OPNET/Riverbed Modeler:
Getting Started

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Lecture № 2

Outline

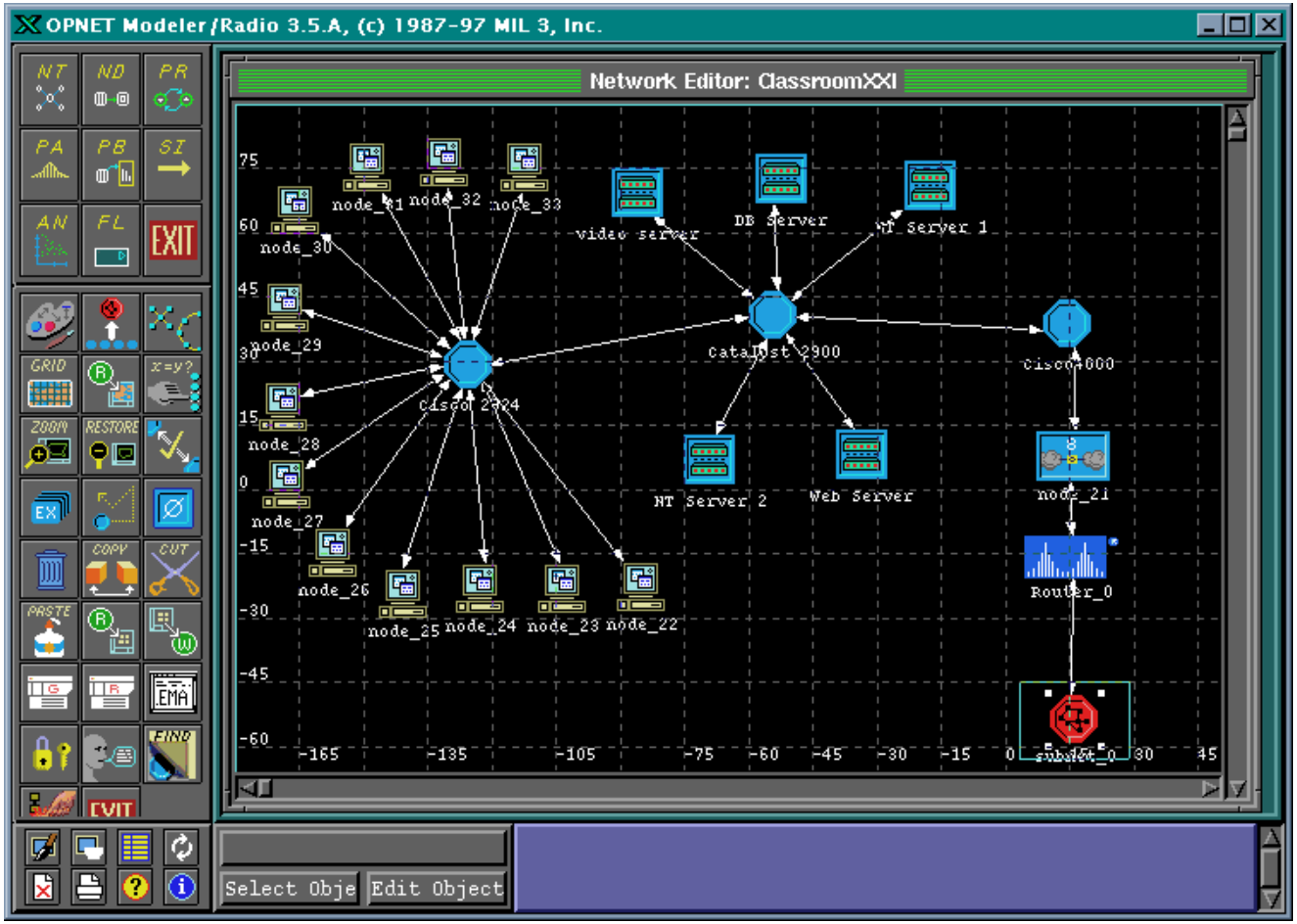
Outline

Introduction

- Alain Cohen, a 20-year-old MIT student, developed OPNET in 1986
  - Alain Cohen and his classmate Steven Baraniuk developed a prototype data network modeling and simulation system they called '**Optimized Network Engineering Tools**', or **OPNET** for short

Introduction (cont'd)

- In 1986, Alain Cohen, along with his brother Marc and Steven Baraniuk, founded **MIL 3, Inc.** (Modeler 1.1)



Introduction (cont'd)

- In 2000, MIL 3 changed its name to **OPNET Technologies, Inc.** and became a public company (Modeler 7.0)
  - Alain Cohen – Chief Technical Officer (CTO)
  - Marc Cohen – Chief Executive Officer (CEO)

- In 2012, OPNET was acquired by **Riverbed Technology, Inc.** for about $1 billion USD (Modeler 17.5)

Introduction (cont'd)

- Selected historical consolidated financial data
  - Significant investments in **research and development (R&D)**

	2012	2011	2010	2009	2008
	(in thousands, except per share amounts)				
Consolidated Statement of Operations Data:					
Revenue:					
Product	$ 85,820	$ 72,392	$ 52,252	$ 51,211	$ 38,838
Product updates, technical support and services	62,299	53,392	47,264	43,067	34,787
Professional services	24,599	22,202	26,831	28,601	27,721
Total revenue	172,718	147,986	126,347	122,879	101,346
Cost of revenue:					
Cost of product	14,177	9,293	5,983	3,536	1,035
Product updates, technical support and services	5,922	5,260	4,859	4,665	4,514
Professional services	16,407	16,183	19,328	20,911	19,154
Amortization of acquired technology	2,159	2,050	1,835	2,172	1,486
Total cost of revenue	38,665	32,786	32,005	31,284	26,189
Gross profit	134,053	115,200	94,342	91,595	75,157
Operating expenses					
Research and development	37,781	34,718	32,043	30,791	27,471
Sales and marketing	55,413	48,733	43,181	42,533	39,357
General and administrative	12,948	12,947	11,011	11,857	11,747
Total operating expenses	106,142	96,398	86,235	85,181	78,575
Operating income (loss)	27,911	18,802	8,107	6,414	(3,418)
Total other income (expense), net	(87)	(151)	(70)	1,246	3,579
Income before income taxes	27,824	18,651	8,037	7,660	161
Provision (benefit) for income taxes	9,491	6,250	2,214	2,928	(372)
Net income	$ 18,333	$ 12,401	$ 5,823	$ 4,732	$ 533
Net income per share:					
Basic	$ 0.81	$ 0.57	$ 0.28	$ 0.23	$ 0.03
Diluted	$ 0.80	$ 0.55	$ 0.28	$ 0.23	$ 0.03

Introduction (cont'd)

- The company's first product was **OPNET Modeler** – a software tool for network **modeling and simulation (M&S)**
- Since then, it has been diversified to provide a range of solutions for:

Application Performance Management

- AppTransaction Xpert
- AppTransaction Xpert Packet Trace Warehouse
- AppInternals Xpert
- AppCapacity Xpert
- AppSQL Xpert
- AppSensor Xpert
- AppMapper Xpert
- Unified Communications Xpert
- AppResponse Xpert Appliance
- AppResponse Xpert Rover
- AppResponse Xpert on RSP
- AppResponse Xpert VMon
- AppResponse Xpert v2000
- AppResponse Xpert for ISR
- AppResponse Xpert BrowserMetrix
- OPNET Dashboards

Network Engineering, Operations & Planning

- SP Guru Network Planner
- SP Guru Transport Planner
- IT Guru Network Planner
- IT Guru
- NetOne Bundle for Enterprises
- VNE Server
- Report Server
- IT NetMapper
- IT Sentinel
- SP Sentinel
- OPNET nCompass for Enterprises
- OPNET nCompass for Service Providers

Modeling & Simulation

- OPNET Modeler
- OPNET Modeler Wireless Suite
- OPNET Modeler Wireless Suite for Defense

Introduction (cont'd)

- Customers:

1. **Service providers**
   - British Telecom, Deutsche Telekom, France Telecom, Inmarsat, ...
2. **Enterprises**
   - Deutsche Post AG, FBI, Oracle, 20th Century Fox, Xerox, ...
3. **Network equipment manufacturers**
   - 3Com Corporation, Cisco Systems, Ericsson, Fujitsu, HP, Nokia, ...
4. **Defense and homeland security**
   - Generic Systems Sweden Ab, NASA, US Air Force, US Army, ...
5. **Universities**
   - **University Program**

Introduction (cont'd)

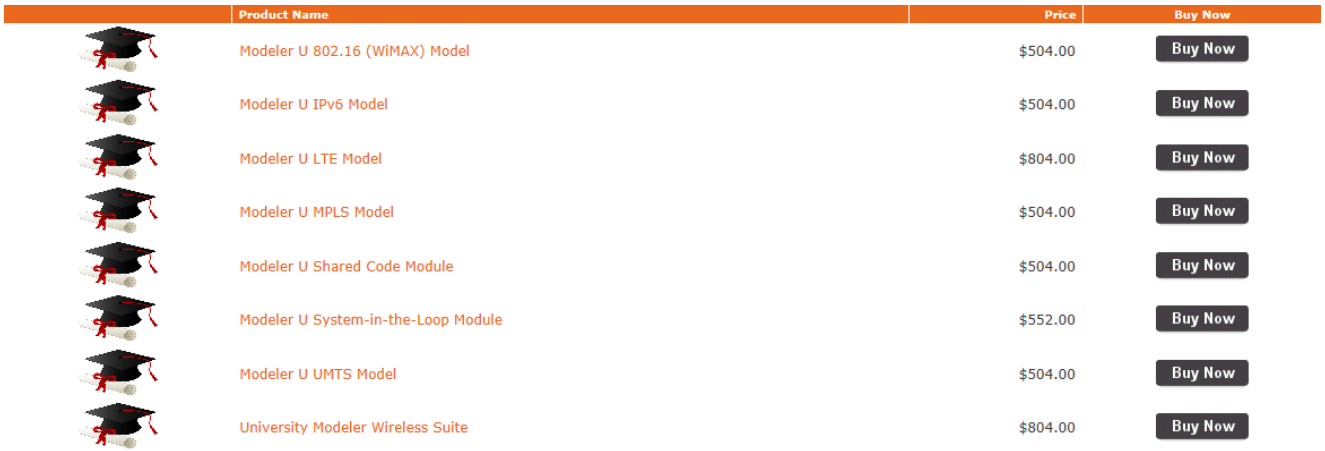
- OPNET University Program (discontinued):

1. **IT Guru**
   - Modeling of a broad range of network protocols and technologies
2. **Modeler**
   - IT Guru with source code for protocol and technology models
3. **Modeler Wireless Suite**
   - Modeler with a broad range of wireless models
4. **SP Guru Transport Planner**
   - Optical network planning and engineering
5. **IT Guru Academic Edition**
   - Based on IT Guru

Introduction (cont'd)

- Products available through the Riverbed University Program:

1. **Modeler**
   - University Research Program
   - https://www.cacetech.com/products/catalog/university.php



	Product Name	Price	Buy Now
	Modeler U 802.16 (WiMAX) Model	$504.00	Buy Now
	Modeler U IPv6 Model	$504.00	Buy Now
	Modeler U LTE Model	$804.00	Buy Now
	Modeler U MPLS Model	$504.00	Buy Now
	Modeler U Shared Code Module	$504.00	Buy Now
	Modeler U System-in-the-Loop Module	$552.00	Buy Now
	Modeler U UMTS Model	$504.00	Buy Now
	University Modeler Wireless Suite	$804.00	Buy Now

2. **Modeler Academic Edition**
   - University Teaching Program
   - https://cms-api.riverbed.com/portal/register

Introduction (cont'd)

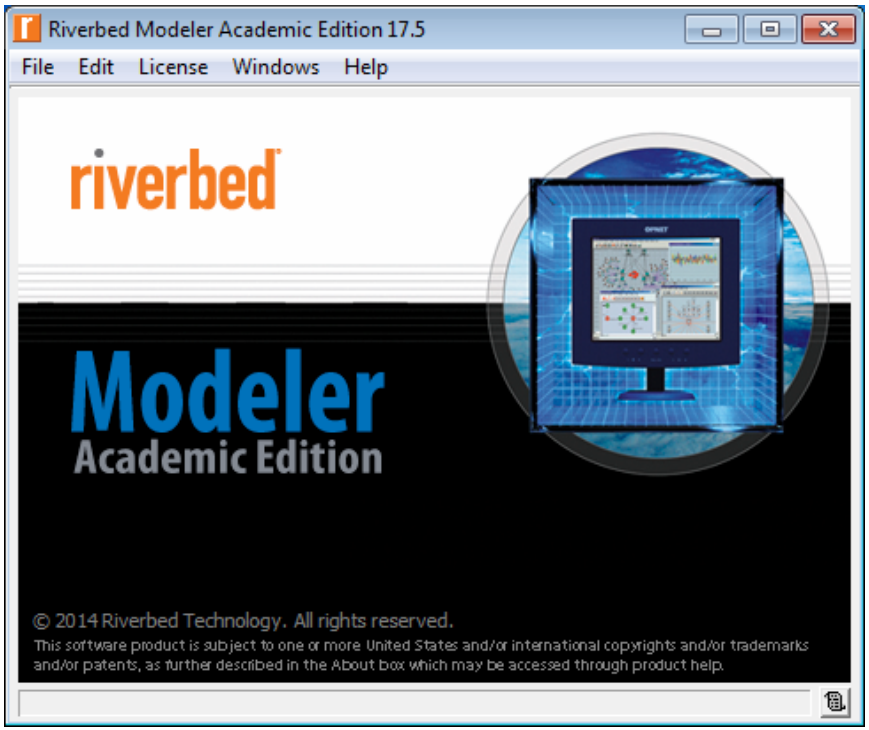
- **Riverbed Modeler Academic Edition 17.5**
  - Free for all users (registration required)
  - 6-month renewable license
  - Based on Modeler 17.5 (build 2014)
  - Replaces IT Guru Academic Edition 9.1 (build 2000)

- Restrictions:
  - Max. number of simulation events = 50 million
  - Max. number of all nodes = 80
  - Max. number of mobile(!) nodes = 20
  - Max. number of intermediate nodes = 20
  - No process and node editors
  - Microsoft Windows only
  - etc.

- modeler_ae_175A_PL7_13312_win.exe: $\sim$ 600 MB

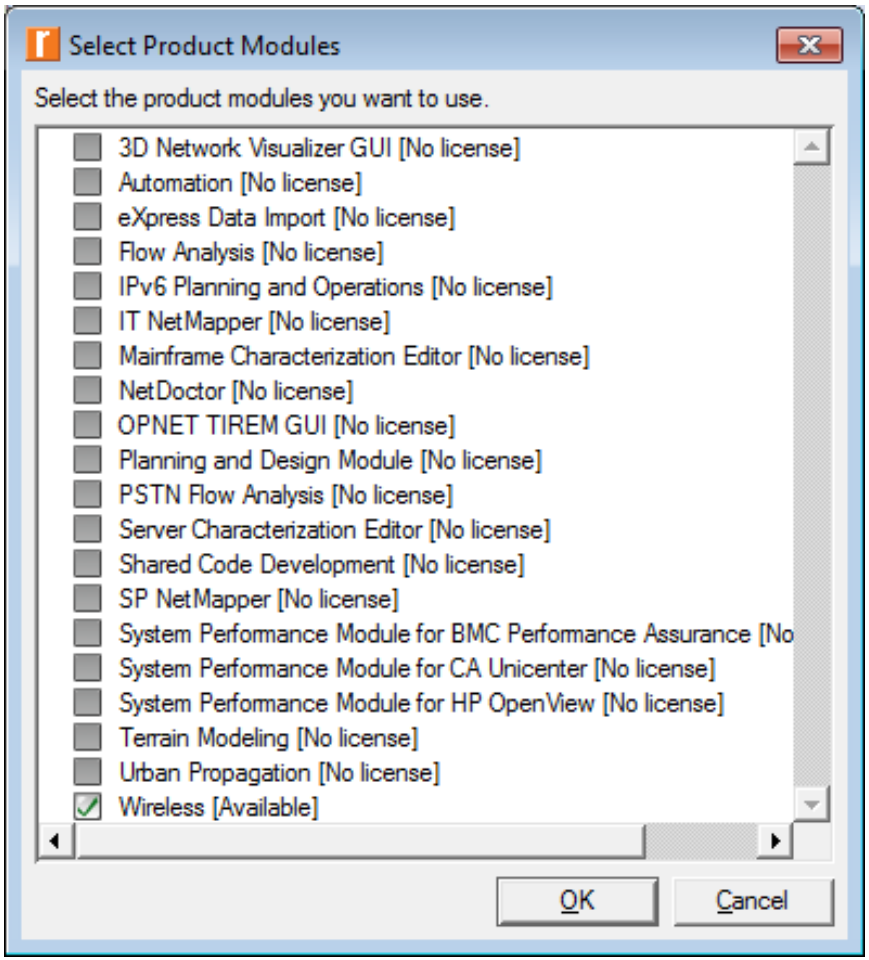
Introduction (cont'd)

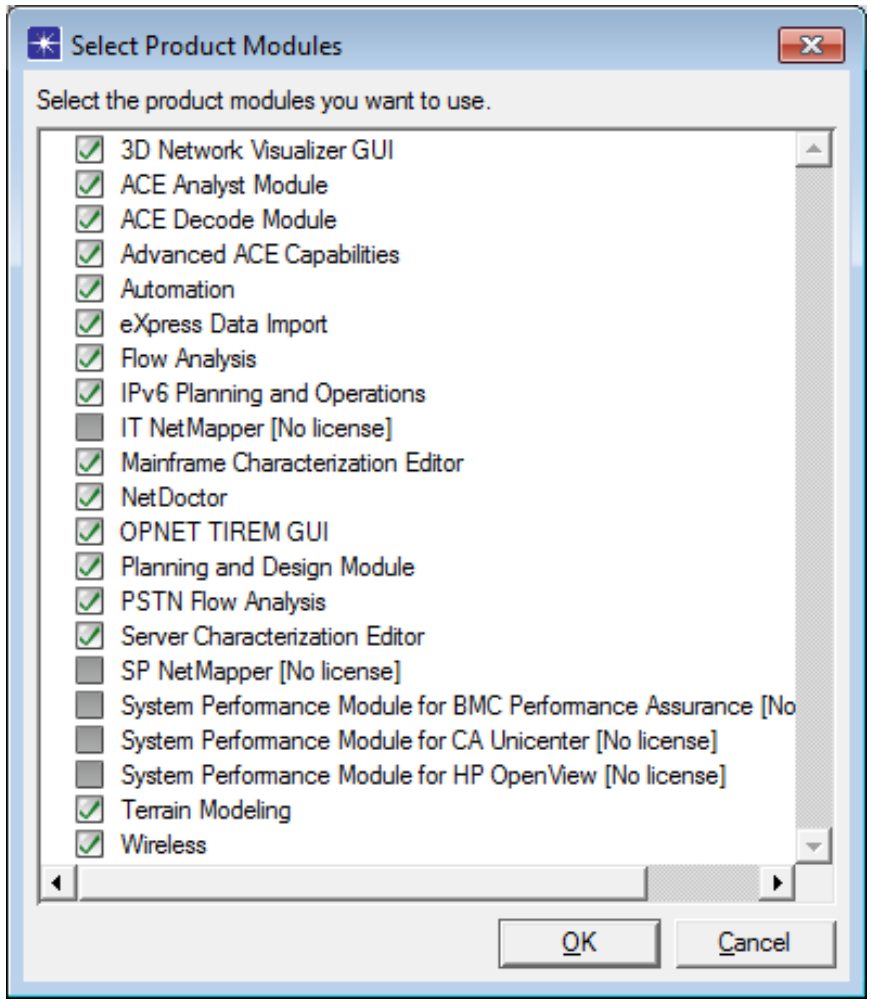
- Academic Edition software is created for introductory(!) level courses



Introduction (cont'd)

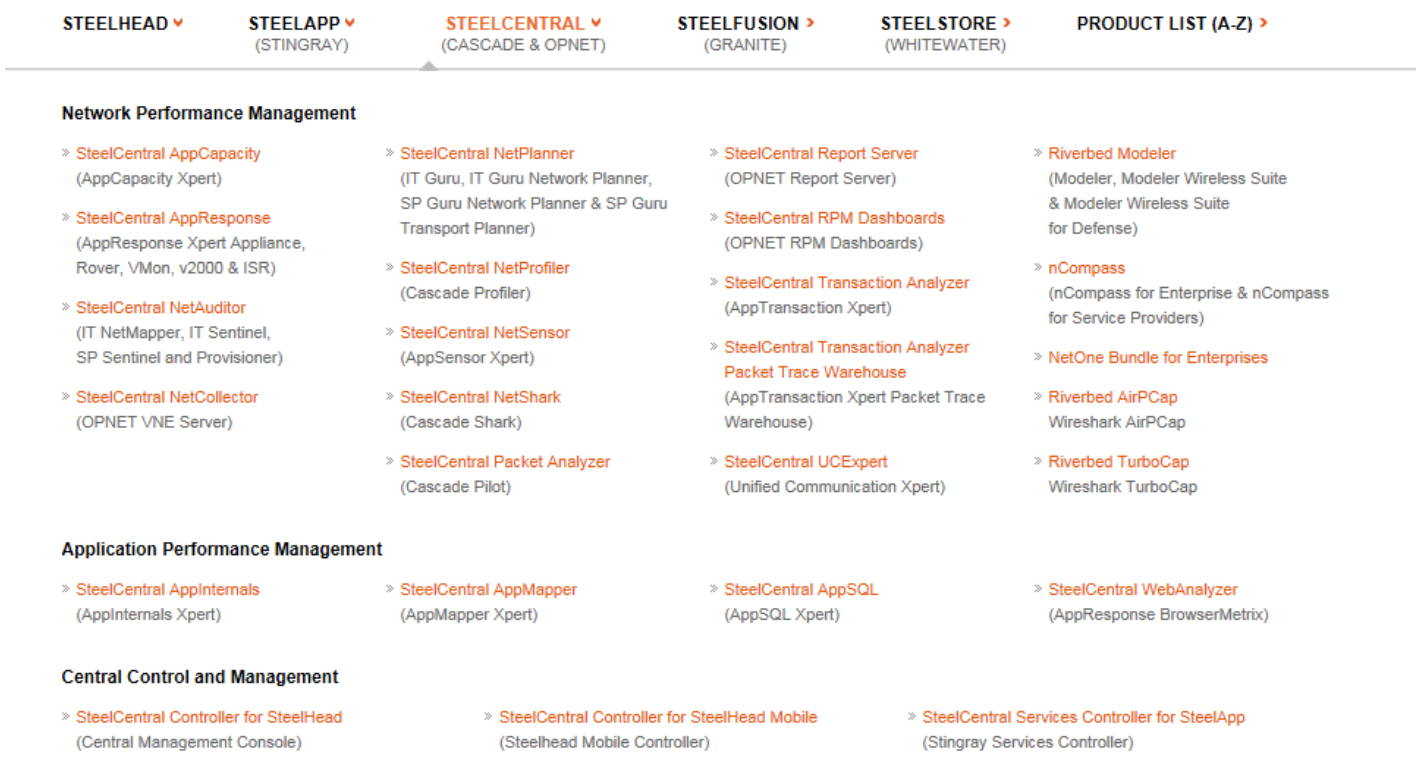
- Riverbed Modeler Academic Edition 17.5 vs. **OPNET Modeler 14.5**





Introduction (cont'd)

- 'We have renamed our products to better describe what they do and reinforce how they are part of an integrated solution called the Riverbed Application Performance Platform™.' http://www.riverbed.com/products/



Introduction (cont'd)

- OPNET/Riverbed solutions enable organizations to optimize their investment in network R&D:
  - Develop proprietary network protocols and technologies
  - Evaluate enhancements to standards-based protocols
  - Test technology designs in realistic scenarios before production
  - Increase R&D productivity and accelerate time-to-market

- OPNET/Riverbed Modeler – a de facto industry standard for network M&S

Introduction (cont'd)

- **Hierarchical GUI-based editors**
  - Intuitive and user-friendly modeling environment
- **High-fidelity modeling**
  - Hundreds of protocol and vendor device models with source code
  - Different aspects of wireless communication, including RF propagation, antenna modeling, signal modulation, node mobility, and interference
- **Scalable simulation**
  - Parallel discrete event simulation kernel
  - Grid computing support for distributed simulation
- **Sophisticated analysis**
  - Integrated GUI-based debugging and analysis tools
- **Integrating live network and application behavior**
  - Optional module (SITL) to interface simulations with live systems
  - Open interface for integrating external files, libraries, and other simulators (e.g., MATLAB)

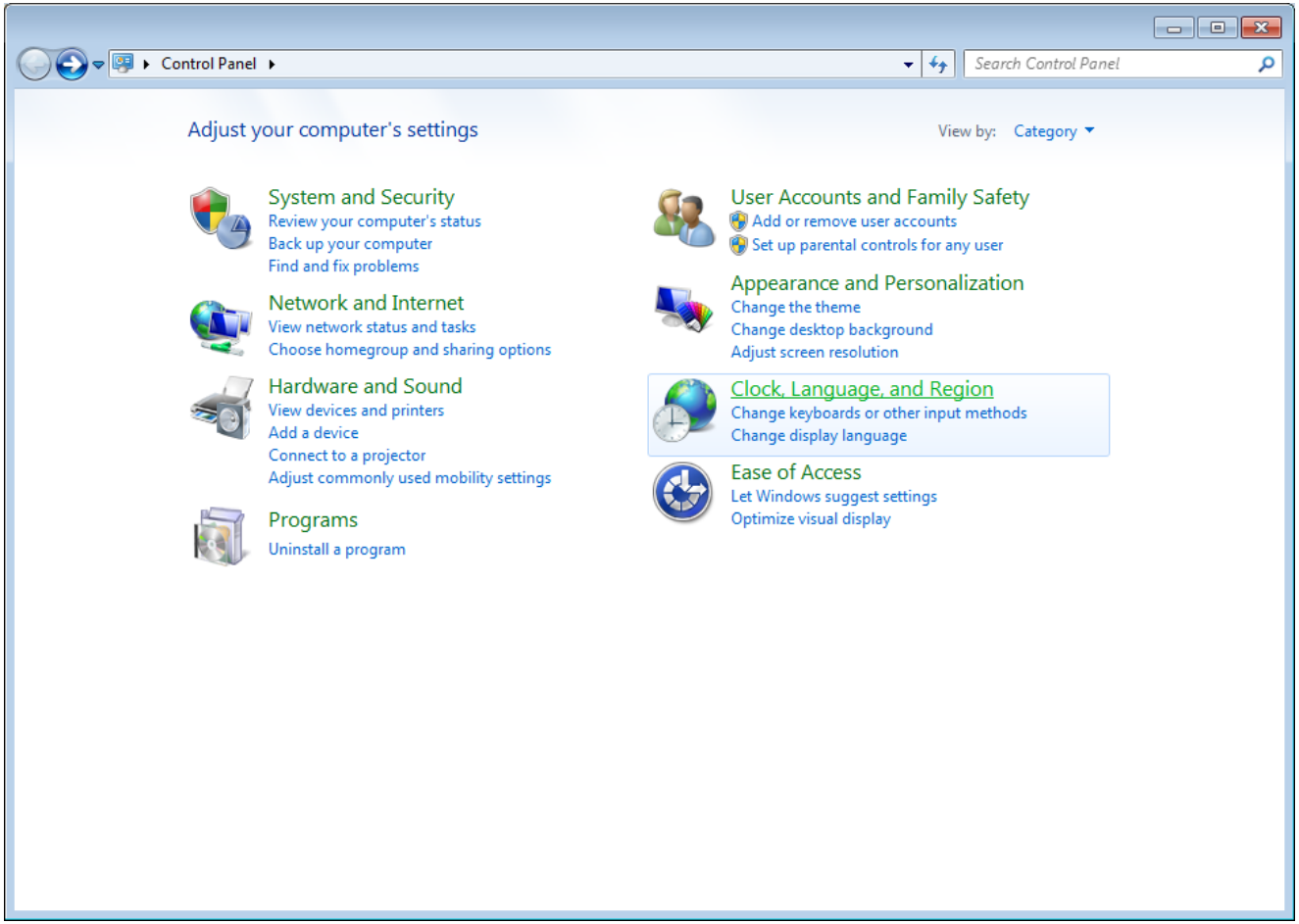
Outline

Installation

- Supported platforms:
  - **Microsoft:** Server 2008, Server 2012, XP, Vista, 7, 8, 8.1, 10
  - **Linux:** Red Hat
- C++ compilers:
  - **Microsoft:** Visual Studio 2002, 2003, 2005, 2008, 2010, 2013
  - **Linux:** gcc 3.4 or higher
- OPNET/Riverbed software does not work with number representation different from **English**
  - The reason is the different decimal separator: 'point' in English, 'comma' practically in all others

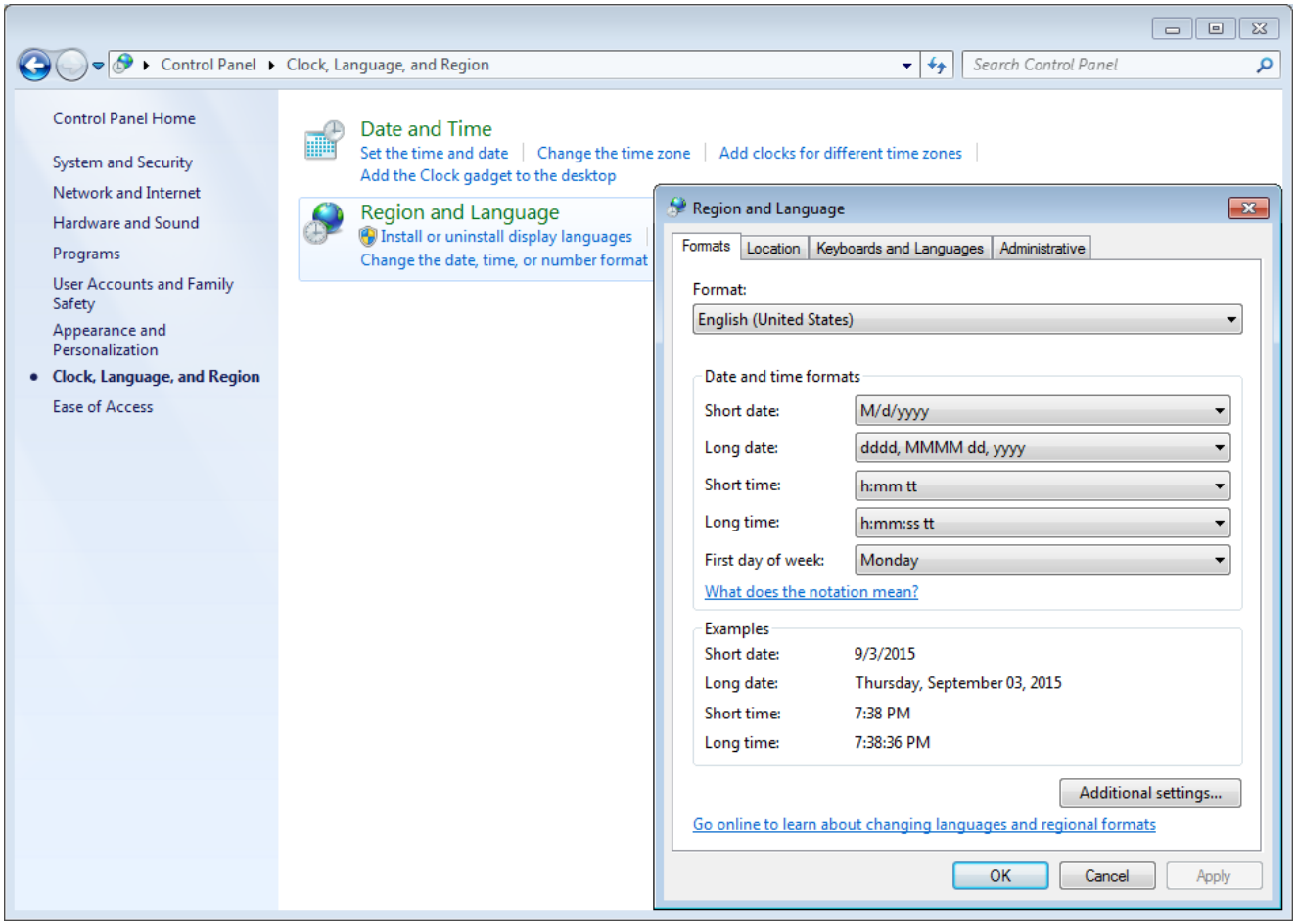
Installation (cont'd)

- **Windows 7:** Control Panel ⇒ Clock, Language, and Region ⇒



Installation (cont'd)

- $\Rightarrow$ Region and Language $\Rightarrow$ Format: **English (United States)**



Installation (cont'd)

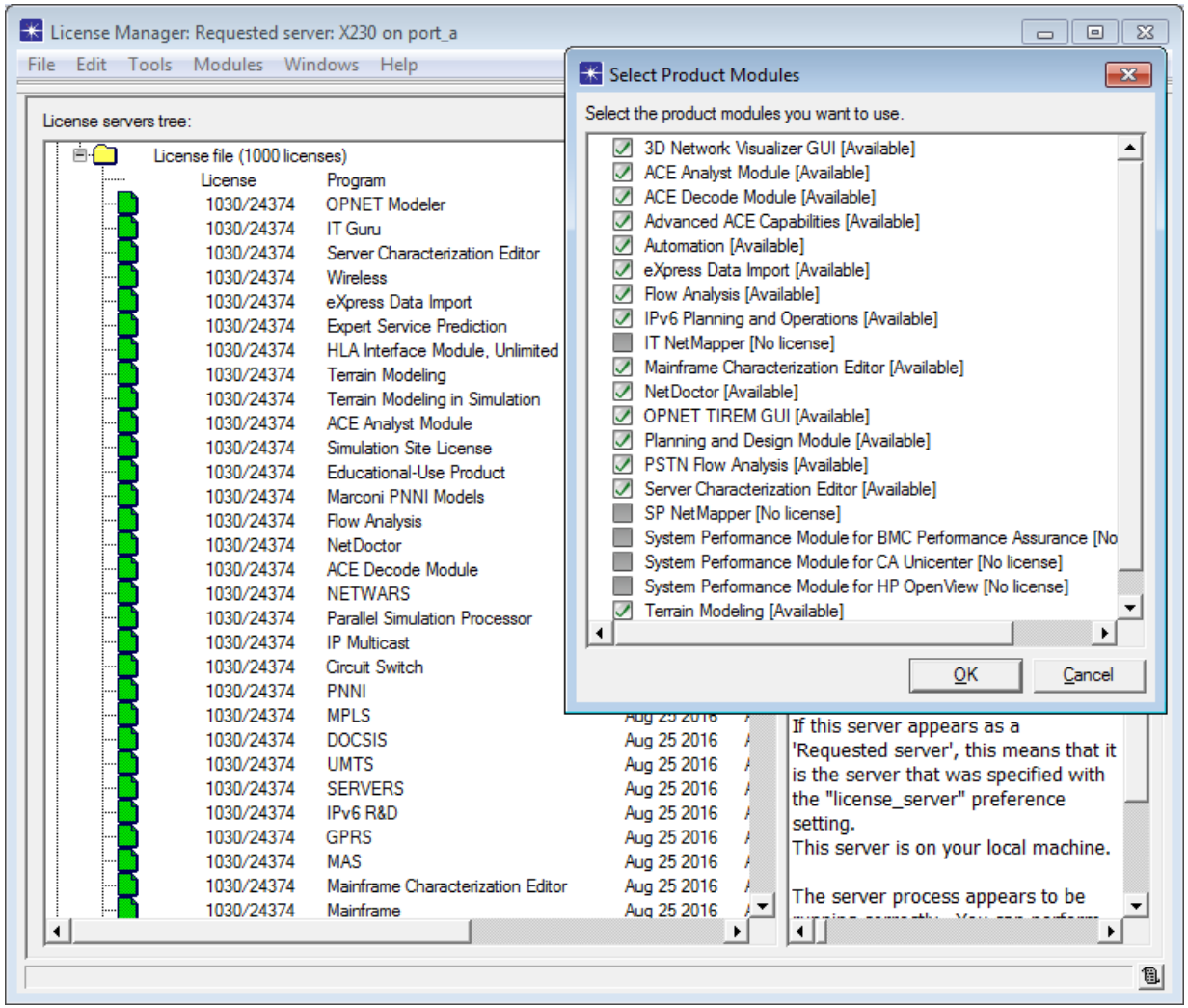
- Installation order:
  - C++ compiler
  - Setting environment variables
  - **Software**
  - **Models**
  - **Documentation**

- All OPNET/Riverbed products must obtain a license prior(!) to their execution

- Licensing modes:
  - **Standalone**
  - Floating – serve licenses from this computer
  - Floating – access licenses from remote server

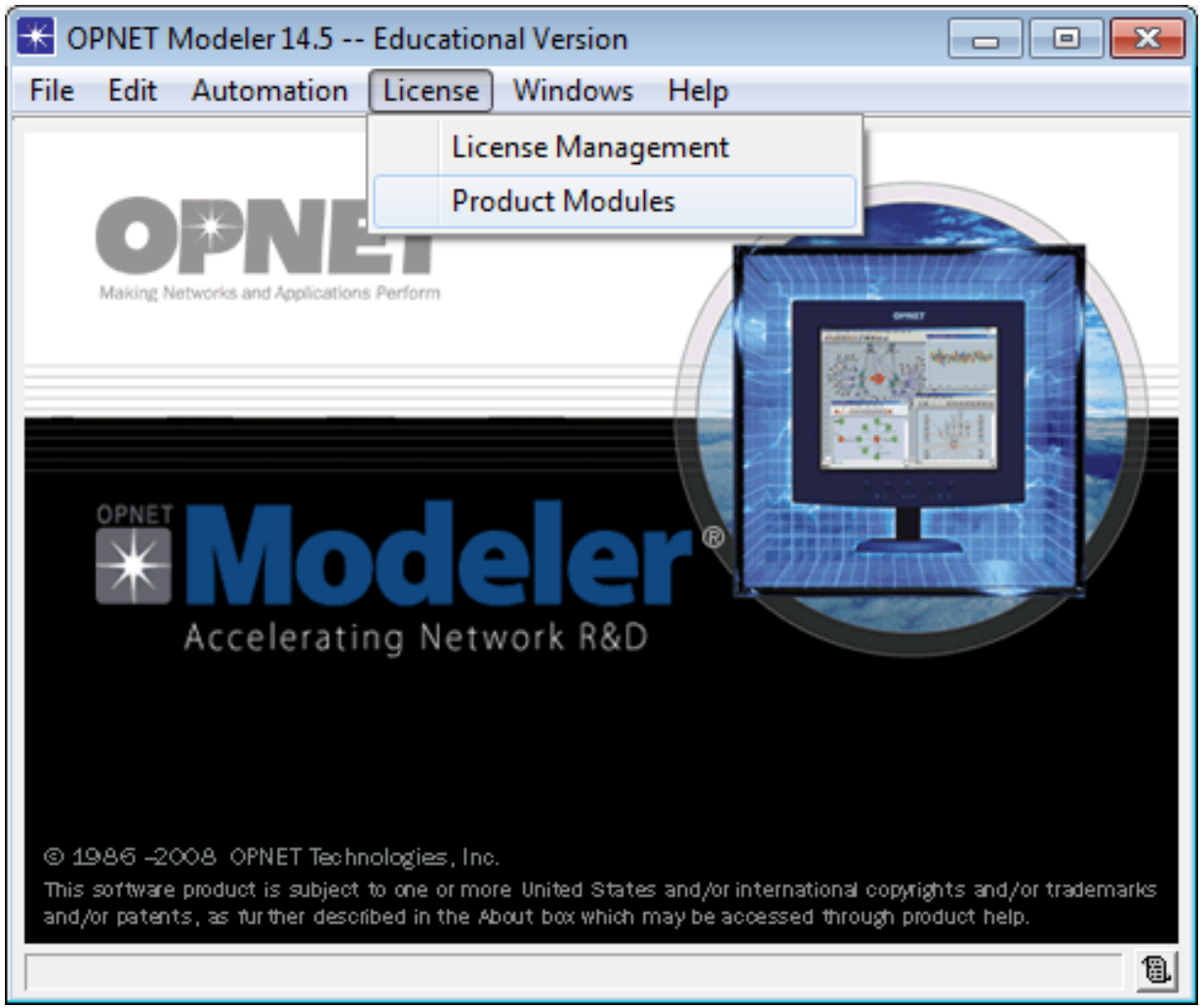
Installation (cont'd)

- Enabling optional product modules
  - Access to these modules will depend on your licenses



Installation (cont'd)

- If you forgot to enable certain modules, you can still do it later



Installation (cont'd)

- At the time of first installation, OPNET/Riverbed generates several new folders on your computer:

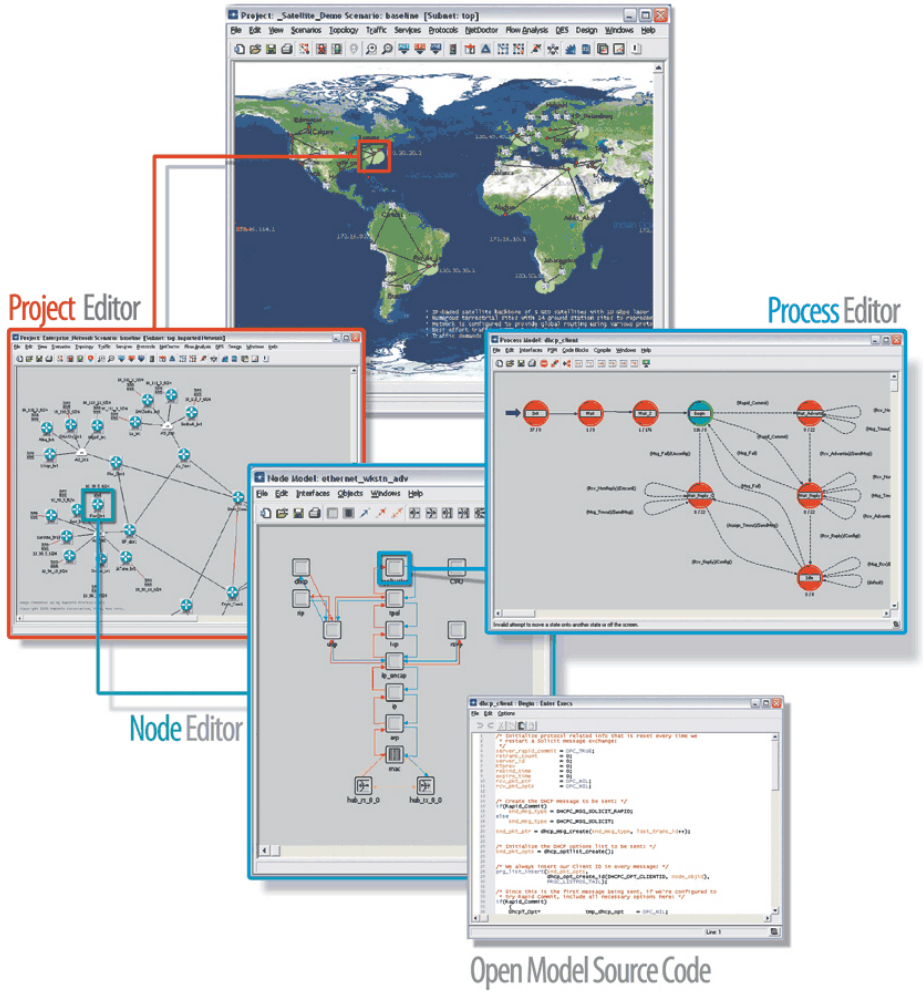
1. **C:/Program Files/OPNET/** or **C:/Riverbed EDU/**

2. **C:/Users/<user name>/op_admin/** – contains backup (bk), temporary (tmp), log files, etc.
3. **C:/Users/<user name>/op_models/** – contains user-created files
4. **C:/Users/<user name>/op_reports/** – contains reports

Outline

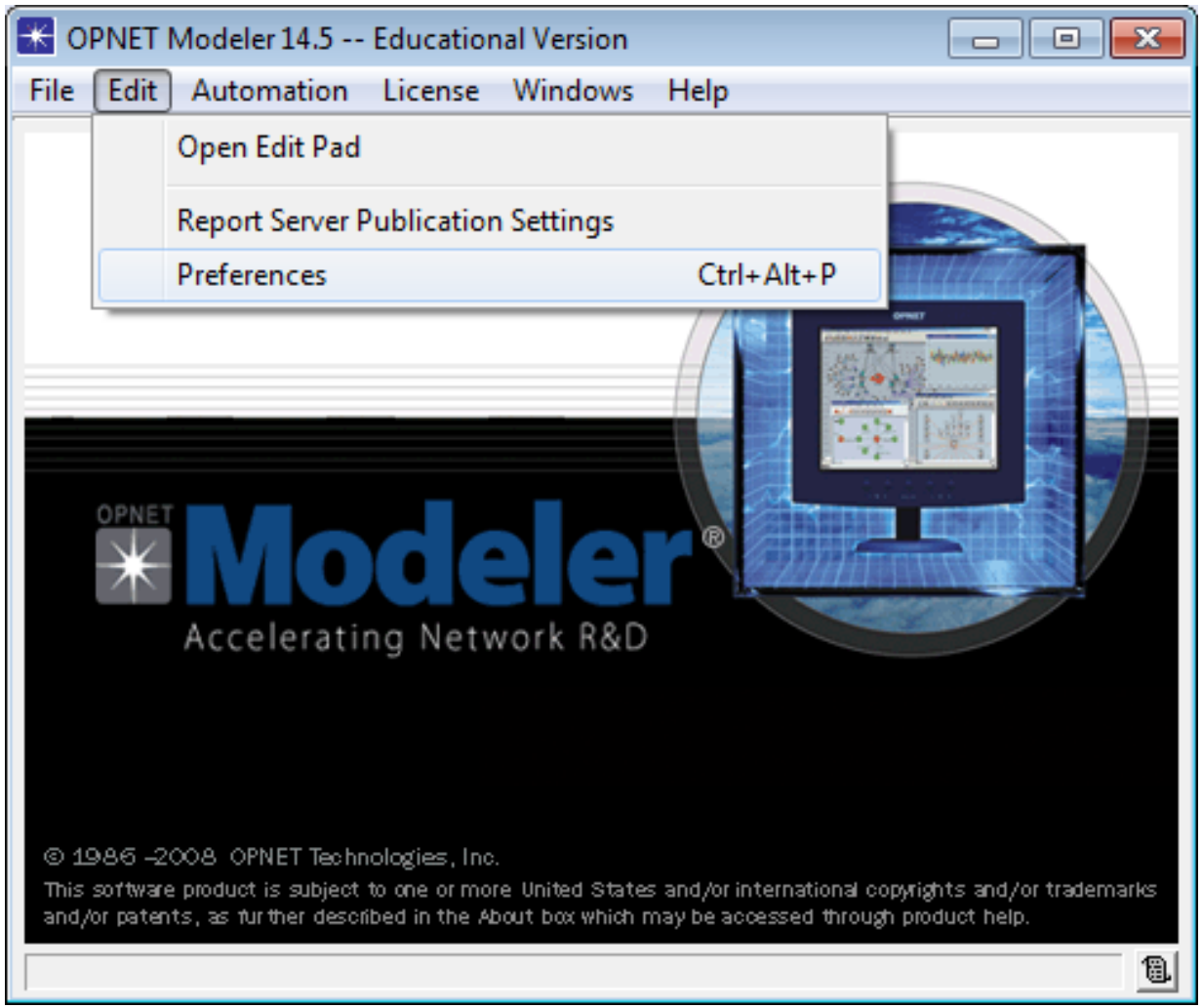
Preferences

- OPNET/Riverbed Modeler is composed of multiple editors, each of which opens in its own window



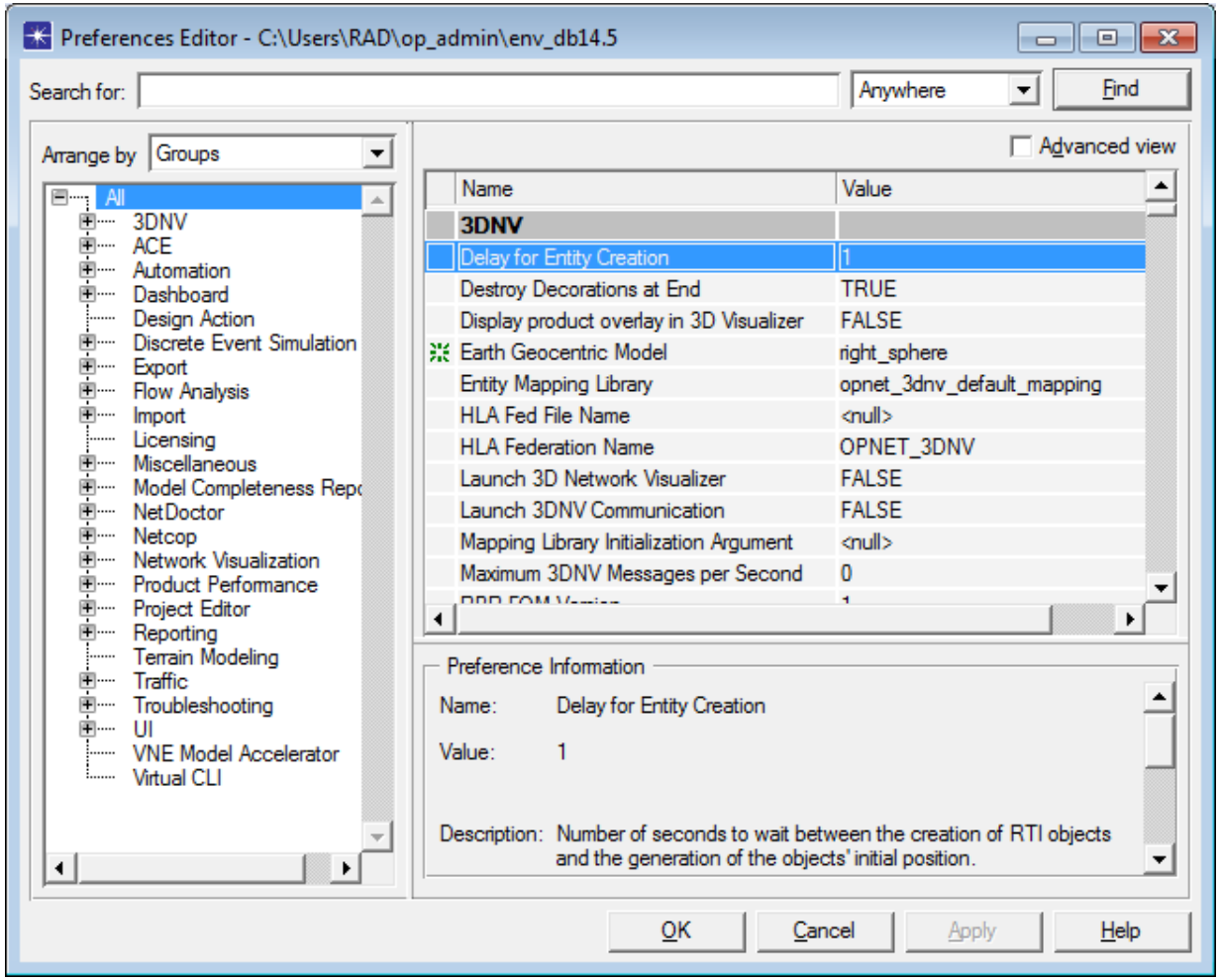
Preferences (cont'd)

- Managing preferences



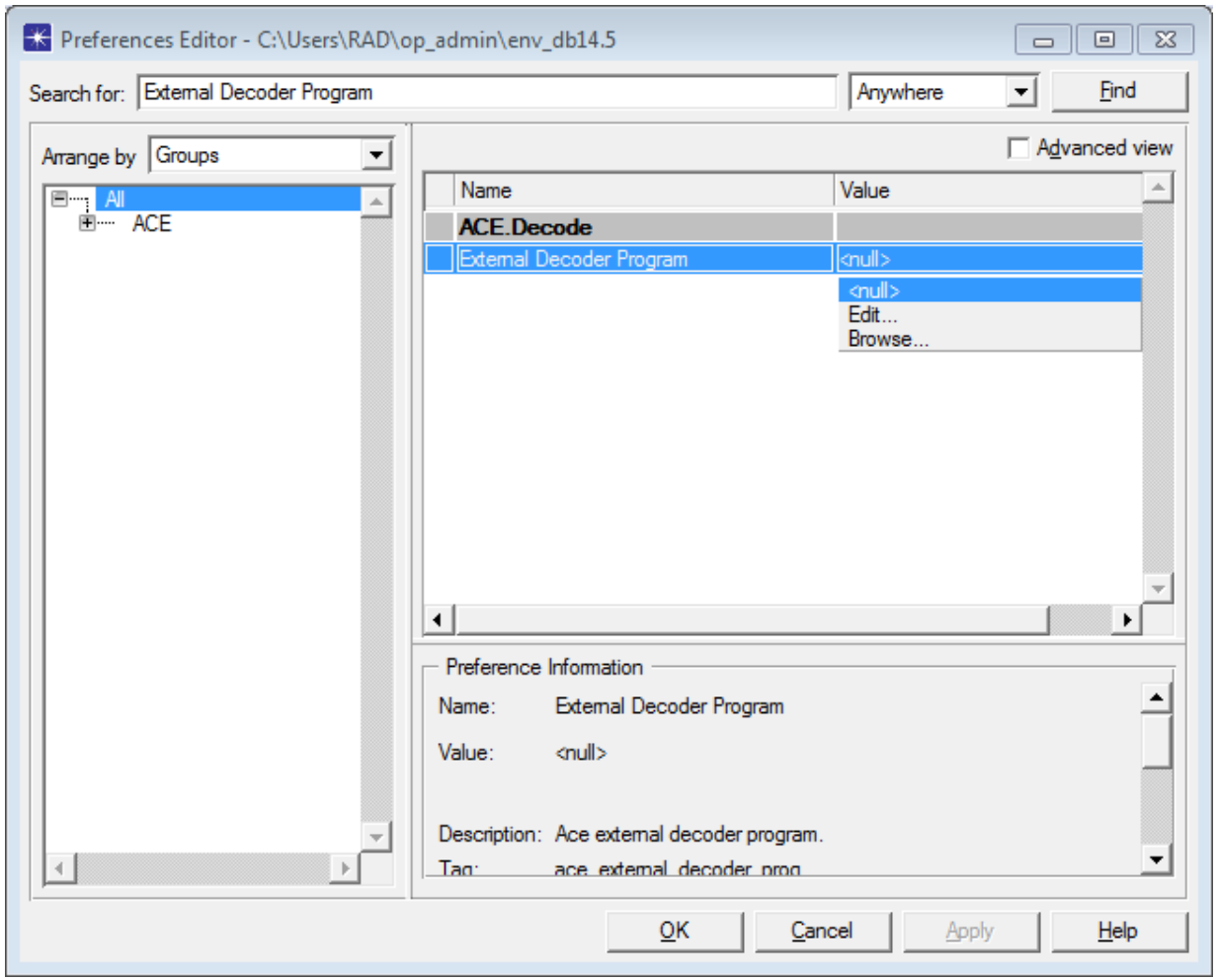
Preferences (cont'd)

- **Preferences Editor** – allows to change software preferences



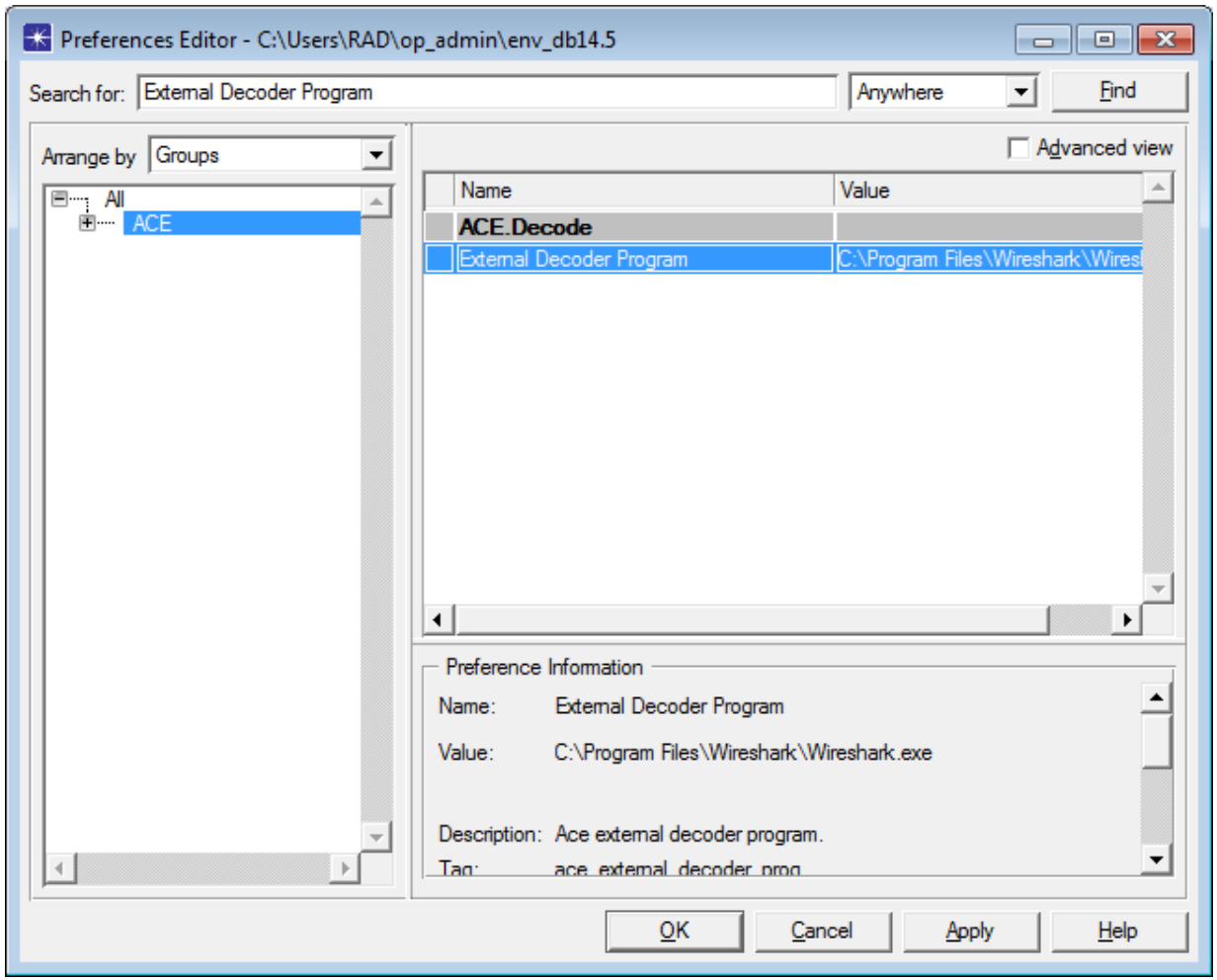
Preferences (cont'd)

- **Example 1:** If Wireshark is installed after Modeler, then be sure to update the 'External Decoder Program' preference



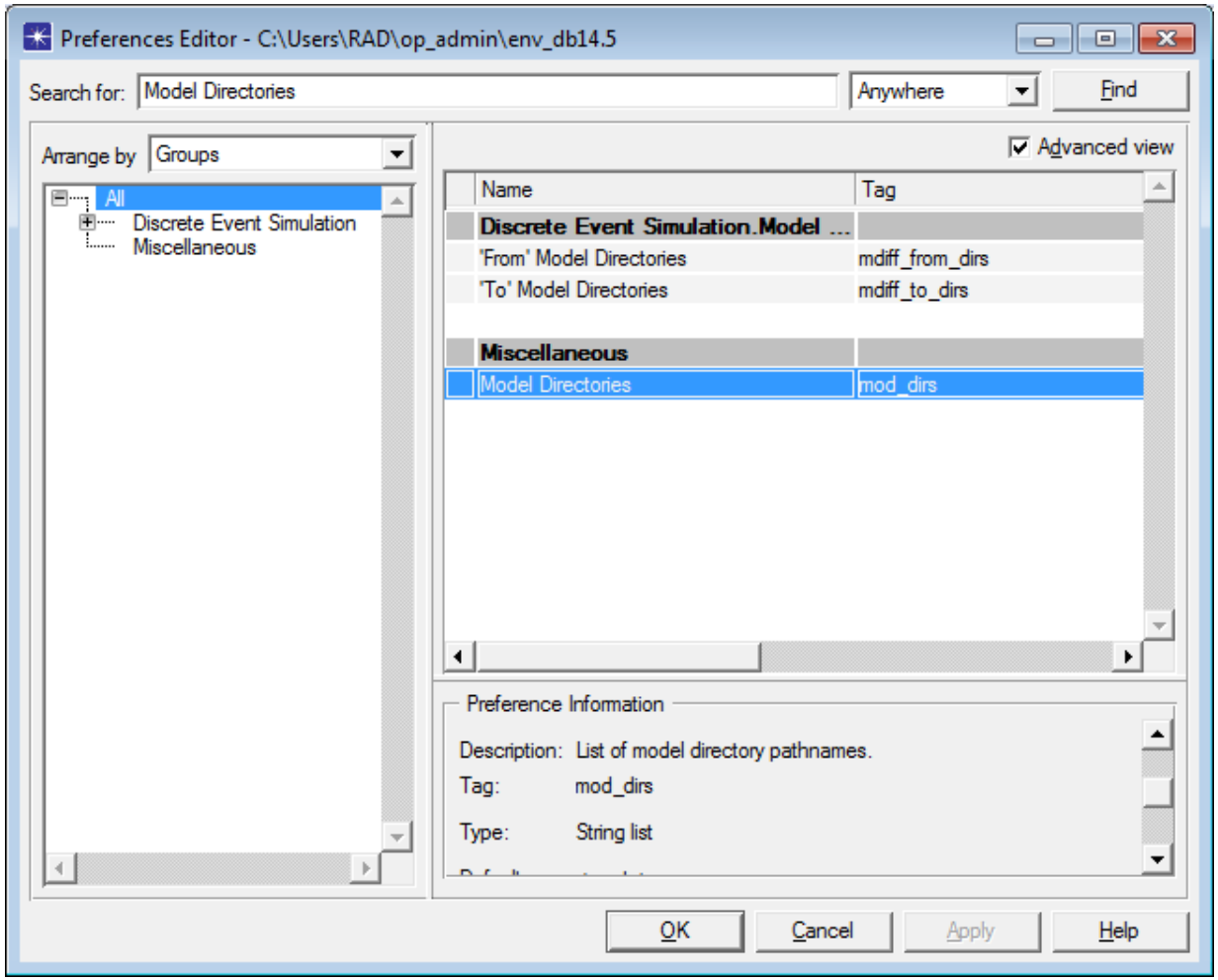
Preferences (cont'd)

- Specify the path and filename of the program used to generate protocol decodes



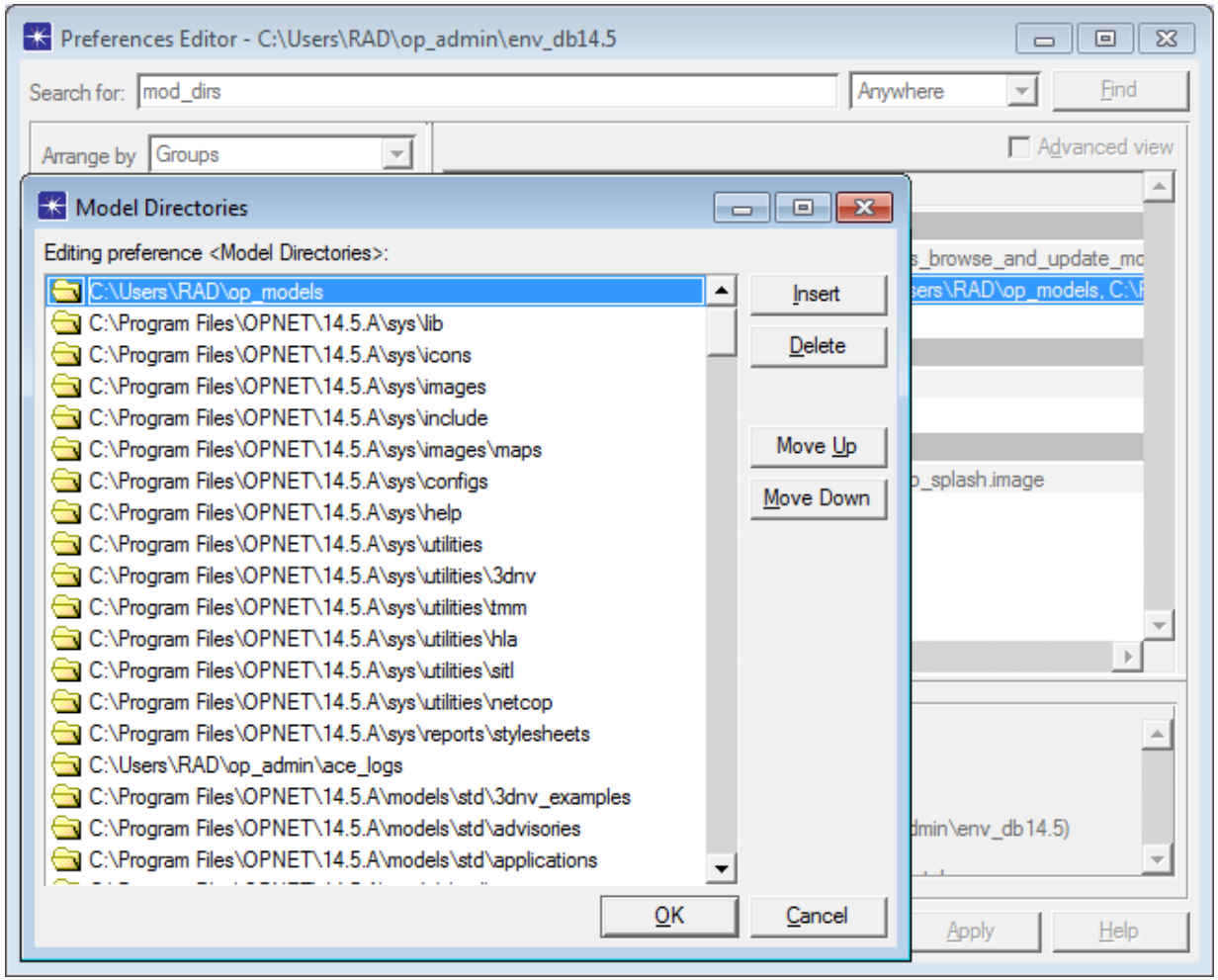
Preferences (cont'd)

- **Example 2:** 'Model Directories' – user-friendly preference name; 'mod_dirs' – technical name (tag)



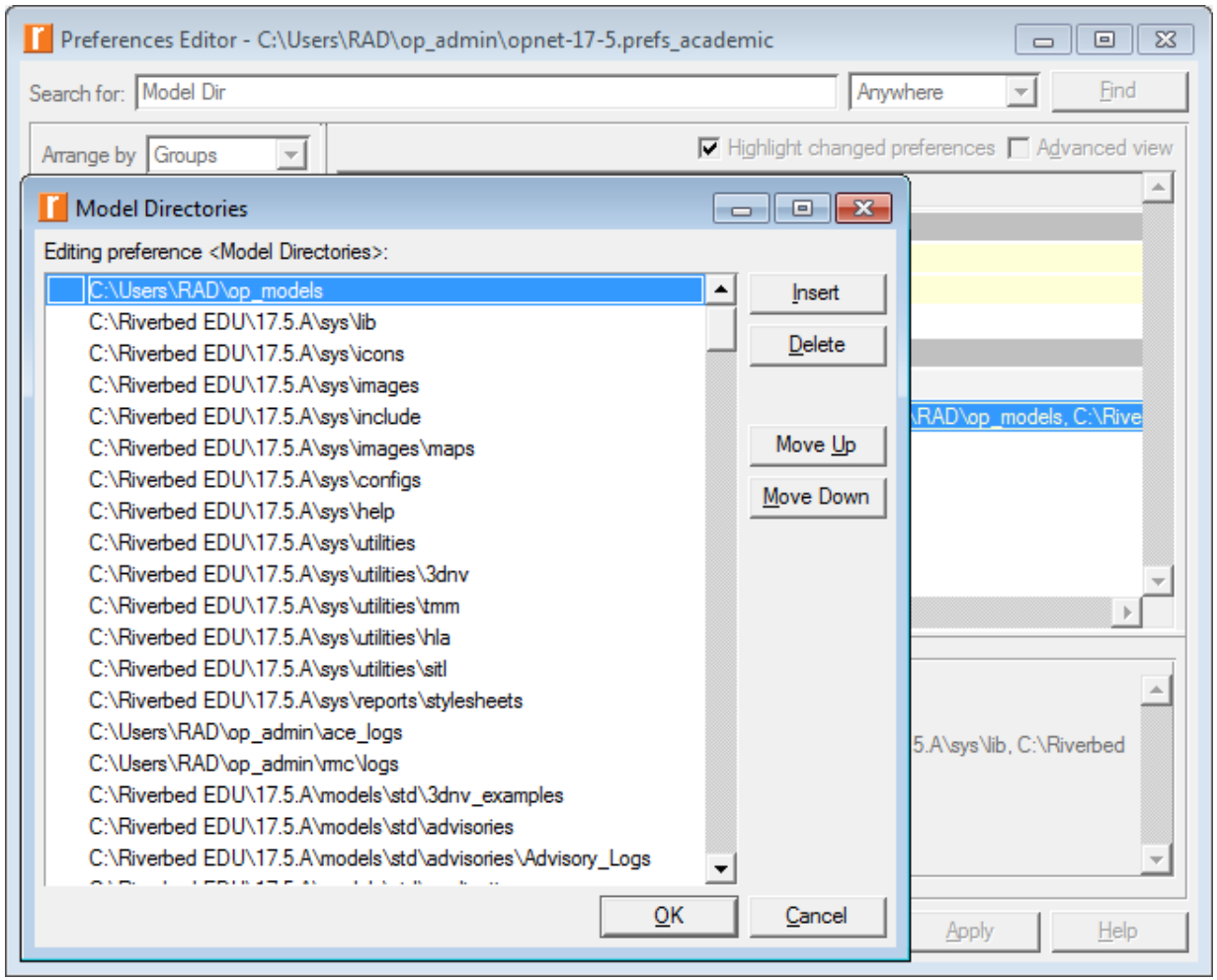
Preferences (cont'd)

- **op_models** – the default folder to store user-created project files



Preferences (cont'd)

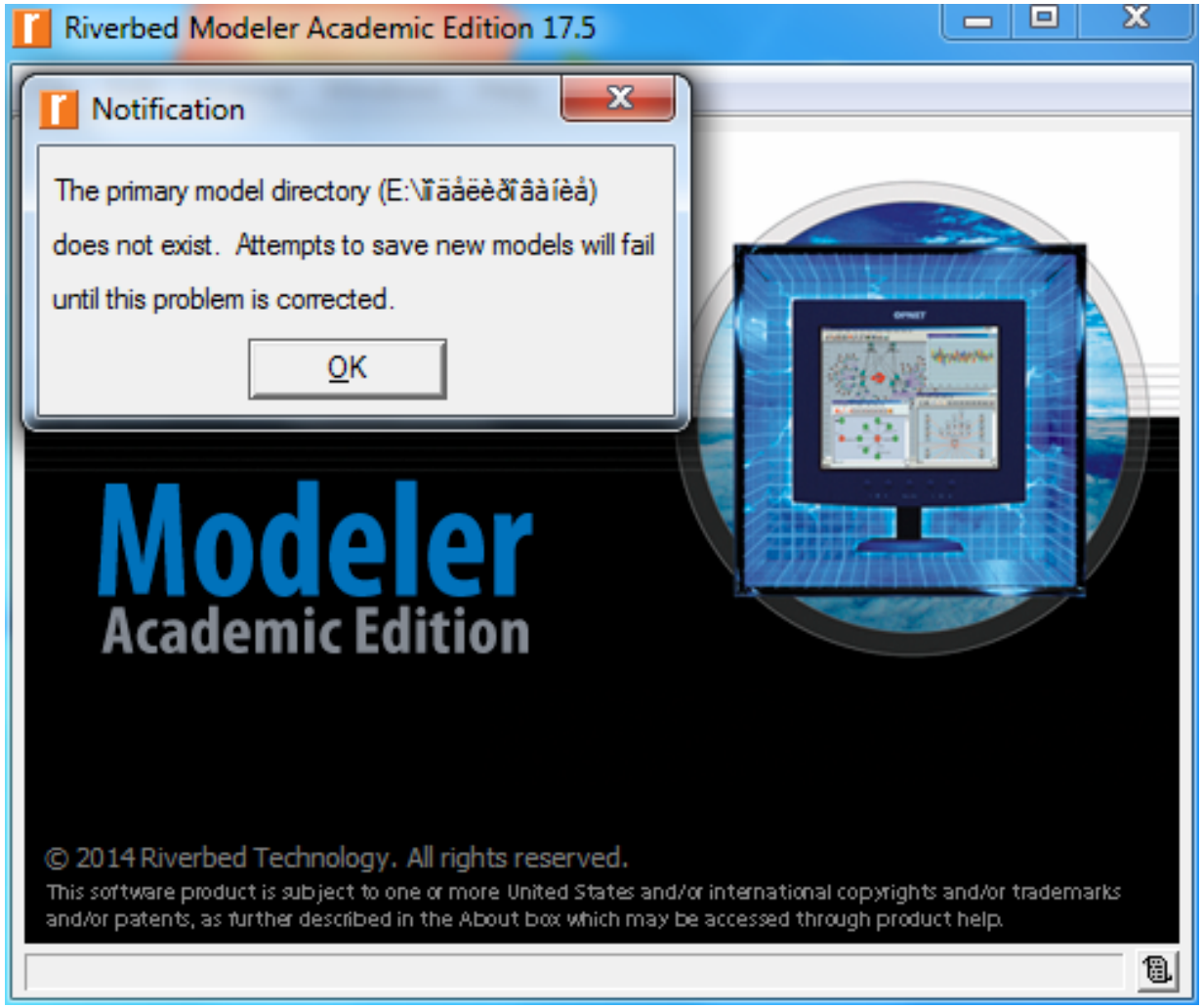
- The order in which the directories are listed in the 'mod_dirs' preference is very important!



Outline

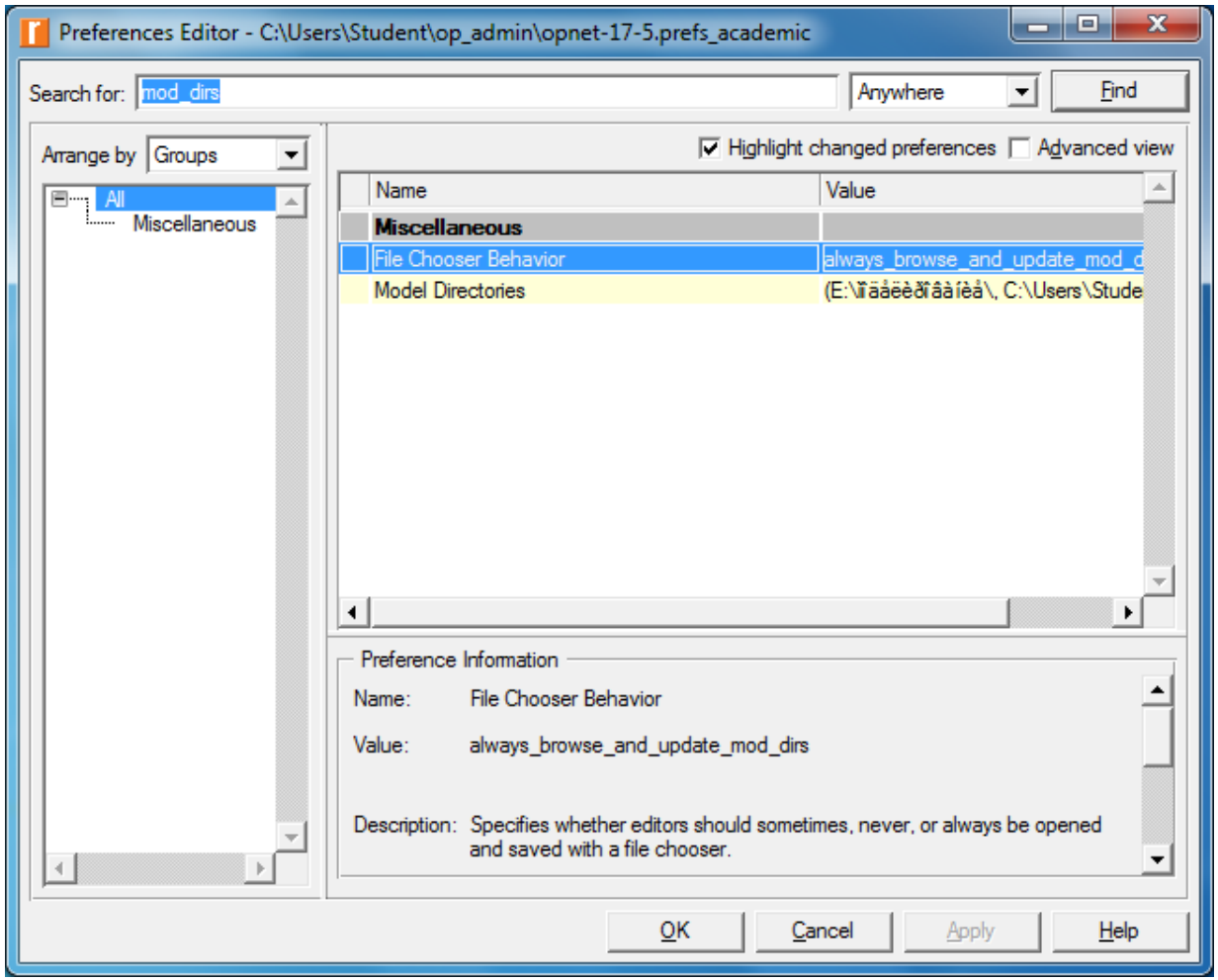
'Save As...' Trouble

- The primary model directory (bla-bla-bla) does not exist. Attempts to save new models will fail until the problem is corrected. ☹



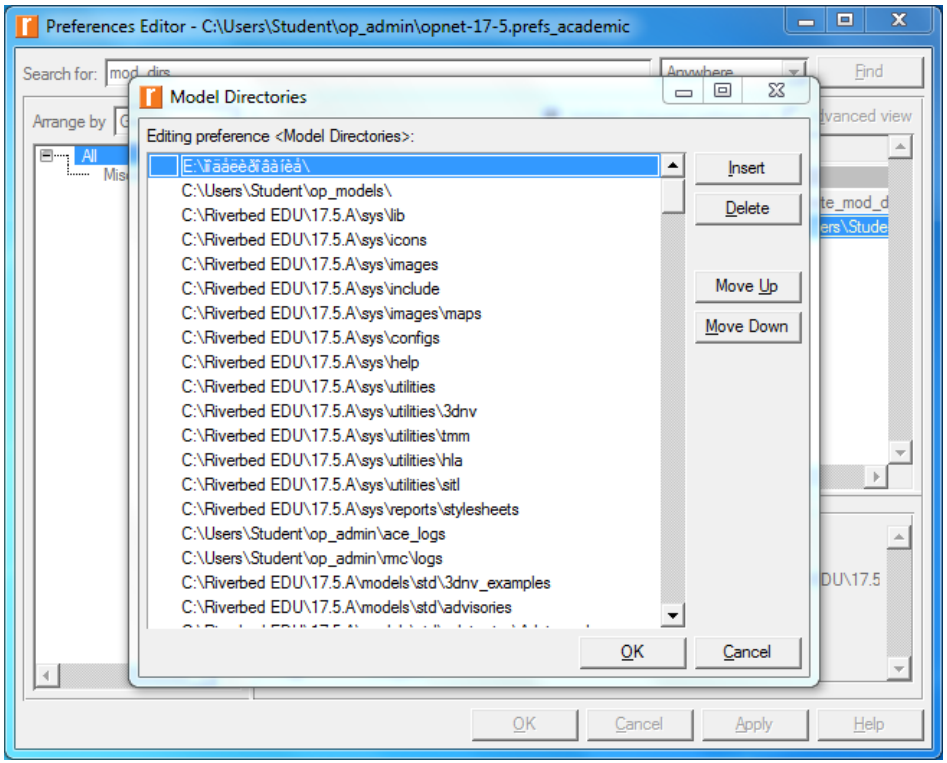
'Save As...' Trouble (cont'd)

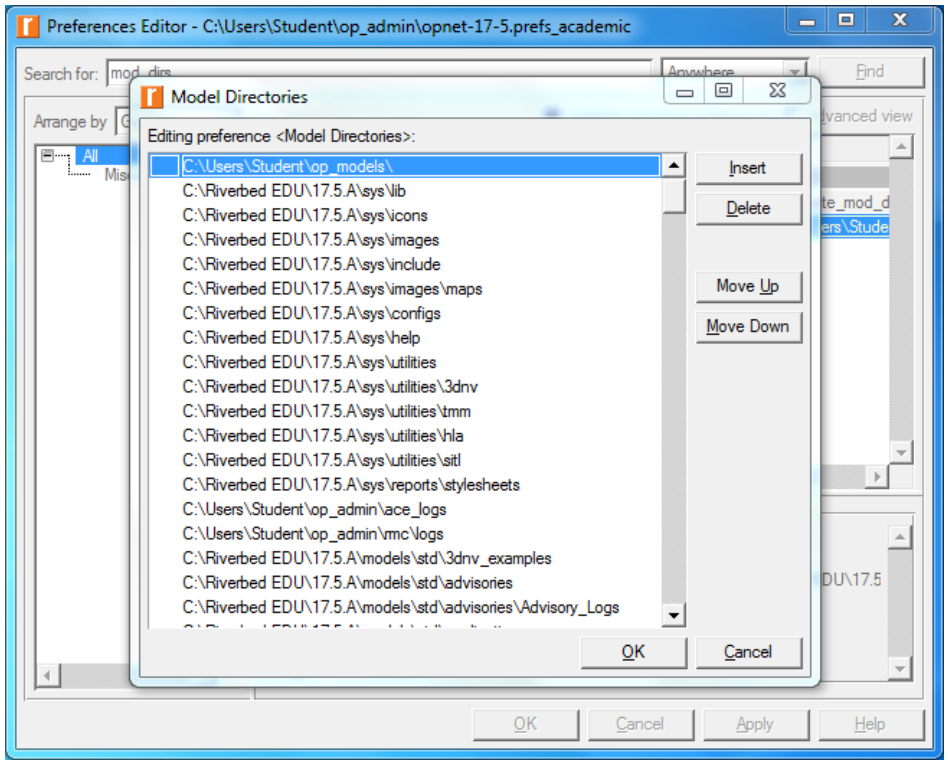
- Edit ⇒ Preferences ⇒ mod_dirs ⇒ Find



'Save As...' Trouble (cont'd)

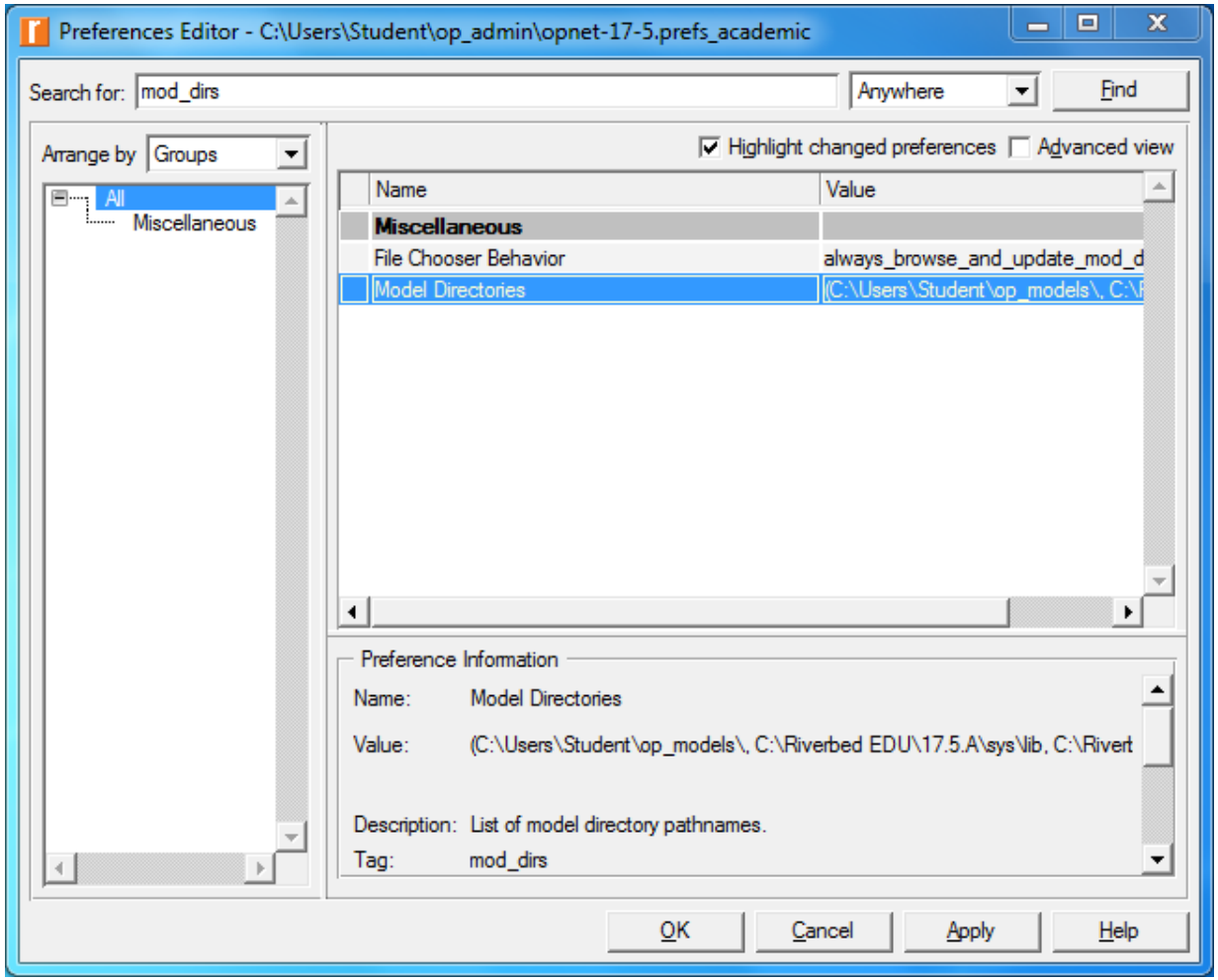
- Delete ⇒ OK





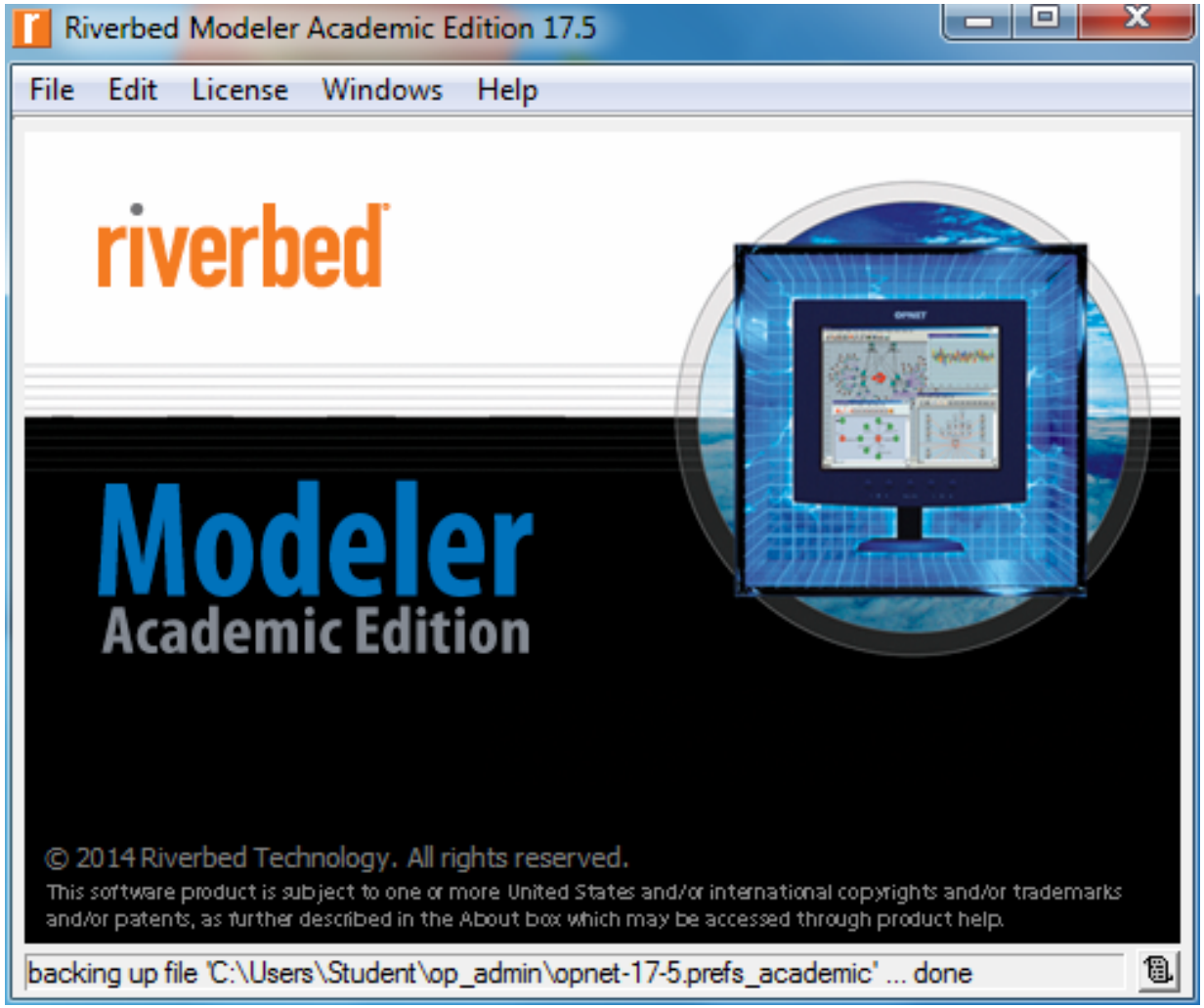
'Save As...' Trouble (cont'd)

- Apply ⇒ OK



'Save As...' Trouble (cont'd)

- Done! ☺



Outline

Getting Started

- OPNET/Riverbed uses a '**project-and-scenario**' approach to model networks

- **Project** – a collection of network-related scenarios, each of which explores a particular aspect of the network design
  - All projects contain at least 1 scenario

- **Scenario** – a single instance of a network
  - Typically, a scenario presents a unique configuration for the network
  - The term 'configuration' can refer to different aspects such as topology, protocols, applications, traffic, and simulation settings

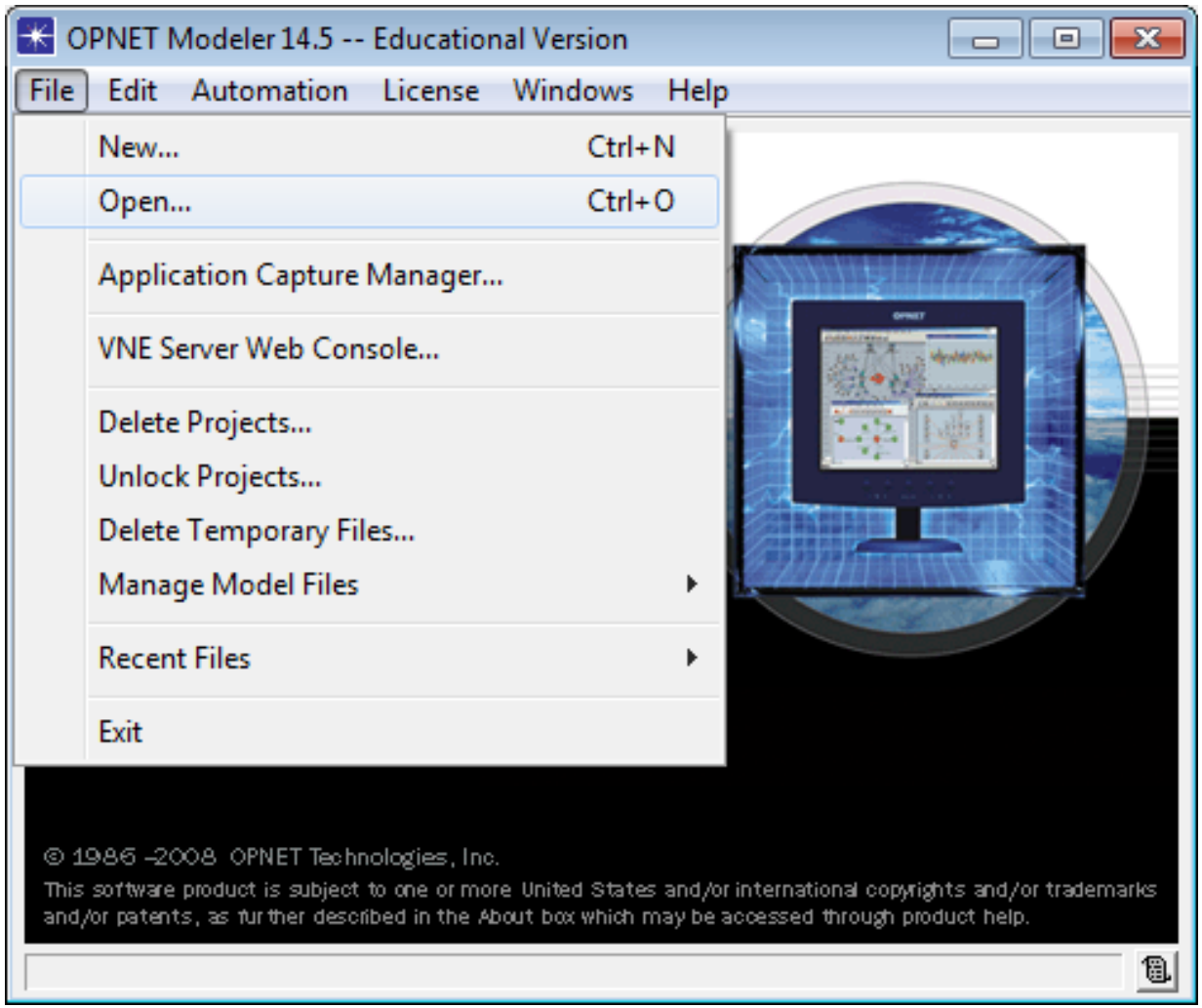
Getting Started (cont'd)

- **OPNET/Riverbed simulation workflow**

1. Create a baseline scenario
   - Build a network topology
   - Add traffic
   - Choose statistics to be collected
   - Run the simulation
   - View the results
2. Duplicate the scenario
   - Make changes
   - Re-run the simulation
   - Compare the obtained results
3. Repeat №2 if needed

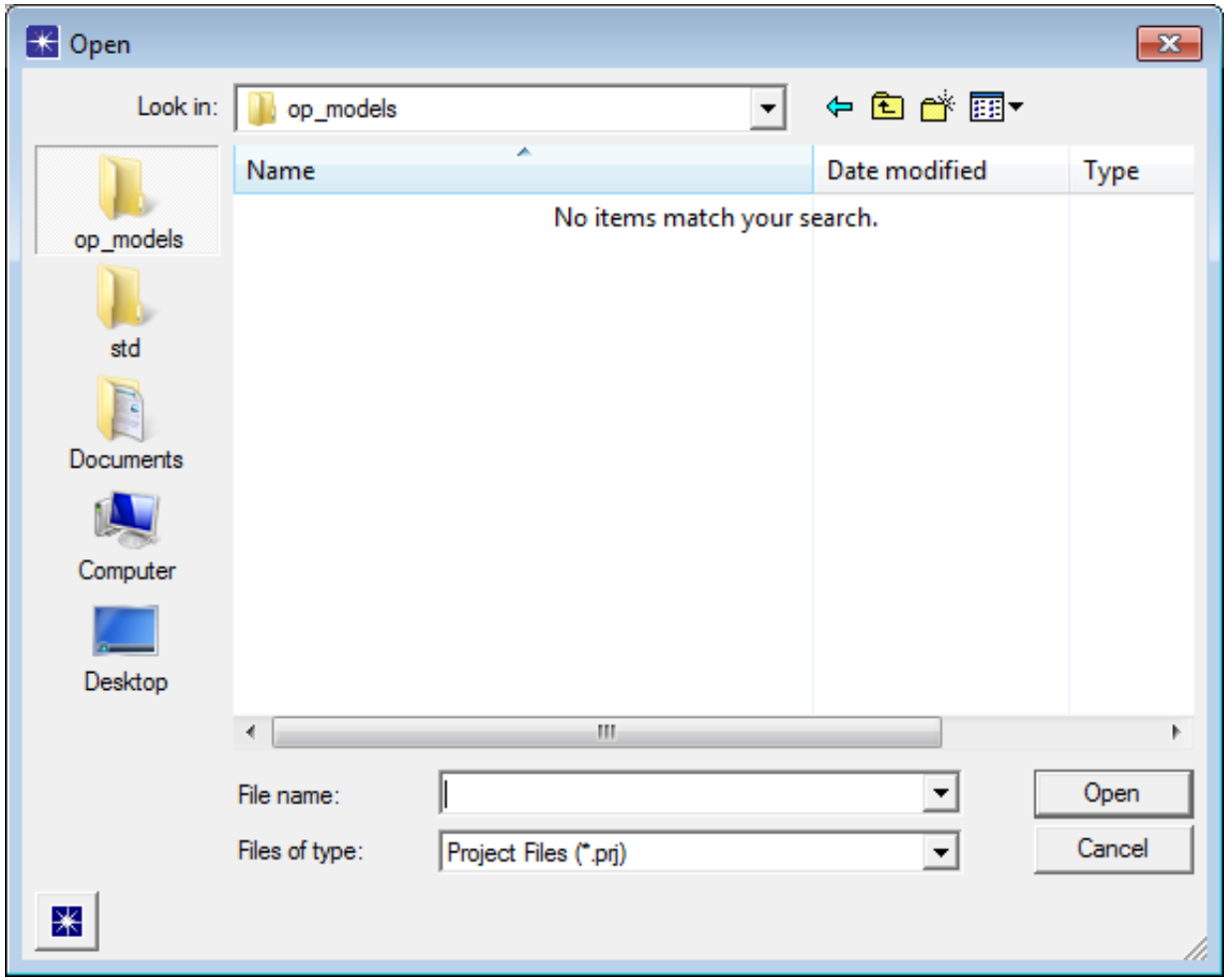
Getting Started (cont'd)

- 2 file browsing methods



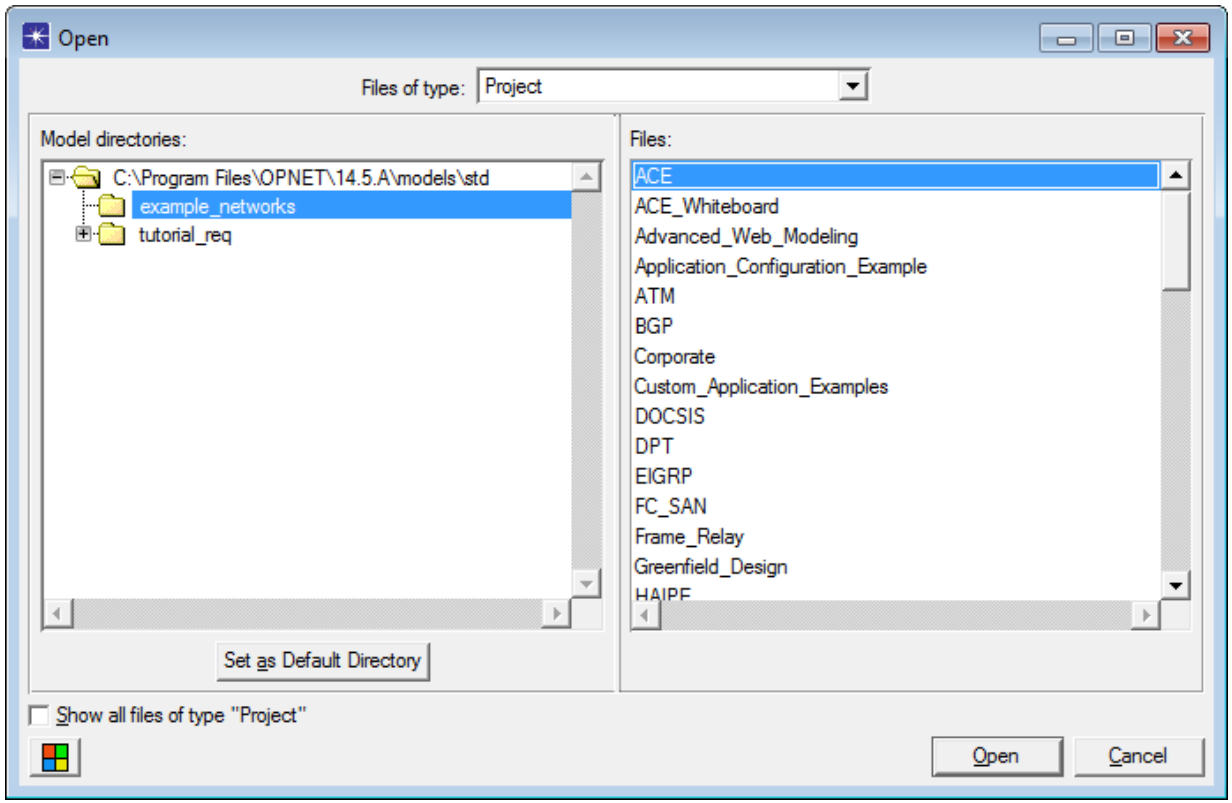
Getting Started (cont'd)

1. **General file chooser** – allows searching of all the mounted storage devices on the current computer



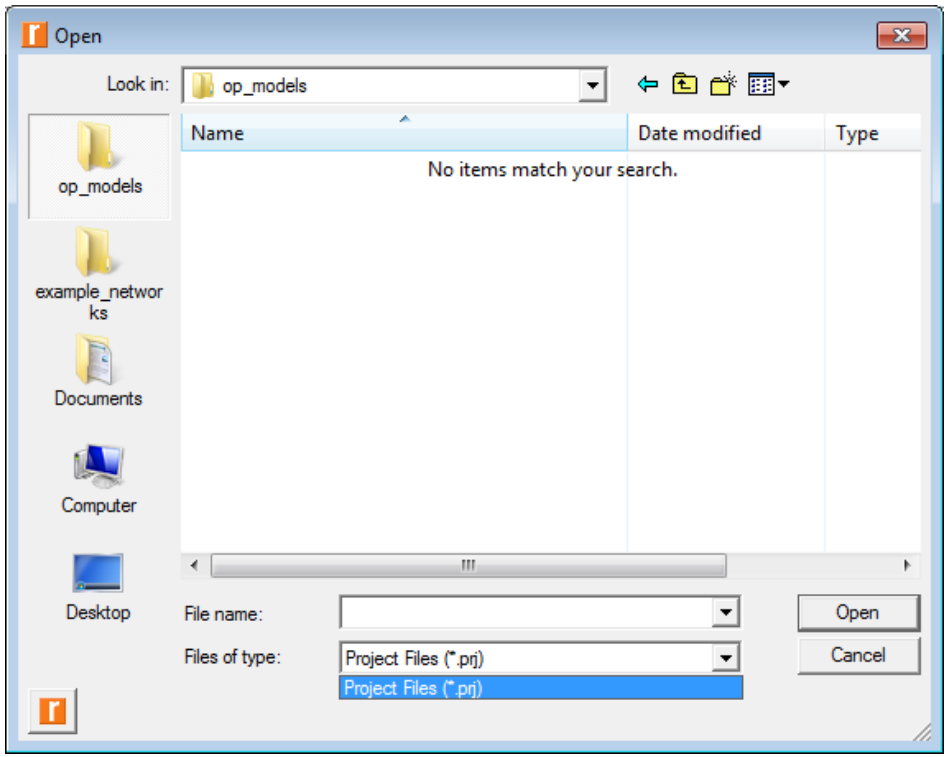
Getting Started (cont'd)

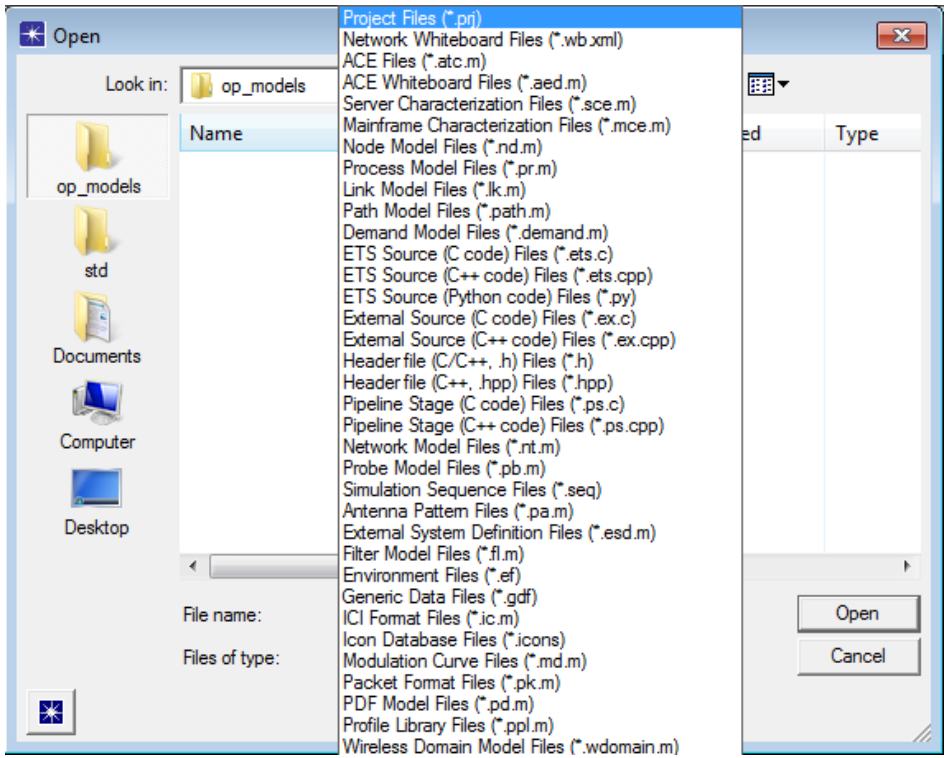
2. **File chooser organized by model directories** – displays only folders known to the program



Getting Started (cont'd)

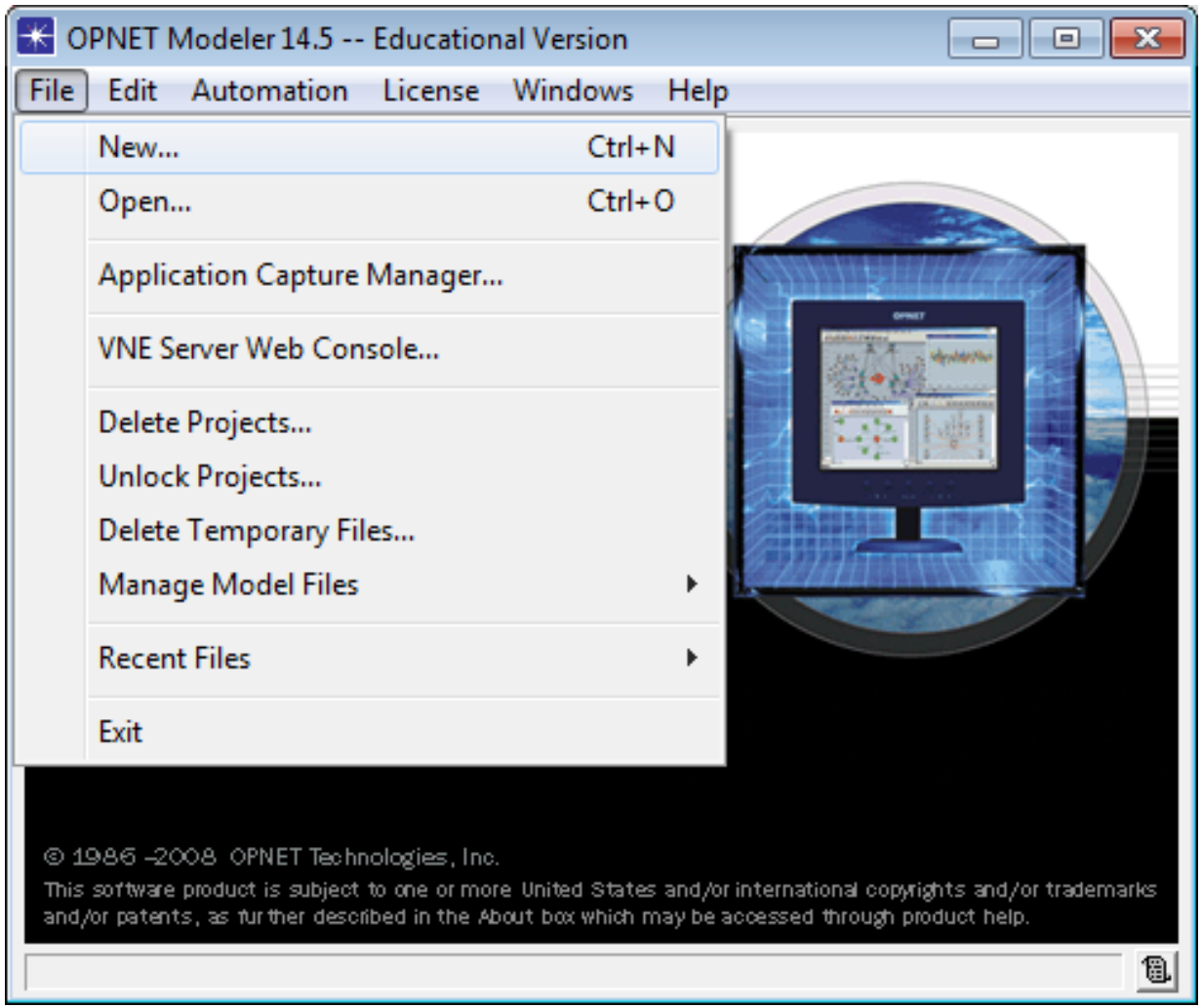
- Riverbed Modeler Academic Edition 17.5 vs. OPNET Modeler 14.5: opening an existing project





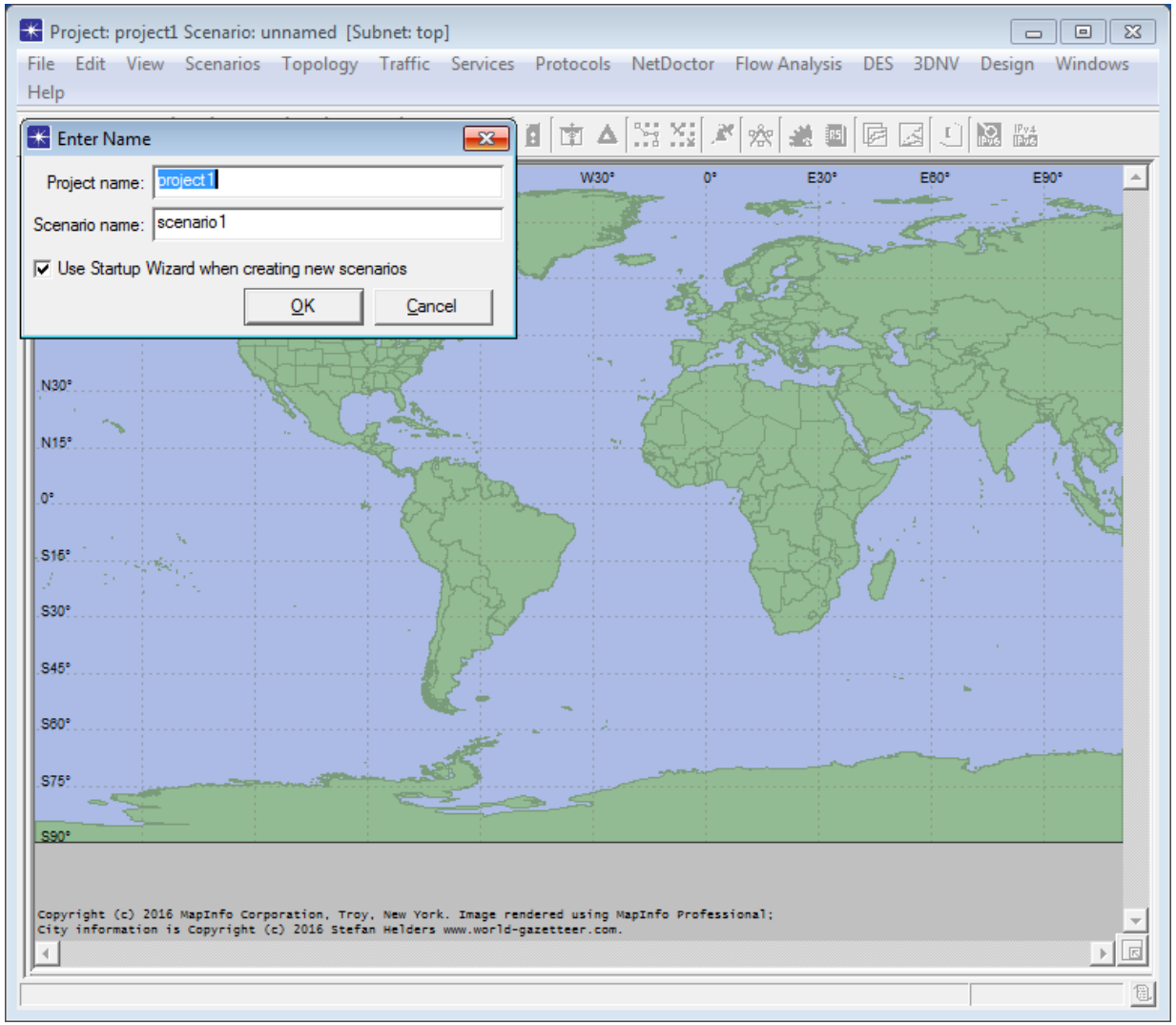
Getting Started (cont'd)

- Creating a new project



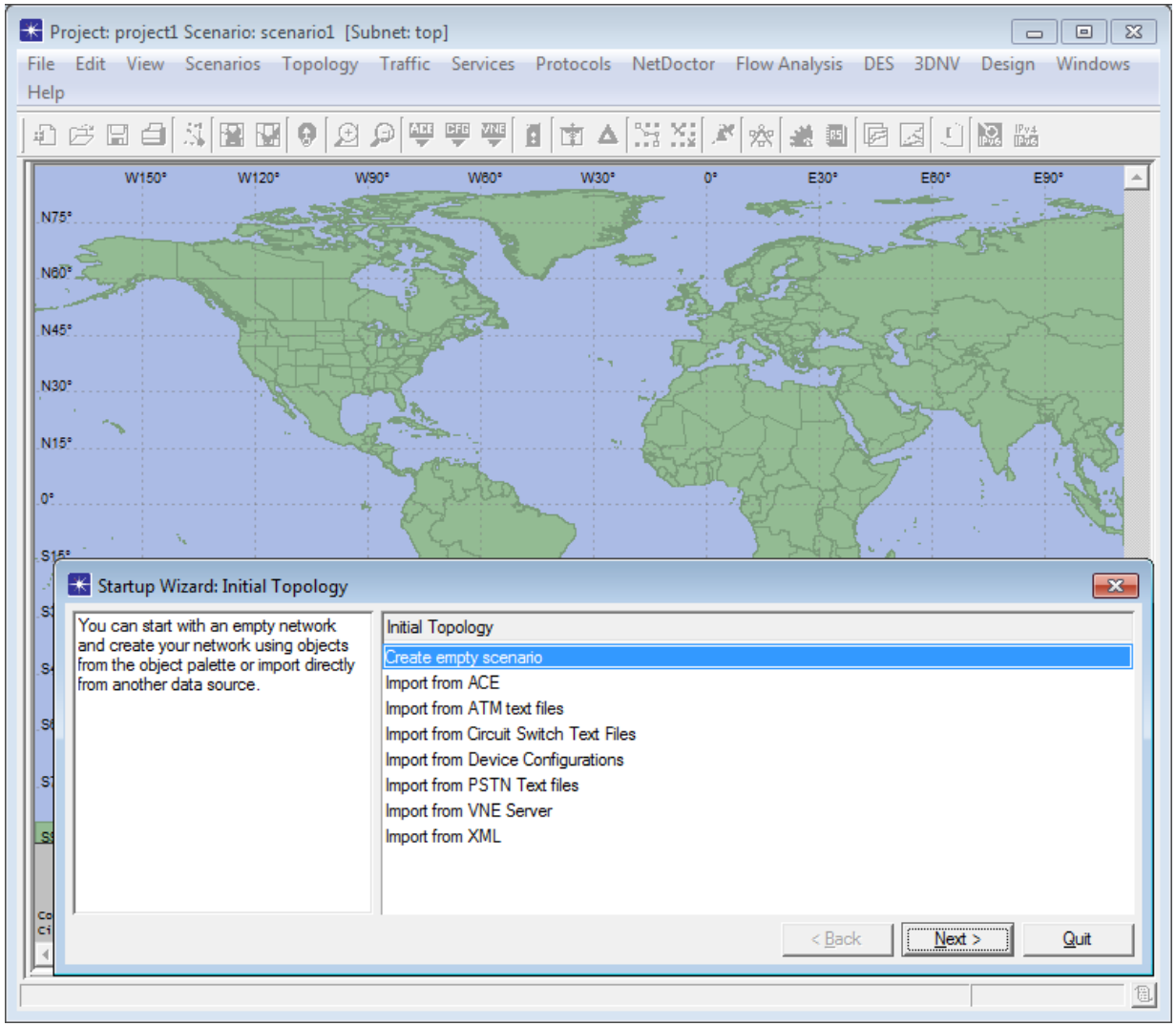
Getting Started (cont'd)

- Enter the desired project and scenario names



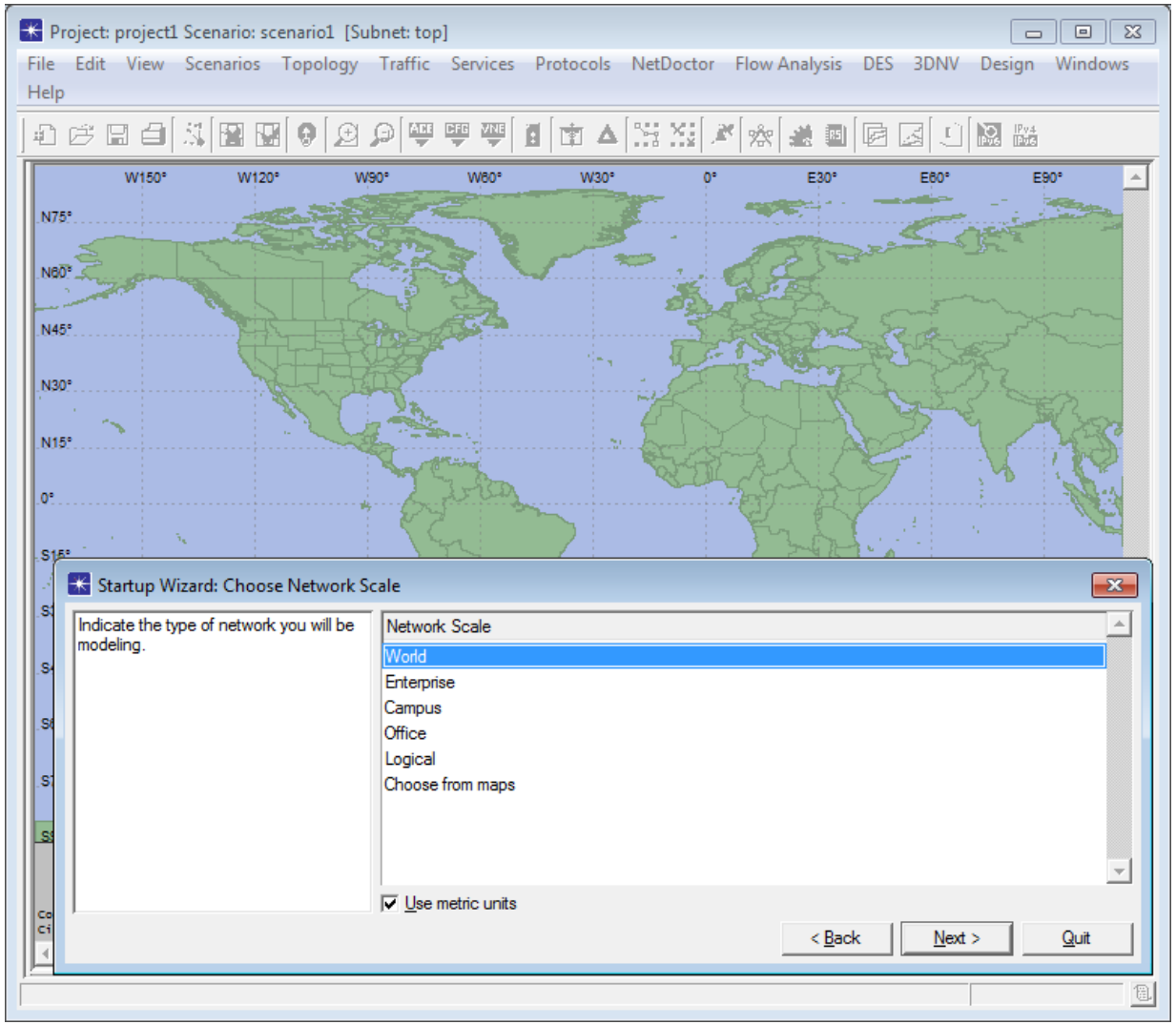
Getting Started (cont'd)

- Startup Wizard: Initial Topology



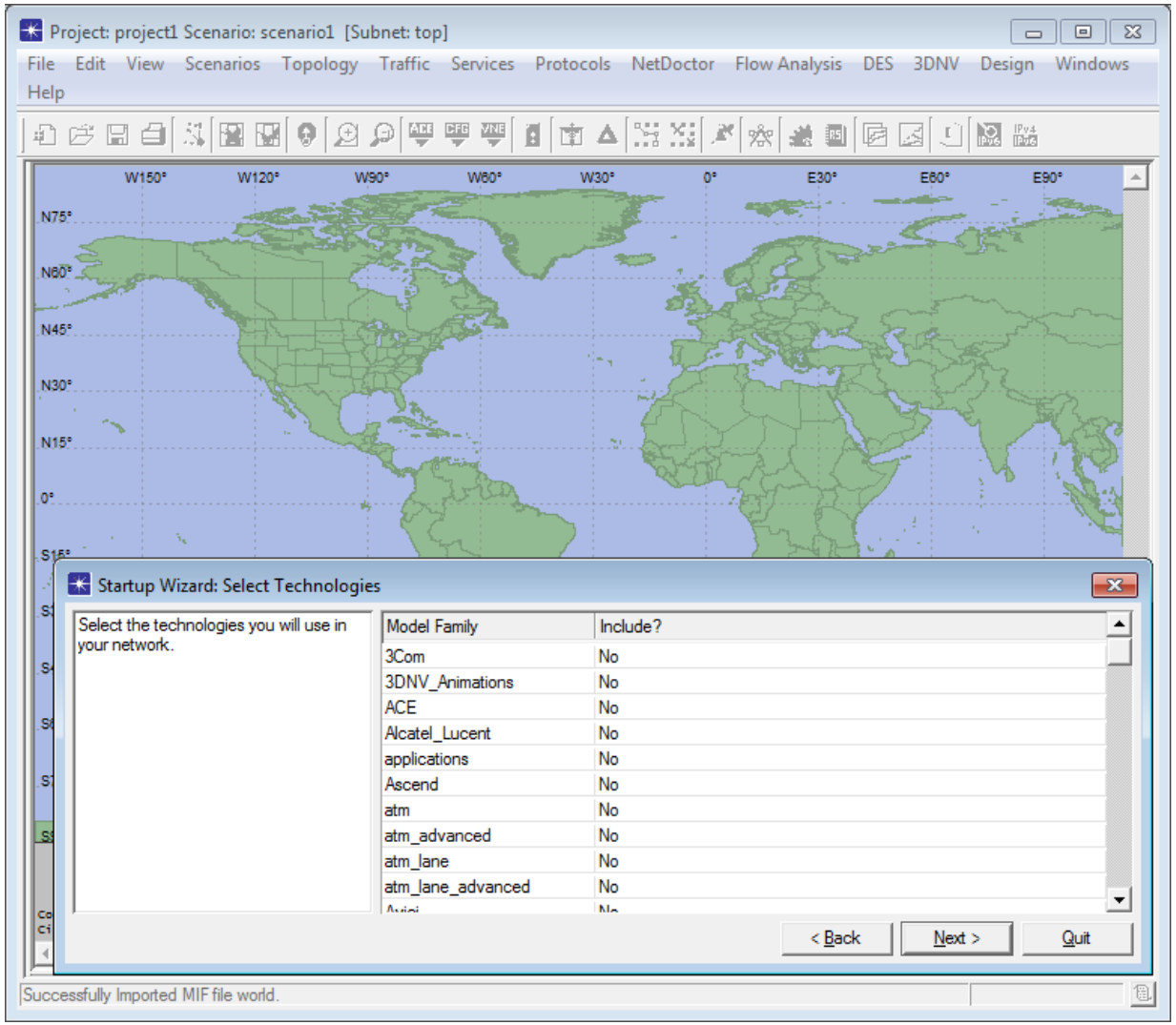
Getting Started (cont'd)

- Startup Wizard: Choose Network Scale



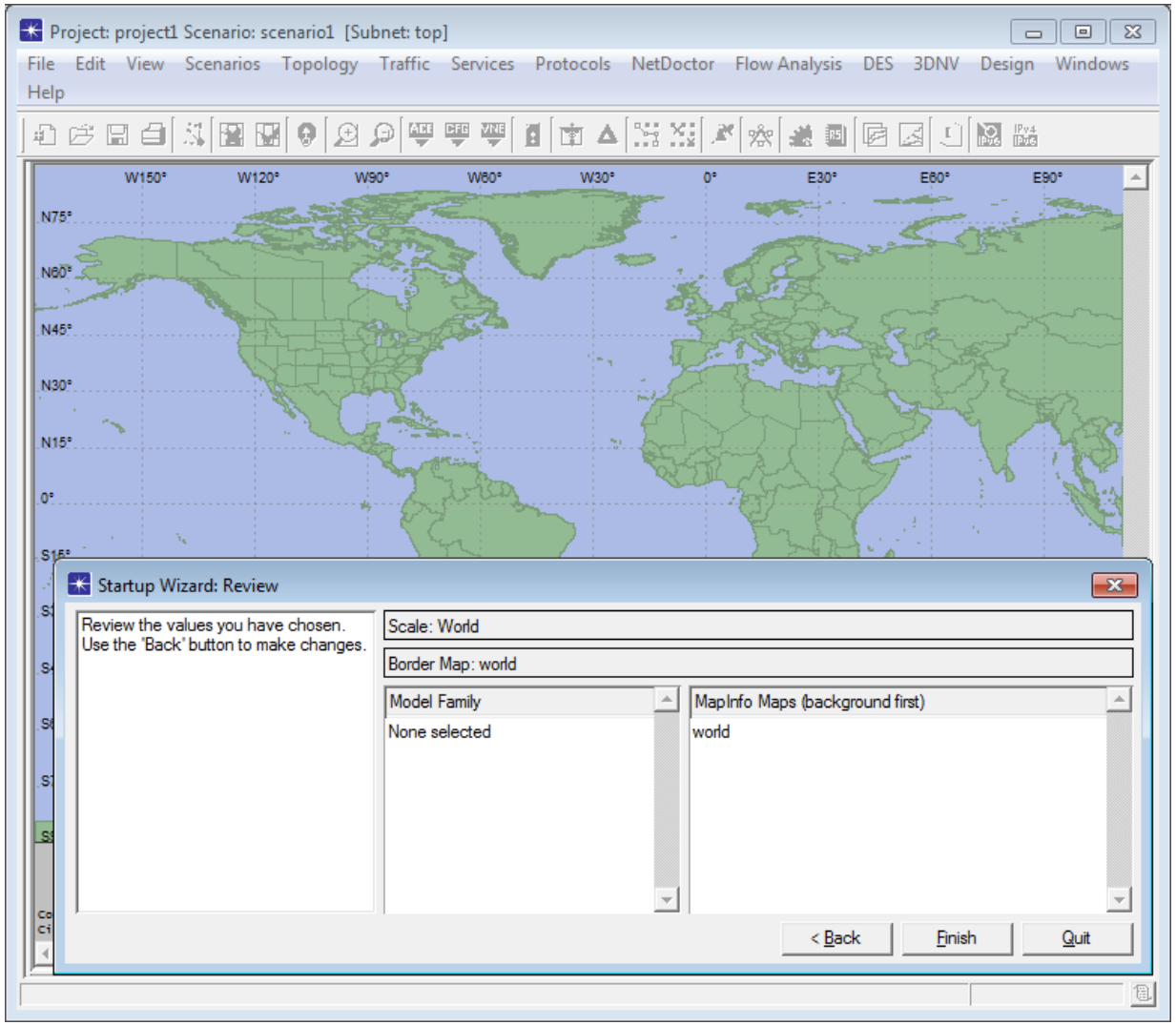
Getting Started (cont'd)

- Startup Wizard: Select Technologies



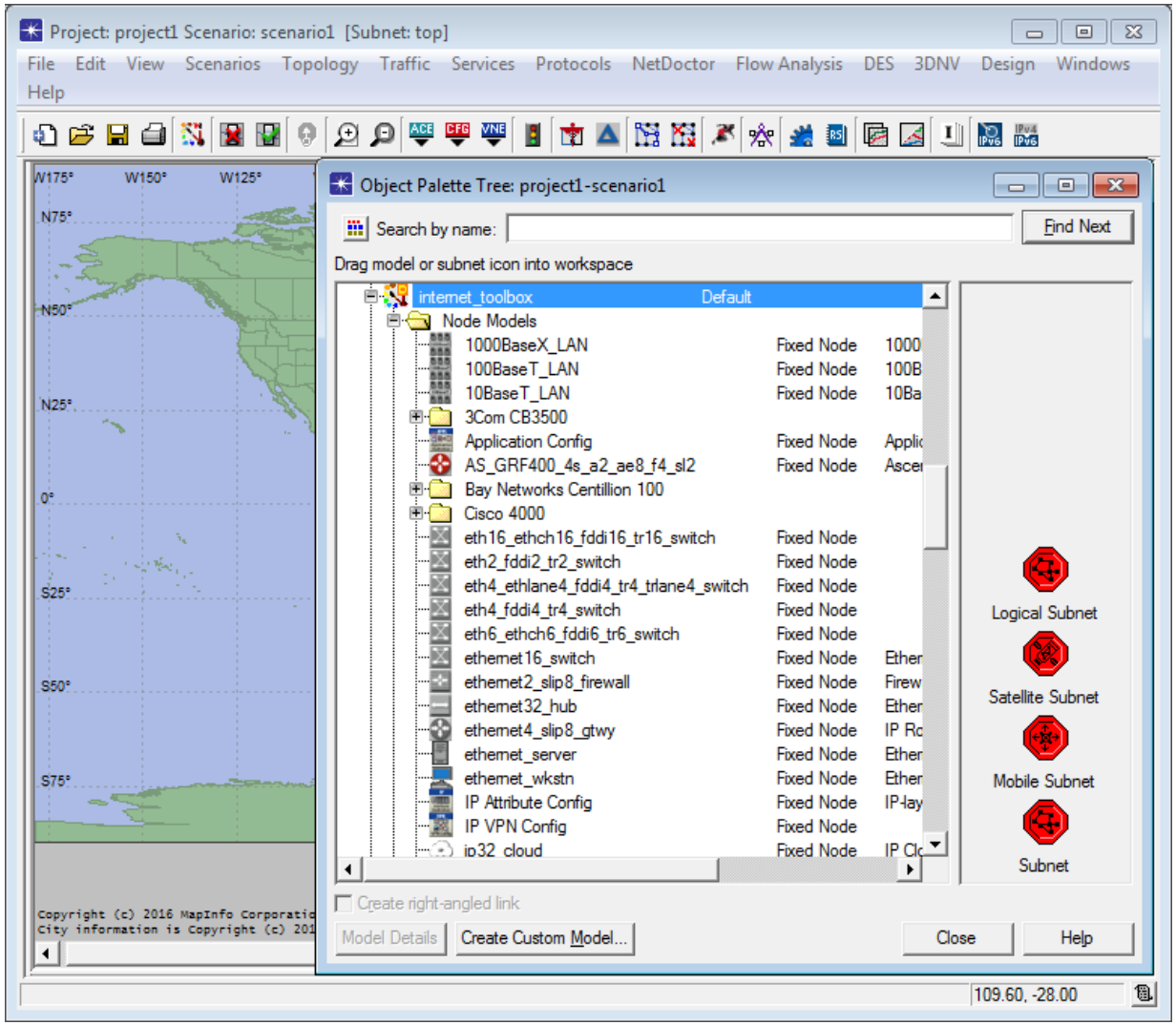
Getting Started (cont'd)

- Startup Wizard: Review



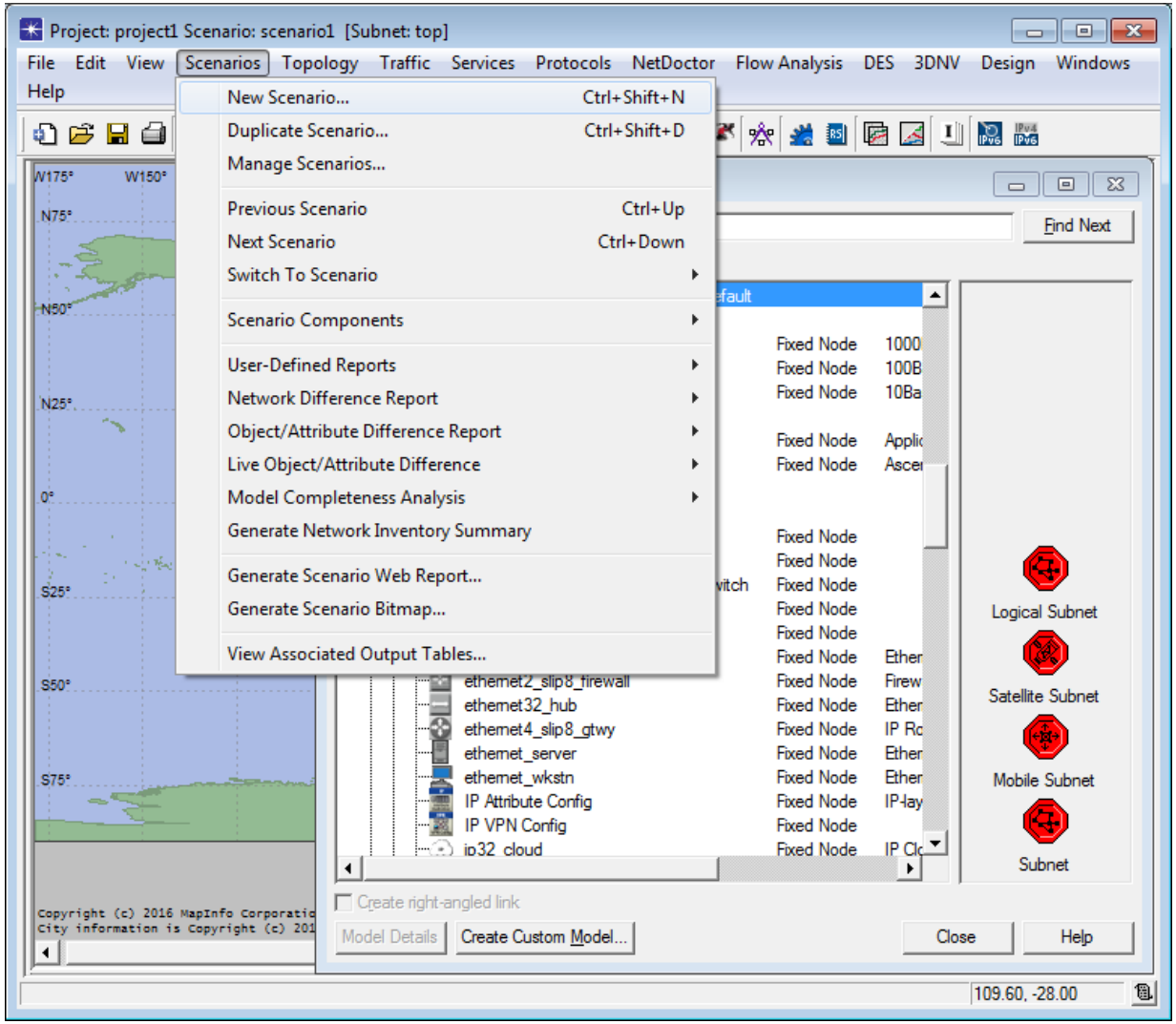
Getting Started (cont'd)

- **Project Editor** – used to create and configure the simulation study



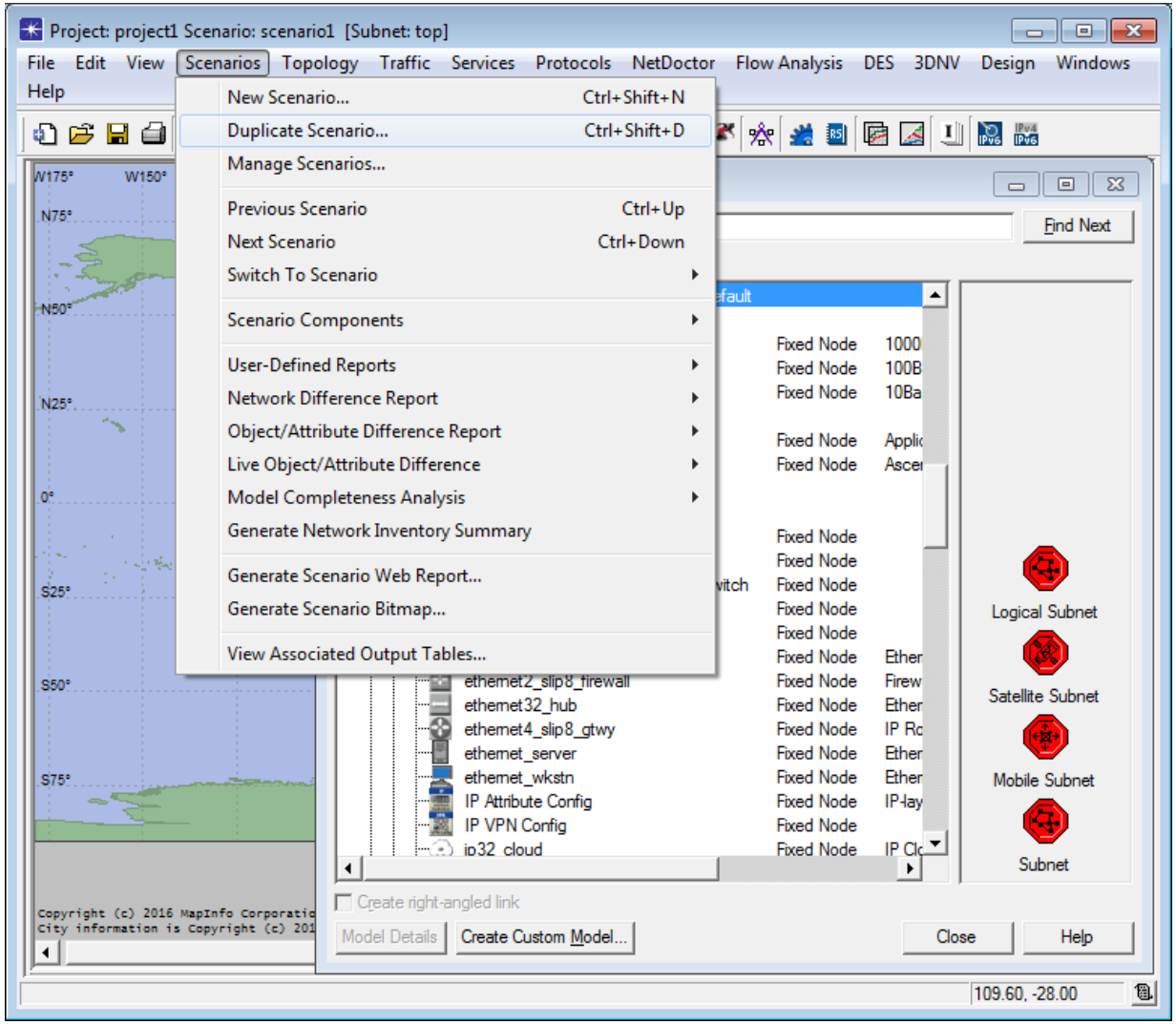
Getting Started (cont'd)

- **New Scenario...** – creates a new empty(!) scenario



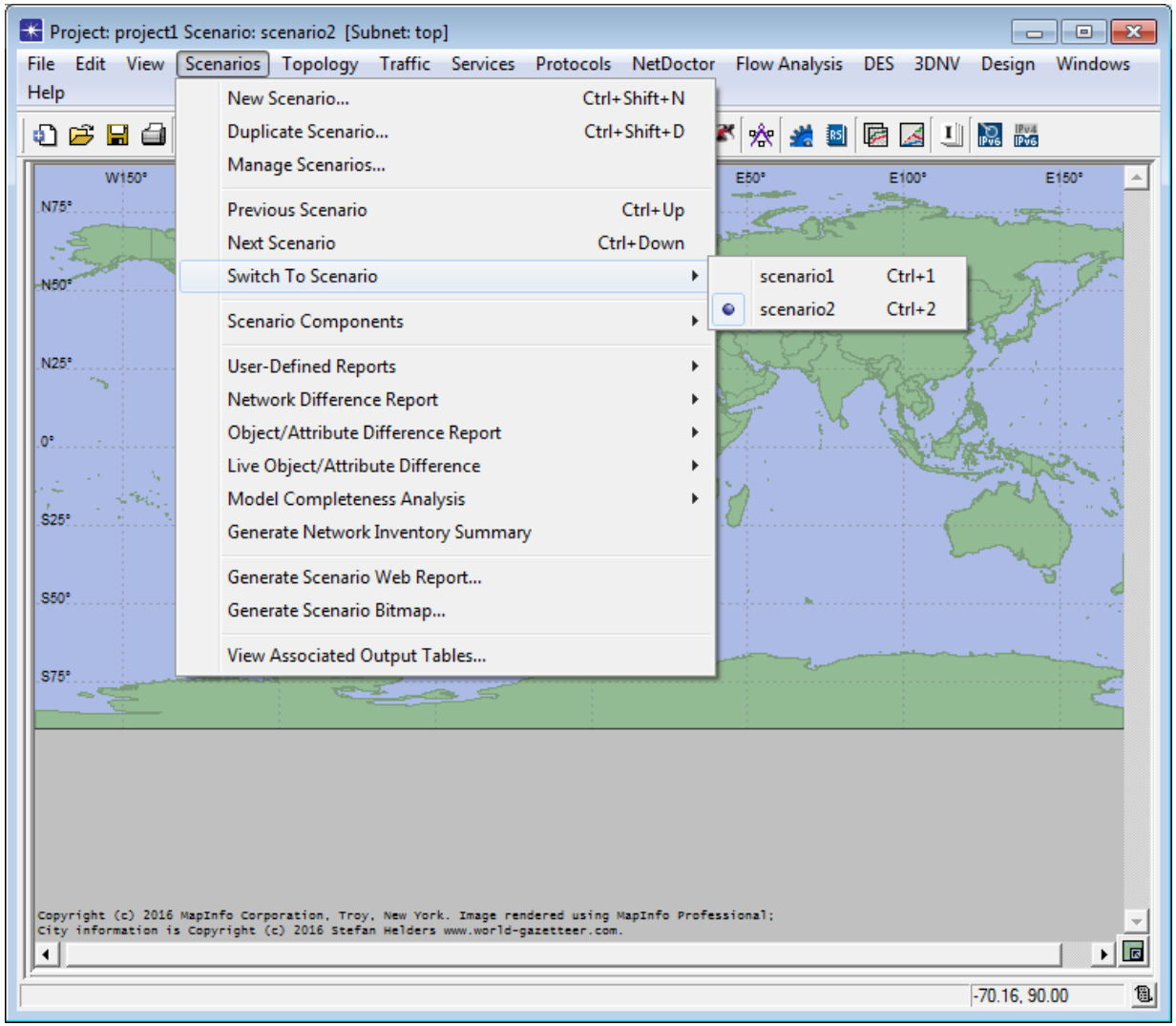
Getting Started (cont'd)

- **Duplicate Scenario...** – creates a new identical(!) scenario



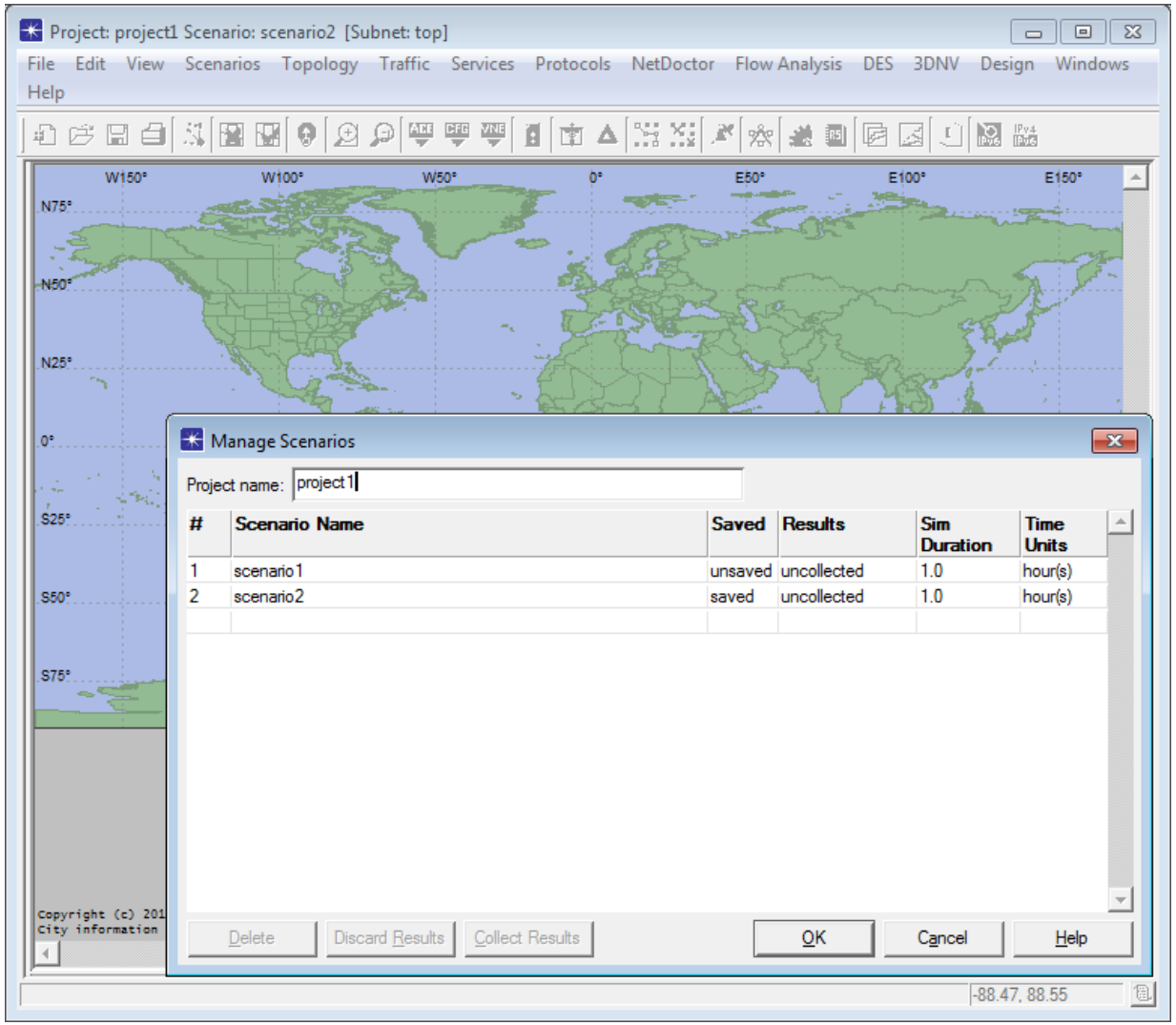
Getting Started (cont'd)

- **Switch to Scenario** – allows switching to a specific scenario



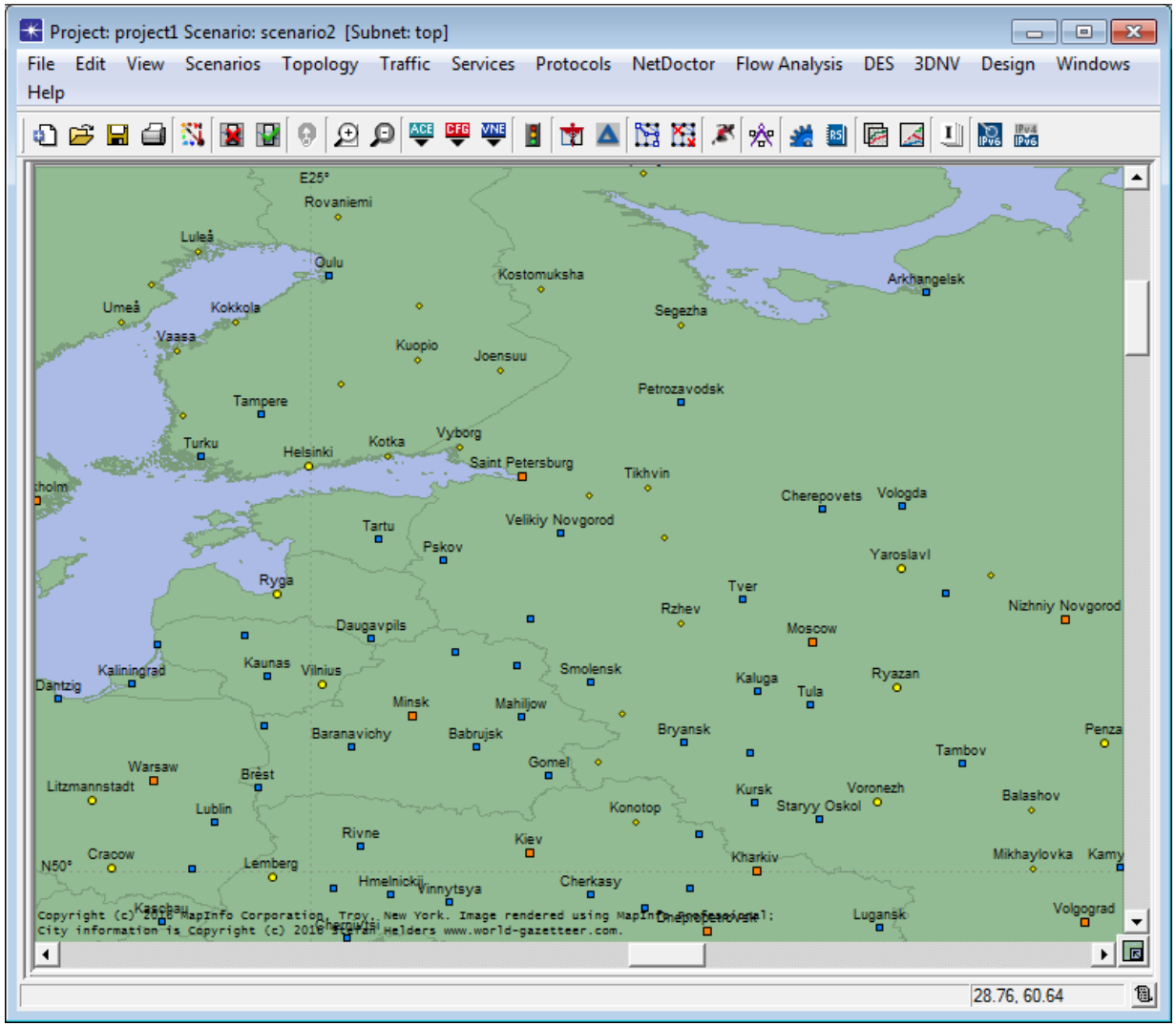
Getting Started (cont'd)

- **Manage Scenarios...** – organizes all scenarios within the project



Getting Started (cont'd)

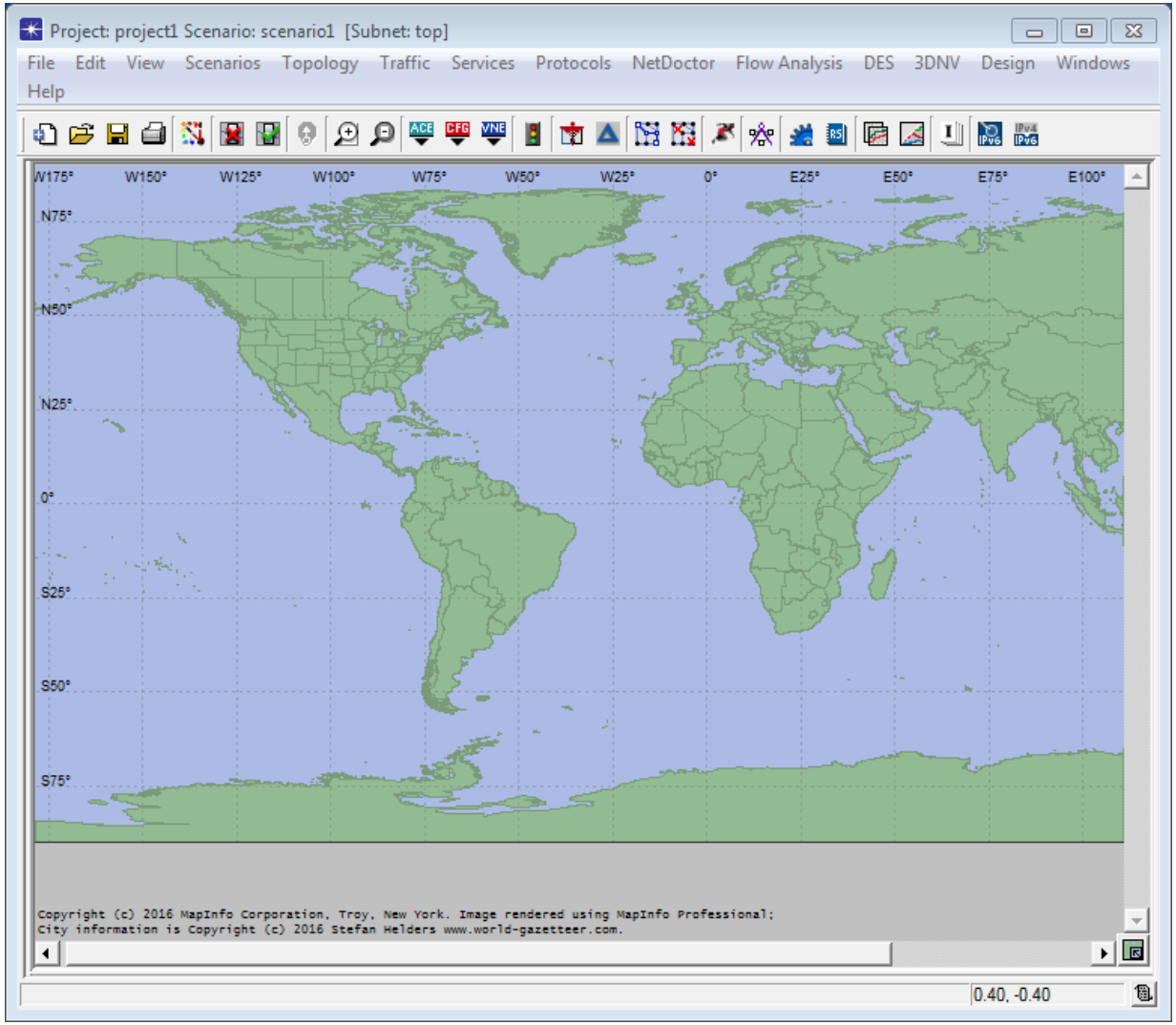
- Scroll the mouse wheel up or down to zoom in and out



Outline

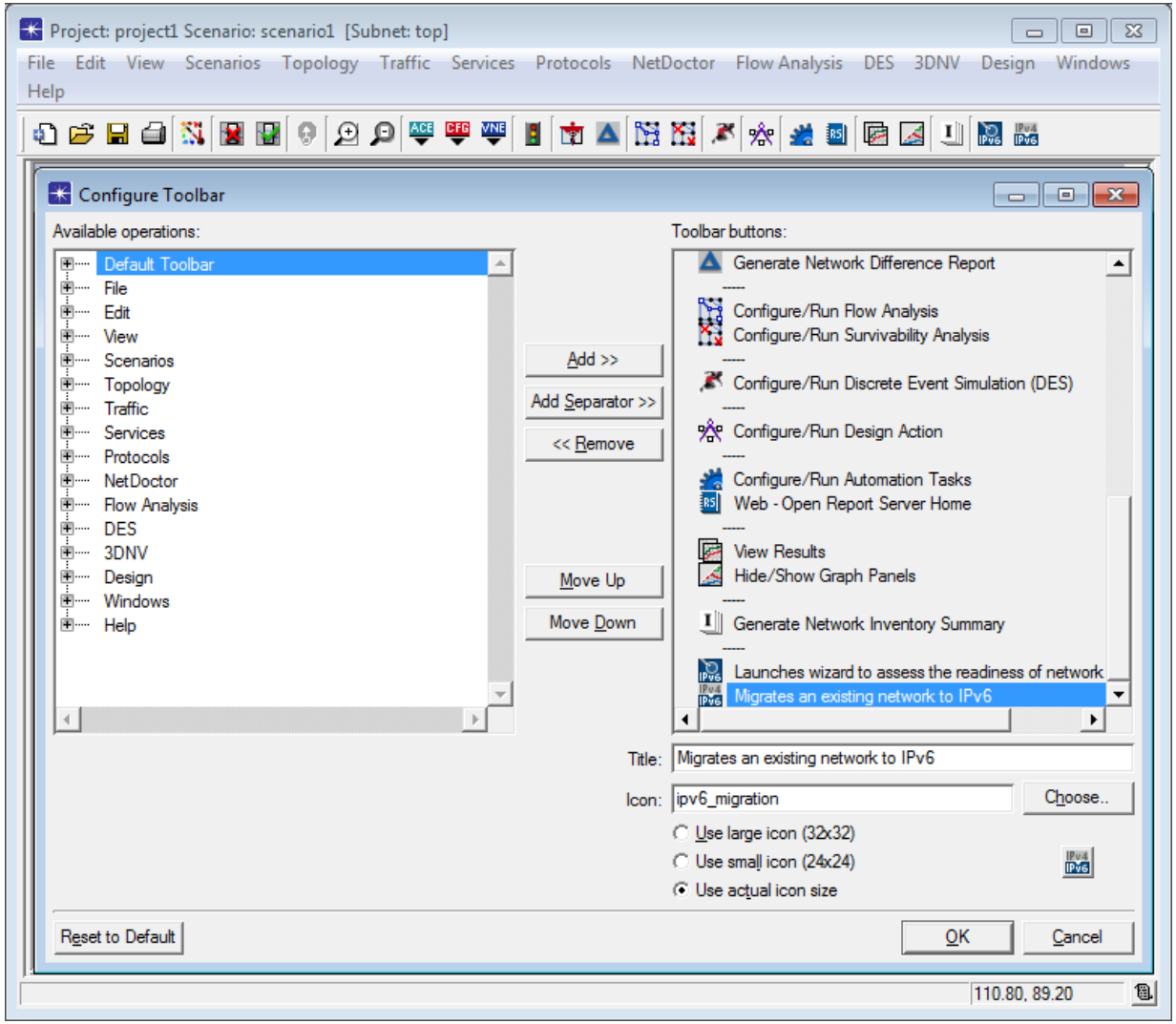
Toolbar Trouble

- **Toolbar** – contains buttons used to invoke certain operations



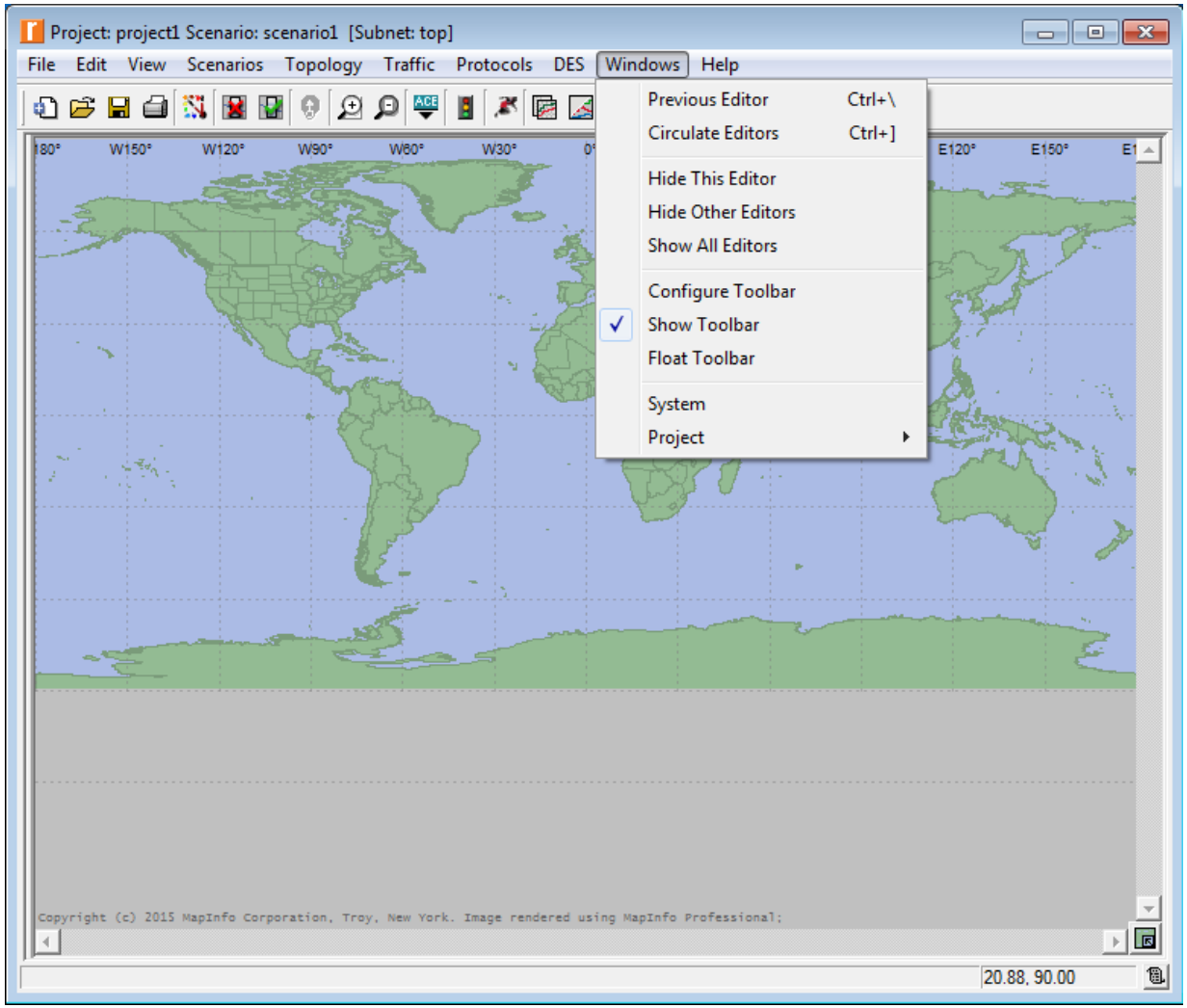
Toolbar Trouble (cont'd)

- Configure Toolbar / Reset to Default



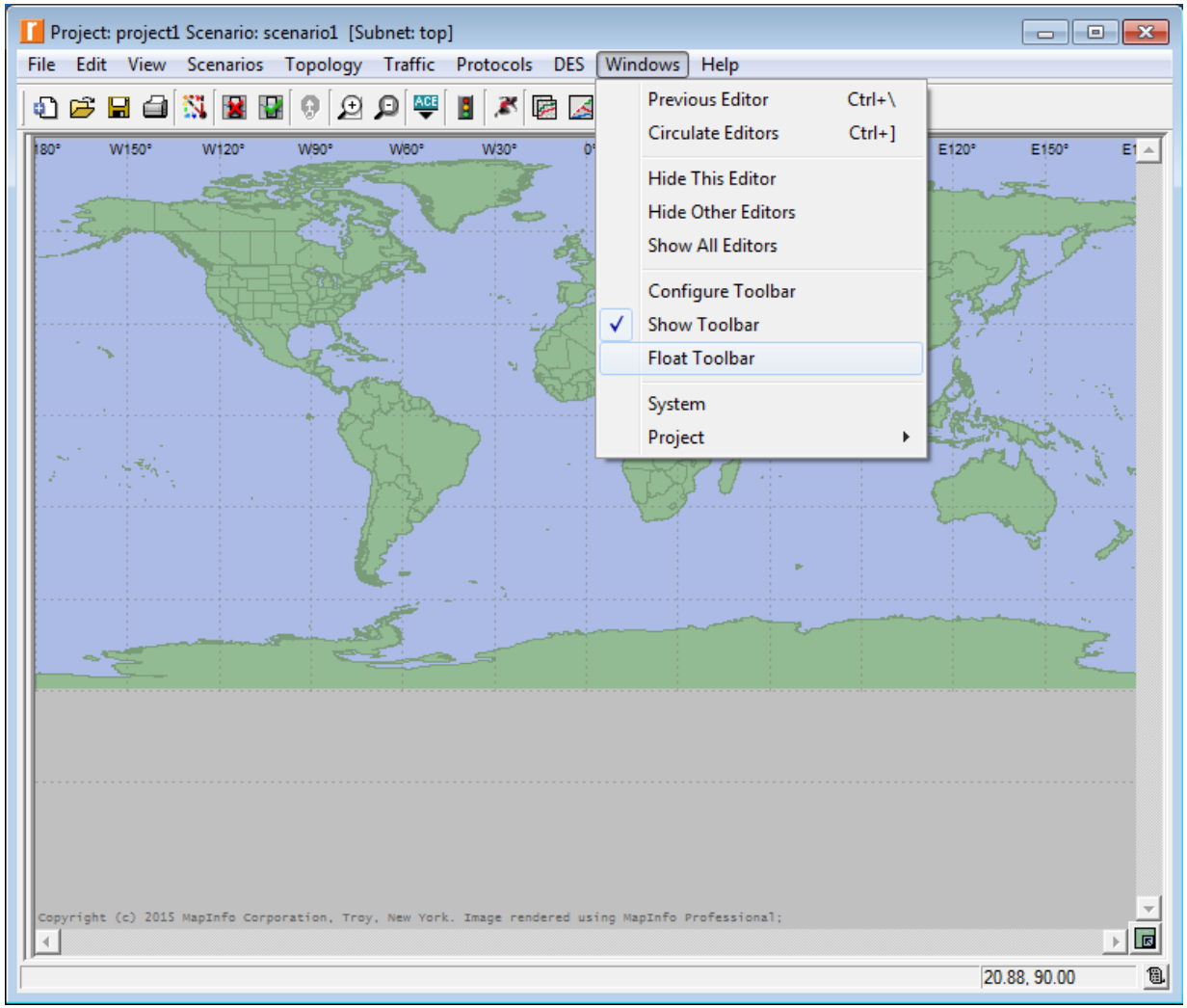
Toolbar Trouble (cont'd)

- Show/Hide Toolbar



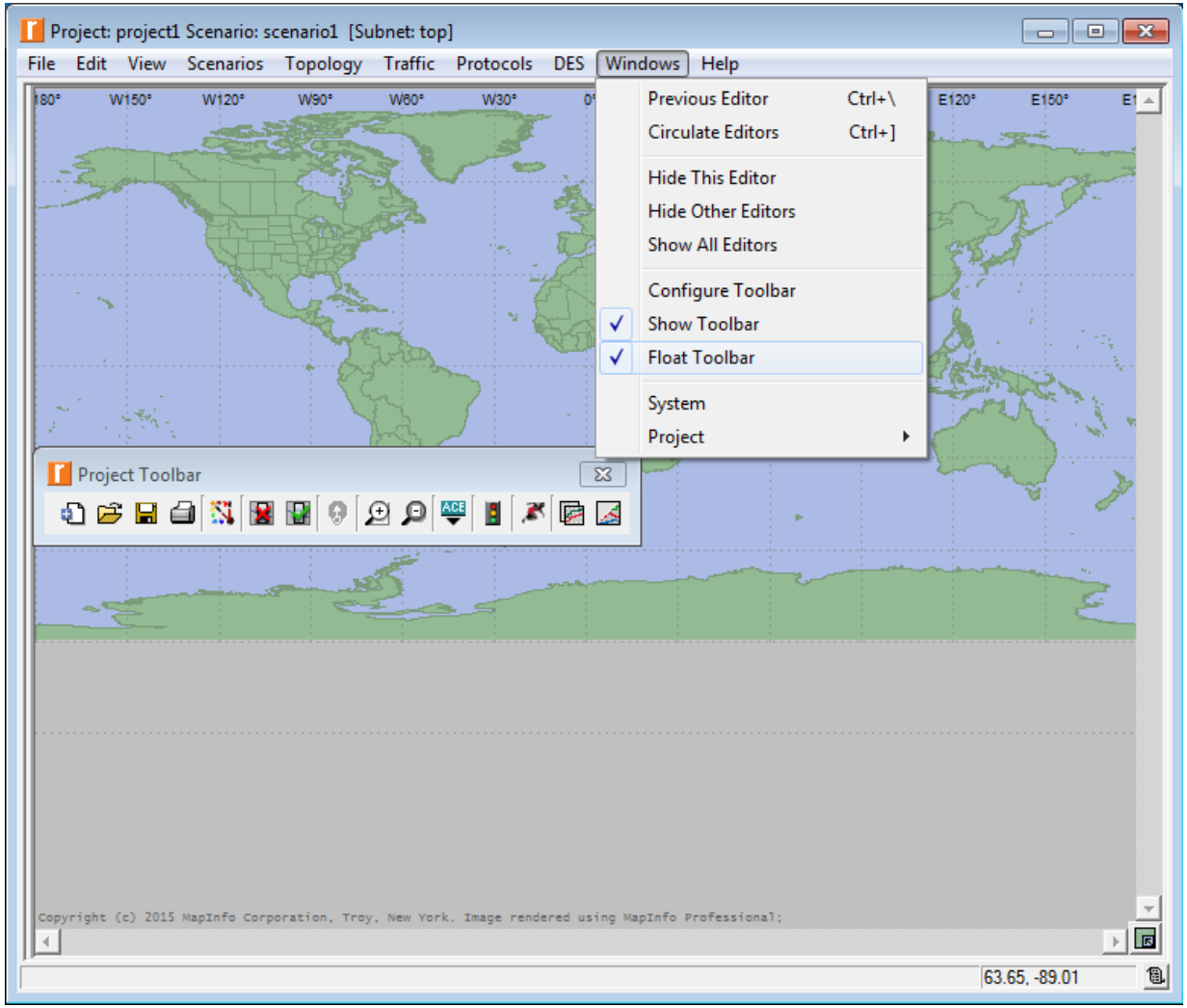
Toolbar Trouble (cont'd)

- Float Toolbar



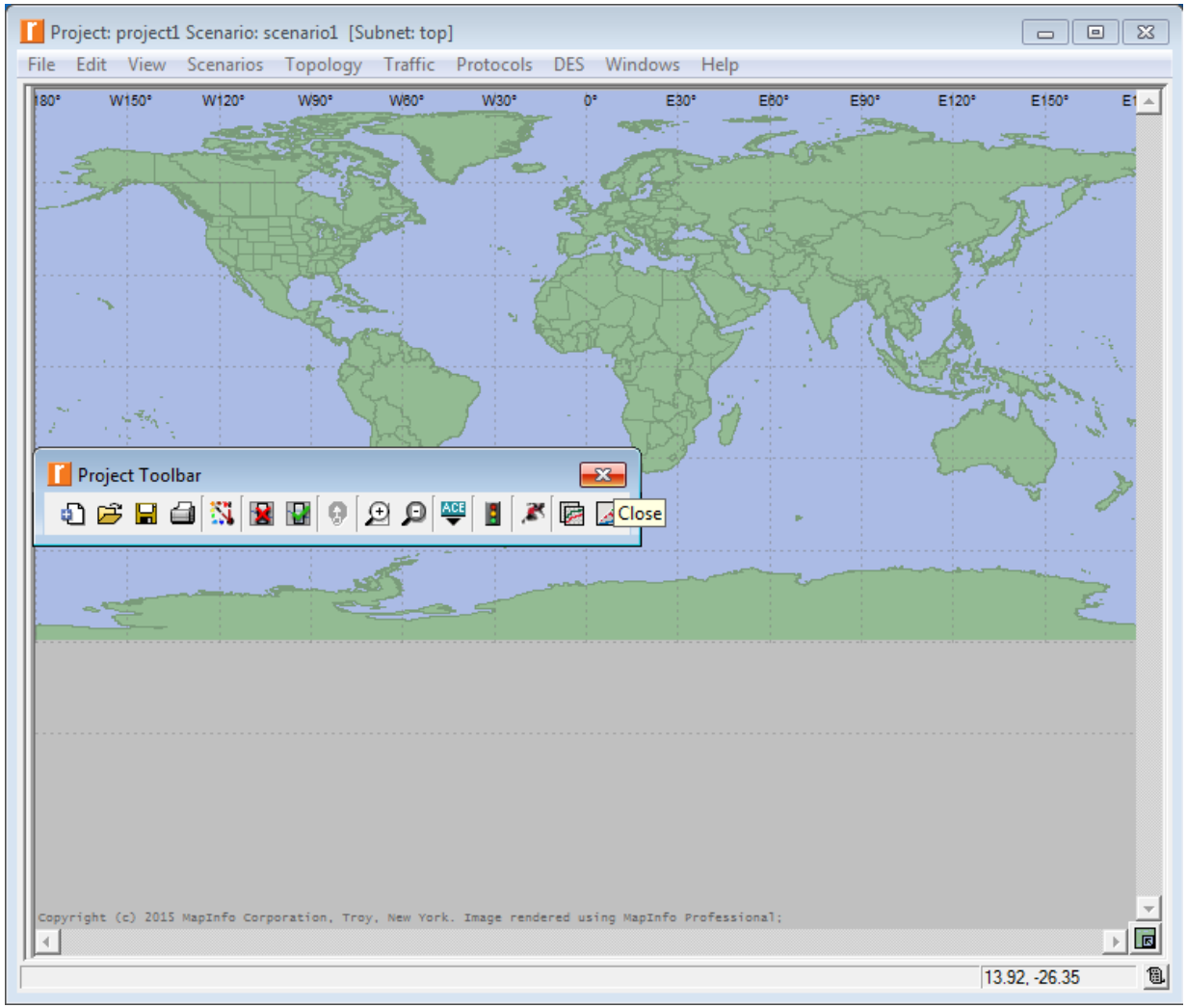
Toolbar Trouble (cont'd)

- Floating



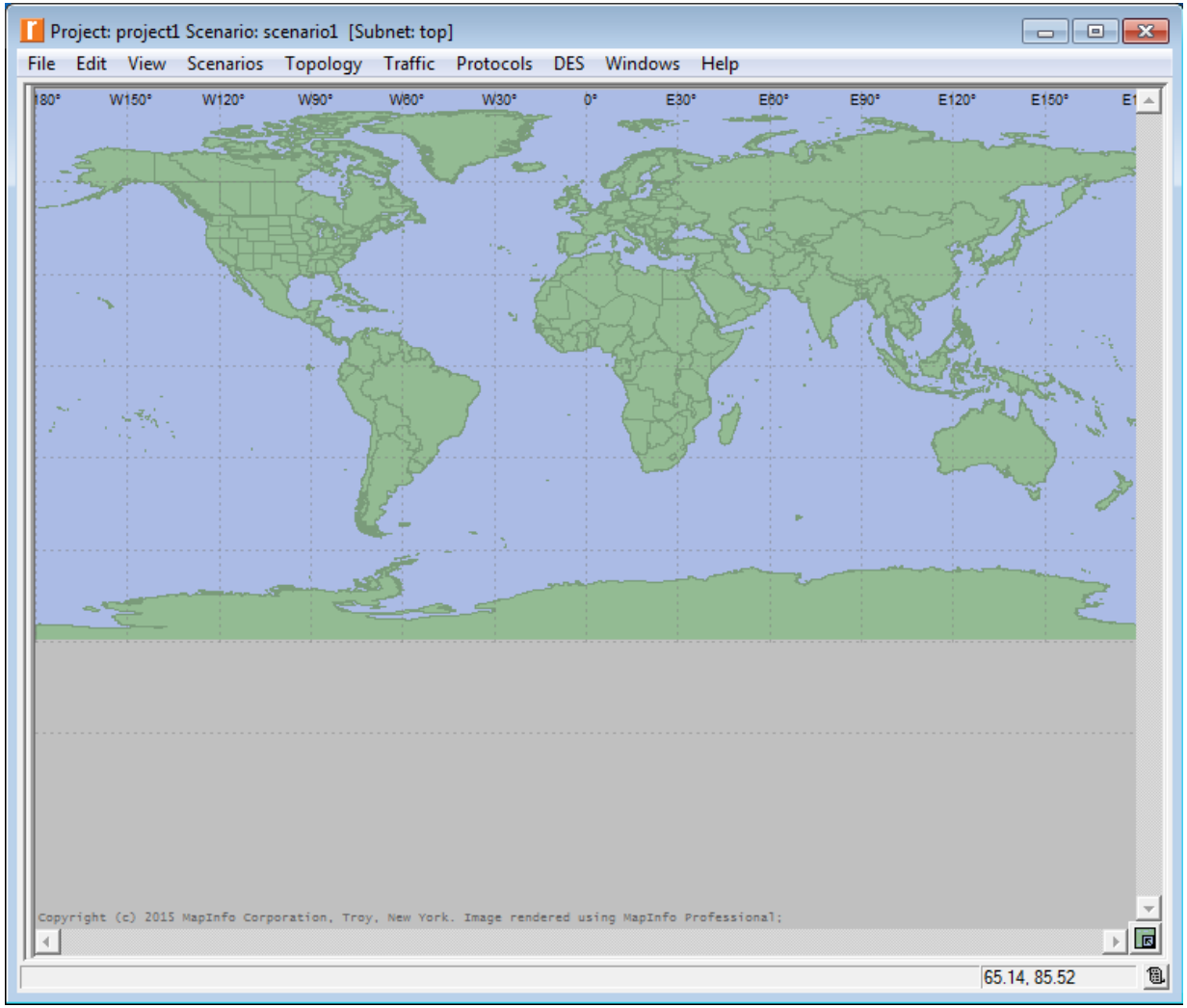
Toolbar Trouble (cont'd)

- Close



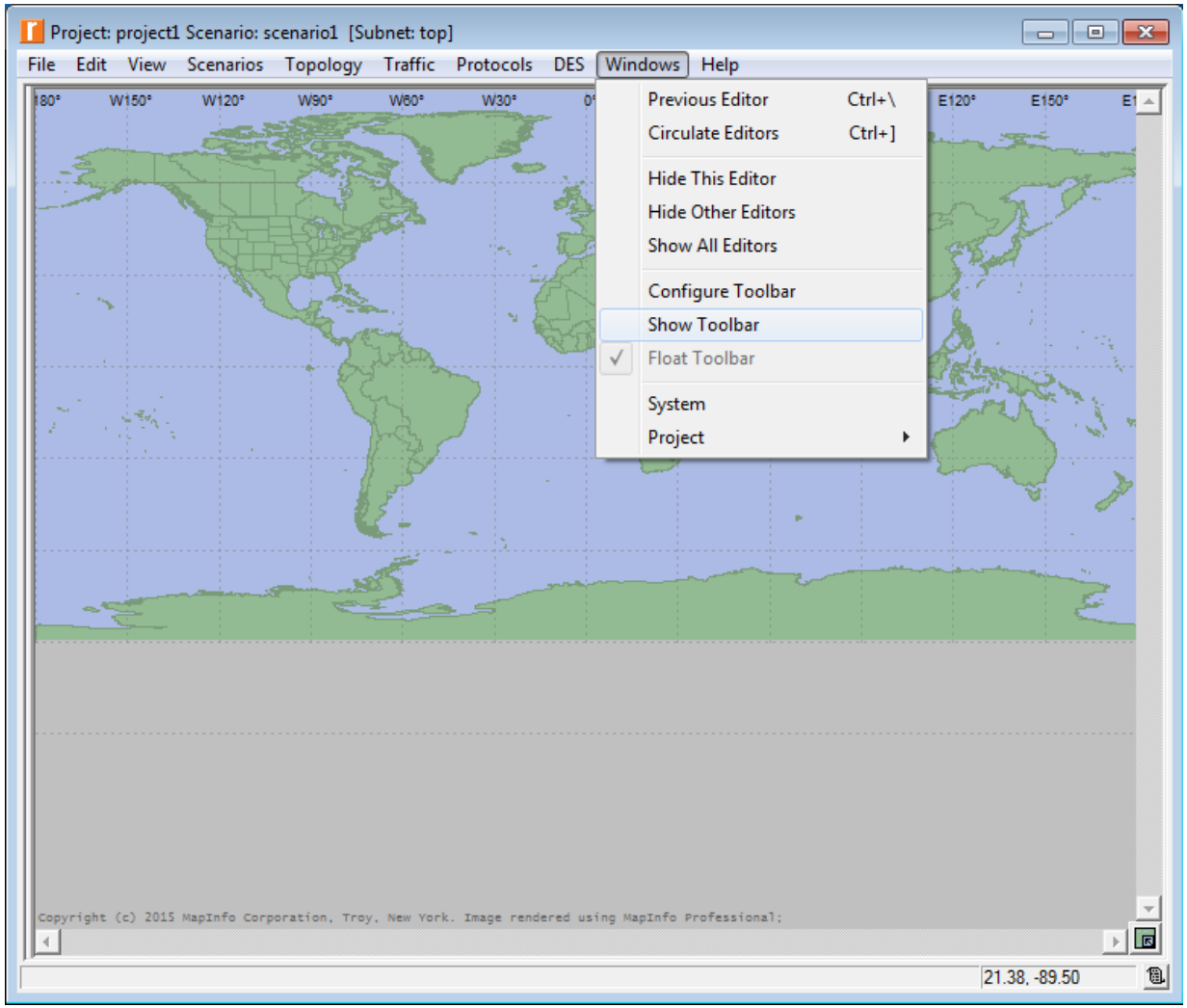
Toolbar Trouble (cont'd)

- And it's gone ☹



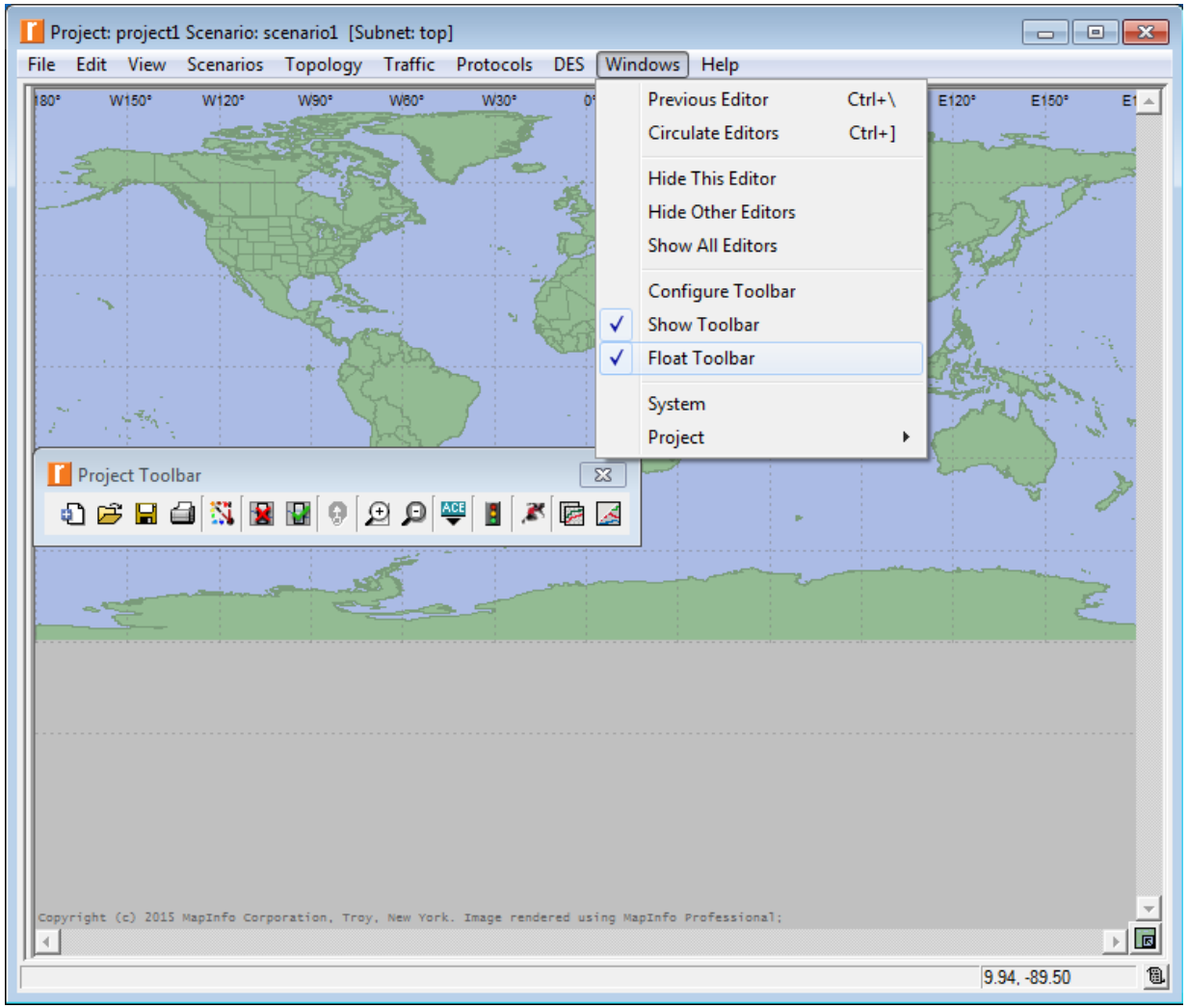
Toolbar Trouble (cont'd)

- Show Toolbar



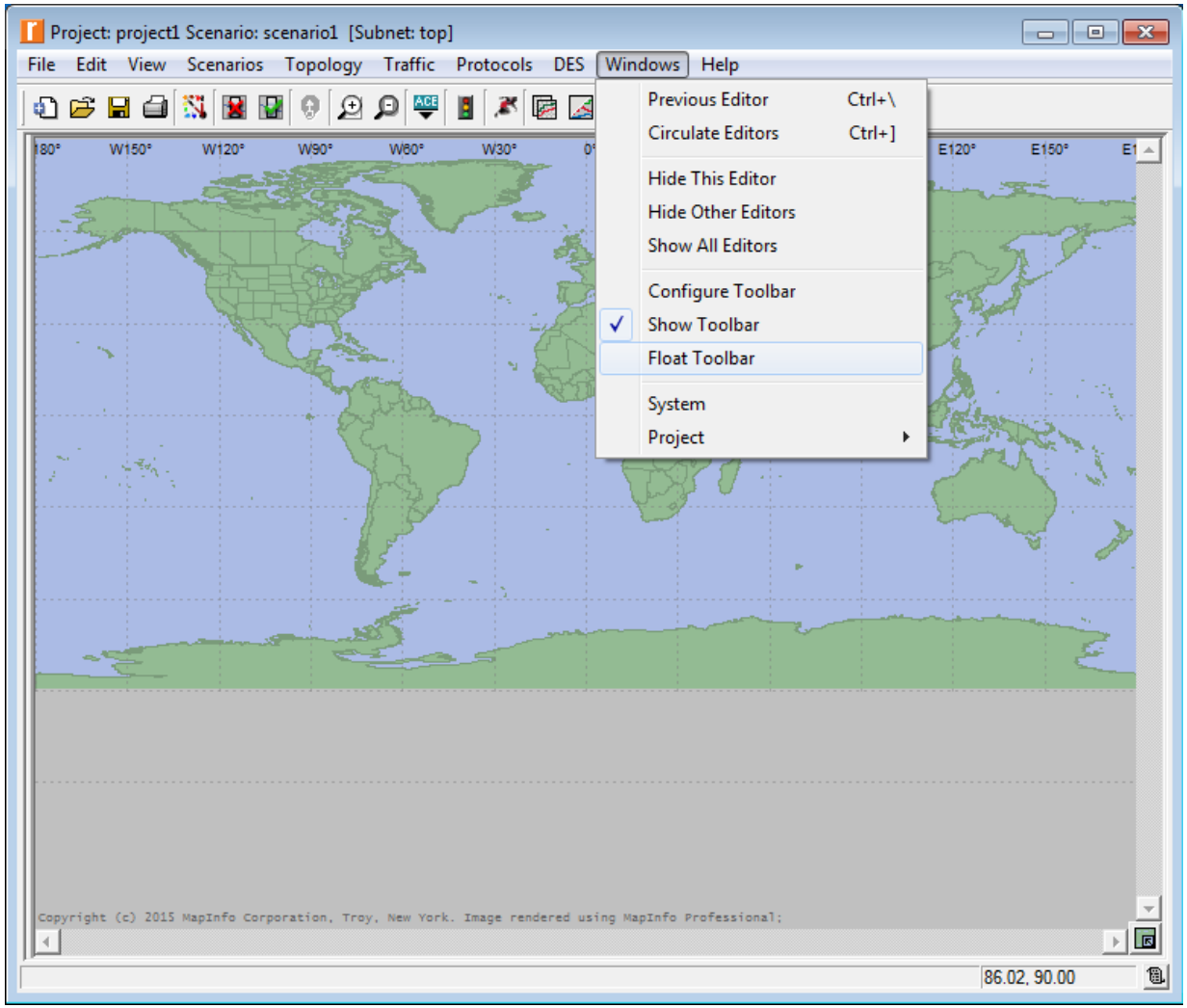
Toolbar Trouble (cont'd)

- And it's back ☺



Toolbar Trouble (cont'd)

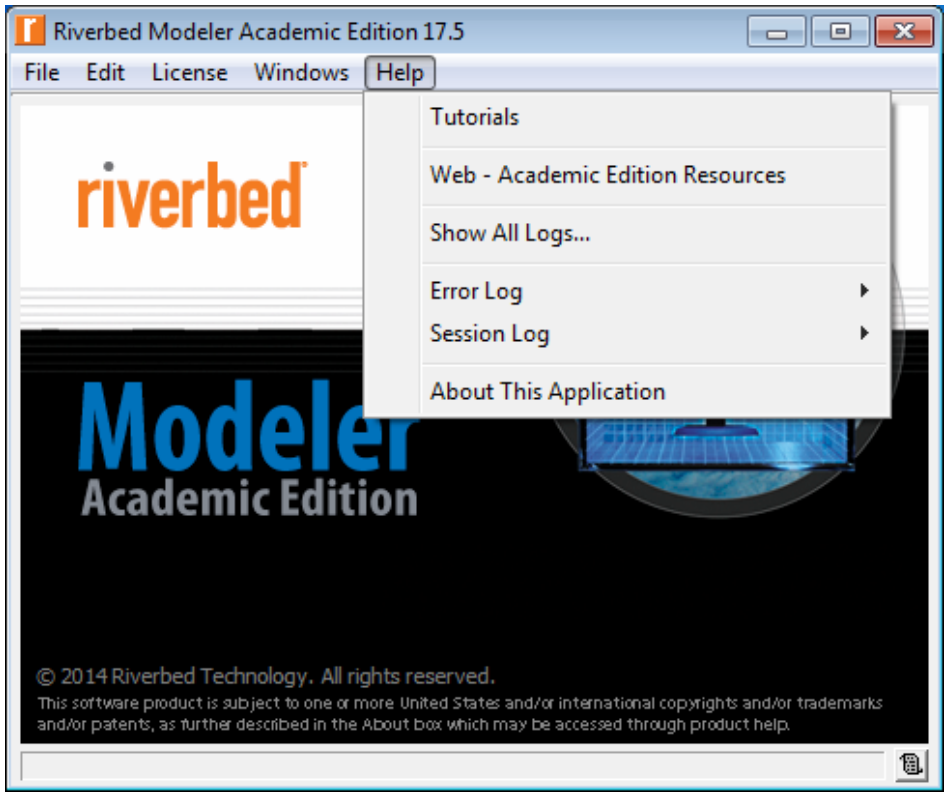
- Done!

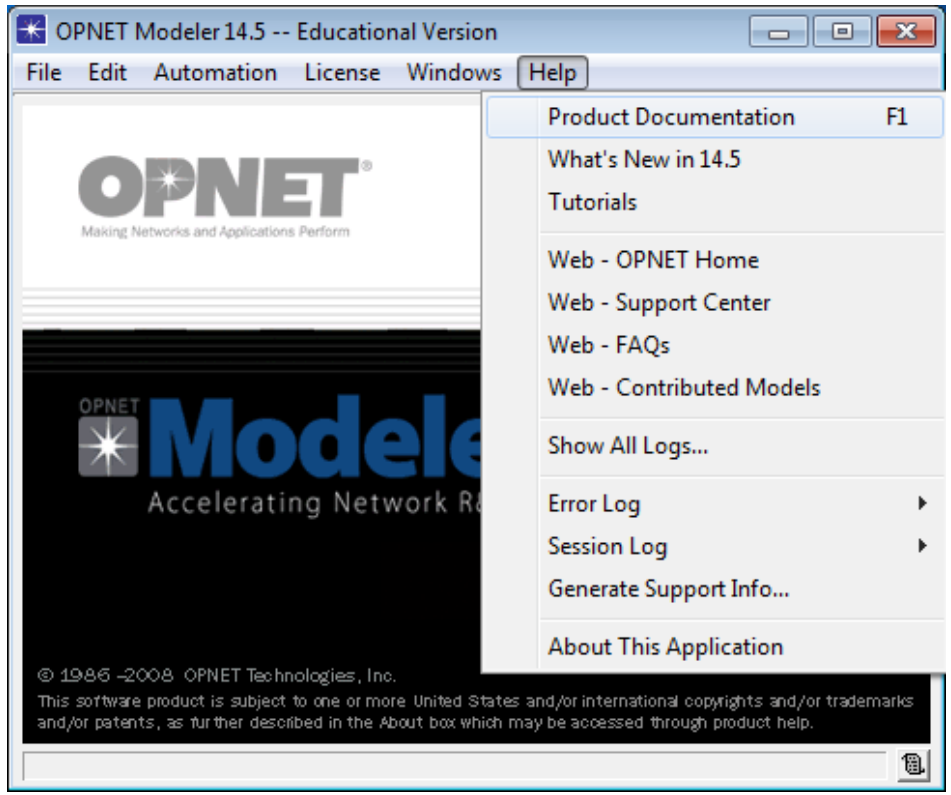


Outline

Bibliography

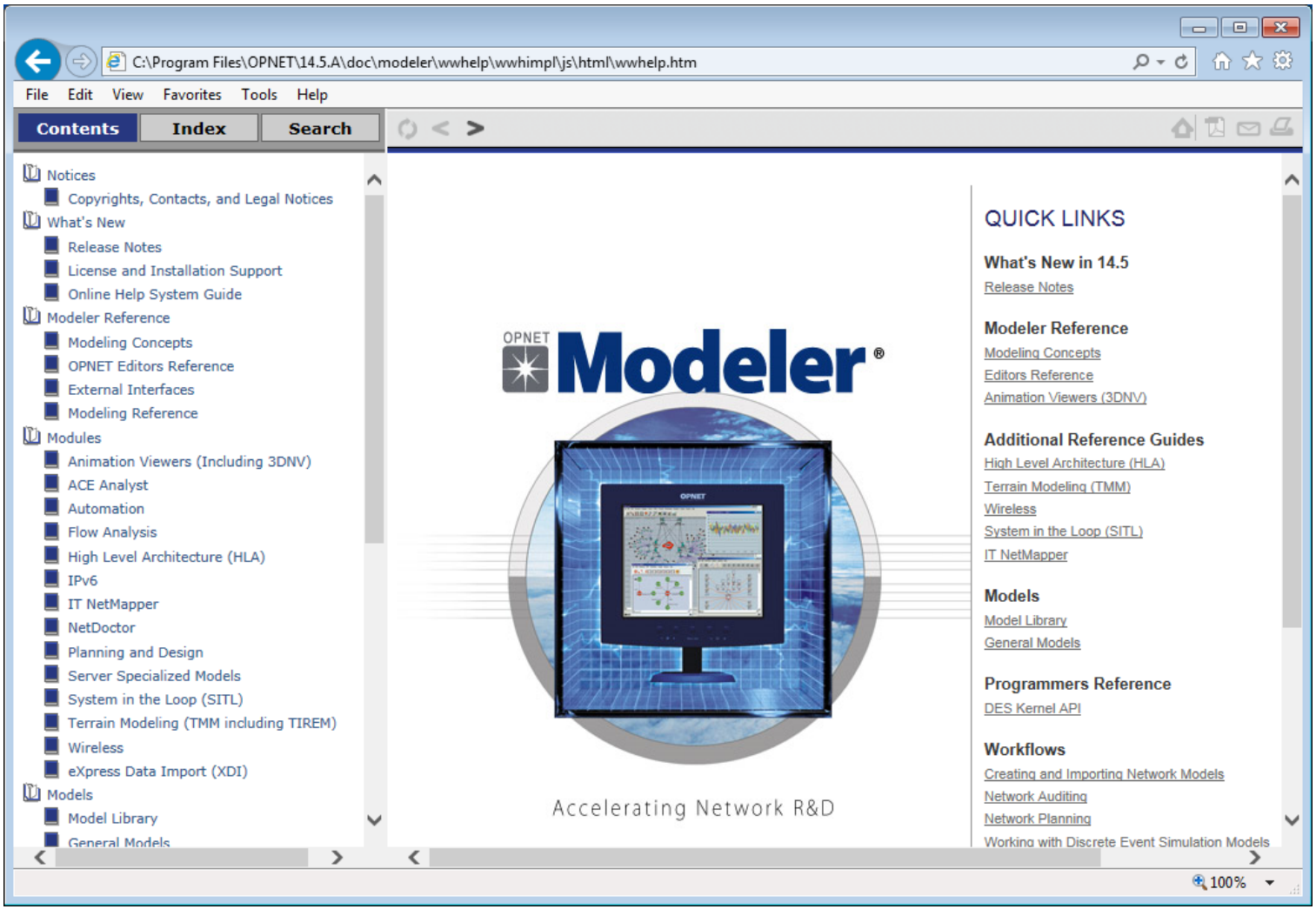
- Unlike Modeler Academic Edition, Modeler includes detailed product documentation





Bibliography (cont'd)

- OPNET/Riverbed documentation is stored as an HTML file



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- A. Sethi, V. Hnatyshin, 'The Practical OPNET User Guide for Computer Network Simulation', CRC Press, 2012
- Z. Lu, H. Yang, 'Unlocking the Power of OPNET Modeler', Cambridge Press, 2012