Note de Laborator
Retele de calculatoare

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Laborator 6

1. Obiective:

- Metoda VLSM – Aplicatii
- Classless Interdomain Routing (CIDR) - Aplicatii
- Utilitarul route (MS Windows …& Linux!)
- Aplicatii IP (**Riverbed Modeler Academic Edition** – mediu de simulare a retelelor de calculatoare (**Varianta: OMNeT++** Network Simulation Framework http://www.omnetpp.org /)
- Aplicatii de retea in **Python**

2. Consideratii teoretice (Indicatii:C_01-C_05;Partea practica:pag.9; Tema:pag.35)

2.1. VLSM (Variable Length Subnet Mask)

Mastile de retea de lungime variabila VLSM (Variable Length Subnet Masks) sunt utilizate pentru alocarea eficienta a spatiului de adrese IP atribuit unei organizatii si agregarea rutelor, cantitatea de informatii de rutare fiind astfel redusa semnificativ. VLSM este definit in RFC 1009 http://www.rfc-editor.org/rfc/rfc1009.txt .

Atunci cand se utilizeaza o singura masca de subretea, reteaua respectiva poate fi partitionata numai in subretele de dimensiune egala. De exemplu, daca aplicam masca de subretea /22 retelei 130.5.0.0/16 vom obtine un numar de 2^6 subretele, fiecare avand 1022 de gazde – usable (valide) hosts (2^{10}-2).
Obs: SubNetID corespunde nr. de pozitii imprumutate (notat cu *nrbi*) din HostID-ul initial

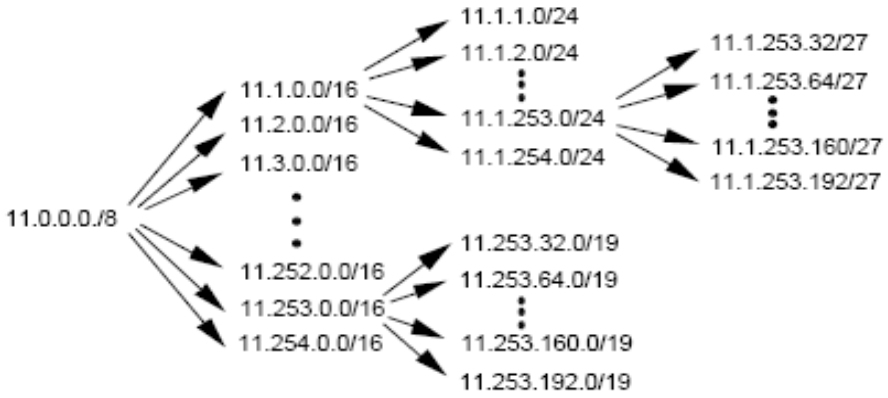
130.5.0.0/22 = 10000010.00000101. 000000 00.00000000
NetID SubNetID HostID

/22: 11111111111111111111110000000000 => 255.255.252.0

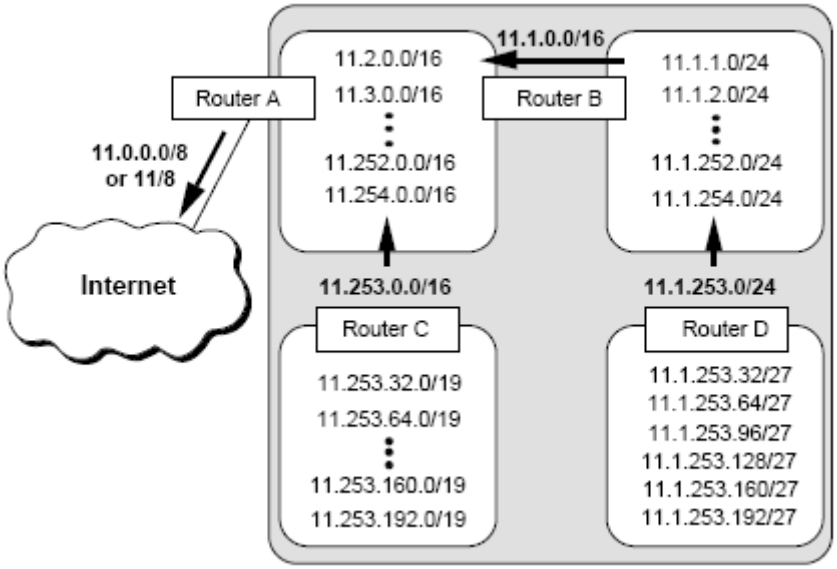
Daca organizatia are nevoie de subretele cu doar 20 de gazde, utilizarea unei singure masti de subretea conduce la irosirea a 1000 de adrese IP valide pentru fiecare subretea !!!!!!!!. **O solutie** la aceasta problema este folosirea mastilor de retea de dimensiune variabila. Daca in exemplul precedent definim si o masca de subretea /26, atunci putem realiza 1024 de subretele cu cate 62 de (usable/valide) gazde fiecare.

2.1.1 Agregarea rutelor

VLSM permite subalocarea recursiva a spatiului de adrese IP atribuit unei organizatii, asftel incat rutele pot fi agreagate, pentru a reduce informatia de rutare de pe ultimul nivel. Din punct de vedere conceptual, o retea este mai intai partitionata in subretele, o parte din subretele sunt partitionate in sub-subretele, s.a.m.d.



Reducerea informatiei de rutare prin agregarea rutelor este ilustrata in figura de mai jos.



Router-ul D poate agrega cele sase subretele aflate in spatele sau printr-un singur mesaj (11.1.253.0/24). In aceasi maniera, Router-ul B rezuma cele sase subretele aflate in spatele sau printr-un singur mesaj(11.253.0.0/16). Deoarece structura retelei organizatiei nu este vizibila in exterior, Router-ul A face publica o singura ruta in Internet (11.0.0.0/8).

Cerinte pentru implementarea VLSM

- Protocolul de rutare utilizat trebuie sa suporte prefixul de retea extins (NetID+SubNetID)
- Toate ruterele trebuie sa suporte un algoritm de rutare care implementeaza dirijarea bazata pe “cel mai lung prefix de retea” – longest match
- Pentru agregarea rutelor, adresele trebuie asignate astfel incat sa respecte topologia retelei.

Pentru a implementa VLSM trebuie folosit un protocol de routare care suporta aceasta tehnologie: RIP-2, OSPF, IS-IS. Protocolul RIP-1 nu suporta utilizarea mastilor de retea de lungime variabila.

Longest match:

Atunci cand adresa IP destinatie a unui pachet este 11.1.2.5 si exista trei intrari diferite in tabela de rutare (11.1.2.0/24, 11.1.0.0/16 si 11.0.0.0/8), routerul va selecta 11.1.2.0/24, deoareca aceasta are cel mai lung prefix de retea care se potriveste adresa IP (*longest match*).

```
Destinatie      11.1.2.5 = 00001011.00000001.00000010.00000101

Ruta #1      11.1.0.0/16 = 00001011.00000001.00000000.00000000  ExitIntf_03
Ruta #2      11.1.2.0/24 = 00001011.00000001.00000010.00000000  ExitIntf_04
Ruta #3       11.0.0.0/8 = 00001011.00000000.00000000.00000000  ExitIntf_00
```

Datorita comportamentului algoritmului de rutare, gazda 11.1.2.5 trebuie sa fie atasata numai la subreteaua 11.1.2.0/24 (Ruta #2), in caz contrar traficul nu va ajunge la destinatie.

2. 2. CIDR

CIDR (Classless Inter-Domain Routing) este documentat in RFC 1517, 1518, 1519 si 1520. Principalele caracteristici CIDR sunt:

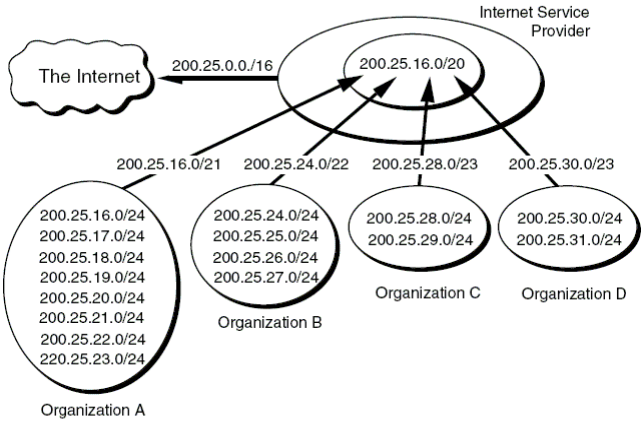
- Elimina conceptele traditionale de adrese de clasa A, B sau C, permitand alocarea eficienta a spatiului de adrese IP.
- Suporta agregarea rutelor, astfel incat o singura intrare in tabela de rutare poate reprezenta un spatiu de adrese echivalent cu cateva mii de rute traditionale (classful).

CIDR elimina conceptul de clase de adrese, si il inlocuieste cu prefixul de retea. Routerele folosesc prefixul de retea, si nu primii 3 biti ai unei adrese IP (cum se intampla in cazul rutarii classful) atunci cand iau decizii de rutare. Ca urmare, CIDR permite implementarea unor retele de dimensiuni variabile. Un preix de retea poate fi atribuit unei adrese oarecare (clasa A, B sau C), numarul de gazde pentru fiecare retea fiind identic. In exemplul de mai jos, fiecare retea suporta 4096 de gazde.

```
Clasa A      10.23.64.0/20      00001010.00010111.01000000.00000000
Clasa B       130.5.0.0/20      10000010.00000101.00000000.00000000
Clasa C    200.7.128.0/20       11001000.00000111.10000000.00000000
```

Blocuri de adrese CIDR (extras)

prefix CIDR	Notatie cu punct zecimal	Nr. de gazde	Nr. de adrese IP traditionale
/0 - /12	……..	……	……..
/13	255.248.0.0	512 K	8 B si 2048 C
/14	255.252.0.0	256 K	4 B si 1024 C
/15	255.254.0.0	128 K	2 B si 512 C
/16	255.255.0.0	64 K	1 B si 256 C
/17	255.255.128.0	32 K	128 C
/18	255.255.192.0	16 K	64 C
/19	255.255.224.0	8 K	32 C
/20	255.255.240.0	4 K	16 C
/21	255.255.248.0	2 K	8 C
/22	255.255.252.0	1 K	4 C
/23	255.255.254.0	512	2 C
/24	255.255.255.0	256	1 C
/25	255.255.255.128	128	1/2 C
/26	255.255.255.192	64	1/4 C
/27	255.255.255.224	32	1/8 C
/28 - /32	……	…….	……..



CIDR Reduces the Size of Internet Routing Tables

2.1. Utilitarul route (Windows/ Linux)

Route – folosit in linie de comanda – permite vizualizarea si modificarea intrarilor in tabela de rutare locala (start→run → cmd→route ?)

```
D:\WINDOWS\system32\cmd.exe
Manipulates network routing tables.

ROUTE [-f] [-p] [command [destination]
                  [MASK netmask]  [gateway] [METRIC metric]  [IF interface]

  -f            Clears the routing tables of all gateway entries.  If this is
                used in conjunction with one of the commands, the tables are
                cleared prior to running the command.
  -p            When used with the ADD command, makes a route persistent across
                boots of the system. By default, routes are not preserved
                when the system is restarted. Ignored for all other commands,
                which always affect the appropriate persistent routes. This
                option is not supported in Windows 95.
  command       One of these:
                  PRINT     Prints  a route
                  ADD       Adds    a route
                  DELETE    Deletes a route
                  CHANGE    Modifies an existing route
  destination   Specifies the host.
  MASK          Specifies that the next parameter is the 'netmask' value.
  netmask       Specifies a subnet mask value for this route entry.
                If not specified, it defaults to 255.255.255.255.
  gateway       Specifies gateway.
  interface     the interface number for the specified route.
  METRIC        specifies the metric, ie. cost for the destination.

All symbolic names used for destination are looked up in the network database
file NETWORKS. The symbolic names for gateway are looked up in the host name
database file HOSTS.

If the command is PRINT or DELETE. Destination or gateway can be a wildcard,
(wildcard is specified as a star '*'), or the gateway argument may be omitted.

If Dest contains a * or ?, it is treated as a shell pattern, and only
matching destination routes are printed. The '*' matches any string,
and '?' matches any one char. Examples: 157.*.1, 157.*, 127.*, *224*.
Diagnostic Notes:
    Invalid MASK generates an error, that is when (DEST & MASK) != DEST.
    Example> route ADD 157.0.0.0 MASK 155.0.0.0 157.55.80.1 IF 1
             The route addition failed: The specified mask parameter is invalid.
 (Destination & Mask) != Destination.

Examples:

    > route PRINT
    > route ADD 157.0.0.0 MASK 255.0.0.0  157.55.80.1 METRIC 3 IF 2
              destination^      ^mask      ^gateway     metric^    ^
                                                        Interface^
      If IF is not given, it tries to find the best interface for a given
      gateway.
    > route PRINT
    > route PRINT 157*                .... Only prints those matching 157*
    > route CHANGE 157.0.0.0 MASK 255.0.0.0 157.55.80.5 METRIC 2 IF 2

      CHANGE is used to modify gateway and/or metric only.
    > route PRINT
    > route DELETE 157.0.0.0
    > route PRINT
```

- Subcomanda print (http://www.articles.techrepublic.com.com/i/tr/)

"When you use the Print subcommand, you'll see a report similar to the one shown in **Figure A**.

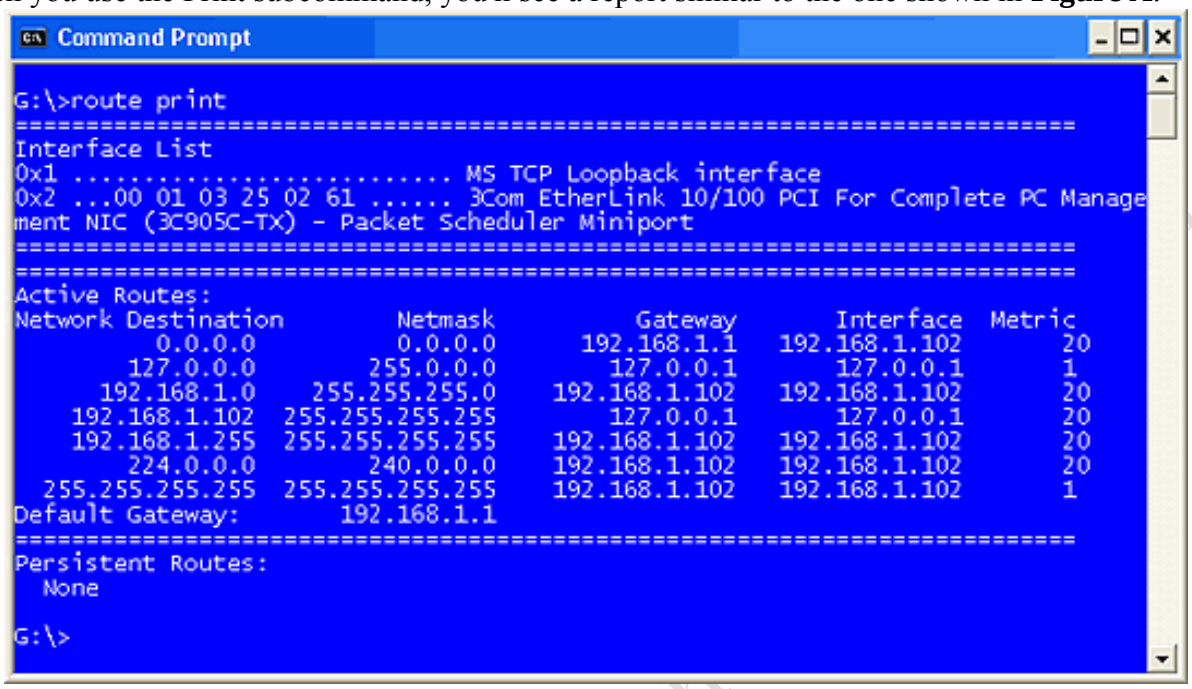


Fig. A: The Route Print command displays the current routing table on a local system.

At the top of this report you'll see the Interface List section, which contains the interface indexes for the Microsoft TCP Loopback adapter and, in the case of this example system, a 3Com Etherlink network adapter card. As you can see, these two adapters have interface indexes listed as hexadecimal values of 0x1 and 0x2, respectively.

The Active Routes section contains the routing table and provides insight on how the Route command's parameters actually function. Since the destination is the ultimate goal of the routing table, here's a closer look at the addresses listed in the Network Destination column.

Each address in Network Destination column from example system is explained in **Table A**.

Table A: The destinations are shown in the Network Destination column.

Network Destination	**Description**
0.0.0.0	Default route (This route is used when no other route is found.)
127.0.0.0	Loopback address
192.168.1.0	Local subnet address
192.168.1.102	Network card address
192.168.1.255	Subnet broadcast address
224.0.0.0	Multicast address
255.255.255.255	Limited broadcast address

In **Figure A**, the Netmask column shows a list of addresses that are applied to each Network Destination address. The Gateway column shows a list of IP addresses that act as the gateway for that route. The Interface column shows a list of IP address assigned to the network adapter that the route

will follow when leaving the local system. The Metric column shows a list of the hop count between the local system and the gateway."

metric *Metric* : Specifies an integer cost metric (ranging from 1 to 9999) for the route, which is used when choosing among multiple routes in the routing table that most closely match the destination address of a packet being forwarded. The route with the lowest metric is chosen. The metric can reflect the number of hops, the speed of the path, path reliability, path throughput, or administrative properties.
http://www.microsoft.com/resources/documentation/windows/xp/all/proddocs/en-us/route.mspx?mfr=true

2.3. MODELER (Riverbed) ACADEMIC EDITION

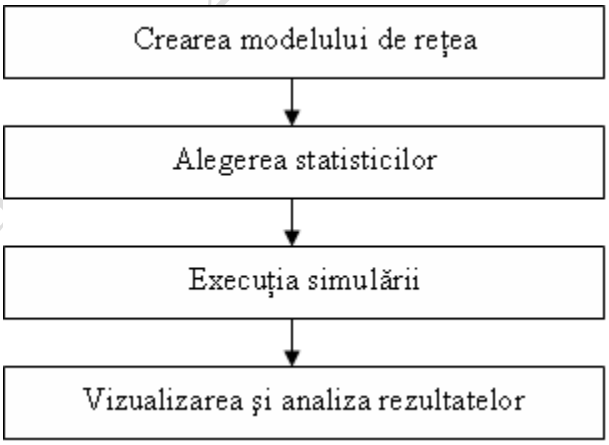
Ovservatie: (Lab_1 + Lab_2 + Lab_3 + Lab_4 + Lab_5 si toate celelalte materiale, prezente la http://www.cdsd.ro …F.F.F.Importante)

Riverbed Modeler Academic Edition (versiune actuala a Opnet-ului - **Op**timized **Net**work *Application and Network Performance*) – mediu de simulare a retelelor de calculatoare - furnizează software de management pentru aplicaţii şi reţele, care oferă soluţii pentru:

- Planificarea capacităţii reţelelor,
- Modelare şi simulare pentru reţele şi aplicaţii
- Managementul configurării reţelelor
- Managementul performanţelor aplicaţiilor

Varianta "programare" C++: OMNeT++ Network Simulation Framework http://www.omnetpp.org/

Riverbed oferă o versiune academică (**Modeler Academic Edition**) - include modele standard pentru protocoale şi echipamentele disponibile în tehnologia IT (disponibile, dupa instalare, în subdirectoarele *C:\Program Files\OPNET EDU\models\std\).* Etapele de lucru avute în vedere sunt definite în *Modeler workflow*:



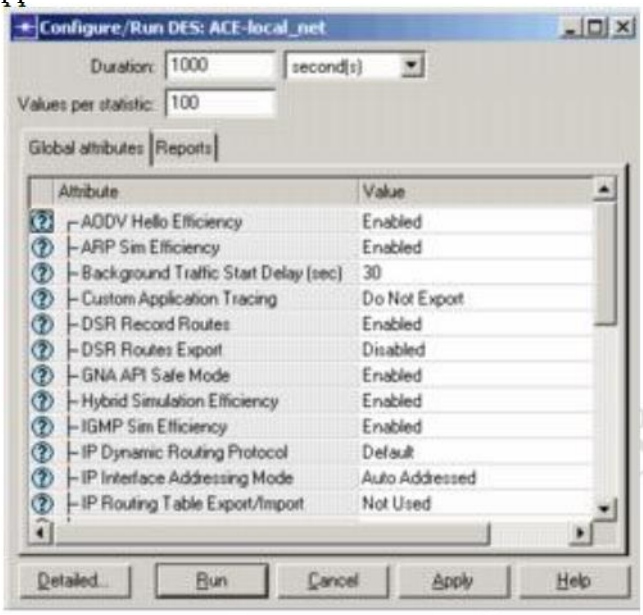
Etapele de lucru pentru Modeler Academic Edition pentru simularea şi analiza unei reţele

Obs: O statistica este o caracteristica numerica a unui esantion (Anexa 3, pag.79, Lab_02)

- **Statistica** este stiinta colectarii, clasificarii, prezentarii, interpretarii datelor numerice si a folosirii acestora pentru a formula concluzii si a lua decizii.
- **Statistica descriptiva (**Descriptive Statistics) se ocupa cu colectarea, clasificarea si prezentarea datelor numerice.
- **Statistica inferentiala** (Inferential Statistics) se ocupa cu interpretarea datelor oferite de statistica descriptiva si cu folosirea acestora pentru a formula concluzii si lua decizii.

Configure/Run DES Dialog Box (Simple)

The Configure/Run DES dialog box lets you configure and run a discrete event simulation for the current scenario. The simple version of the dialog box, (shown in the following figure), which appears when the DES configuration mode is set to “simple”, presents a reduced set of controls to simplify configuration and execution of **discrete event simulations**. Only single simulation runs are supported.



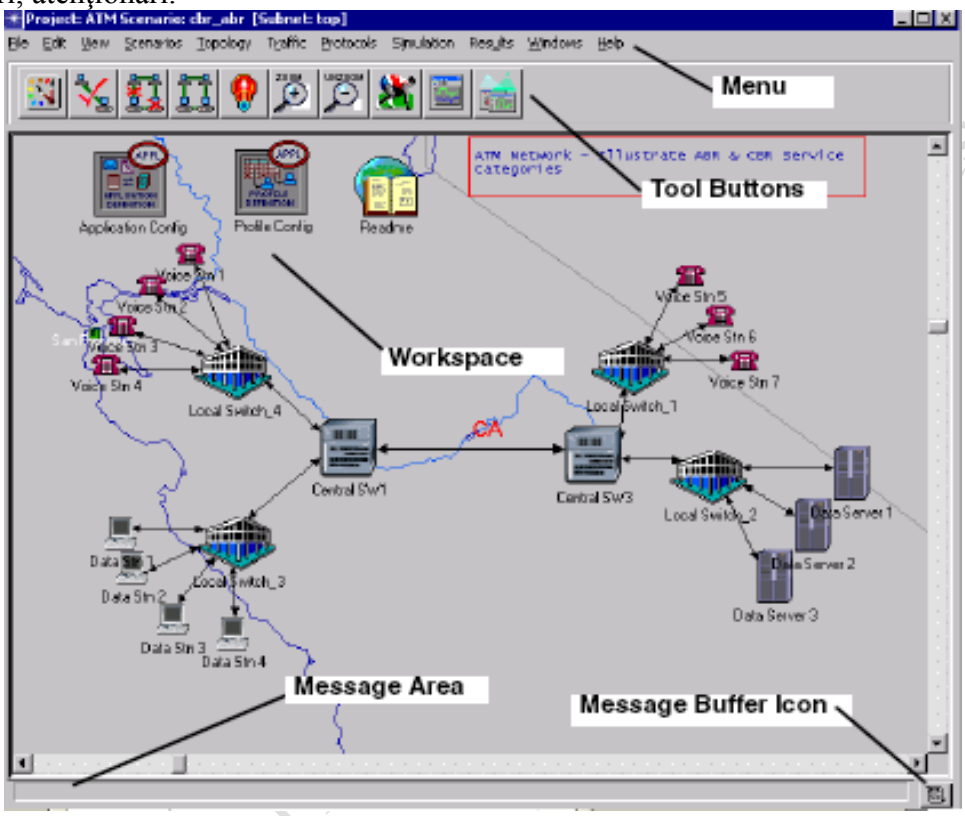
The simple Configure/Run DES dialog box has two pages of controls. These controls are organized by type and can be selected by clicking the corresponding tab. The following table lists the controls in this dialog box.

Element	Description
Basic controls	Duration field—Sets the duration of the simulation. Specify units with the pull-down menu following this field. This value sets the “duration” simulation preference. Values per statistic field—Sets the maximum number of values collected for each statistic. This value sets the “num_collect_values” simulation preference.
Global Attributes page	Use this page to define the values of global simulation attributes. This page is similar to the Global Attributes page—Used to define the values of global simulation attributes for the simulation. seen in Detailed mode, except that you cannot set multiple values for an attribute or automatically reset the default value.
Reports page	Use this page to select Statistic reports and Service Level Agreement (SLA) reports for the simulation. Reports are predefined sets of statistic probes. This page is identical to the Configure/Run DES Dialog Box (Detailed)—Report Controls seen in Detailed mode.
Dialog box controls	Detailed… button—Switches temporarily to detailed mode and the detailed Configure/Run DES dialog box, as described in Configure/Run DES Dialog Box (Detailed). (This button does not change the des.configuration_mode preference.) Run button—Saves the current settings, closes the dialog box, and runs the simulation. Running a simulation from here opens the Simulation Execution Dialog Box. Cancel button—Closes the dialog box without saving any changed settings. Apply button—Saves the current settings and keeps the dialog box open. Help button—Opens a help file for the dialog box.

Workspace este spaţiul de lucru din partea centrală a ferestrei editorului, care este folosit pentru crearea modelului reţelei, selectarea şi deplasarea obiectelor reţelei, alegerea operaţiilor specifice conextului.

Message Area, plasată în partea de jos a ferestrei, furnizează informaţii despre starea *tool-ului.*

Message Buffer Window, plasata în partea de jos în stânga, permite accesul la o listă de mesaje, notificări, atenţionări.



Project Editor Window

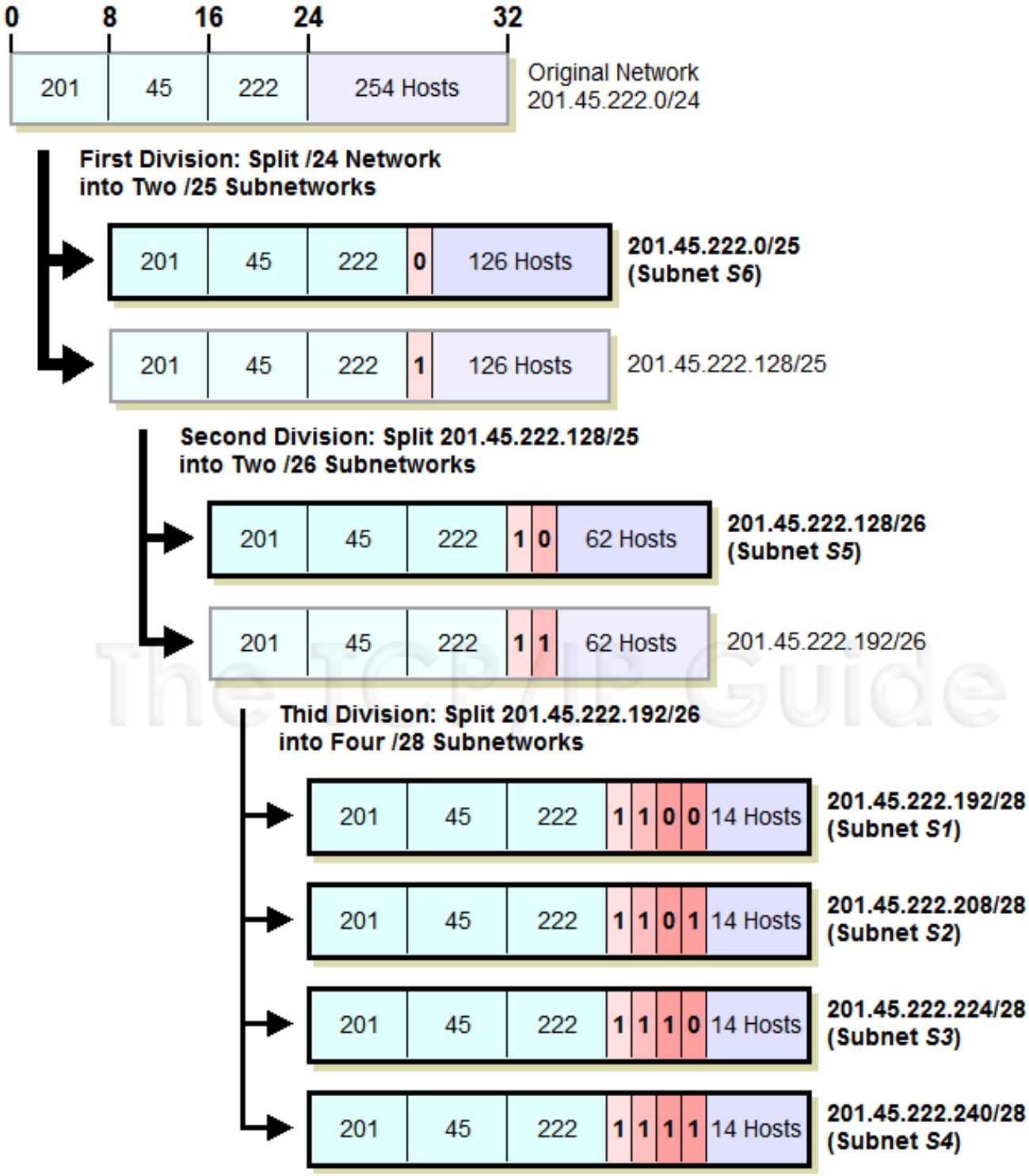
Butoane folosite în *Project Editor*

Semnificaţia butoanelor din *Project Editor*

1. Open object palette	*6. Zoom*
2. Check link consistency	*7. Restore*
3. Fail Selected objects	*8. Configure discrete event simulation*
4. Recover selected objects	*9. View simulation results*
5. Return to parent subnet	*10. Hide or show all graphs*

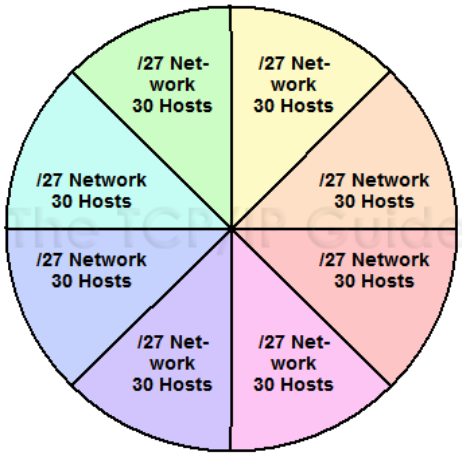
3. Partea practica (Tema – pag.35)

3.1. Aplicatie VLSM (analiza)



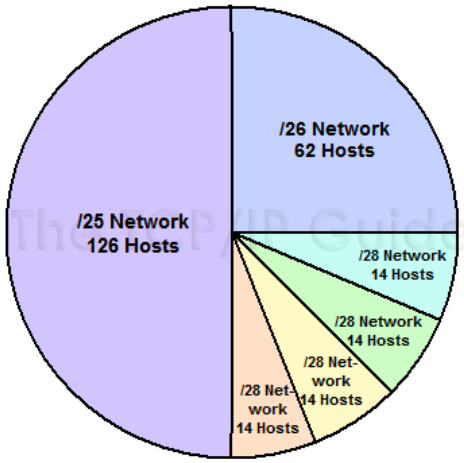
	Tabelul de adrese IP:			
QUIZ	**Nr. SR**	**Adresa SR**	**Interval adrese hosturi**	**Adresa broadcast SR**

Subnetting:



Class C (/24) Network (254 Hosts)

VLSM:



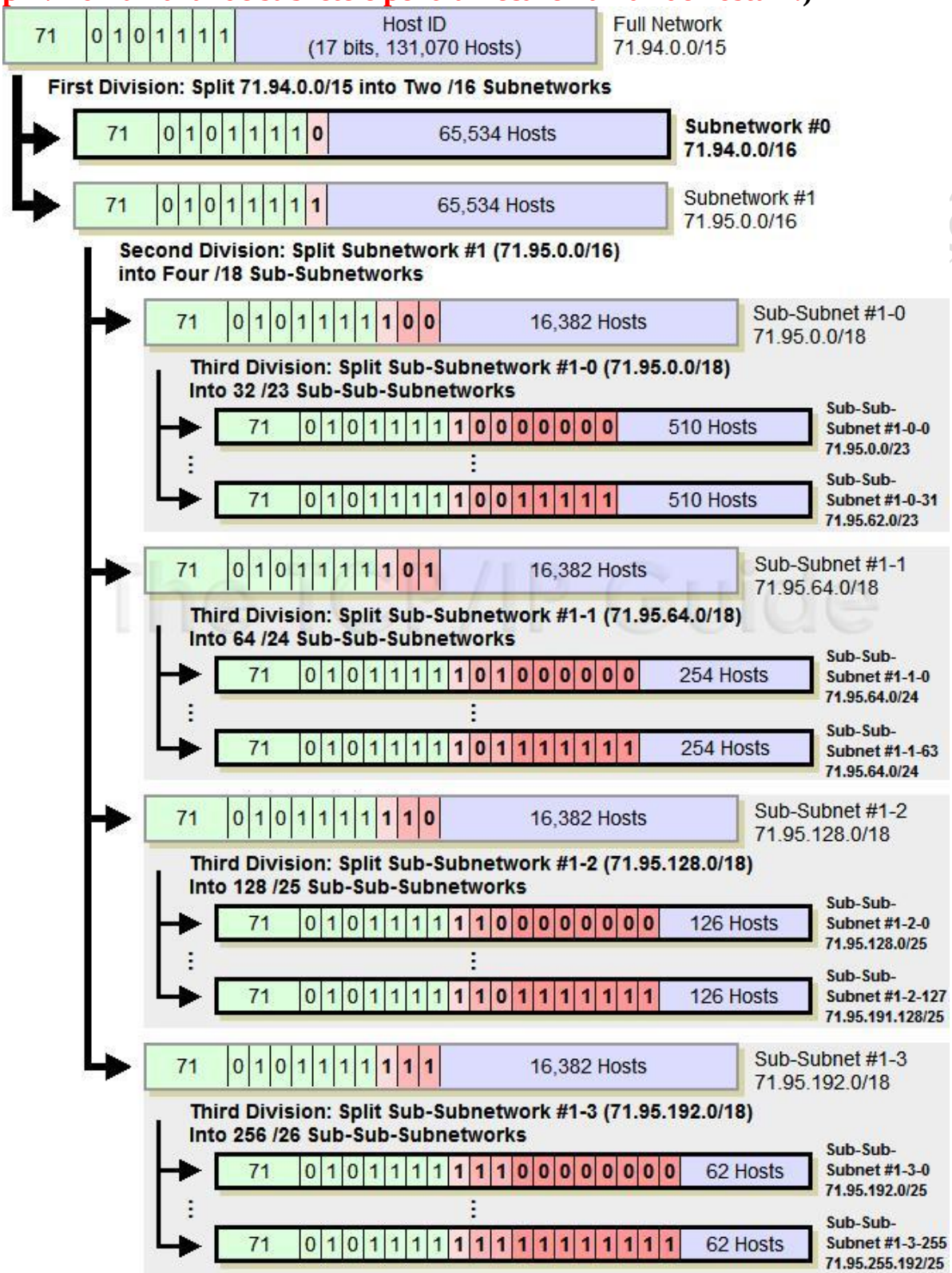
Class C (/24) Network (254 Hosts)

3.2. Exercitiu propus (VLSM – si in C_05)

O organizatie a primit o adresa de retea 140.25.0.0/16 si doreste sa partitioneze spatiul de adrese folosind VLSM. In primul rand se va realiza subalocarea adresei de baza in 16 blocuri de dimensiuni egale. Subreteaua 1 va fi partionata in continuare in 32 de blocuri iar Subreteaua 14 va fi partitionata in 16 blocuri. In final, Sub-subreteaua 14-14 va fi partitionata in 8 blocuri.

a) Definiti cele 16 subretele ale adresei 140.25.0.0/16
b) Definiti adresele host-urilor pentru Subnet 3 (140.25.48.0/20)
c) Definiti sub-subretelele pentru Subnet 14 (140.25.224.0/20)
d) Definiti adresele host-urilor pentru Sub-subnet 14-3
e) Definiti sub-sub-subretelele pentru Sub-subnet 14-14
f) Definiti adresele host-urilor pentru Sub-sub-subnet 14-14-2

3.3. Aplicatie CIDR pentru blocul de adrese 71.94.0.0 /15 (analiza cantitativa privind numarul de subretele pentru fiecare numar de hosturi!)



Tabelul de adrese IP:

Nr. SR	Adresa SR	Interval adrese hosturi	Adresa broadcast SR

3.4. Utilitarul route

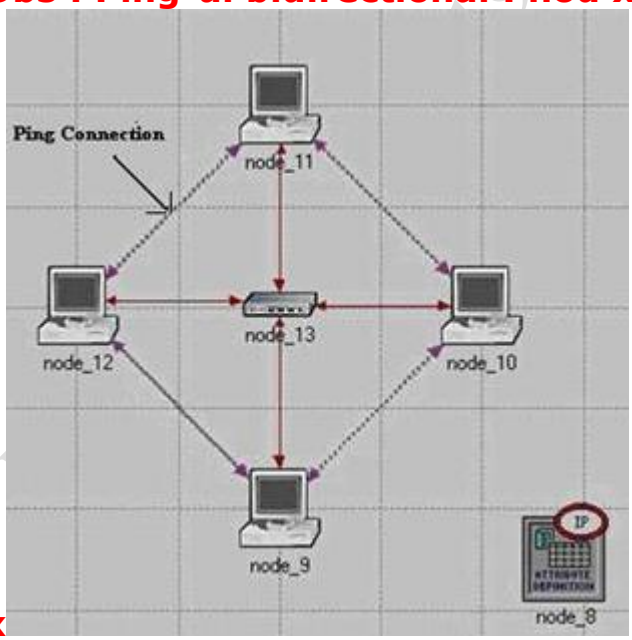
3.4.1. in cmd, *route print*: captura + interpretarea inregistrarilor (recomandare: pag.5 + documentare);
3.4.2. se va folosi: tracert http://www.google.com si se retine ultima adresa IP, notata cu IP_google
3.4.2. stergerea rutei default si ping la www.yahoo.com si la www.google.com . Ce se intampla? Comentati!!!
3.4.3. adaugarea unei rute la IP_google anterioara
3.4.4. tracert http://www.google.com ; Comentati!
3.4.5. adaugati ruta default
3.4.6. ping la www.yahoo.com si la www.google.com ; Comentati

3.5. Aplicatii Riverbed Modeler Academic Edition

3.5.1.Simulare PING – scenariul 1 (3_RMA_Ping_Tutorial_1.mp4)
3.5.2.Simulare PING – scenariul 2 (4_RMA_Ping_Tutorial_2.mp4)
3.5.3. Simulati transmisia mesajelor *ping* intr-o retea compusa din 6 noduri si determinati numarul pachetelor pierdute.
5_Ping_Tutorial; 6_Ping_Command_Windows; 7_Ping_Command_Linux
Indicatie:
Pasul 1: Creati un proiect nou (new Project) – Nume_Prenume_ping
Pasul 2: Creati reteaua:

Selectati patru **Ethernet work stations** din **Ethernet tools**, **object palette**.
Selectati **Ethernet16 hub** din **Ethernet tools, object palette**.
Conectati componenele utilizand legaturi **10Base_T** .
Selectati **IP attribute definition** din **Ethernet tools**, **object palette**.
Selectati **IP_ping_traffic** din **Demand Models, internet tools**, **object palette**.
Scenariul obtinut va fi unul asemanator celui din figura urmatoare:

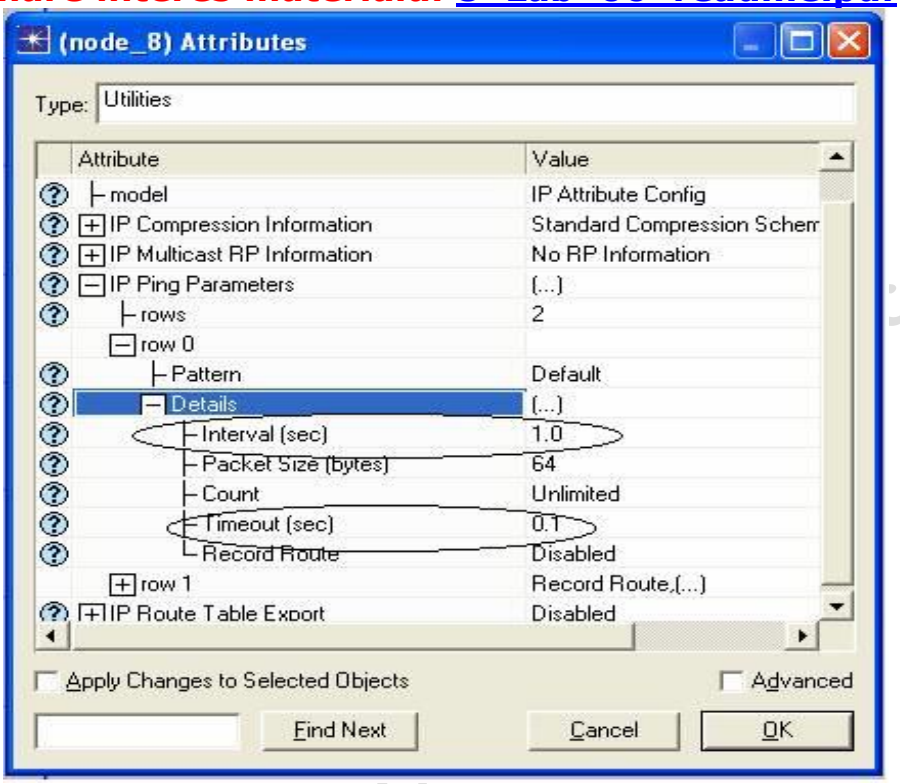
Obs : Ping-ul bidirectional ! nod x → nod y si nod y ->nod x



Pasul 3: Configurati obiectul IP Attribute Definition.
Click dreapta pe obiectul **IP Attribute Definition** in work space.

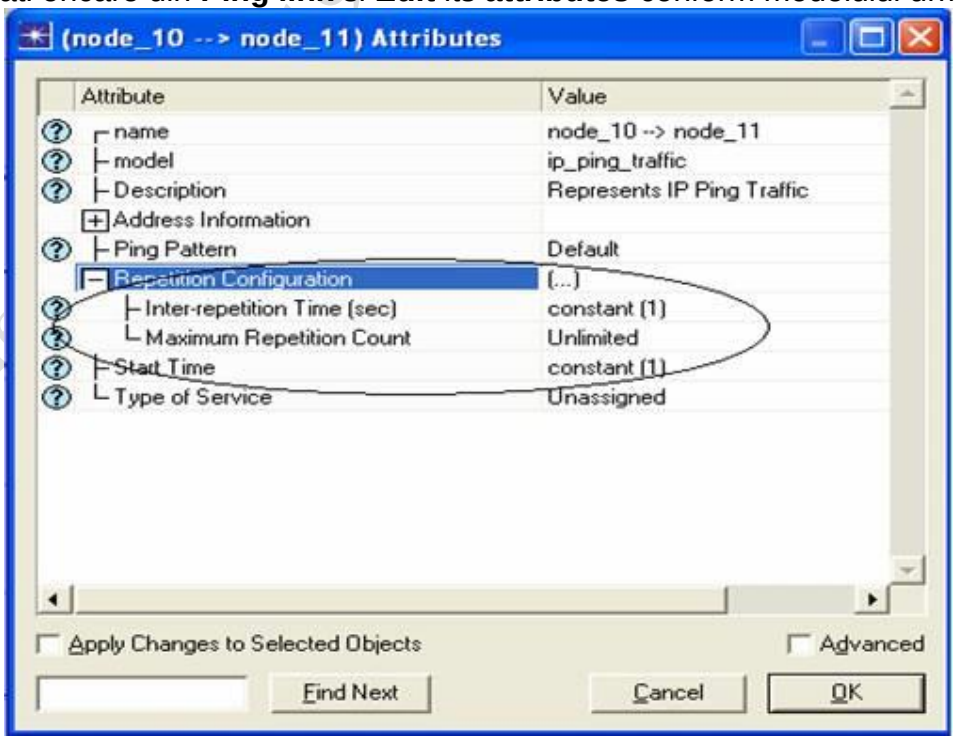
- Selectati **Edit Attribute=>IP Ping Parameters**.
- Setati parametrii conform modelului urmator:

Obs.: De f.mare interes materialul 8_Lab_06_readme.pdf



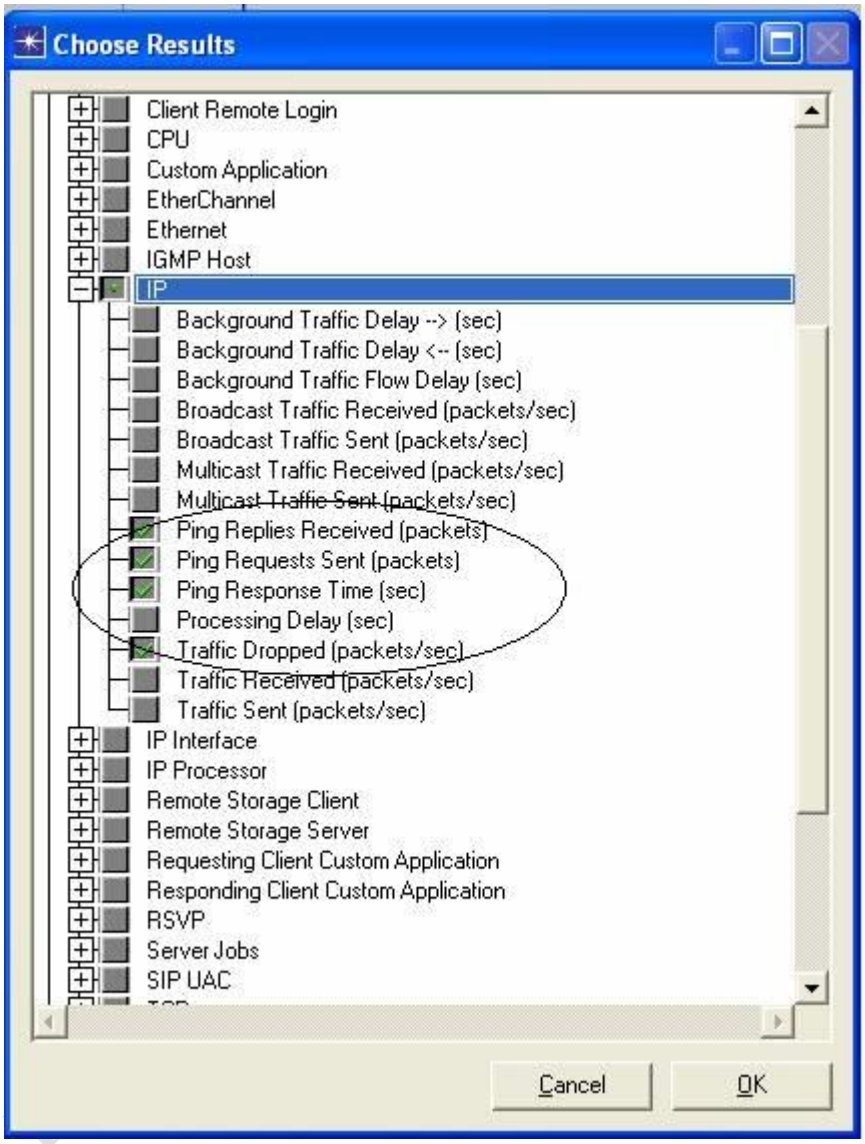
Pasul 4: Configurati IP Ping Links:

- **Click** dreapta pe oricare din **IP ping link si selectati similar Demands**.
- Selectati oricare din **Ping link** si **Edit** its **attributes** conform modelului urmator:



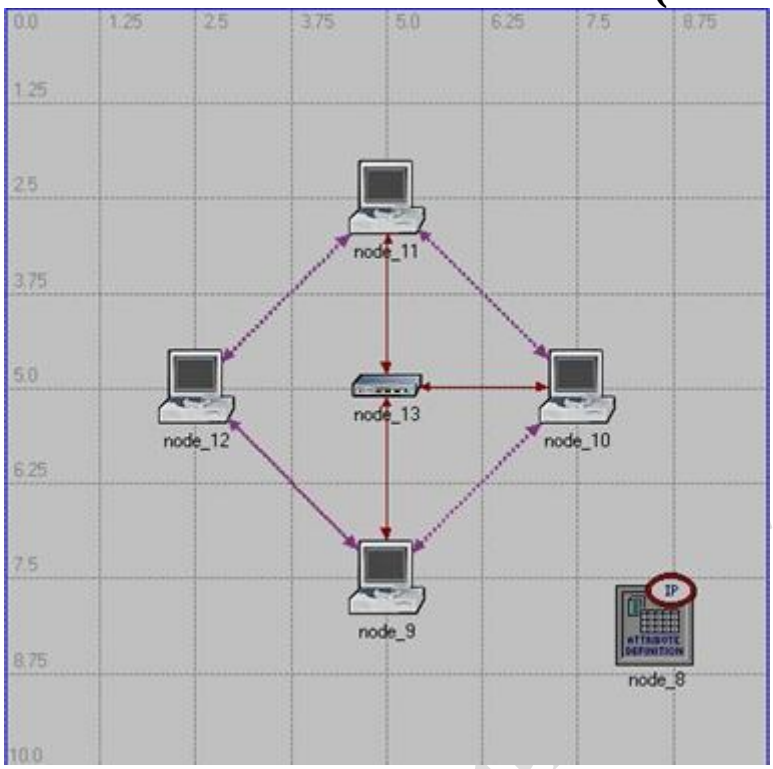
Pasul 5: Alegeti Individual Statistics:

- **Click dreapta** pe work space si alegeti **individual statistics.**
- **Node Statistics** => **IP** => **(Ping Replies, Ping Request Sent, Ping Response Time, Traffic Dropped)**



Pasul 6: Duplicati scenariul

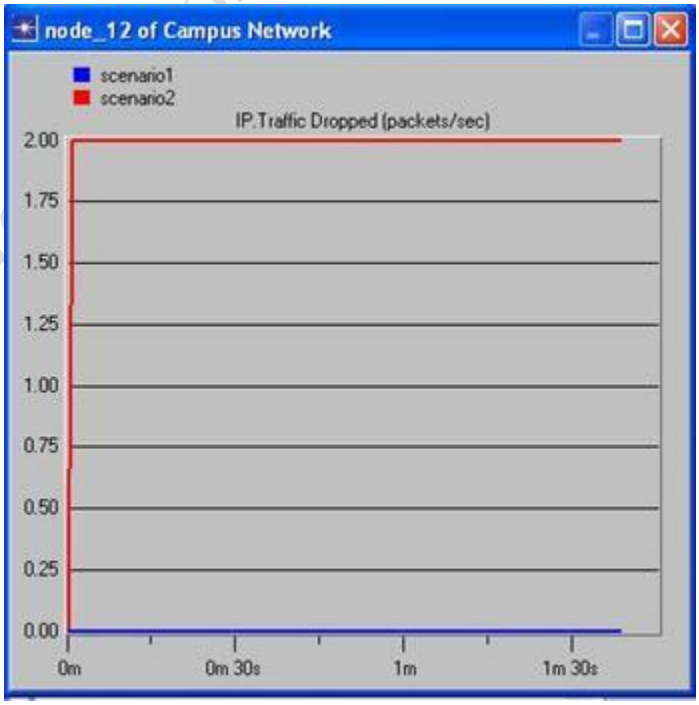
- **In acest scenariu inlaturati orice legatura dintre hub si workstation. Exemplu:**



Pasul 7.Rulati Simularea:

- Click pe **Run Button**
- Setati **Duration** la **100 seconds**.
- Click pe **Run.**

Pasul 8: Vizualizati si comparati resultatele:



Interpretarea rezultatelor

Cand nodul 12 a fost deconectat pachetele ping s-au pierdut (aceasta se justifica si in reprezentarea grafica). Se pot observa rezultate similare pentru nodurile 11 si 9 care vor pierde 1 pachet. Nu va fi nici-o schimbare pentru nodul 10. Rata de generare a pachetului este de 1 pachet (ping)/destinatie/ secunda.

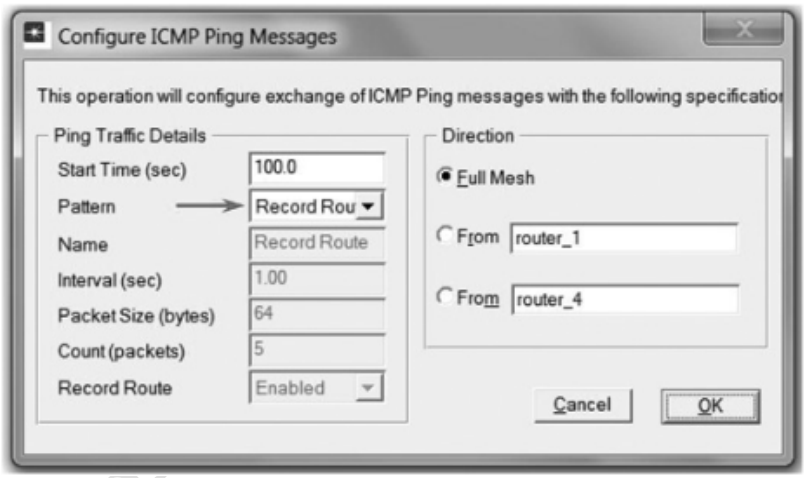
3.5.4. Ping IPv4 si IPv6

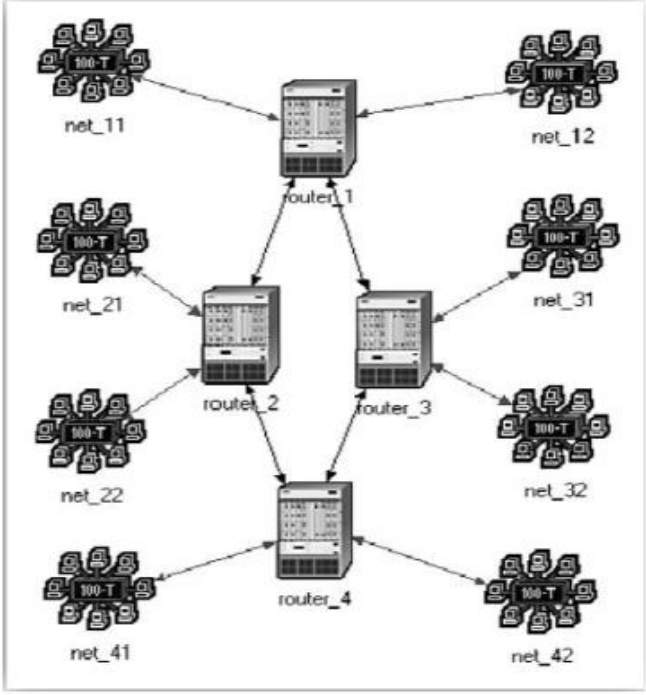
1.

The Ping Scenario

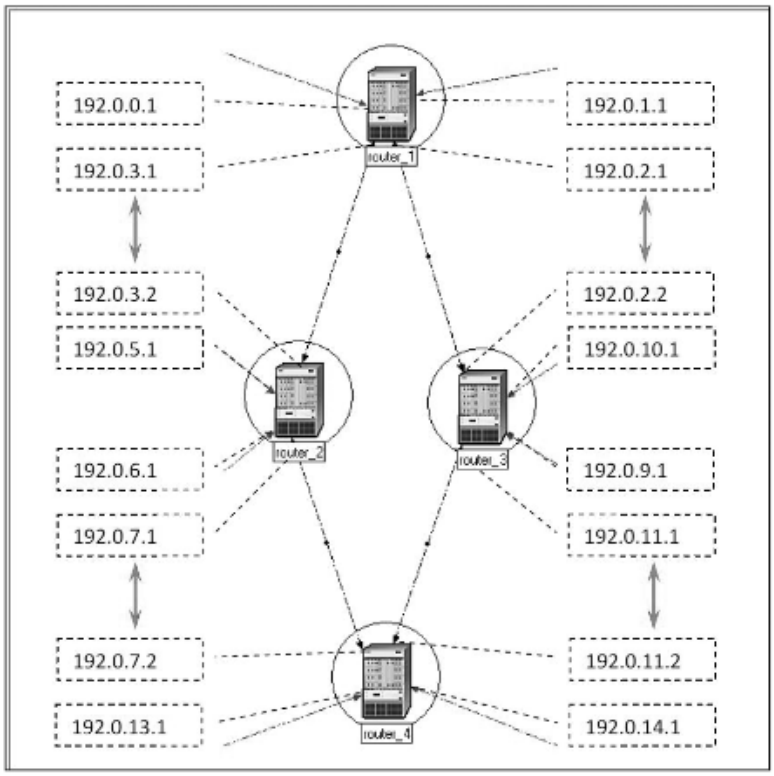
In this scenario, we will utilize the ping model to print the list of traversed nodes while the ICMP request message is sent to the destination and the ICMP response is received from the destination. Traversed routes are logged in the simulation log file.

1. Select **Duplicate Scenario** from the **Scenarios** menu and name it **ICMP_Ping** → Click **OK**.
2. Select both **router_1** and **router_4** simultaneously (click on both of them while holding the **Shift** key) → Select the **Protocols** menu → **IP** → **Demands** → **Configure Ping Traffic on Selected Nodes**.
3. Change the **Pattern** attribute to **Record Route** as shown → Click **OK**.





Notice that a Ping Parameter node will be added to the project space. In addition, the ping demand is created between router_1 and router_4 as a dotted line.



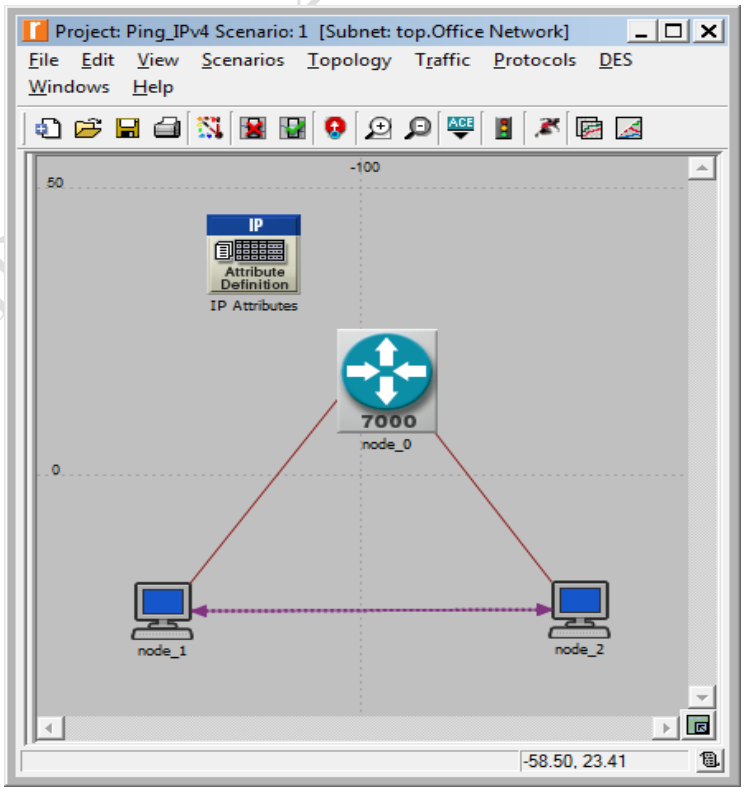
Getting the Ping Report

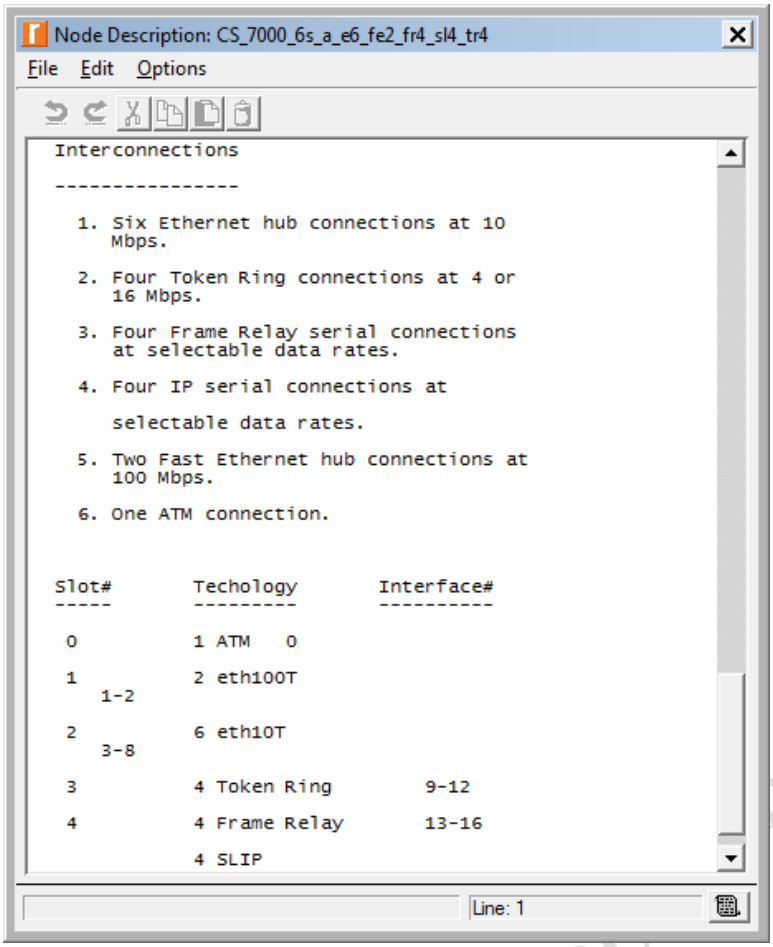
To check the content of the ping report for router_1:

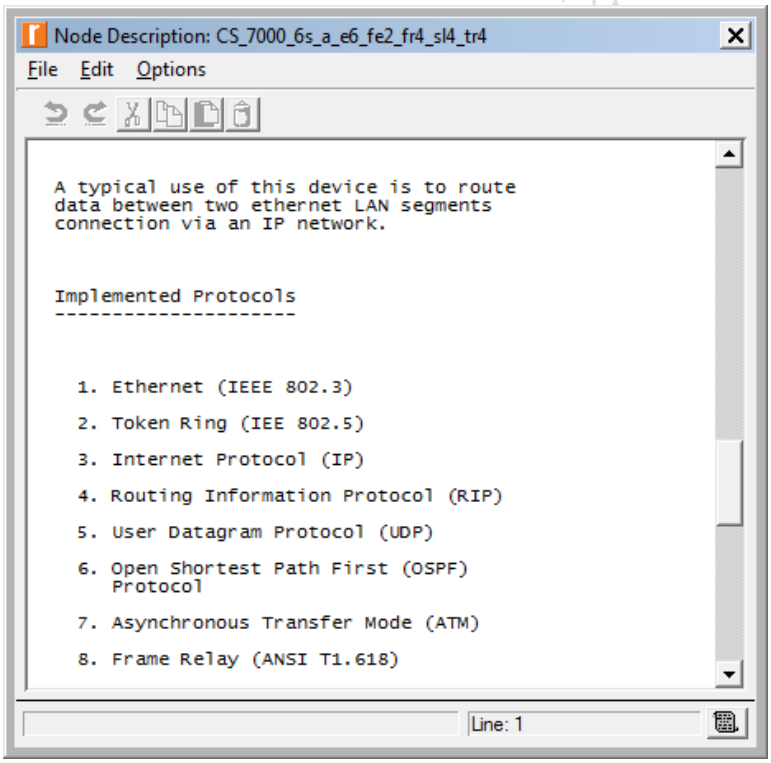
1. Go to the ICMP_Ping scenario → Go to the Results menu → Open Simulation Log → Click on the field PING REPORT for "Campus Network router_1" as shown.

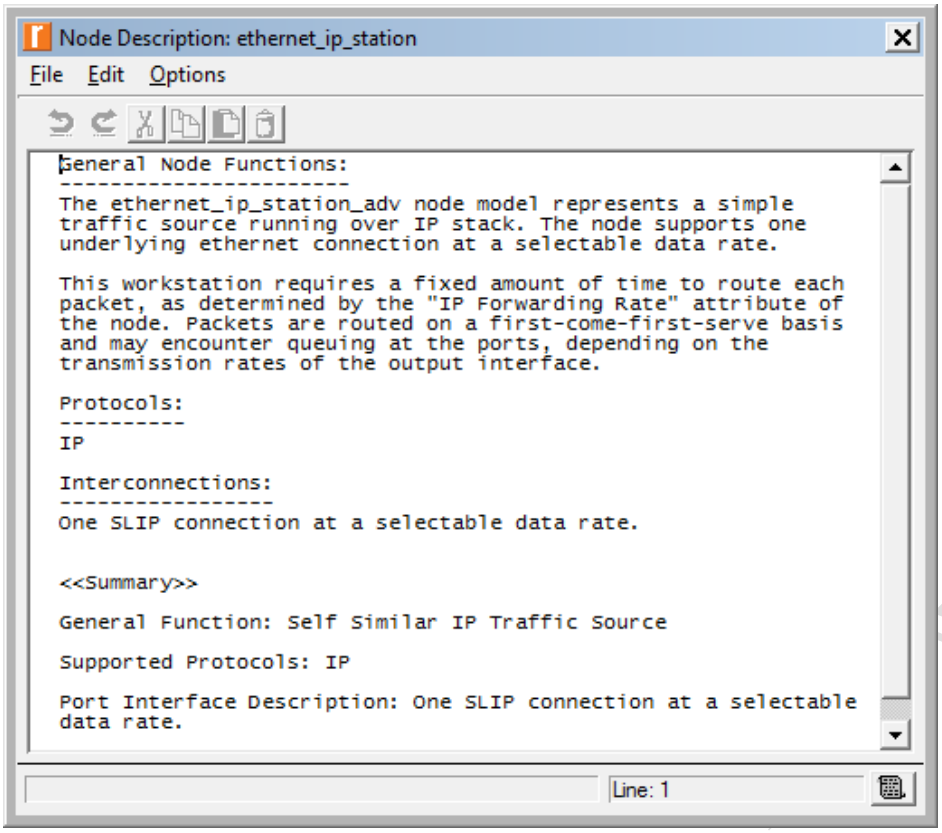
```
PING REPORT for "Campus Network.router_1" (192.0.4.1)

DETAILS:
  Received  ICMP echo reply packet for a
  request packet sent to the following node:

    IP Address: 192.0.4.1
    Node Name : Campus Network.router_1

PERFORMANCE:
  Based on the first ICMP echo request packet
  (i.e., a "ping" packet) sent to the above
  node, the following metrics were computed:

    1. Response Time: 0.00025 seconds

    2. List of traversed IP interfaces:

       IP Address        Hop Delay      Node Name
       ----------        ---------      ---------
        192.0.11.2       0.00000      Campus Network.router_4
        192.0.2.2        0.00005      Campus Network.router_3
        192.0.4.1        0.00005      Campus Network.router_1
        192.0.2.1        0.00002      Campus Network.router_1
        192.0.11.1       0.00005      Campus Network.router_3
        192.0.11.2       0.00005      Campus Network.router_4

  Note that the IP addresses shown above represent
  the address of the output interface on which the
  IP datagram was routed from the corresponding
  nodes to the next node enroute to its destination
  and back.
```

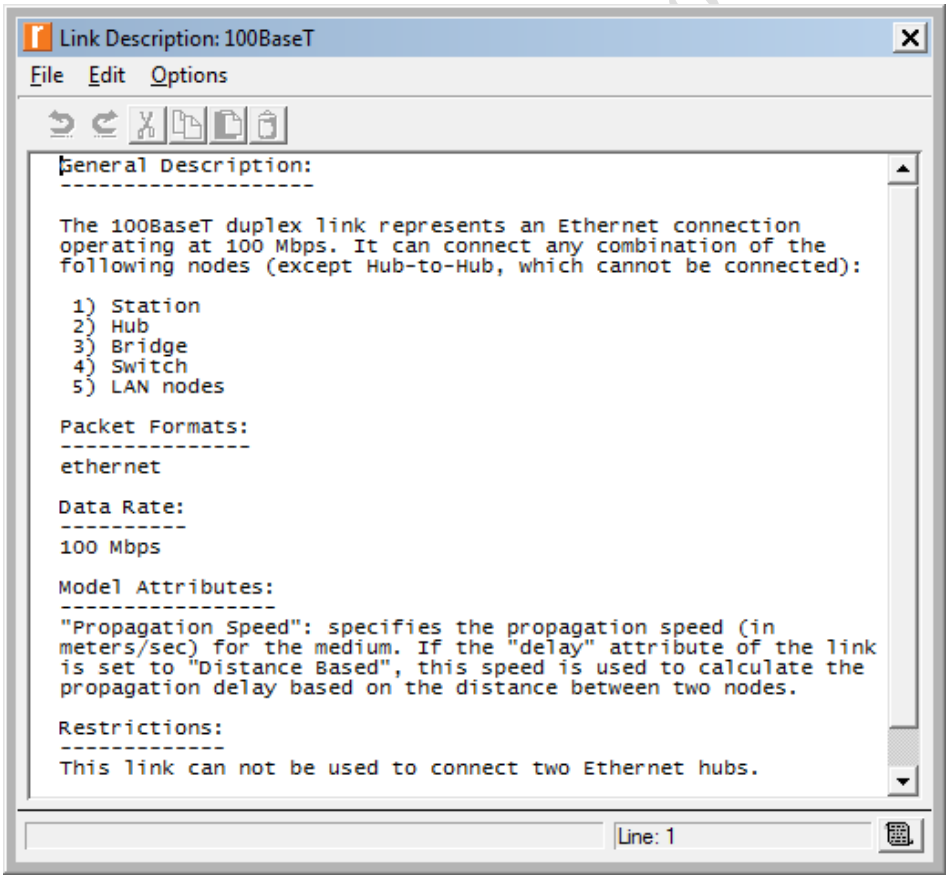
2. Ping – Internetwork Communication

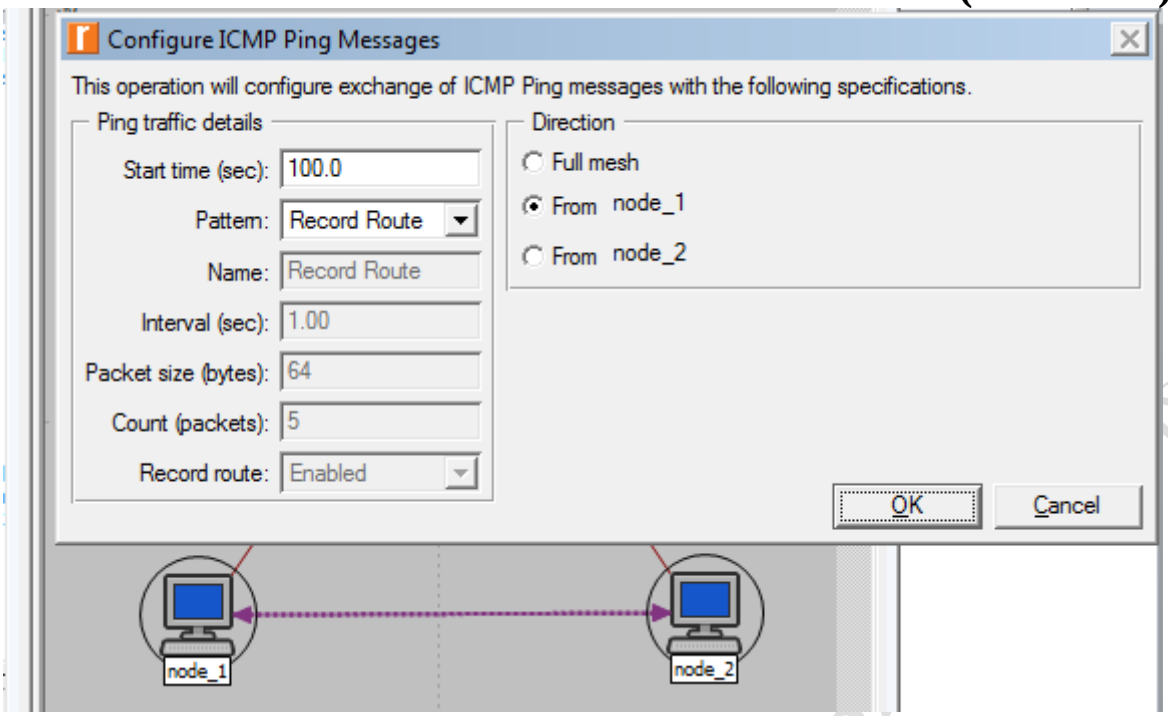


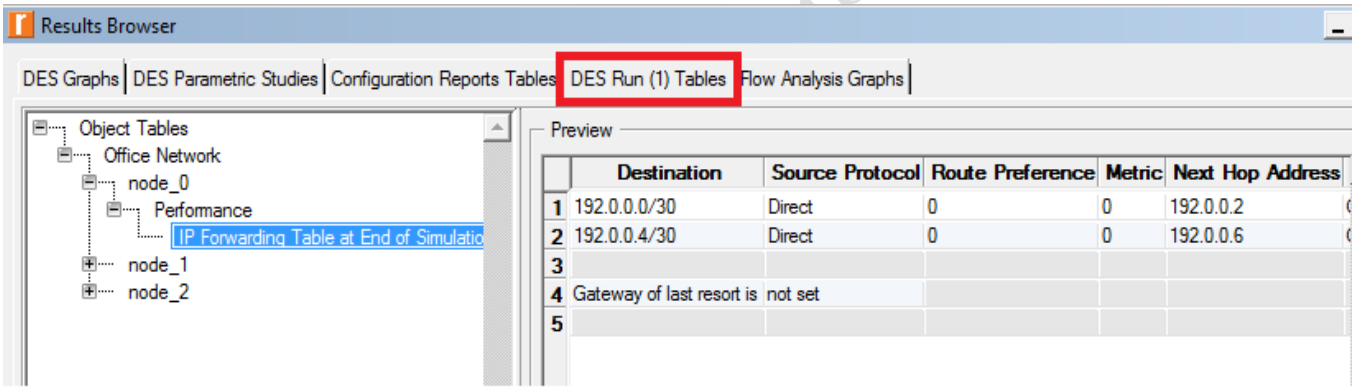


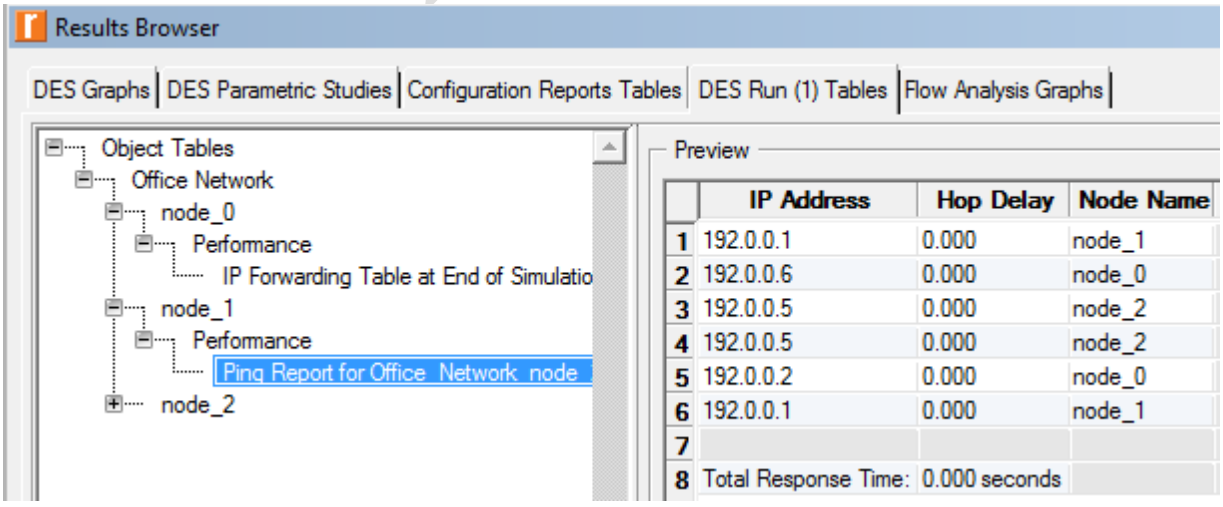


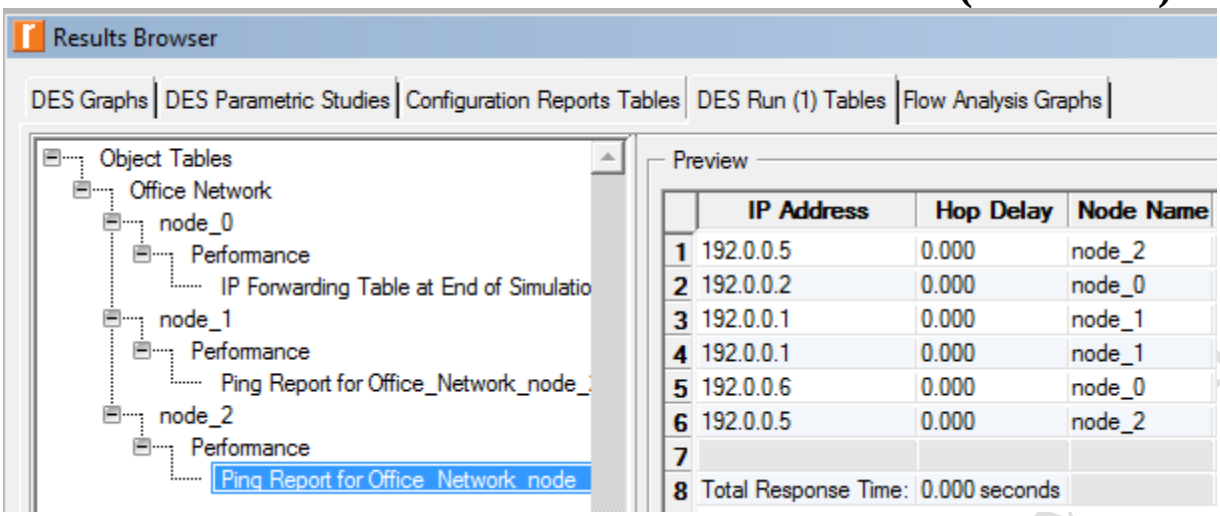

Node Description: ethernet_ip_station
File Edit Options
General Node Functions:
The ethernet_ip_station_adv node model represents a simple traffic source running over IP stack. The node supports one underlying ethernet connection at a selectable data rate.
This workstation requires a fixed amount of time to route each packet, as determined by the "IP Forwarding Rate" attribute of the node. Packets are routed on a first-come-first-serve basis and may encounter queuing at the ports, depending on the transmission rates of the output interface.
Protocols:
IP
Interconnections:
One SLIP connection at a selectable data rate.
<<Summary>>
General Function: Self Similar IP Traffic Source
Supported Protocols: IP
Port Interface Description: One SLIP connection at a selectable data rate.
Line: 1


Link Description: 100BaseT
File Edit Options
General Description:
The 100BaseT duplex link represents an Ethernet connection operating at 100 Mbps. It can connect any combination of the following nodes (except Hub-to-Hub, which cannot be connected):
1) Station
2) Hub
3) Bridge
4) Switch
5) LAN nodes
Packet Formats:
ethernet
Data Rate:
100 Mbps
Model Attributes:
"Propagation Speed": specifies the propagation speed (in meters/sec) for the medium. If the "delay" attribute of the link is set to "Distance Based", this speed is used to calculate the propagation delay based on the distance between two nodes.
Restrictions:
This link can not be used to connect two Ethernet hubs.
Line: 1

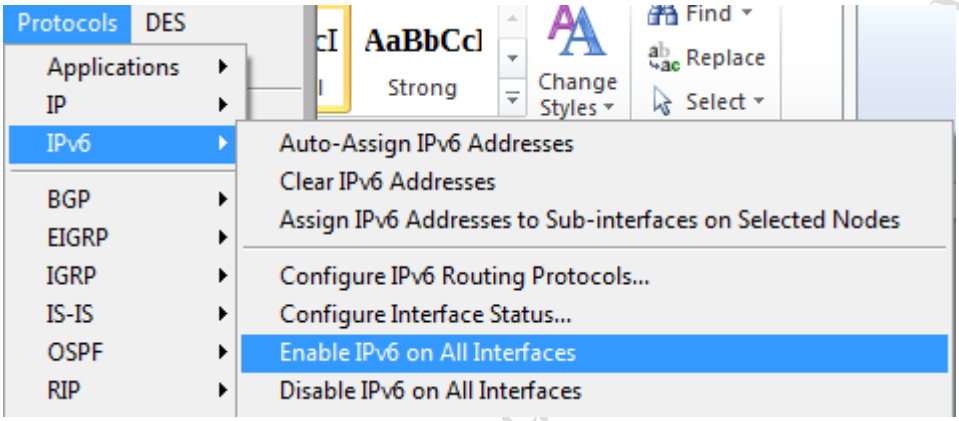

Configure ICMP Ping Messages
This operation will configure exchange of ICMP Ping messages with the following specifications.
Ping traffic details
Start time (sec): 100.0
Pattern: Record Route
Name: Record Route
Interval (sec): 1.00
Packet size (bytes): 64
Count (packets): 5
Record route: Enabled
Direction
Full mesh
From node_1
From node_2
OK
Cancel
node_1
node_2

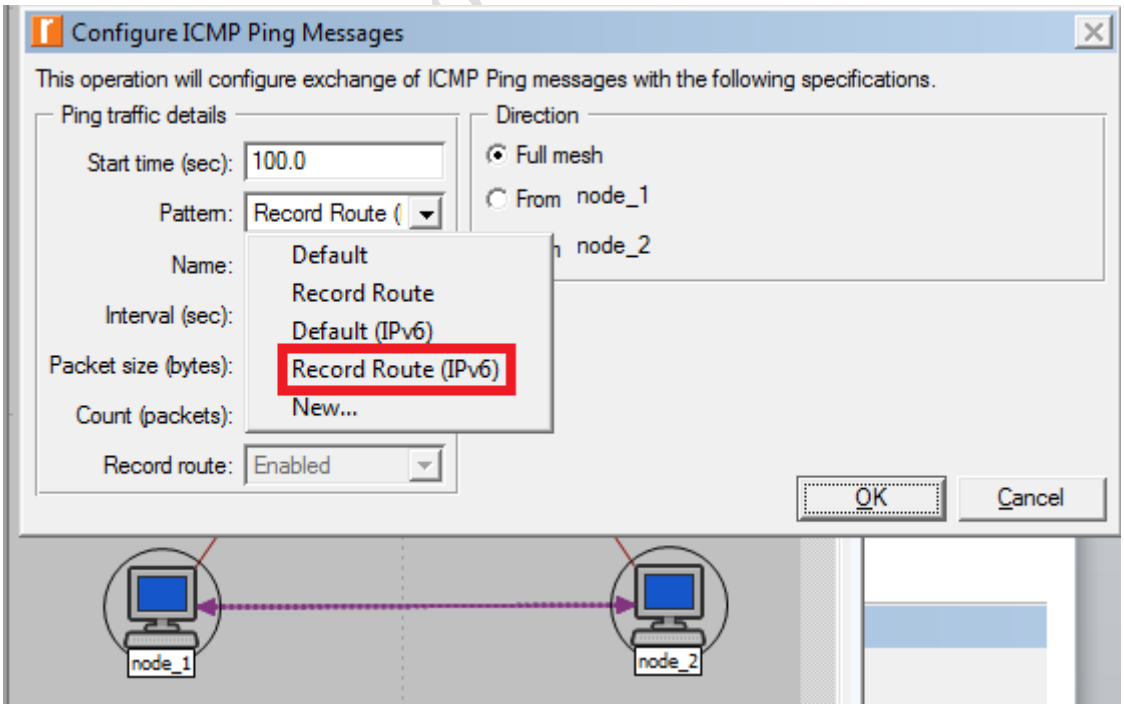

Results Browser
DES Graphs
DES Parametric Studies
Configuration Reports Tables
DES Run (1) Tables
Flow Analysis Graphs
Object Tables
Office Network
node_0
Performance
IP Forwarding Table at End of Simulatio
node_1
node_2
Preview
Destination
Source Protocol
Route Preference
Metric
Next Hop Address
1 192.0.0.0/30 Direct 0 0 192.0.0.2
2 192.0.0.4/30 Direct 0 0 192.0.0.6
3
4 Gateway of last resort is not set
5

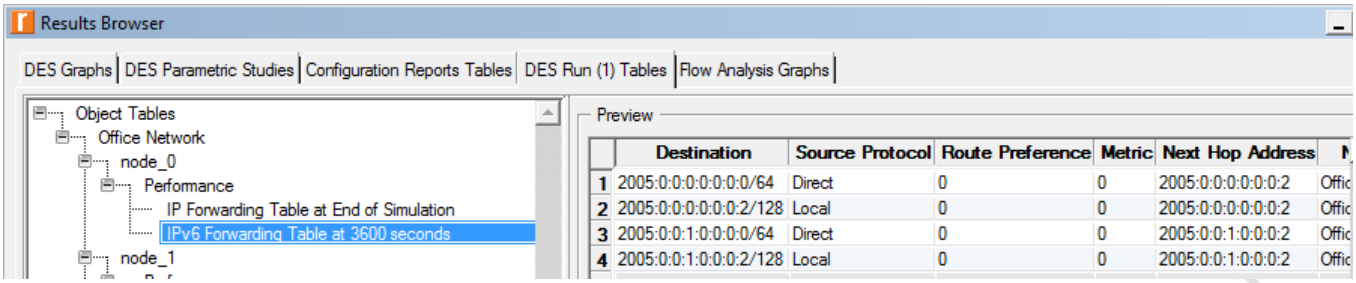

Results Browser
DES Graphs
DES Parametric Studies
Configuration Reports Tables
DES Run (1) Tables
Flow Analysis Graphs
Object Tables
Office Network
node_0
Performance
IP Forwarding Table at End of Simulatio
node_1
Performance
Ping Report for Office_Network_node
node_2
Preview
IP Address
Hop Delay
Node Name
1 192.0.0.1 0.000 node_1
2 192.0.0.6 0.000 node_0
3 192.0.0.5 0.000 node_2
4 192.0.0.5 0.000 node_2
5 192.0.0.2 0.000 node_0
6 192.0.0.1 0.000 node_1
7
8 Total Response Time: 0.000 seconds

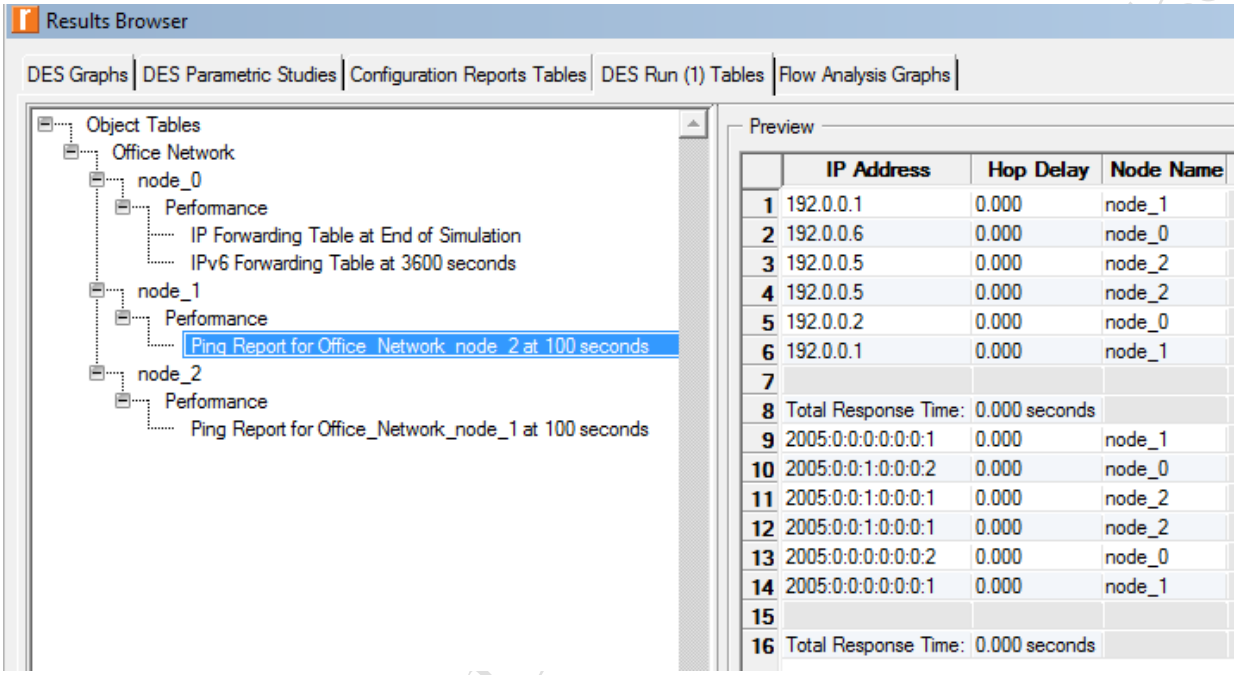

Results Browser
DES Graphs
DES Parametric Studies
Configuration Reports Tables
DES Run (1) Tables
Flow Analysis Graphs
Object Tables
Office Network
node_0
Performance
IP Forwarding Table at End of Simulatio
node_1
Performance
Ping Report for Office_Network_node_
node_2
Performance
Ping Report for Office_Network_node
Preview
IP Address
Hop Delay
Node Name
1 192.0.0.5 0.000 node_2
2 192.0.0.2 0.000 node_0
3 192.0.0.1 0.000 node_1
4 192.0.0.1 0.000 node_1
5 192.0.0.6 0.000 node_0
6 192.0.0.5 0.000 node_2
7
8 Total Response Time: 0.000 seconds

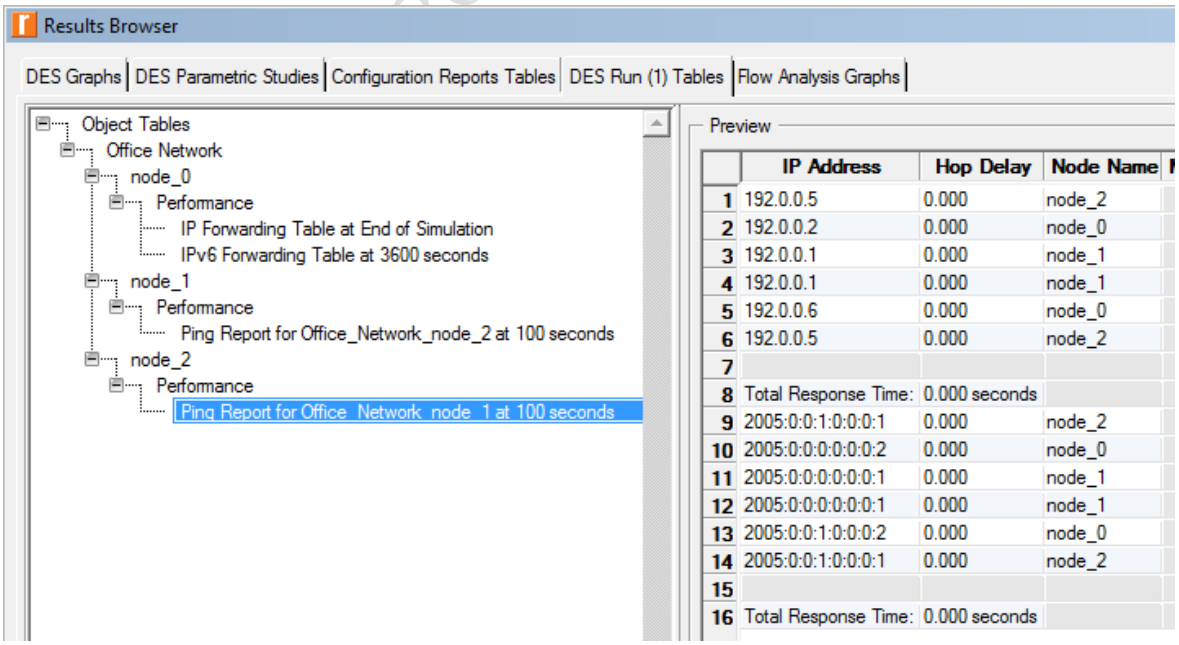
IPv6


Protocols
DES
Applications
IP
IPv6
BGP
EIGRP
IGRP
IS-IS
OSPF
RIP
AaBbCcI
Strong
Change Styles
Find
Replace
Select
Auto-Assign IPv6 Addresses
Clear IPv6 Addresses
Assign IPv6 Addresses to Sub-interfaces on Selected Nodes
Configure IPv6 Routing Protocols...
Configure Interface Status...
Enable IPv6 on All Interfaces
Disable IPv6 on All Interfaces


Configure ICMP Ping Messages
This operation will configure exchange of ICMP Ping messages with the following specifications.
Ping traffic details
Start time (sec): 100.0
Pattern: Record Route (
Name:
Interval (sec):
Packet size (bytes):
Count (packets):
Record route: Enabled
Default
Record Route
Default (IPv6)
Record Route (IPv6)
New...
Direction
Full mesh
From node_1
node_2
OK
Cancel
node_1
node_2


Results Browser
DES Graphs
DES Parametric Studies
Configuration Reports Tables
DES Run (1) Tables
Flow Analysis Graphs
Object Tables
Office Network
node_0
Performance
IP Forwarding Table at End of Simulation
IPv6 Forwarding Table at 3600 seconds
node_1
Preview
Destination
Source Protocol
Route Preference
Metric
Next Hop Address
1 2005:0:0:0:0:0:0:0/64 Direct 0 0 2005:0:0:0:0:0:0:2
2 2005:0:0:0:0:0:0:2/128 Local 0 0 2005:0:0:0:0:0:0:2
3 2005:0:0:1:0:0:0:0/64 Direct 0 0 2005:0:0:1:0:0:0:2
4 2005:0:0:1:0:0:0:2/128 Local 0 0 2005:0:0:1:0:0:0:2

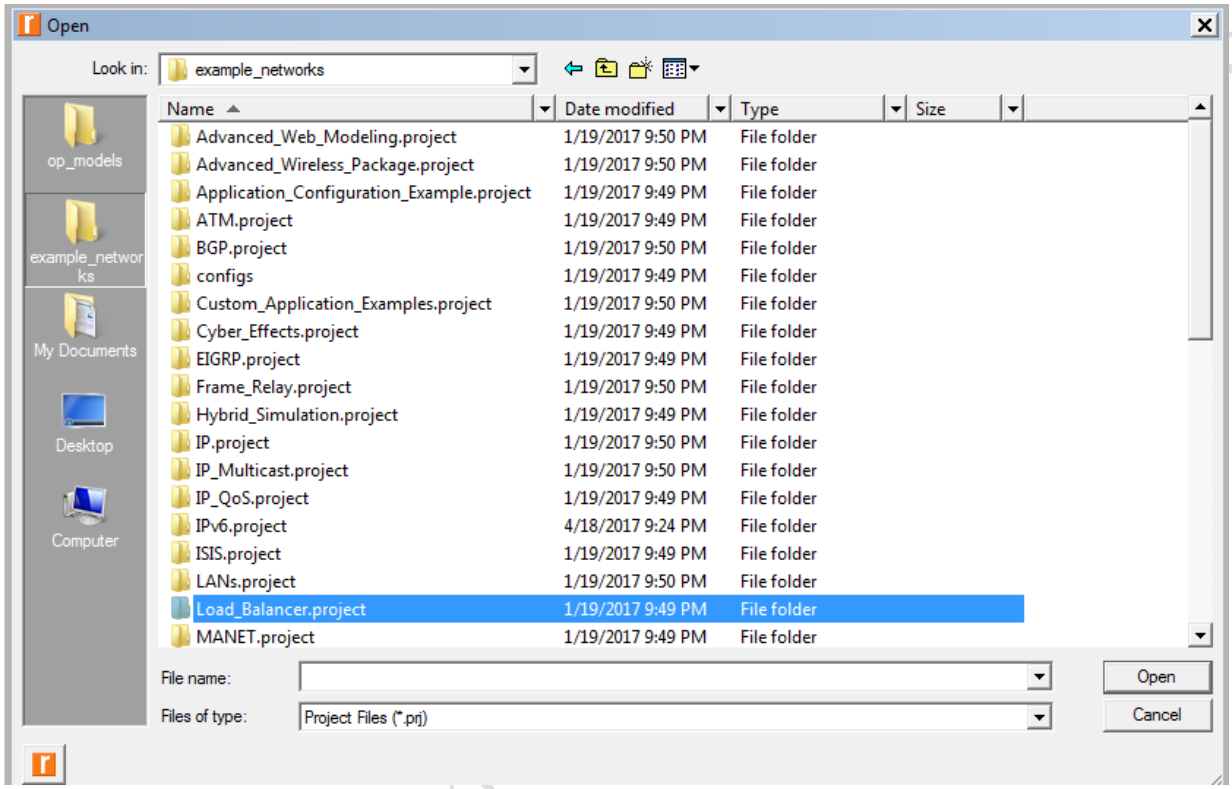

Results Browser
DES Graphs
DES Parametric Studies
Configuration Reports Tables
DES Run (1) Tables
Flow Analysis Graphs
Object Tables
Office Network
node_0
Performance
IP Forwarding Table at End of Simulation
IPv6 Forwarding Table at 3600 seconds
node_1
Performance
Ping Report for Office_Network_node_2 at 100 seconds
node_2
Performance
Ping Report for Office_Network_node_1 at 100 seconds
Preview
IP Address
Hop Delay
Node Name
1 192.0.0.1 0.000 node_1
2 192.0.0.6 0.000 node_0
3 192.0.0.5 0.000 node_2
4 192.0.0.5 0.000 node_2
5 192.0.0.2 0.000 node_0
6 192.0.0.1 0.000 node_1
7
8 Total Response Time: 0.000 seconds
9 2005:0:0:0:0:0:0:1 0.000 node_1
10 2005:0:0:1:0:0:0:2 0.000 node_0
11 2005:0:0:1:0:0:0:1 0.000 node_2
12 2005:0:0:1:0:0:0:1 0.000 node_2
13 2005:0:0:0:0:0:0:2 0.000 node_0
14 2005:0:0:0:0:0:0:1 0.000 node_1
15
16 Total Response Time: 0.000 seconds


Results Browser
DES Graphs
DES Parametric Studies
Configuration Reports Tables
DES Run (1) Tables
Flow Analysis Graphs
Object Tables
Office Network
node_0
Performance
IP Forwarding Table at End of Simulation
IPv6 Forwarding Table at 3600 seconds
node_1
Performance
Ping Report for Office_Network_node_2 at 100 seconds
node_2
Performance
Ping Report for Office_Network_node_1 at 100 seconds
Preview
IP Address
Hop Delay
Node Name
1 192.0.0.5 0.000 node_2
2 192.0.0.2 0.000 node_0
3 192.0.0.1 0.000 node_1
4 192.0.0.1 0.000 node_1
5 192.0.0.6 0.000 node_0
6 192.0.0.5 0.000 node_2
7
8 Total Response Time: 0.000 seconds
9 2005:0:0:1:0:0:0:1 0.000 node_2
10 2005:0:0:0:0:0:0:2 0.000 node_0
11 2005:0:0:0:0:0:0:1 0.000 node_1
12 2005:0:0:0:0:0:0:1 0.000 node_1
13 2005:0:0:1:0:0:0:2 0.000 node_0
14 2005:0:0:1:0:0:0:1 0.000 node_2
15
16 Total Response Time: 0.000 seconds

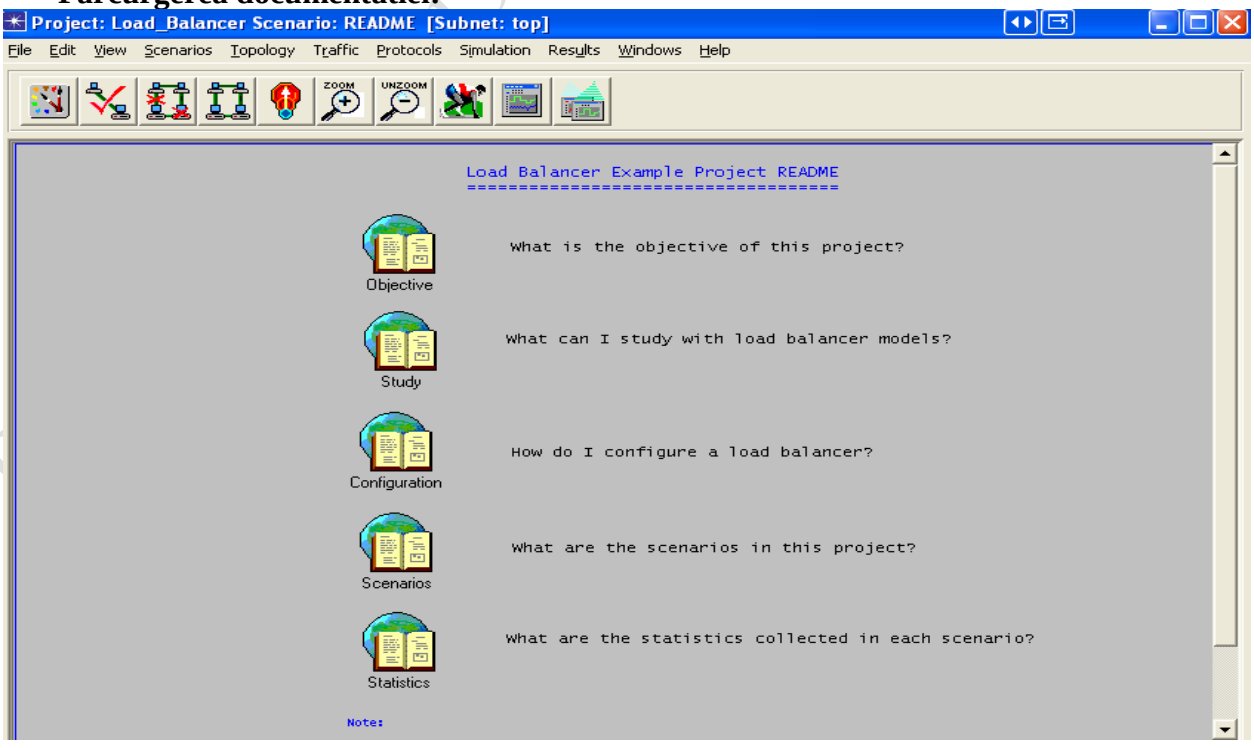
3.5.5. Configurarea unor *rute default* : **Reluarea exercitiului de mai jos; capturi semnificative ale tabelelor de rutare ale TUTUROR RUTERELOR, in cele 2 ipostaze: fara ruta default configurata; cu ruta default configurata**

Obs.: De f.mare interes materialul 0_Lab_06_readme.pdf

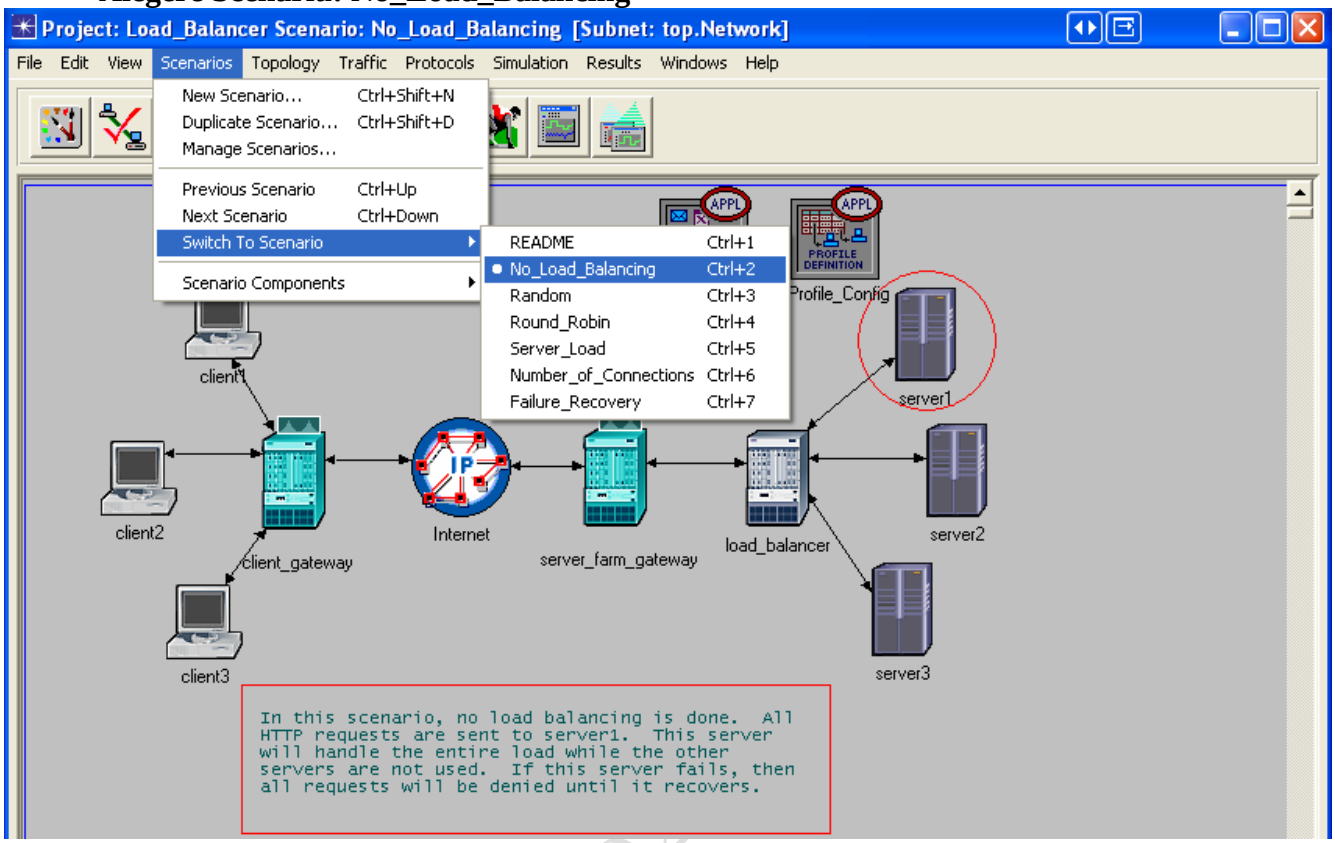
- **Lansare in executie Riverbed Modeler:**



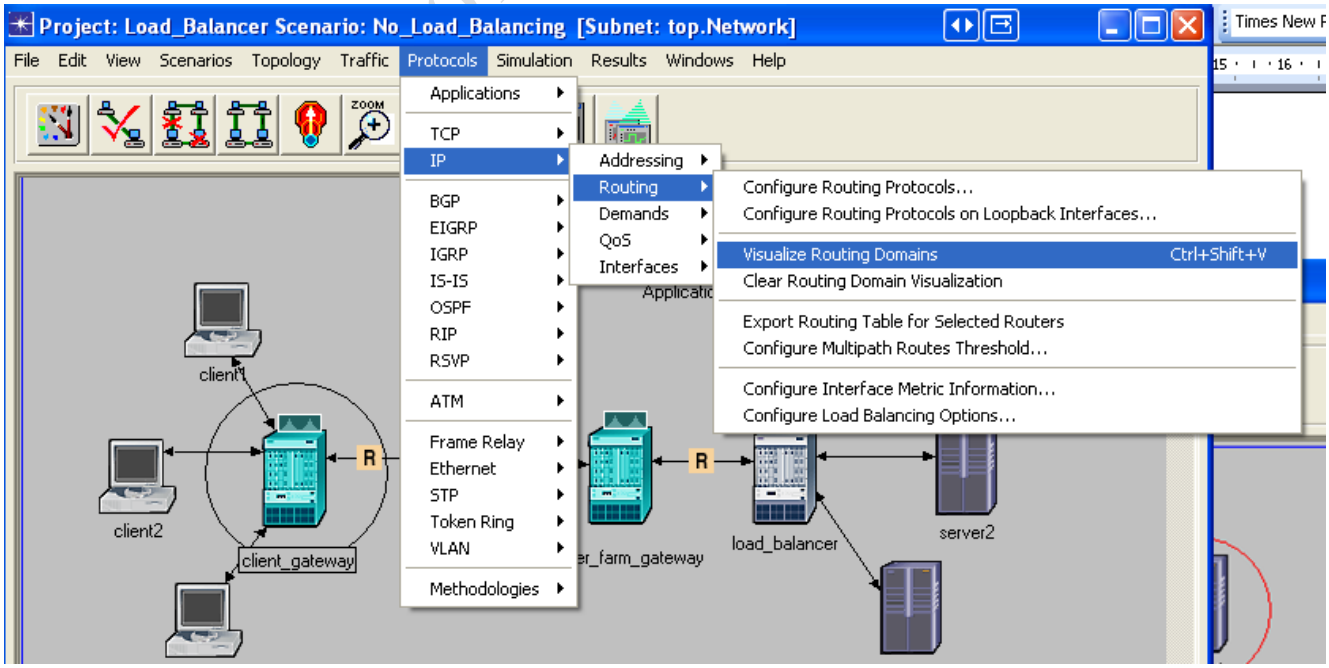
- **Parcurgerea documentatiei:**



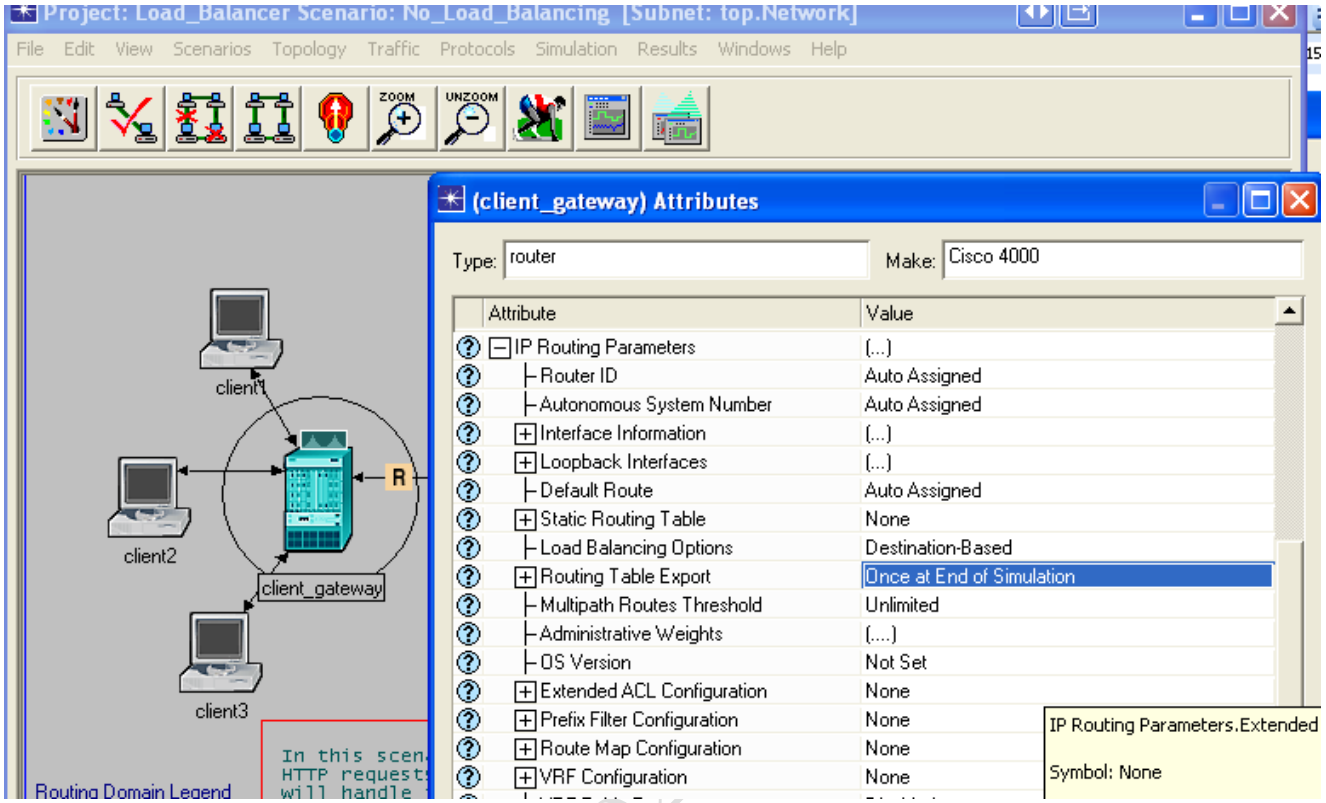
- **Alegere Scenariu: No_Load_Balancing**



- **Domenii de rutare:**



- **Exportul tabelei de rutare a ruterului client_gateway (procedam similar pentru toate ruterele)**



Configurarea Simulării (Simulation)

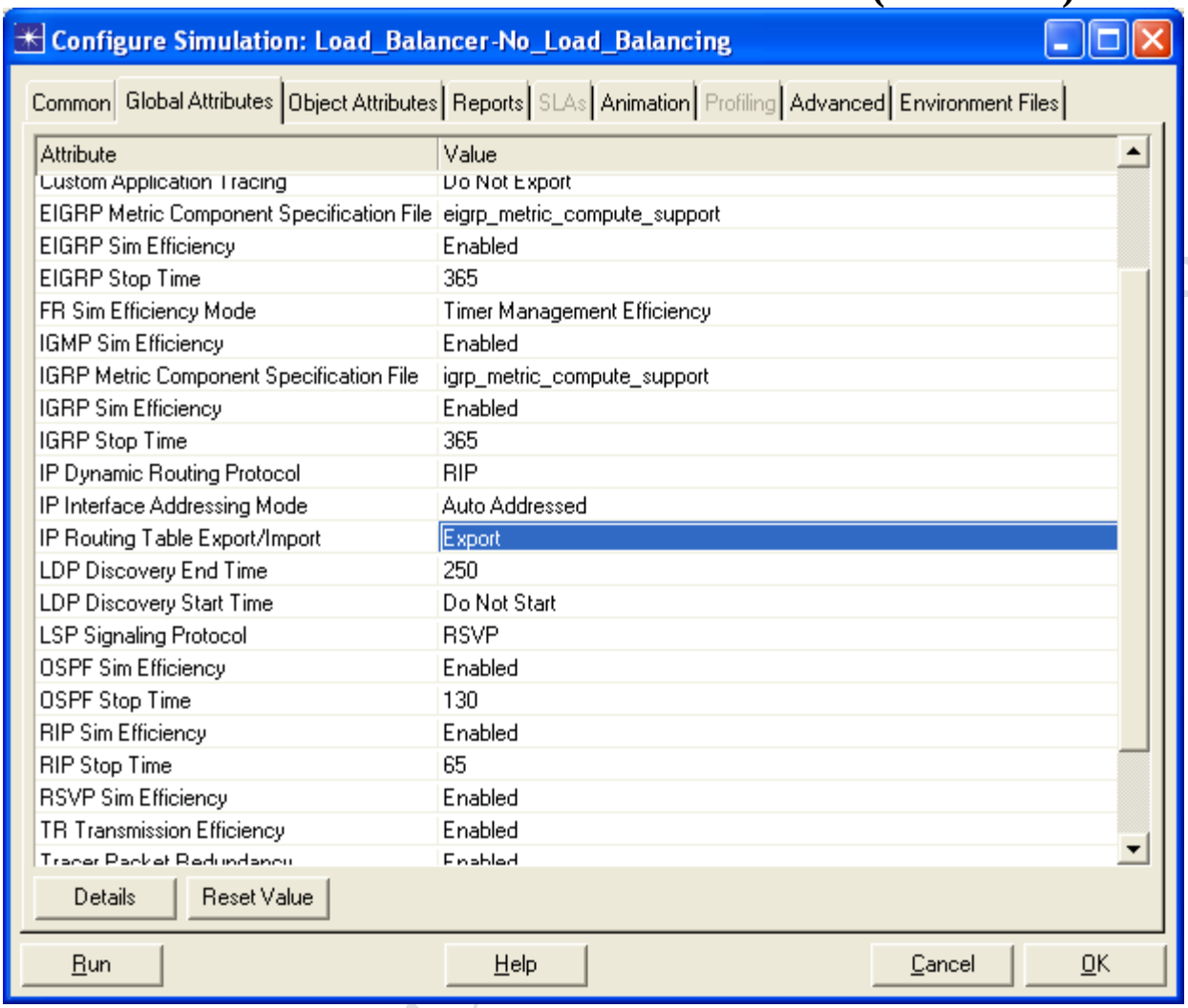
Aici avem nevoie de a configura câţiva parametrii a simulării (simulation):

1. Click pe  şi fereastra *Configure Simulation* ar trebui să apară.
2. Setaţi **durata (duration)** : Ex 1 ora
3. Click pe opţiunea **Global Atributes** şi schimbaţi următoarele atribute:

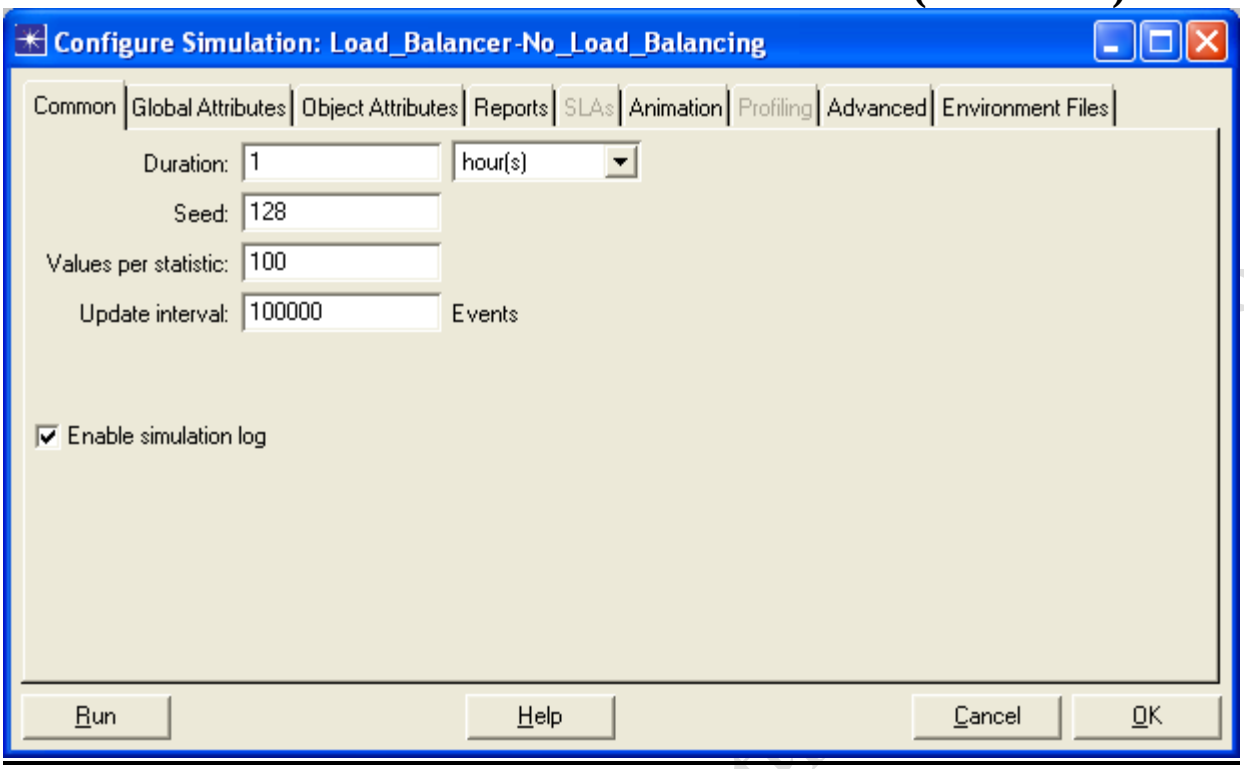
a. **IP Dynamic Routing Protocol = RIP**. Acesta configurează protocolul RIP să fie protocolul de routare pentru toate routerele din reţea.

b. **IP Interface Addressing Mode = Auto Addressed/Export**.

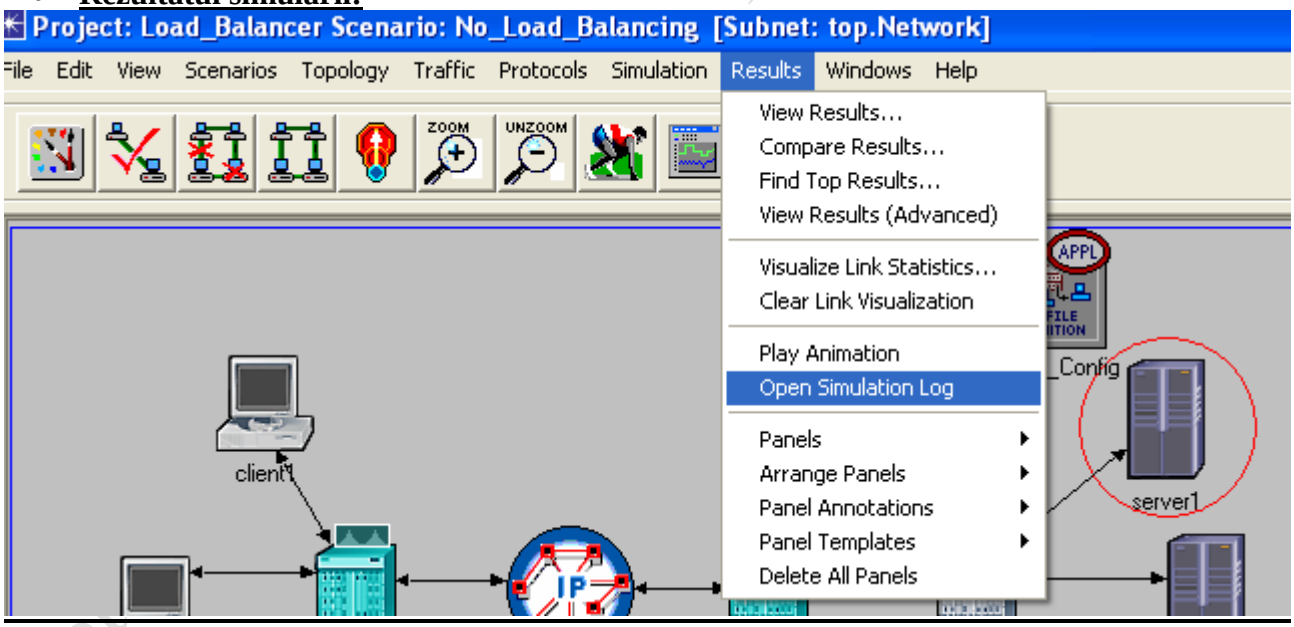
c. **IP Routing Table**: EXPORT



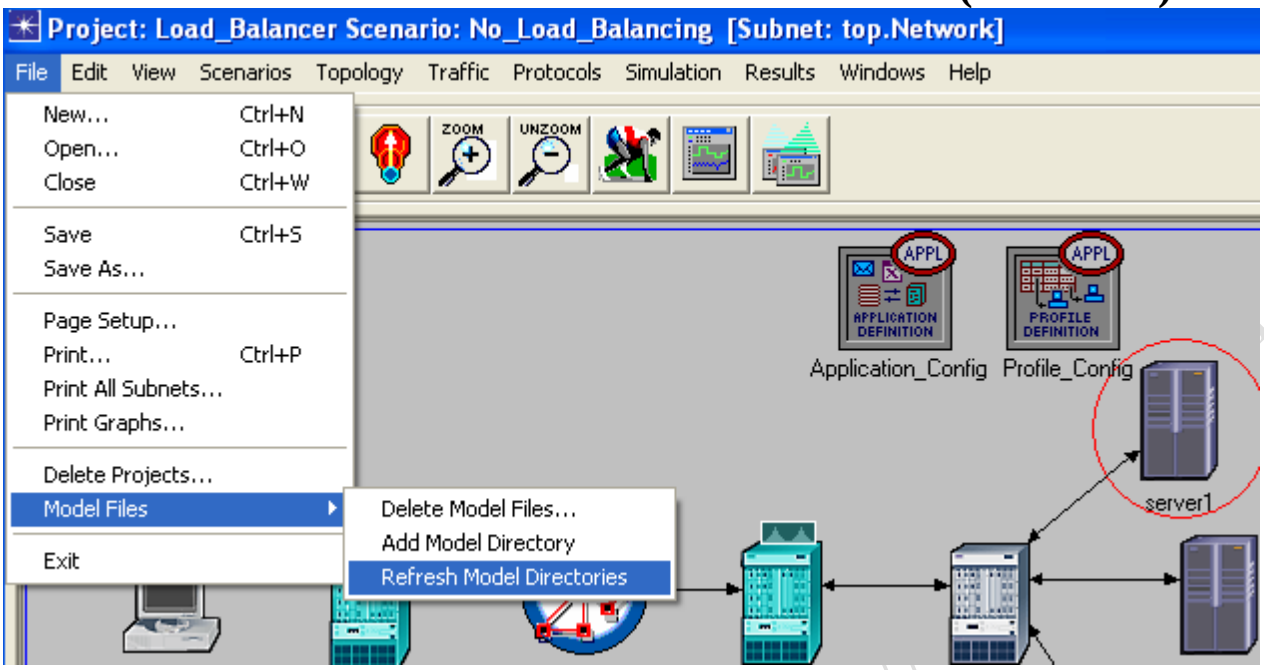
- **Rulati simularea: click pe**  si RUN:

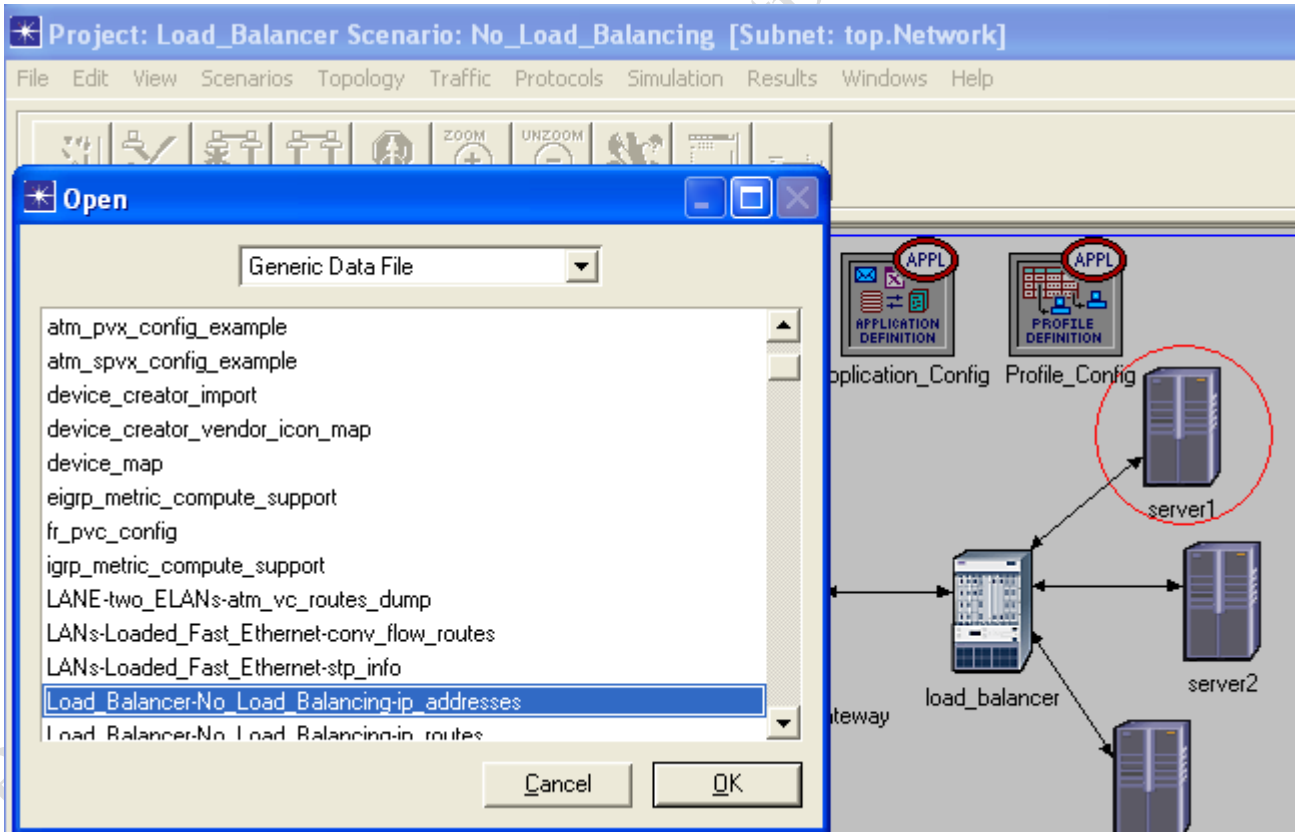


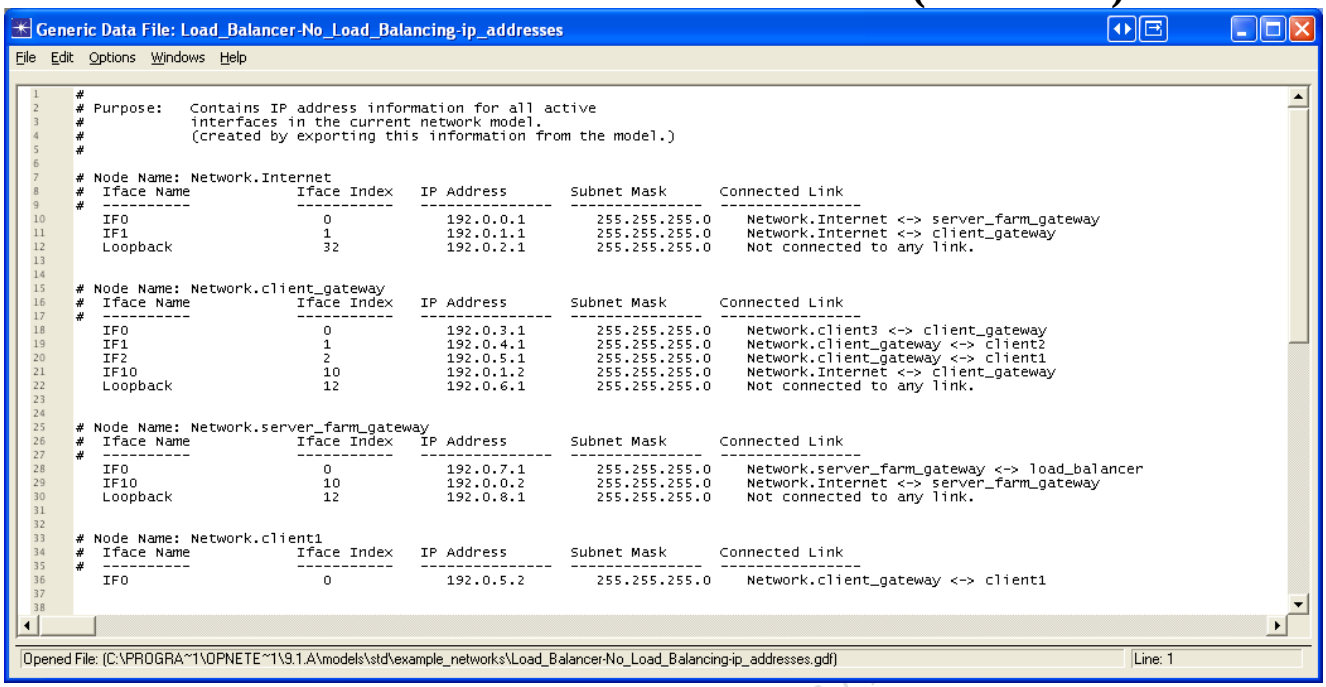
- **Rezultatul simularii:**



- **Preluarea informatiilor privind configurarea interfetelor – Se va completa pe baza acestor informatii Tabela de adresare pentru studiul de caz pus in discutie; Pe schema de lucru se vor completa adresele IP ; Informatiile acestea sunt de un real folos pentru cunoasterea retelei si intelegerea inregistrarilor din tabelele de rutare !!!!!!!!!!**

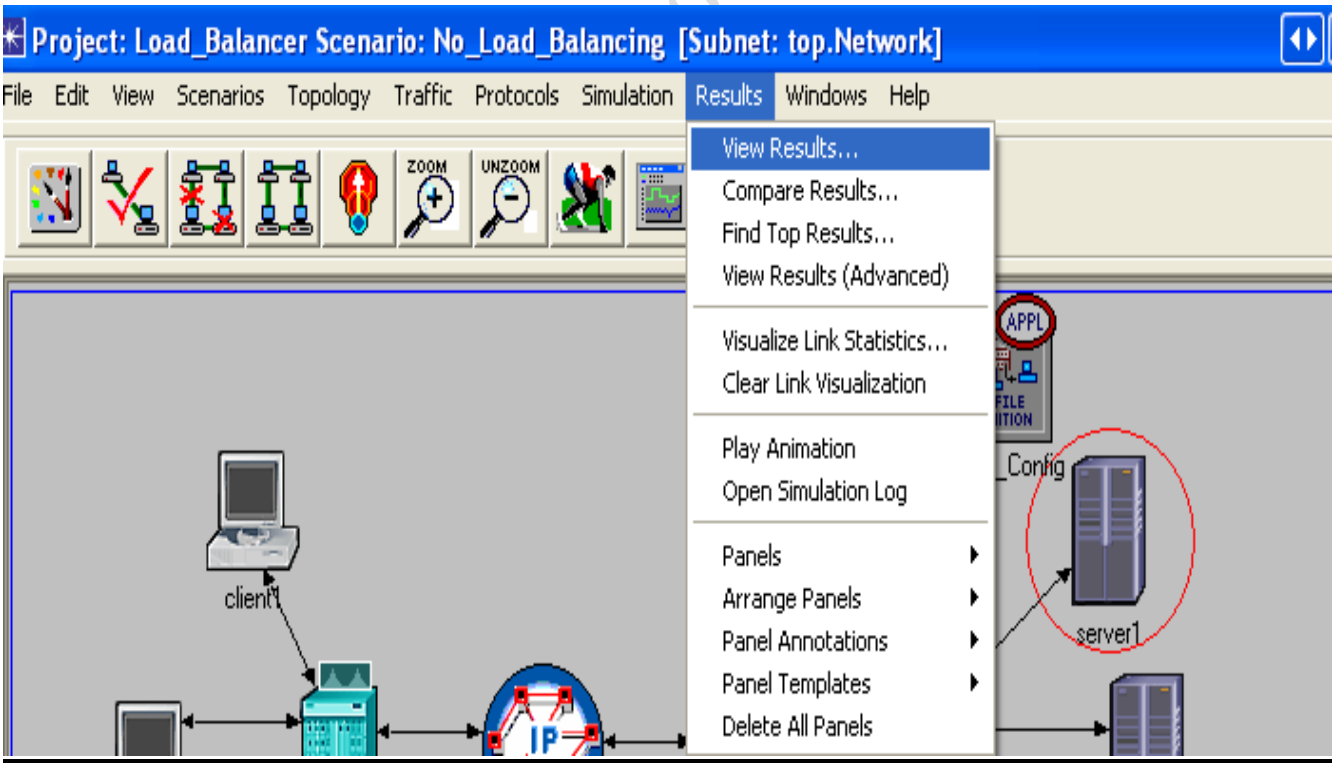

Project: Load_Balancer Scenario: No_Load_Balancing [Subnet: top.Network]
File Edit View Scenarios Topology Traffic Protocols Simulation Results Windows Help
New... Ctrl+N
Open... Ctrl+O
Close Ctrl+W
Save Ctrl+S
Save As...
Page Setup...
Print... Ctrl+P
Print All Subnets...
Print Graphs...
Delete Projects...
Model Files
Exit
Delete Model Files...
Add Model Directory
Refresh Model Directories
ZOOM
UNZOOM
APPL
APPLICATION DEFINITION
PROFILE DEFINITION
Application_Config
Profile_Config
server1


Project: Load_Balancer Scenario: No_Load_Balancing [Subnet: top.Network]
File Edit View Scenarios Topology Traffic Protocols Simulation Results Windows Help
Open
Generic Data File
atm_pvx_config_example
atm_spvx_config_example
device_creator_import
device_creator_vendor_icon_map
device_map
eigrp_metric_compute_support
fr_pvc_config
igrp_metric_compute_support
LANE-two_ELANs-atm_vc_routes_dump
LANs-Loaded_Fast_Ethernet-conv_flow_routes
LANs-Loaded_Fast_Ethernet-stp_info
Load_Balancer-No_Load_Balancing-ip_addresses
Cancel
OK
APPL
APPLICATION DEFINITION
PROFILE DEFINITION
Profile_Config
server1
load_balancer
server2

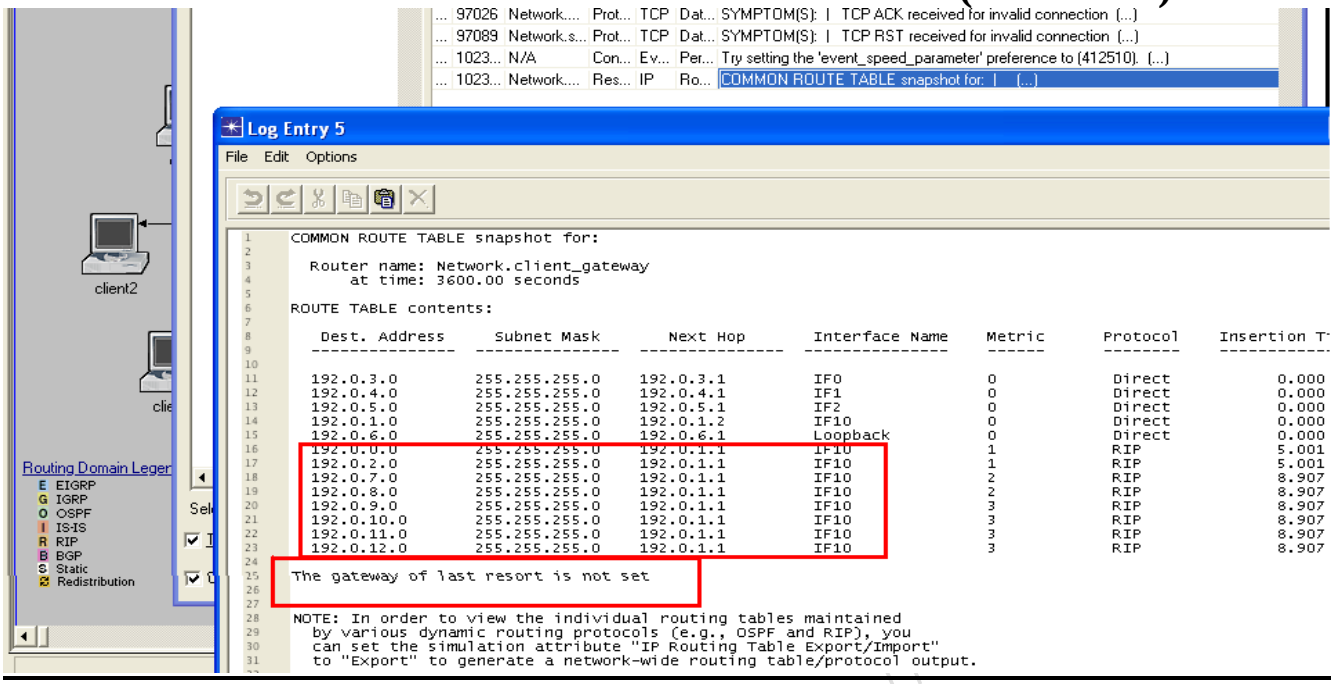


- **Dupa simulare – Vizualizarea rezultatelor….ne intereseaza (deocamdata !!!!) tabelele de rutare ale tuturor ruterelor**

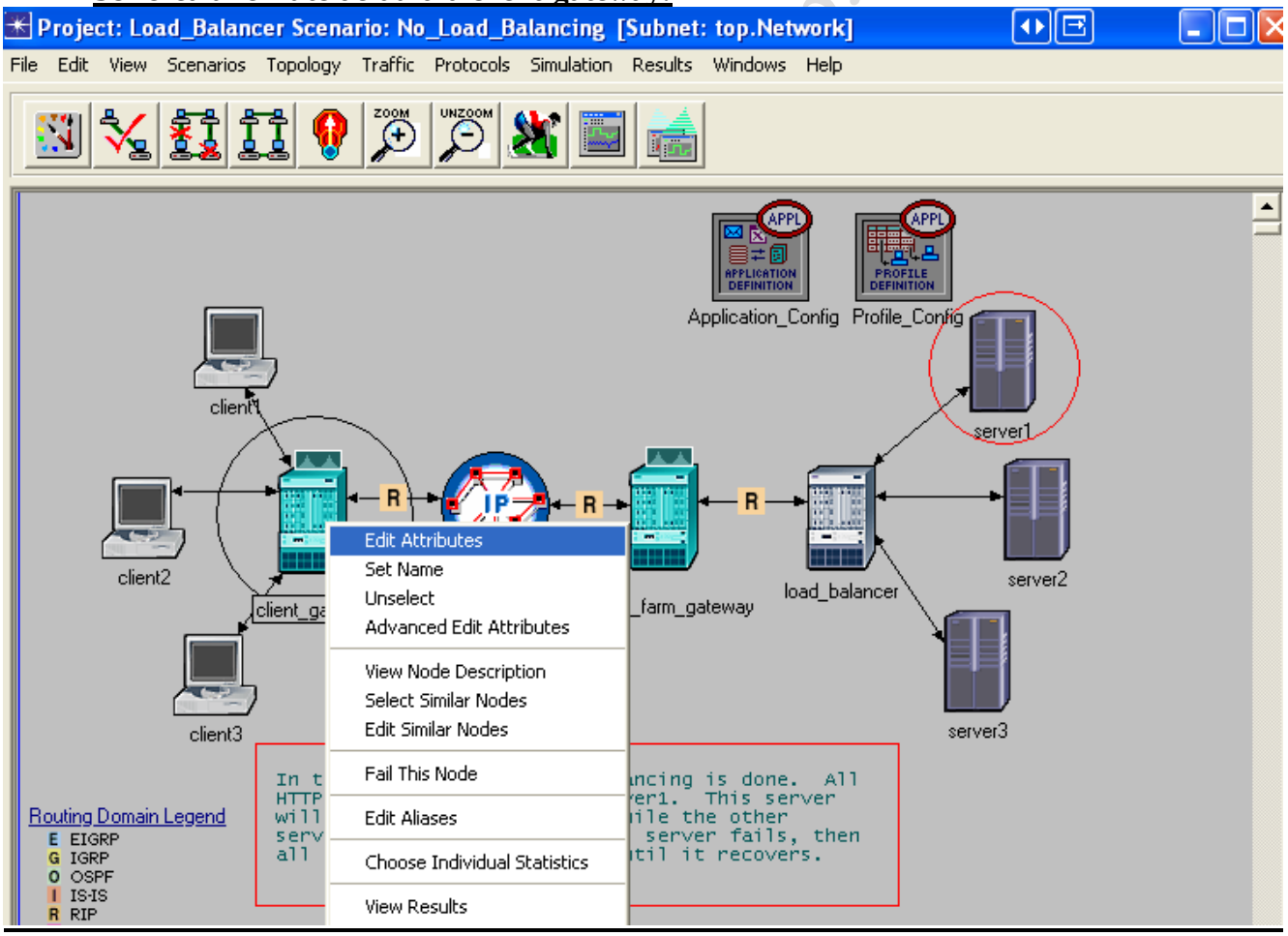
Aici s-a exemplificat numai pentri client-gateway !!!!

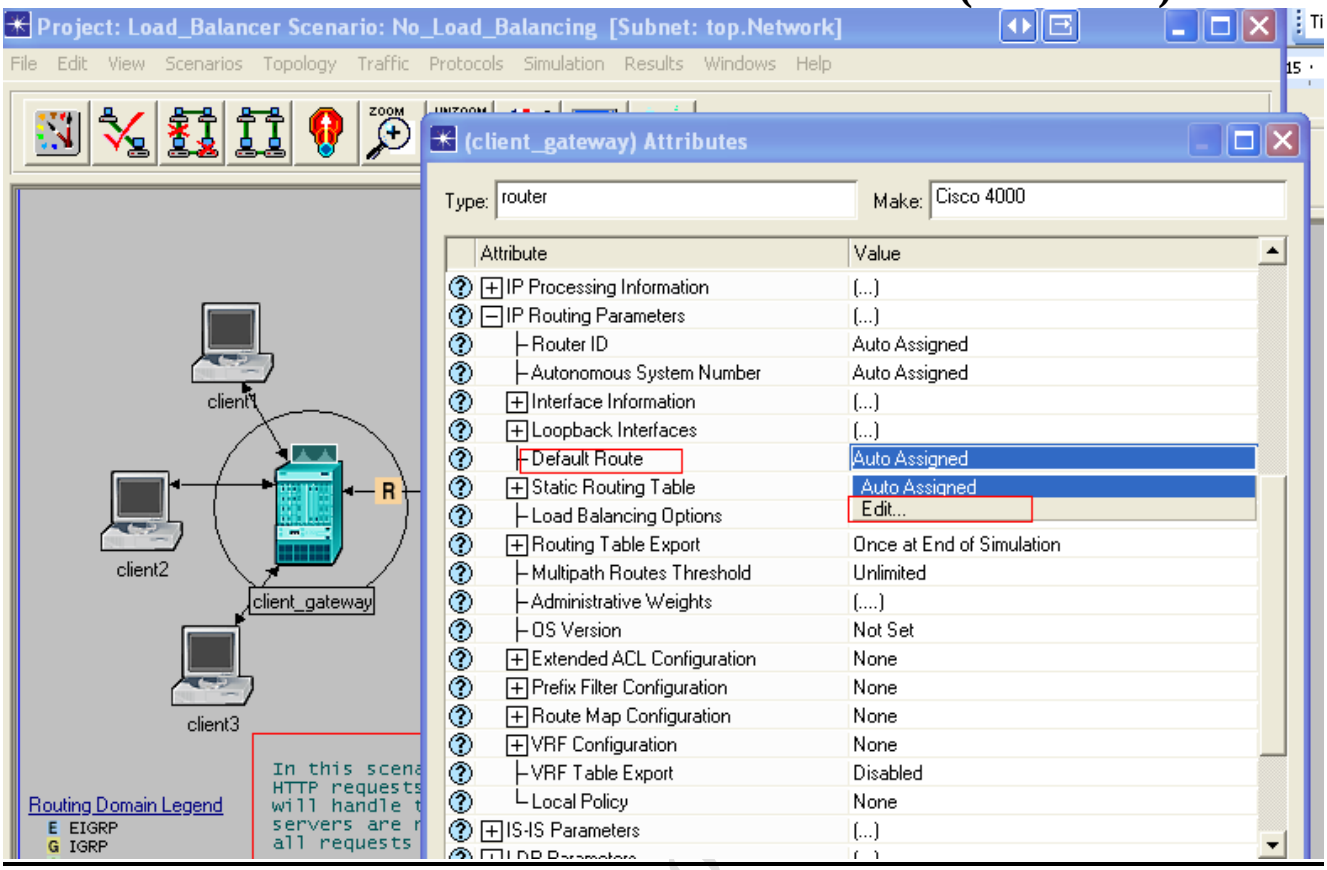


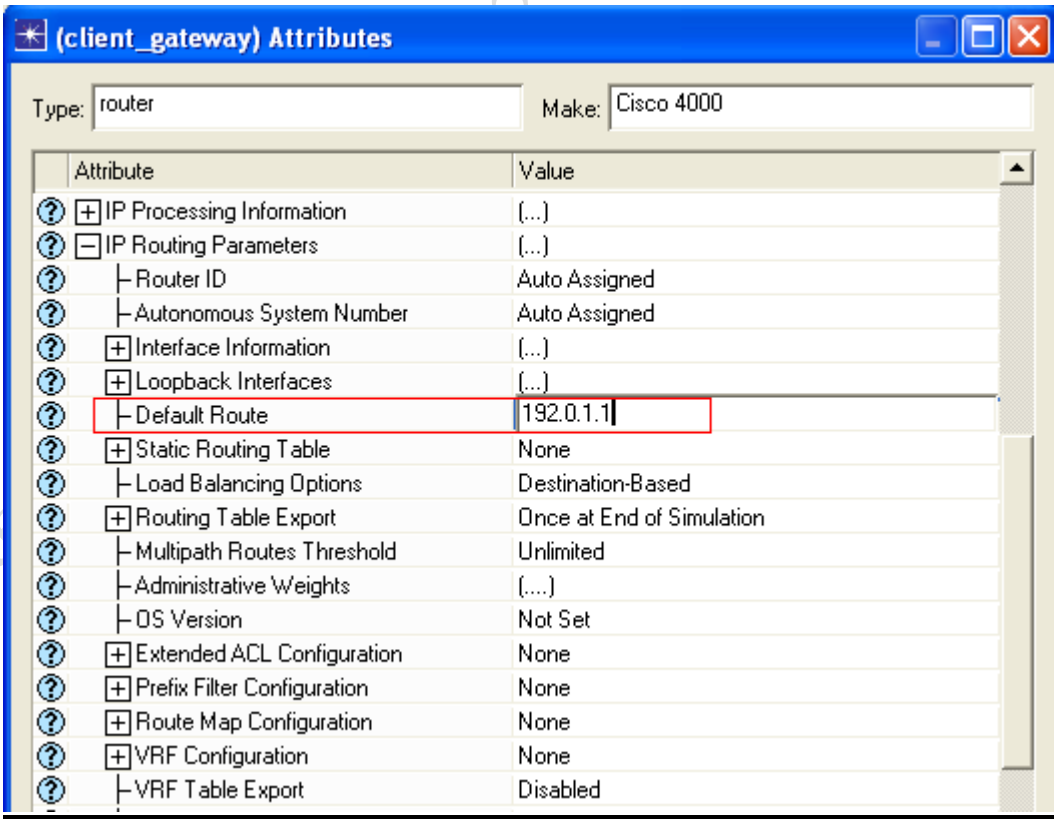
- **Se va comenta lipsa rutei default:**

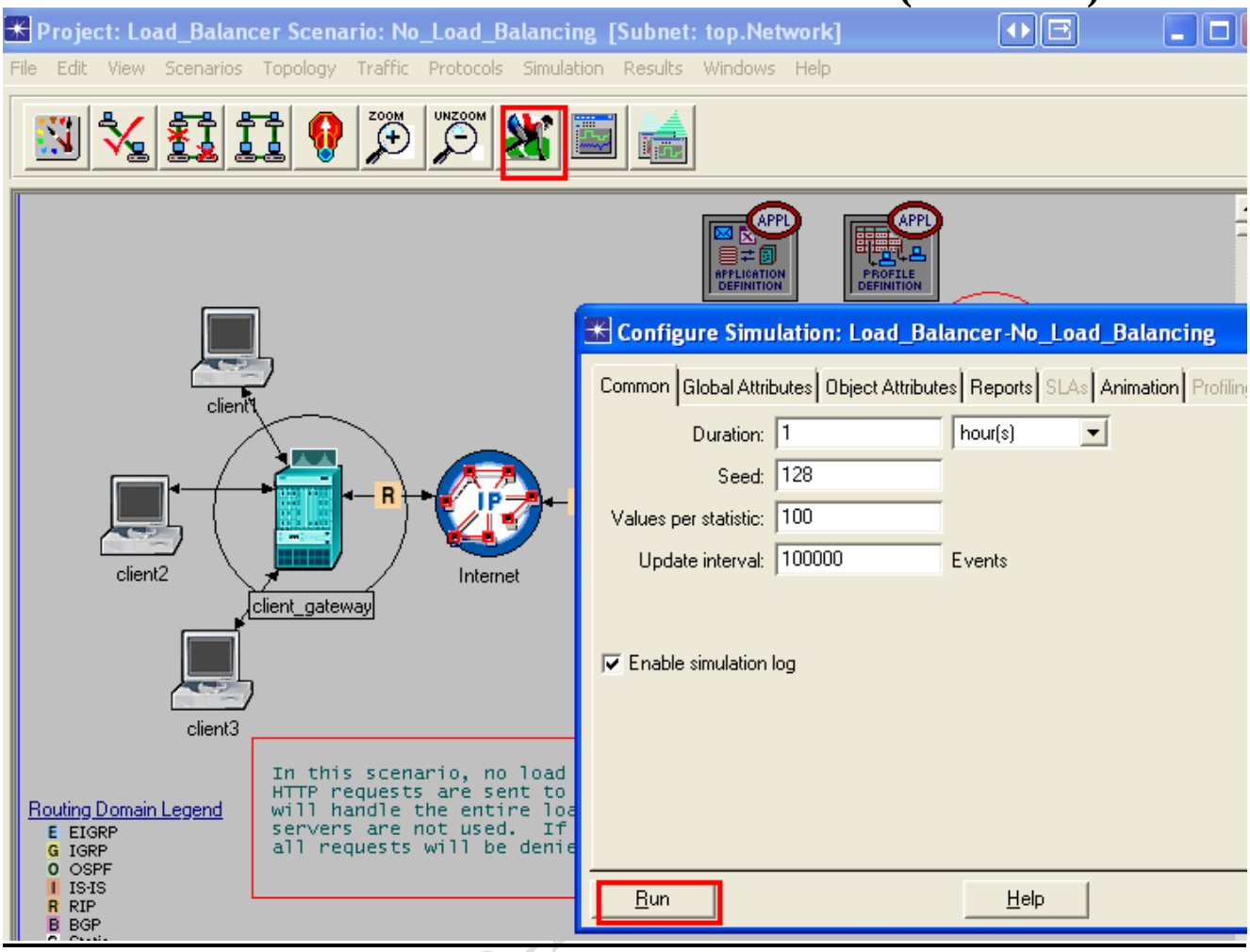


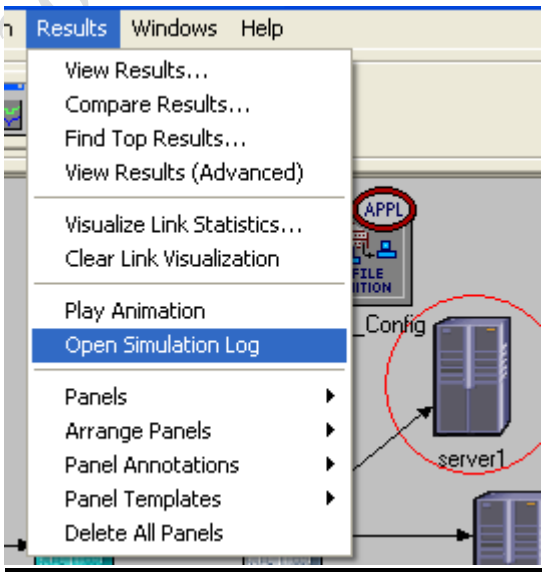
- **Scrierea unei rute default la client-gateway:**



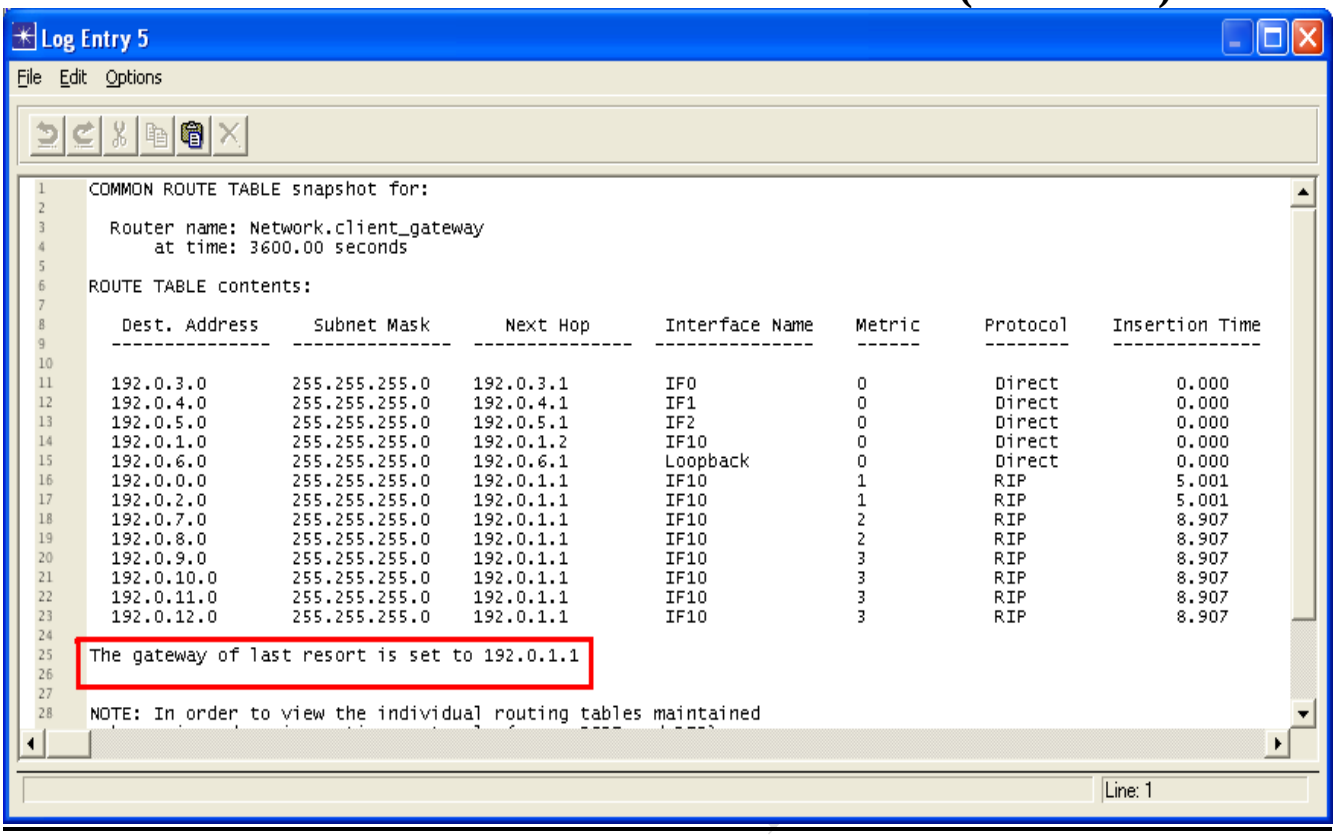

Project: Load_Balancer Scenario: No_Load_Balancing [Subnet: top.Network]
File Edit View Scenarios Topology Traffic Protocols Simulation Results Windows Help
client1
client2
client3
client_gateway
R
Routing Domain Legend
E EIGRP
G IGRP
(client_gateway) Attributes
Type: router
Make: Cisco 4000
Attribute
Value
IP Processing Information (...)
IP Routing Parameters (...)
Router ID Auto Assigned
Autonomous System Number Auto Assigned
Interface Information (...)
Loopback Interfaces (...)
Default Route Auto Assigned
Static Routing Table Auto Assigned
Load Balancing Options Edit...
Routing Table Export Once at End of Simulation
Multipath Routes Threshold Unlimited
Administrative Weights (....)
OS Version Not Set
Extended ACL Configuration None
Prefix Filter Configuration None
Route Map Configuration None
VRF Configuration None
VRF Table Export Disabled
Local Policy None
IS-IS Parameters (...)


(client_gateway) Attributes
Type: router
Make: Cisco 4000
Attribute
Value
IP Processing Information (...)
IP Routing Parameters (...)
Router ID Auto Assigned
Autonomous System Number Auto Assigned
Interface Information (...)
Loopback Interfaces (...)
Default Route 192.0.1.1
Static Routing Table None
Load Balancing Options Destination-Based
Routing Table Export Once at End of Simulation
Multipath Routes Threshold Unlimited
Administrative Weights (....)
OS Version Not Set
Extended ACL Configuration None
Prefix Filter Configuration None
Route Map Configuration None
VRF Configuration None
VRF Table Export Disabled





- **Se va comenta rezultatul urmator:**



Obs: Completam similar cu rute default …pe unde s-ar mai putea scrie!!!!

3.6. Aplicatii de retea in Pyton

3.6.1. Recapitulare (Lab_02, Lab_03)

- **Python_intro**
- **Programare_Python**
- **Byte-of-python**

Obs: Anexa - The Programming Process (pag.40)

3.6.2. Calculul CRC-32 pentru un sir de caractere preluat ca argument la rularea programului.

Indicatii (Solutie ce poate fi adaptata cerintelor de mai sus):

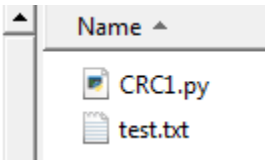
CRC3.py | cidr-to-iptables.py

```
1  import binascii
2
3  print(binascii.crc32(b"Computer Networks"))
4  crc=binascii.crc32(b"Computer Networks")&0xffffffff
5  print('crc32 = {:#010x}'.format(crc))
6
```

```
(base) D:\0000_crc>python CRC3.py
2960339118
crc32 = 0xb07330ae
```

Indicatii:
https://docs.python.org/3.1/library/binascii.html
format() - https://www.programiz.com/python-programming/methods/built-in/format
str.format() - https://www.digitalocean.com/community/tutorials/how-to-use-string-formatters-in-python-3

3.6.3. Calculul CRC-32 pentru fisierul test.txt indicat ca argument la rularea programului.



Indicatii (Solutie ce poate fi adaptata cerintelor de mai sus):

CRC1.py

```
1  import binascii
2
3  def CRC32_from_file():
4      f = open('test.txt', 'r+')
5      buff = f.read()
6      buf = (binascii.crc32(buff.encode()) & 0xFFFFFFFF)
7  #   return "%08X" % buff
8      print("%08X" % buf)
9      print('crc32 = {:#010X}'.format(buf))
10
11 CRC32_from_file()
12
13 # Output:
14 # 8651825C
15 # 0x8651825C
```

```
(base) D:\0000_crc>python CRC1.py
8651825C
crc32 = 0X8651825C
```

3.6.4. Aplicatii - adresare IP

Tutorial 1: IP Addresses, Subnets and Ranges

Se va parcurge integral: 9_Tutorial_1.pdf

3.6.5. Challenge: Aplicatie Python pentru Subnetting si VLSM (Documentarea solutiei: algoritm, instructiuni etc) + Interfata grafica (QtDesigner…)

Observatii

1. **Atentie (Modeler)** – Proiectul creat se salveaza implicit in:
   C:\Users\student(NUME user)\op_model\NUME_PROIECT

NUME_PROIECT ***contine proiectul modeler propriu-zis***

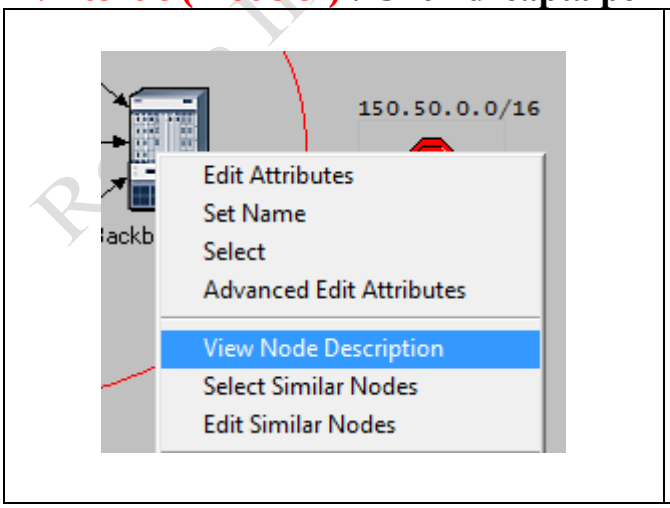
VARIANTA

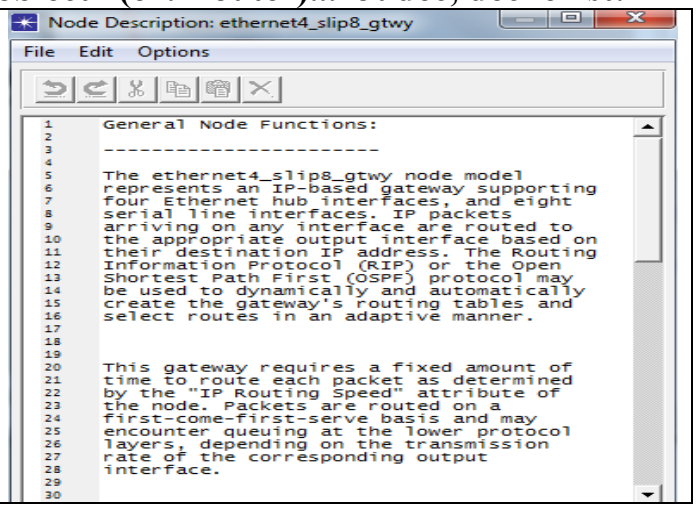
se arhiveaza intreg folderul ***Folder creat mai jos…el contine proiectul opnet propriu-zis***

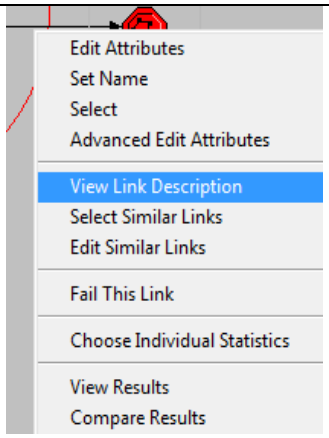
- In directorul **....\Studenti\Info3\Nume_Prenume** se creează directorul **\L2_Modeler_Nume_Prenume** folosind:
  - ***File → New → Folder***
- Se lansează în execuţie IT Guru.
- Se selectează directorul în care vor fi plasate fişierele proiectului.
  - ***File → Model Files →Add Model Directory***
  - Se selectează directorul în care se va lucra (în acest director vor fi salvate fişierele proiectului curent)
  - Se arhiveaza (eventual!) **L2_Modeler_Nume_Prenume (Atentie, gmail nu "prea vrea" .rar in .rar http://www.makeuseof.com/tag/4-ways-email-attachments-file-extension-blocked/)**

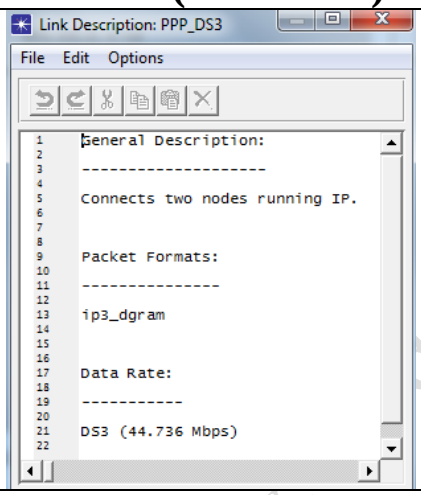
Atentie (Modeler Academic Edition) – se foloseste **readme_mod_work_dir.pdf (este prezent in arhiva Lab_01)** pentru a identifica folderul op_models in care se salveaza default ***proiectul Modeler.***

2. Atentie (Modeler) : Click dreapta pe "obiect" (ex. Router)..."Judec, deci exist!"









…..similar omnet++….. (http://www.omnetpp.org)

4. Tema:

- **Toate punctele din sectiunea 3 "partea practica"** se vor relua de catre cursanti, folosind etapele de lucru indicate. **Rezultatele experimentale:**
  - **L6_nume+prenume_IP_cmd(folder): contine foldere corespunzatoare exercitiilor 3.1, 3.2, 3.3, 3.4 (utilitarul route, capturi comentate), fiecare cu .png si .doc.**
  - **L6_nume+prenume_Modeler (folder)** - contine **proiectele Modeler de la pct 3.5. (3.5.1., 3.5.2, 3.5.3., 3.5.4., 3.5.5)** si **L5_nume+prenume_Modeler.doc** (**document .doc):** rezultatele experimentale: **comentarii insotite de capturi corespunzatoare proiectelor Modeler (3.5.1., 3.5.2, 3.5.3., 3.5.4., 3.5.5) pasi intermediari importanti/topologia fizica, rezultate/capturi pentru View node description si View link description (obs.2 anterioara), exercitiile rezolvate, raspunsuri la intrebari, rezultate finale, observatii finale)**. ATENTIE: proiectele Modeler vor avea denumiri de tipul 3.5_Nume_Prenume)/ (**Varianta "programare" C++: OMNeT++ Network Simulation Framework** http://www.omnetpp.org/)
  - **L6_nume+prenume_Python (folder) – cu subfloderele 3.6.2, 3.6.3, 3.6.4., 3.6.5. (fiecare din acestea contine scripturile .py si document .doc (snipping tool) pentru aplicatiile Python. RECOMANDARE:** 3.6.1 (Lab2, Lab3, Lab4, Lab5)

se vor arhiva cu numele **L6_nume+prenume_info3.rar si** se va trimite prin e-mail la adresa retelecdsd@gmail.com precizandu-se la **subject: L6_nume+prenume_info3**, pana pe data de **15 noiembrie 2019 ora 8.00 a.m., e.n. (Atentie, gmail nu "prea vrea" .rar in .rar http://www.makeuseof.com/tag/4-ways-email-attachments-file-extension-blocked).**
Cursantii sunt incurajati sa analizeze si sa comenteze rezultatele obtinute, studiind si materialele indicate in bibliografie si anexe. **(+ Recapitulare Laboratoarele 1+2+3+4+5!)**
DE ANALIZAT readme-ul readme_mod_work_dir.pdf (si un numai!... de exemplu si **readme_lab_modeler.pdf) de la adresa http://www.cdsd.ro**

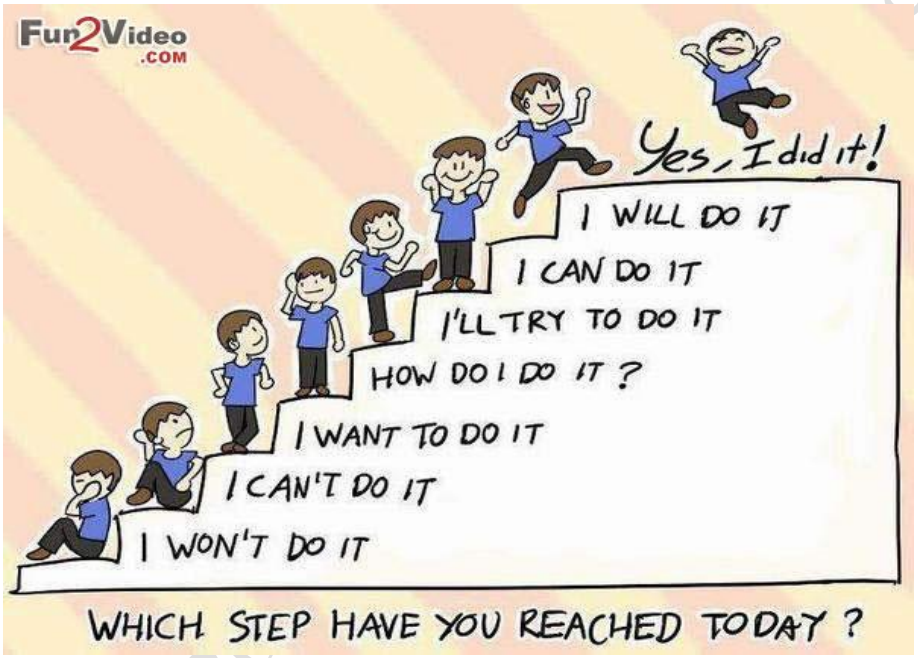
Observatie: Studentii "pasionati" de programare C++, dornici de afirmare....pot opta sa foloseasca pe langa Modeler (sau ca varianta), framework-ul Omnet++ www.omnetpp.org/ **, cu**

pastrarea scenariilor pentru aplicatie, descrise in laborator. Se acorda BS-uri - ”Bonusuri” ...SUBSTANTIALE!)

Obs:

Punctaj maxim (Data trimiterii temei)			
<= 15.11. 2019	19.11. 2019	23.11.2019	27.11.2019
100 pct	80 pct	60 pct	50 pct

Obs: Participarea (activa!) la Curs si Laborator permite, prin cunostintele acumulate, obtinerea unor rezultate bune si f. bune, asa cum ni le dorim cu totii.



Sursa: http://www.funnfun.in/wp-content/uploads/2013/06/steps-of-success-encouraging-quote.jpg

How to send an e-mail

http://lifehacker.com/5803366/how-to-send-an-email-with-an-attachment-for-beginners
https://support.google.com/mail/answer/6584?hl=en “As a security measure to prevent potential viruses, Gmail doesn't allow you to send or receive executable files (such as files ending in `.exe`).”
https://support.google.com/mail/answer/2480713?hl=en
http://fastupload.ro/free.php
http://www.computerica.ro/siteuri-transfer-fisiere-mari-upload/

Bibligrafie:

Lab_01, Lab_02, Lab_03, Lab_04, Lab_05, TL_01, TL_02, TL_03, TL_04
http://www.cdsd.ro/cursuri

http://support.microsoft.com/kb/140859
http://www.windowsreference.com/windows-2000/how-to-add-static-route-in-windows-xp2000vista/
http://www.comptechdoc.org/os/linux/usersguide/linux_ugrouting.html

http://linux-ip.net/html/ch-routing.html
http://www.3com.com/other/pdfs/infra/corpinfo/en_US/501302.pdf
http://www.microsoft.com/resources/documentation/windows/xp/all/proddocs/en-us/route.mspx?mfr=true

efg' Mathematics, http://www.efg2.com/Lab/Mathematics/CRC.htm
http://en.wikipedia.org/wiki/Cyclic_redundancy_check
http://www34.brinkster.com/dizzyk/crc32.asp
http://www.createwindow.com/programming/crc32/crcfile.htm
http://webnet77.com/cgi-bin/helpers/crc.pl
http://www.softpedia.com/get/Others/Miscellaneous/CRC32-Calculator.shtml
http://www.wikiera.net/EthernetCRC-readytouseexample.html
http://www.wireshark.org/docs/wsug_html_chunked/ChAdvChecksums.html

Modeler Tutorials
https://rpmapps.riverbed.com/ae/4dcgi/SIGNUP_NewUser
https://supportkb.riverbed.com/support/index?page=content&id=S24443
https://rpmapps.riverbed.com/ae/4dcgi/DOWNLOAD_HOME
https://rpmapps.riverbed.com/ae/4dcgi/REG_TransactionCode

- Install Riverved Modeler 17 5 Windows 10, 8 1, 8 and 7 **(**https://www.youtube.com/watch?v=TpenN2jYbHQ)
- Install Riverbed Modeler (https://www.youtube.com/watch?v=DQ3XhHYuFGA)
- How to activate riverbed modeler 17.5 **(**https://www.youtube.com/watch?v=h-ImeJMqiSA)
- How to solve invalid activation of Opnet Modeler 17.5 **(**https://www.youtube.com/watch?v=13ZBcXkW46s)
- Riverbed Modeler 17.5 Tutorial - Switched Lan (https://www.youtube.com/watch?v=XdebwQLrr0w)
- 6-Virtual LAN (VLAN) configuration in OPNET Riverbed (https://www.youtube.com/watch?v=Ajz7bVO5WJM)
- Riverbed Modeler Configuracion VLAN (https://www.youtube.com/watch?v=rP3jPMcyEFk)
- Ethernet (lab_04)
- Riverbed Opnet 17.5 Tutorial - The Ethernet network **(**https://www.youtube.com/watch?v=fS_J6ApFJtc)
- 6-Virtual LAN (VLAN) configuration in OPNET Riverbed (https://www.youtube.com/watch?v=Ajz7bVO5WJM)
- Riverbed Modeler Tutorial 3 Configuracion VLAN (https://www.youtube.com/watch?v=rP3jPMcyEFk)

Python (Lab1, Lab2, Lab3, Lab4, Lab5)
Using Python on Windows - https://docs.python.org/3/using/windows.html
The Hitchhiker's Guide to Python - http://docs.python-guide.org/en/latest/intro/learning/
A Byte of Python - https://www.gitbook.com/book/swaroopch/byte-of-python/details
GUI Programming in Python - https://wiki.python.org/moin/GuiProgramming
https://winpython.github.io/ ; https://www.python.org/

Anexa: The Programming Process

1. Identify the Problem - **What** Are You Trying To Do?
    - Requirements
    - Specification
2. Design a Solution - **How** Is It Going To Be Done?
3. Write the Program - **Teaching** the Computer
    - Code
    - Compile
    - Debug
4. Check the Solution - **Testing** it Understands You