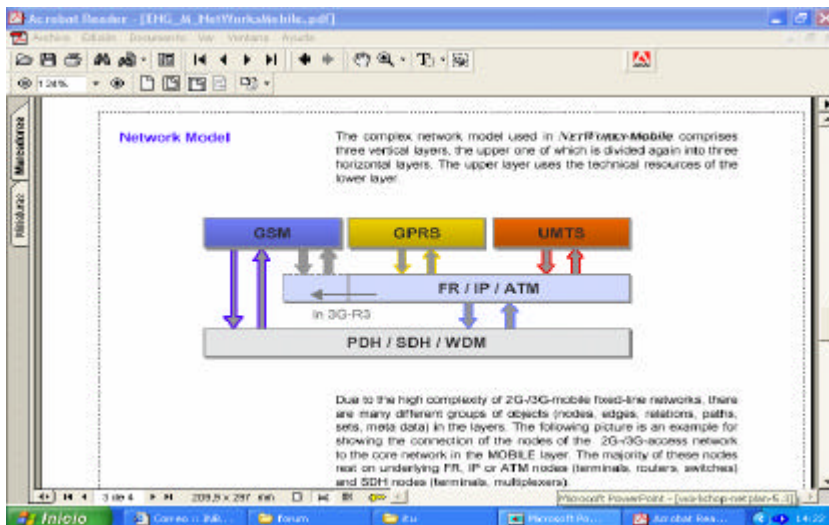
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# Network Planning Tools: NetWORKS



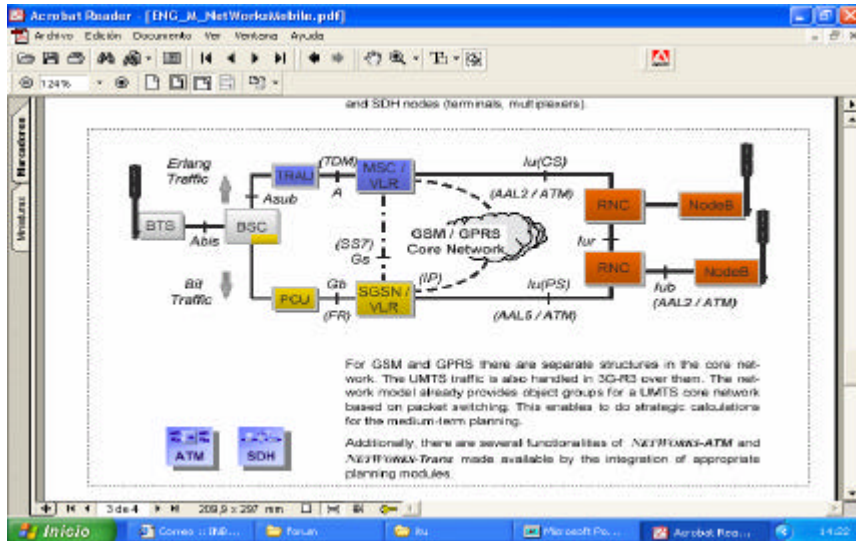
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# Network Planning Tools: NetWORKS



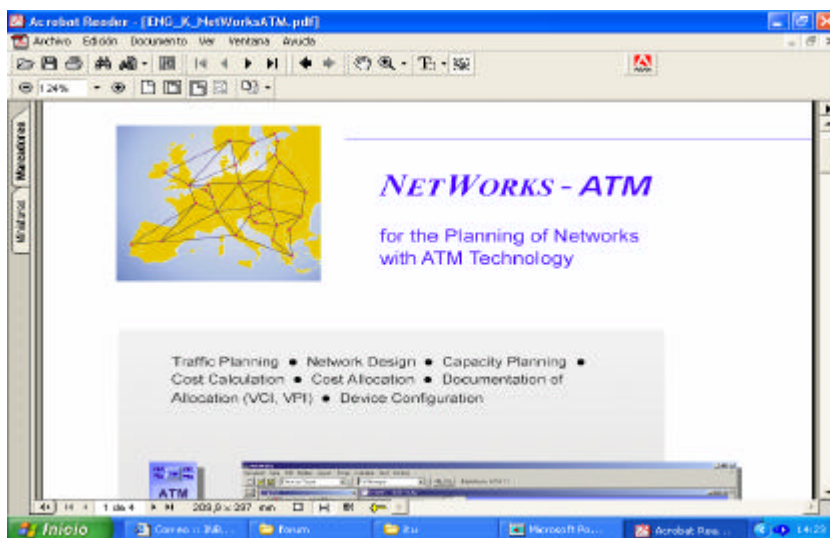
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# Network Planning Tools: NetWORKS



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Microanálisis

- Presentation
- Edition
- Calculation
- Optimization
- Documentation

NetWORKS-ATM supports you in doing these steps during the planning process for ATM technology networks. The focus is on

- Displaying different services needing an ATM and describing them with traffic parameters,
- Finding appropriate network topologies,
- Determining the required resources in case of a given QoS,
- Defining routing strategies, addressing schemes and network levels,
- Assigning identifiers for VC (virtual channels) and VP (Virtual Paths),
- Configuring the ATM network elements (switches).

**Network Model and Planning Ways**

The network model defines an ATM layer which can be related to adjacent layers. There are three phases of the planning process with NetWORKS-ATM:

Design

With taking into account the device locations, the transmission sect-

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# Network Planning Tools: NetWORKS

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Microanálisis

Bandwidth Demand to the ATM Transport Network

ATM

Bandwidth Demand to the ATM Transport Network

VC-DEMAND

VC-LINK

VP-DEMAND

VP-LINK

ATM-DEVICE-POINT

VC - virtual channel identifier

VP - virtual path identifier

TRANS

ATM-DEVICE-LINK

TRANS-CONNECTION

Bandwidth Demand to the PDH/SDH Transport Network

Device	Location	Device	Device Type	Device Class	Device Size	Device Cost
1	1	1	1	1	1	1
2	2	2	2	2	2	2
3	3	3	3	3	3	3
4	4	4	4	4	4	4
5	5	5	5	5	5	5
6	6	6	6	6	6	6
7	7	7	7	7	7	7
8	8	8	8	8	8	8
9	9	9	9	9	9	9
10	10	10	10	10	10	10

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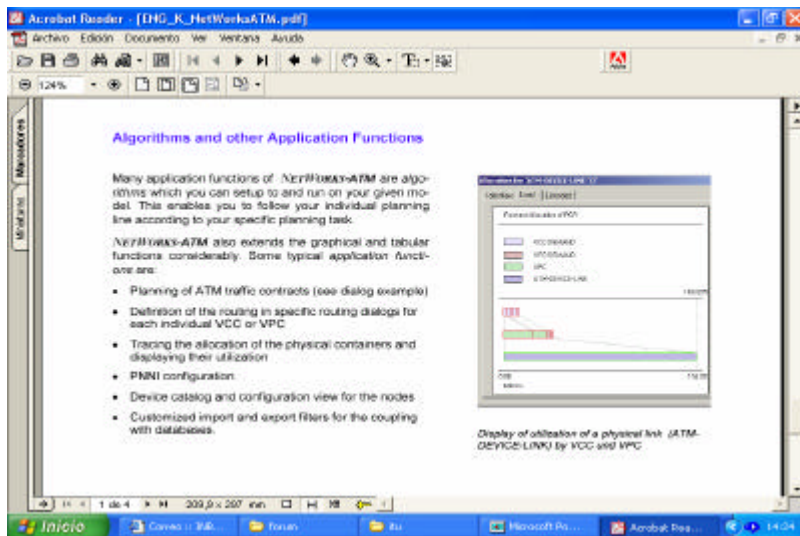
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# Network Planning Tools: NetWORKS



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# Network Planning Tools: NetQuad

Telecom  
Network  
Planning



**Objective :** NetQuad is a Telecom network planning tool to design, optimize and dimension several network layers as: PSTN, Transmission, ATM, IP

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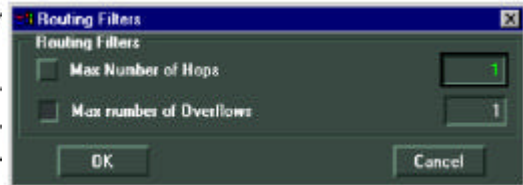
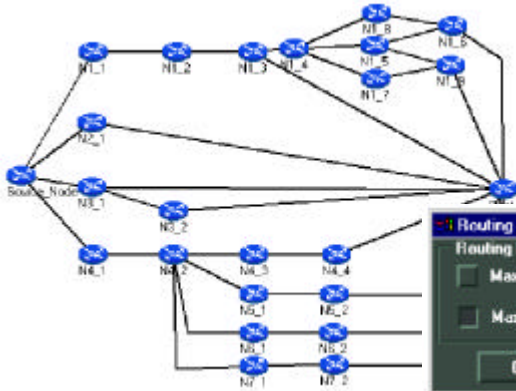
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# Network Planning Tools: NetQuad Telephony

- Local/transit exchanges
- Traffic point to point (import for more complex affinity method)
- Routing can be computed or forced



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# Network Planning Tools: NetQuad Telephony Results

**Routing Table**

Node Name	Traffic Source	Traffic Destination	Route Number	Traffic Type	Next Node Name	Share	Next Node Name	Share	Next Node Name	Share
Source_Node	Source_Node	Dest_Node	T1	1	N2_1	0.50	N3_1	0.50		
Source_Node	Source_Node	Dest_Node	T1	2	N1_1	1.00				
N1_1	Source_Node	Dest_Node	T1	1	N1_2	1.00				
N1_2	Source_Node	Dest_Node	T1	1	N1_3	1.00				
N2_1	Dest_Node	Source_Node	T1	1	Source_Node	1.00				
N2_1	Source_Node	Dest_Node	T1	1	Dest_Node	1.00				
N3_1	Dest_Node	Source_Node	T1	1	Source_Node	1.00				
N3_1	Source_Node	Dest_Node	T1	1	Dest_Node	1.00				
N3_1	Source_Node	Dest_Node	T1	2	N3_2	1.00				
N3_2	Dest_Node	Source_Node	T1	1	N3_1	1.00				
N3_2	Source_Node	Dest_Node	T1	1	Dest_Node	1.00				
N1_3	Source_Node	Dest_Node	T1	1	Dest_Node	1.00				
N1_3	Source_Node	Dest_Node	T1	2	N1_4	1.00				
N1_4	Source_Node	Dest_Node	T1	1	N1_3	1.00				
N1_4	Source_Node	Dest_Node	T1	2	N1_5	0.33	N1_8	0.33	N1_7	0.33
N1_8	Source_Node	Dest_Node	T1	1	N1_8	1.00				
N1_5	Source_Node	Dest_Node	T1	1	N1_8	0.50	N1_9	0.50		
N1_7	Source_Node	Dest_Node	T1	1	N1_9	1.00				
N1_6	Source_Node	Dest_Node	T1	1	Dest_Node	1.00				

- Lists for routes
  - Load-sharing
  - Overflow...

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## Network Planning Tools: NetQuad Telephony Results

- PCM can be 24,30 or 31 circuits size
- Cartographic view with colours
- End to end loss as a result
- No failure simulation available

Trunk's sizing report

Source.Site	Source.Node	Dest.Site	Dest.Node	Trunk	Min.Number.of.Circuits	Number.of.Circuits
top	Source_Node	top	N1_1	Source_Node_N1_1	0	0
top	Source_Node	top	N2_1	Source_Node_N2_1	42	62
top	Source_Node	top	N3_1	Source_Node_N3_1	42	62
top	Source_Node	top	N4_1	Source_Node_N4_1	0	0
top	N1_1	top	N1_2	N1_1_N1_2	0	0
top	N1_2	top	N1_3	N1_2_N1_3	0	0
top	N2_1	top	Dest_Node	N2_1_Dest_Node	42	62
top	N3_1	top	N3_2	N3_1_N3_2	0	0
top	N3_1	top	Dest_Node	N3_1_Dest_Node	42	62
top	N4_1	top	N4_2	N4_1_N4_2	0	0

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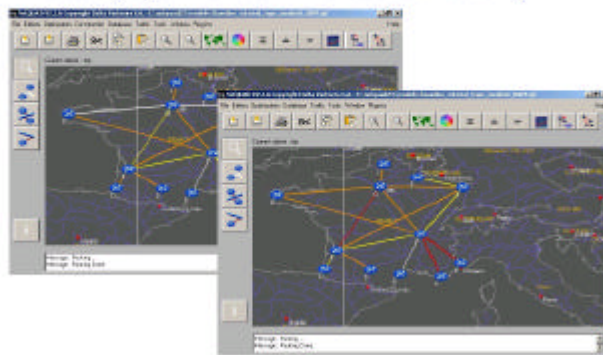


## Network Planning Tools: NetQuad IP



April 2008: M-CP-CP-1-S-FQ/IMP  
Copyright 1999-2000 DELTA Partners SA

### Routing (ex : Nombre Minimal de Sauts vs. OSPF)



HIGH TECHNOLOGY FOR TELECOMMUNICATION AND DISTRIBUTED SYSTEMS

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# Network Planning Tools: NetQuad

## IP



- Nodes types and links can be declared as fixed or can be changed on bandwidth needs
- Equipment library to be done

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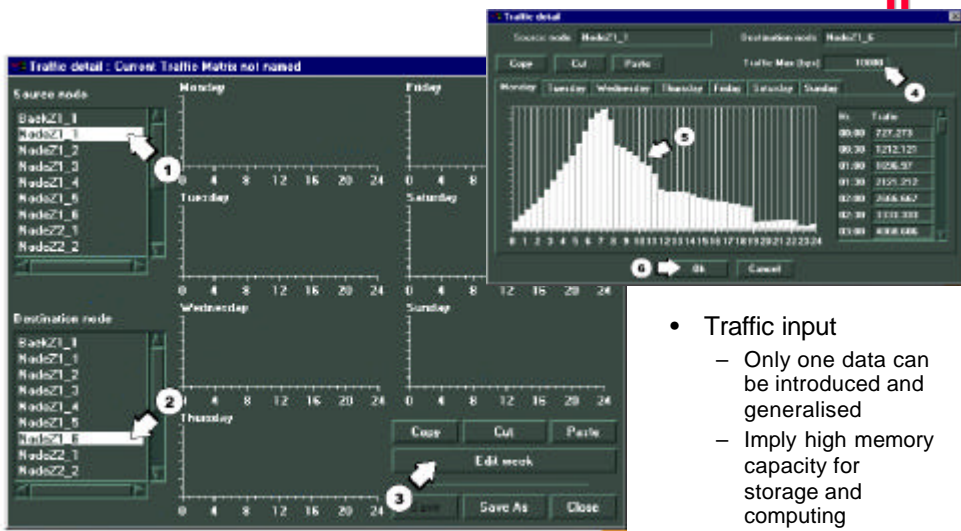
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# Network Planning Tools: NetQuad

## IP



- Traffic input
  - Only one data can be introduced and generalised
  - Imply high memory capacity for storage and computing

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# Network Planning Tools: NetQuad IP Results

The screenshot displays two windows from the NetQuad software. The 'Route Window' shows a table of routes with columns for 'Route Hop', 'Route Hop', 'Route Hop', 'Route Hop', and 'Route'. The 'Dynamic Addressing' window shows a table with columns for 'Attribute Name', 'Unit', 'OSPF Zone', 'OSPF Metric', 'Required Bandwidth', 'Allocated Bandwidth', and 'Usage Type'.

Attribute Name	Unit	OSPF Zone	OSPF Metric	Required Bandwidth	Allocated Bandwidth	Usage Type
Default Value	Link type	0	1 000000	0 000000	0 000000	opt/Up
Back21_1_Back21_3	Link type	1	1	4 000 05802	4 000	opt/Up
Back21_1_Back21_2	Link type	1	1	5 000 33 094	4 000	opt/Up
Back21_2_Back21_1	Link type	0	1	3 000	3 000	opt/Up
Back21_2_Back21_3	Link type	1	1	0	0	opt/Up
Back22_1_Back21_1	Link type	0	1	3 000	3 000	opt/Up
Back21_1_Back21_2	Link type	3	1	3 000	4 000	opt/Up
Web21_1_Back21_2	Link type	1	1	4 000 05802	4 000	opt/Up
Web21_1_Back21_4	Link type	1	2	0	0	opt/Up
Web21_2_Back21_1	Link type	1	1	4 000 05802	4 000	opt/Up
Web21_3_Back21_3	Link type	1	1	4 000 05802	4 000	opt/Up
Web21_4_Back21_1	Link type	1	1	0	0	opt/Up
Web21_5_Back21_0	Link type	1	1	0	0	opt/Up
Web21_0_Back21_2	Link type	1	1	5 000 11 045	4 000	opt/Up
Web21_1_Back21_2	Link type	1	1	5 000 33 094	4 000	opt/Up
Web22_1_Back21_1	Link type	3	1	0	0	opt/Up

- Lists for routes and loads
- Failure simulation under Netquad basic module

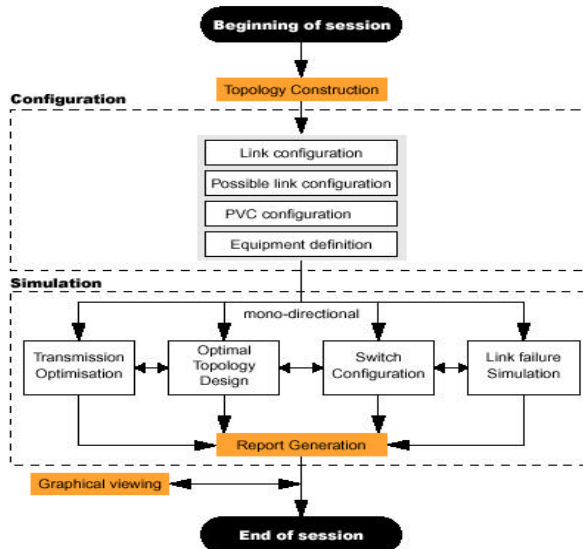
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# Network Planning Tools: NetQuad ATM



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# Network Planning Tools: NetQuad ATM



- Traffic per PVC basis can include PCR, SCR, UBR types...
- Equipment library to be done

ATM Traffic Data

Unit: tps

	PCR_0	PCR_01	SCR_0	SCR_01	MBS_0	MBS_01	MCR_0	MCR_01	Tagg
Forward	0	700k	0	0	0	0	0	0	No
Backward	0	0	0	0	0	0	0	0	No

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# Network Planning Tools: NetQuad ATM Results

Report Window

File Tools Help

Generate Report for TRUNK UTILIZATION INFORMATION:

Site of Material | Trunk Util. Info | Link Information | Routing Information | Unrouted PVCs

Link Name	Src Site/Src Switch	Dest Site/Dest Switch	Dist Switch Traffic Conn	Load T. (B)	Load T. (M)	Load T.
Node_1_Node_2	Subnet_1/Node_1	Subnet_1/Node_2	-:0:	75.00	0	
Node_1_Node_3	Subnet_1/Node_1	Subnet_1/Node_3	No traffic defined	0	0	
Node_1_Node_5	Subnet_1/Node_1	Subnet_3/Node_5	No traffic defined	0	0	
OTDLink_105	External/Node_1	External/Node_5		0	0	

Site of Material | Trunk Util. Info | Link Information | Routing Information | Unrouted PVCs

Link Name	Src Site/Src Switch	Dest Site/Dest Switch	Bandwidth	Extra Cost	Cost/Month	Cost/Year	Cost/Year
Node_1_Node_2	Subnet_1/Node_1	Subnet_1/Node_2	T1	0	4086530	4903230	58838760
OTDLink_105	Subnet_1/Node_1	Subnet_3/Node_5	E3	0	10326200	123914400	1486972800
Node_2_Node_3	Subnet_1/Node_2	Subnet_1/Node_3	T1	0	3362002	4034400	48412800
Node_3_Node_4	Subnet_1/Node_3	Subnet_1/Node_4	T1	0	4454392	5345280	64143360
<b>Total cost</b>					<b>22994250</b>	<b>277792800</b>	<b>3344736000</b>

- Trunk utilisation and price

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# Network Planning Tools: NetQuad ATM Results

Generated Report for ROUTED PVCs:

Name	Src SNA/Svc Switch	Dest SNA/Svc Switch	Traffic	ConnID	RateID	QoS	Number	Link Name Src Svc Dest
PVC_1	Subnet_1/Node_1	Subnet_1/Node_4	ATM	CBR	T1	1	1	
PVC_6	Subnet_1/Node_1	Subnet_2/Node_5	ATM	CBR	T1	1	2	

Generated Report for UNROUTED PVCs:

Name	Src SNA/Svc Switch	Dest SNA/Svc Switch	Traffic	ConnID	RateID	QoS	Number	Comment
PVC_2	Subnet_1/Node_1	Sub_1/Node_6	ATM	CBR	T1	1	1	Too Much Failed

- Detailed routing or unrouted PVCs
  - New routing to be applied by the user or less constraint on the link size and node load
- Failure simulation available

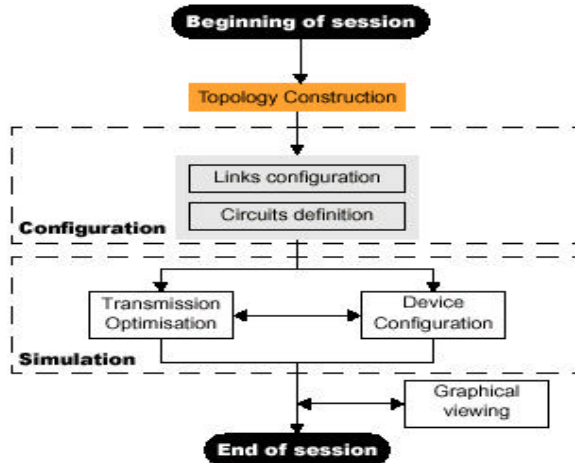
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# Network Planning Tools: NetQuad SDH



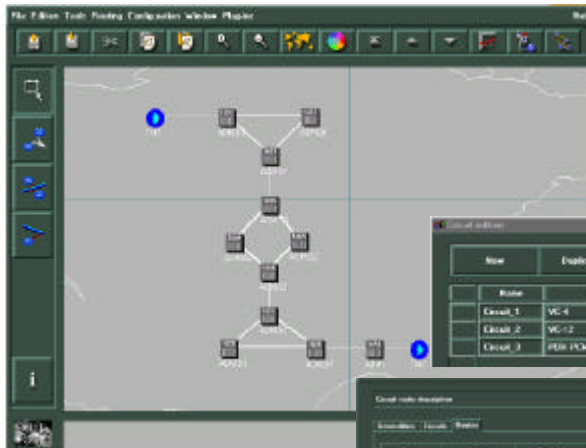
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# Network Planning Tools: NetQuad SDH



- Distances based on Long/Lat co-ordinates
- Point to point traffic definition
- Manual definition of rings and ring size
- Equipment library to be done

Name	Equipment	Dirct	From port	Insert	Export
Circuit_1	VC-4	ADM11	ADM12	1	3 VC-12
Circuit_2	VC-12	ADM11	ADM1	1	3 VC-12
Circuit_3	PCM 64Kbps	DM1	DM2	1	3 64Kbps

Name	Type	Reflex	Reflex	Reflex	Reflex	Reflex	Reflex
Circuit_101	Receivable side	ADM12_ADM11	ADM12_ADM11				
Circuit_101	Transmit side	ADM12_ADM11	ADM12_ADM11				
Circuit_101	Receivable side	ADM11_ADM11	ADM11_ADM11	Circuit_101	ADM11_ADM11	ADM11_ADM11	ADM11_ADM11
Circuit_101	Receivable side	ADM11_ADM11	Circuit_101	ADM11_ADM11			

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# Network Planning Tools: NetQuad SDH Results

Name	Type	A End	B End	Total Bandwidth	Remaining Bandwidth	Cost
ADM12_ADM12	STM-16	ADM12/11225	ADM12/11225	1008 VC-12	402 VC-12	1
ADM12_ADM12	STM-16	ADM12/11225	ADM12/11225	1008 VC-12	402 VC-12	1
ADM12_ADM12	STM-16	ADM12/11225	ADM12/11225	1008 VC-12	345 VC-12	1
ADM12_ADM12	STM-16	ADM12/11225	ADM12/11225	1008 VC-12	345 VC-12	1
ADM11_ADM11	STM-4	ADM11/11225	ADM11/11225	252 VC-12	252 VC-12	1
ADM11_ADM11	STM-4	ADM11/11225	ADM11/11225	252 VC-12	252 VC-12	1
ADM11_ADM11	STM-4	ADM11/11225	ADM11/11225	252 VC-12	252 VC-12	1
ADM11_ADM11	STM-4	ADM11/11225	ADM11/11225	252 VC-12	252 VC-12	1
ADM11_ADM11	STM-4	ADM11/11225	ADM11/11225	252 VC-12	252 VC-12	1
ADM11_ADM11	STM-4	ADM11/11225	ADM11/11225	252 VC-12	252 VC-12	1
ADM11_ADM11	STM-4	ADM11/11225	ADM11/11225	252 VC-12	252 VC-12	1
ADM11_ADM11	STM-1	ADM11/11225	ADM11/11225	63 VC-12	63 VC-12	1
ADM11_ADM11	STM-1	ADM11/11225	ADM11/11225	63 VC-12	63 VC-12	1



- All point to point routes and available bandwidth
- Precise definition of equipment library can be done under Script (modifying existing models)

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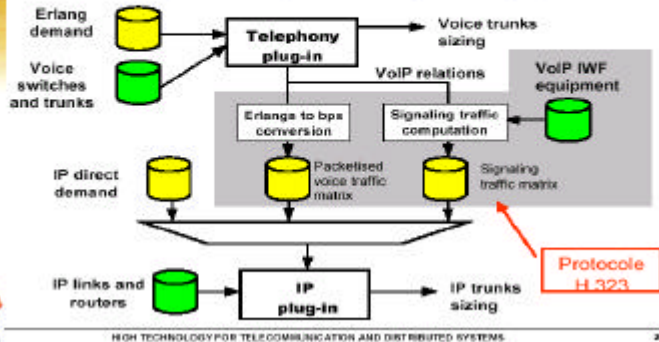
# Network Planning Tools: NetQuad VoIP



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## Routeage multi-niveaux (suite)

Comment ça marche (Voix sur RIP, par exemple) ?



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33

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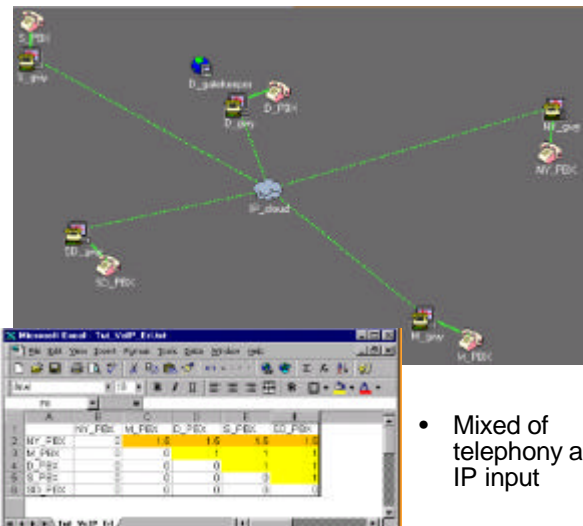
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# Network Planning Tools: NetQuad VoIP

Seattle\_Denver [ Seattle - Denver ]  
Name: Seattle\_Denver [ Complete ]  
Node 1: Seattle [ Country: UNITED\_STA ]  
Node 2: Denver [ Country: UNITED\_STA ]  
Length (Fm): 1638.46 [ Update ]  
In Order: F  
Model: RipLink [ Custom ]  
Operator: US\_carrier [ ]  
Service: LL\_T1 [ ]  
DataRate (bit): 1544000  
Delay (s): 0  
CompressionRate: 1  
File Load (T): 0  
Weight: 0  
Link Type: SL  
[ Cancel ] [ Lock Operator ] [ Topology level ]  
[ Ok ] [ Cancel ]



- Mixed of telephony and IP input

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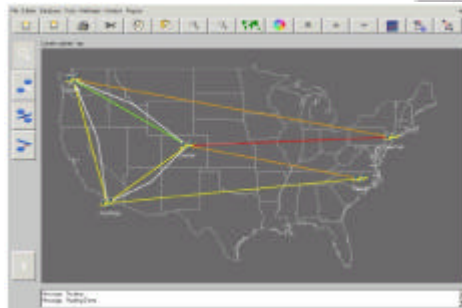
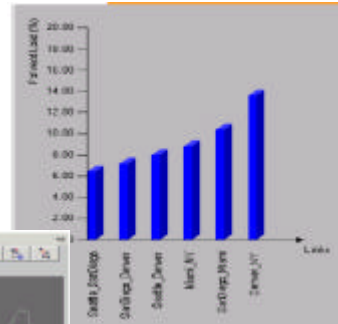
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# Network Planning Tools: NetQuad VoIP



- Mixed of results using IP routing laws



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# Network Planning Tools: NetQuad Script

## Exemple de script Positionnement de routeurs OSPF



```
inc 1, world, worldnumbers;
string node1;
string site[10];
double X_Pos[10], Y_Pos[10];

hq_topology France_Net;
hq_node hqnode;
hq_geoSubinet hq_geo;

NodeNumber = 11;
Hq_Geol = hq_SearchGeoSubnetByName("top");
node1 = "ospfnode1";
for (i=0; i<NodeNumber; i = i+1)
{
  hqnode = hq_NewNode ( France_Net, Hq_Geol, site[i], node1, X_Pos[i], Y_Pos[i]);
  hqnode.country = "FRANCE";
  hqnode.site = site[i];
}
world = hq_refreshTopology 0;
```

- Based on C language
- Includes all attributes of the objects that can be found and enhanced in Netquad



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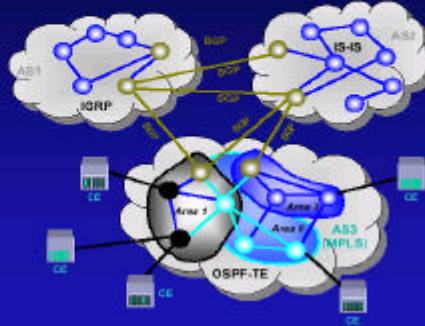


## Dimensioning tool Netquad MPLS Phase 1



### NetQUAD: Outil Général pour Réseaux IP

- Les systèmes Autonomes
- Protocole BGP4 pour un nombre d'AS quelconque
- Plusieurs protocoles IGP
- Traitement des zones dans OSPF
- MPLS avec OSPF-TE ou IS-IS-TE
- Domaines DiffServ
- Calcul des tables de routage IP
- Traitement simultané du routage IP et des LSP
- Propagation des trafics
- Trace précise des flux de bout en bout, par classe de service, sur une interface ...



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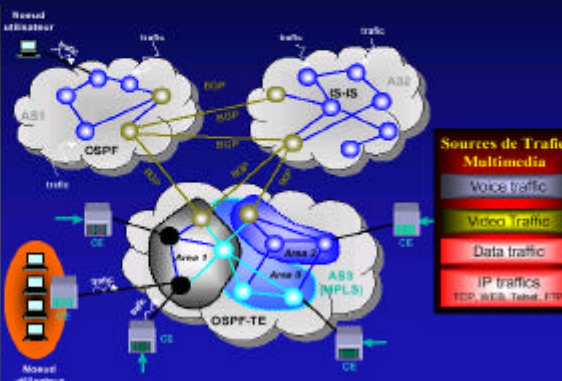


## Dimensioning tool Netquad MPLS Phase 2



### NetQUAD: Modélisation Précise des Performances

- Théorie du trafic différentiel
- Simulation Hybride
- Flux non Poissoniens, trafics TCP ...
- Evaluation précise des délais et des pertes dans chaque « device » du réseau
- Evaluation des performances de bout en bout et en cœur de réseau
- Routeurs DiffServ (Policy, shaping, priority queuing, WFQ ...)



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