# **OPNET/Riverbed Modeler:** Building Network Topologies

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Lecture № 3

## Outline

#### Network topologies

- Object palette
- Building network topologies
- 4 Verifying connectivity
- 5 Failing and recovering objects
- 6 Subnets

### Annotation palette

### Outline

### Network topologies

- 2 Object palette
- 3 Building network topologies
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#### Annotation palette

## Network Topologies

- Personal Area Network (PAN) a network used for communications among devices close to a person
- Local Area Network (LAN) a network covering a small geographic area, like a home, office, floor or a building
- Campus Area Network (CAN) a network made up of an interconnection of LANs within a limited geographic area
- Metropolitan Area Network (MAN) a network spanning a city
- Wide Area Network (WAN) a network, which provides communications support to an area ranging in size from a region, country, or even a good portion of the entire world

- Communication networks can be categorized by their scale
  - But beware of absolutes!



Characteristic	LANs	WANs
Number of users	Shared by a relatively small number of users	Shared by a large number of users
Topology	Usually limited to bus, ring, star, or tree	Virtually unlimited design capability
Data routing	Normally follow a fixed route	Use dynamic routing to reroute data in case of link failure or excessive traffic
Ownership	An organization that installs a LAN normally owns all of the components, including the cabling	The construction of a WAN requires the leasing of transmission facilities from one or more operators
Regulations	Primarily in the areas of building codes (level of electromagnetic emission, type of wiring, etc.)	Subject to a number of governmental regulations at the local and national levels

- Most LANs are designed to operate based on the interconnection of nodes that follow a specific topology
- Physical topology describes how the nodes are physically connected
  - Some of physical topologies are variants of others



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- Logical topology describes how information is passed among nodes
- Basic logical topologies:
  - Bus
  - Ring
  - Star
- The physical and logical topologies are independent(!) of each other
  - A network may be laid out physically in one fashion but operate logically in an entirely different manner

Topology	Physical	Logical
Bus	All nodes are connected to a single continuous cable	All data are broadcast to the entire network
Ring	All branches of the network are connected to a closed loop branches of the network the next in an a sequence; whe reach the last returned to the node	Data flow from one node to the next in an ordered sequence; when the data reach the last node, they are returned to the originating node
Star	All branches of the network are connected through a central node	A central node directs all network transmissions so data are only delivered to the nodes they are intended for

• Physical topology vs. logical topology



Physical topology: star



Logical topology: star



Logical topology: bus



Logical topology: ring

## Outline

#### Network topologies

### Object palette

- 3 Building network topologies
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- 6 Subnets

#### Annotation palette

## Object Palette

#### • **Object Palette** – provides access to all OPNET/Riverbed models



#### • Open Object Palette

Project: project1 Scenario: sc	enario1 [Subnet: top.Office Network]					
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#### • internet toolbox – the default model family



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#### • Any other model families can be specified during project creation



• You can change the scenario's default model family (default palette)



#### • Models: Node, Link, Path, Demand, Wireless Domain, Shared



 Node Models – contains models of the communicating devices such as hubs, switches, routers, gateways, workstations, and servers



 Link Models – contains models of the links such as 1000Base-T Ethernet link, T1 duplex link, and 16 Mbps Token Ring



• **Shared Models** – contains a collection of different models grouped according to common properties such as vendors or technologies



Model naming conventions



#### • 3C\_SSII\_1100\_3300\_4s\_ae52\_e48\_ge3

- 3C\_...\_4s = a stack of 4 switches manufactured by 3Com, Inc.
- SSII\_1100 = SuperStack II 1100
- SSII\_3300 = SuperStack II 3300
- ae52 = 52 auto-sensing Ethernet ports
- e48 = 48 Ethernet ports
- ge3 = 3 Gigabit Ethernet ports



• Use 'View Model Details' or 'Model Details'



• See 'Model Description'

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Node Model Description: 3C_SSII_1100_330	00_45_ae52_e48_qe3
Comments	Parent model
Model Description:	3C_SSII_1100_3300_4e_ue42_e48_ge43_e6v           Vew Parent
Keywords	Supported node types
node <u>switch</u>	Node Type Default Icon fixed sw_3com
ethemet 10BaseT 100BaseT	Logical Subnet
Attributes	Satelite Subnet
Attribute Name	Initial Value
Bridge Parameters	() Mobile Subnet
Delay, Jitter and Loss	Unassigned
LACP System Priority	32768
Switch Port Configuration	() Subnet
Switch Port Group Configuration	None
	Not Configured
Switch System Management Parameters	

Compare with an abstract node in ns-2 (network simulator v2):
 set node\_0 [\$ns node]



• Searching for models based on their names



Not all model names contain complete words!



• Use 'Create Custom Model' to create your own custom node models



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## Outline

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#### Annotation palette

# Building Network Topologies

- Methods for building network topologies:
  - Manually, by dragging and dropping objects from the Object Palette window to the Project Editor workspace
  - ② Manually, using the Topology ⇒ Rapid Configuration... command from the toolbar to specify and build a complete network topology quickly
  - Automatically, by **importing** the network model from an external data source – either a system that monitors your network or one or more data files that describe the network

### • Riverbed Modeler Academic Edition 17.5 vs. **OPNET Modeler 14.5**

🚺 Startup Wizard: Initial Topology		×
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• Adding nodes from Object Palette



• Adding links from Object Palette



#### $\bullet\,$ To delete nodes or links, select them and use DEL or Edit $\Rightarrow\,$ Delete

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• Topology  $\Rightarrow$  Rapid Configuration...

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#### • Specifying a seed value for the random number generation

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• Some topologies may require randomness for node placement

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#### • Example 1: 5 workstations (seed = 1) and 5 servers (seed = 2)



#### • Example 2: 5 workstations (seed = 1) and 5 servers (seed = 1)



• Select the desired topology configuration from the pull-down list



#### • If the Node or Link model lists do not contain the models needed

🔣 Rapid Cont	figuration: Bus	×	
Models			ysis DES 3DNV Design Windows
Node model:	NONE	Number: 5	_
Link model:	NONE 1000BareX LAN	Tap model: NONE	8 R J R R
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	ethernet32_hub		
	ethernet4_slip8_gtwy		
82.5	ethernet_server		
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• Then use 'Select Models...' to choose the necessary model family

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#### • internet toolbox $\Rightarrow$ ethcoax

Rapid Con	figuration: Bus			<b>—</b>		• ×
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Link model:	NONE ethcoax16_bridge	-	Tap model: eth_tap			
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• Creating a bus topology with Rapid Configuration



## Outline

#### 1 Network topologies

- 2 Object palette
- 3 Building network topologies
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  - 5 Failing and recovering objects
- 6 Subnets

#### Annotation palette

# Verifying Connectivity

- Simply placing nodes into a project workspace and connecting them with links is not sufficient to create a working model of a network topology
- There are a variety of constraints on how nodes can be connected with links
- The simulation will not proceed if these constraints have not been followed
- OPNET/Riverbed Modeler provides sophisticated debugging tools

#### • Topology $\Rightarrow$ Verify Links... $\Rightarrow$ Verify links

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• All links and paths are connected properly ©



#### • 1 incorrect link or path was found $\ensuremath{\mathbb{S}}$



- Common mistakes in connecting nodes:
- Connecting a link to a node that doesn't support the link's protocol
   E.g., FDDI vs. ethernet\_server
- Connecting more nodes to a device than the number of available ports a = 5 17 other part, which we other parts for switch
  - E.g., 17 ethernet\_wkstn vs. ethernet16\_switch
- Connecting a link to a wrong port
  - E.g., 5 100BaseT and 7 PPP\_DS1 vs. ethernet4\_slip8\_gtwy

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#### Annotation palette

## Failing and Recovering Objects

- Often it is important to determine how the system behaves when one or more nodes/links go down
- Methods for failing and recovering objects
  - Manually, by removing objects from the Project Editor workspace and adding them back
  - ② Manually, using the Topology ⇒ Fail Selected Objects and Recover Selected Objects commands from the toolbar
  - Automatically, using the Failure Recovery node to fail and recover objects at specific times during the simulation

## Failing and Recovering Objects (cont'd)

#### • Fail/Recover Selected Objects



# Failing and Recovering Objects (cont'd)

#### • Failure Recovery



## Failing and Recovering Objects (cont'd)

#### • node 0 will fail at time 100 and then recover at time 200 seconds

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50.0	3	- Name	Office Network.node_0
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	3	- Status	Fail
	6	8 Office Network.node_0	
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#### Annotation palette

### Subnets

- Subnet (aka subnetwork) a container that encompasses a set of nodes and links to represent a physical or logical grouping of objects
- Subnets can also contain other subnets
- Subnets within other subnets form the hierarchy of the network model
- Besides the objects it contains, the primary attributes of a subnet are:
  - Geographical position
  - Physical span
  - Mobility
- However, subnets may be used just to arrange network objects in a 'virtual topology' without considering physical properties such as geographic positions

#### • Use 'Create Fixed Subnet...' or drag and drop 'Subnet'

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N75°	Import Topology	+	Cre	ate Logic	al Subnet			
5	Export Topology	•	Cre	Create Mobile Subnet Create Satellite Subnet				
	Import Performance Metrics	•	-					
NB0*	Configure Link Delays	+	Cre	Create And Populate Geographic Subnets				
	Model Assistant	+	Me	Move Selected Nodes Into Parent Subnet				
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Copyright (c) 2016 NapInfo Corp	Recover Selected Objects							
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#### • Fixed Subnet (Subnet) - has a physical span specified in degrees





• Riverbed Modeler Academic Edition : no x/y span ③

- Longitude = x position
- Latitude = y position



#### • Use 'Create Logical Subnet...' or drag and drop 'Logical Subnet'

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W175° W150° W125°	Subnets	- '	Create Fixed SL	ibnet					
N75°	Import Topology	•	Create Mobile Subnet						
1.5 1 5 1	Export Topology	•	Create Satellite Subnet						
	Import Performance Metrics	•		create satellite subjects					
N50*	Configure Link Delays	•	Create And Po	Create And Populate Geographic Subnets Group Nodes Into Subnets Move Selected Nodes Into Parent Subnet					
7	Model Assistant		Move Selected						
N25*	Create Custom Device Model		Move Selected	Move Selected Nodes Into Patent Subnet					
	Rapid Configuration	L T	Fixed Node	Applic					
	Delete Unconnected Nodes		Fixed Node	Ascer					
0*	Deploy Wireless Network								
ALC: NO	Open Edge Connectivity Wizard		Fixed Node	_					
\$25*	Terrain	+ vite	ch Fixed Node						
	Define Trajectory		Fixed Node		Logical Subnet				
	Clear Trajectory Assignment		Fixed Node	Ether					
\$50°	Bandom Mobility	•	Fixed Node	Firew	Satellite Subnet				
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	Import STK Orbit		Fixed Node	Ether					
\$75*	Verify Links	Ctrl+L	Fixed Node Fixed Node	IP-lay	Mobile Subnet				
	Shared Risk Groups	+	Fixed Node	IP CK T					
	Fail Selected Objects		r wed houe	"Ľ	Subnet				
Copyright (c) 2016 MapInfo Corp	Recover Selected Objects								
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### • Logical Subnet - has no physical span

• All objects inside are assumed to be in the same geographic location (i.e., the location of the logical subnet)





• Create And Populate Geographic Subnets...



Roman Dunaytsev (SUT)

#### Network Modeling & Simulation

#### • Asia $\Rightarrow$ Russia $\Rightarrow$ Saint Petersburg $\Rightarrow$ Create »



### • Saint Petersburg (logical subnet)





• Add one or more subnets



Roman Dunaytsev (SUT)

Network Modeling & Simulation

#### • Populate each of the created subnets with network objects



• Utility objects should be added only once, usually in the top subnet



## Outline

#### 1 Network topologies

- 2 Object palette
- 3 Building network topologies
- 4 Verifying connectivity
- 5 Failing and recovering objects
- 6 Subnets

### Annotation palette

• Topology  $\Rightarrow$  Open Annotation Palette

