QualNet:
Overview and Examples

Roman Dunaytsev

The Bonch-Bruevich Saint-Petersburg
State University of Telecommunications

roman.dunaytsev@spbgut.ru

Lecture № 9

Outline

Outline

Introduction

- **Global Mobile Information System Simulator (GloMoSim)** – a network simulator
  - Project: 1997 – 2000
  - Sponsorship: Defense Advanced Research Projects Agency (DARPA)
  - Developer: University of California, Los Angeles (UCLA)
  - Language: PARSEC (a C-based parallel simulation language)
  - Project status: closed

- DARPA's requirements:
  - High speed
  - High scalability
  - Modeling and simulation of wireless and heterogeneous networks

- Software:
  - Open source
  - **Freeware**

Introduction (cont'd)

- **QualNet** – the commercial spin-off of the GloMoSim simulator
  - Company: Scalable Network Technologies, Inc. (SCALABLE)
  - Founded: 1999
  - Founder: Dr. Rajive Bragodia (Parallel Computing Laboratory, UCLA)
  - https://www.scalable-networks.com/
- Application fields:
  - Research and development (R&D)
  - Planning and optimization
  - Education and training
- Software:
  - Open source
  - **Commercial**

Introduction (cont'd)

- Customers:

1. **Service providers**
   - AT&T, France Telecom, NTT DoCoMo, . . .
2. **Enterprises**
   - Microsoft, Panasonic, TOSHIBA, TOYOTA, . . .
3. **Network equipment manufacturers**
   - Lucent Technologies, . . .
4. **Defense and homeland security**
   - NASA, US Air Force, US Army, US Navy, . . .
5. **Universities**
   - **SCALABLE EDU Program**

Introduction (cont'd)

- Official site:
  - https://www.scalable-networks.com/
- Recent version:
  - **qualnet**-**9.2**, 2020
- Operating systems:
  - Windows
  - Linux

Introduction (cont'd)

- QualNet key capabilities:
  - High scalability enables more sophisticated design and analysis
  - Faster-than-real-time simulation optimizes productivity
  - High-fidelity models deliver more accurate results
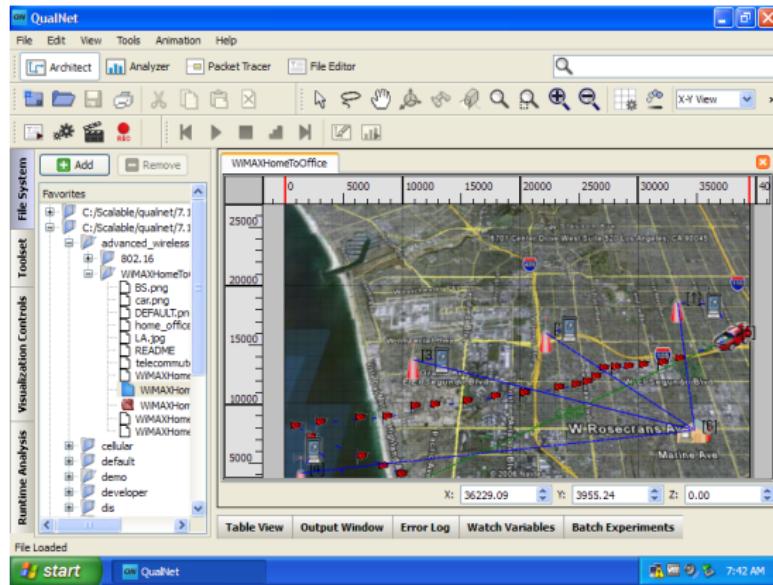
Introduction (cont'd)

- **Graphical User Interface (GUI)**
  - Easy-to-use

- **Sophisticated analysis**
  - Integrated GUI-based debugging and analysis

- **High-fidelity modeling**
  - Various equipment and protocols, terrain and weather effects

- **Scalable simulation**
  - 32-bit and 64-bit fully parallel simulation kernel
  - Grid computing support for distributed simulation

- **Integrating live network and application behavior**
  - Commands that control various elements during scenario execution
  - Protocols and mechanisms that enable interaction with other systems

Introduction (cont'd)

- Built for speed:
  - Takes full advantage of the multi-threading capabilities of multi-core, multi-processor, cluster and 64-bit processor systems
  - Supports simulation with 1000s of network nodes

- Example:
  - 'A cluster of 16 dual 2GHz Opteron systems connected by an Infiniband switch achieved real-time speed for 3,500 nodes'

Outline

Installation of QualNet 4.5.1

- System requirements:
  - Sun Java 2 SDK, Standard Edition (1.4.2 or higher)
  - C++ compiler (VC7 or higher)
  - Setting environment variables

- Installation order:
  1. Sun Java SDK
  2. QualNet
  3. License

- Free 30-day trial
  - qualnet-4_5_1-eval-YYYY.MM.DD.lic
  - 'YYYY.MM.DD' = delivery date

- Install **J2SE Development Kit 5.0 Update 22**
  - jdk-1_5_0_22-windows-i586-p.exe

- Install **QualNet 4.5.1**
  - qualnet-4_5_1-evaluation-installer.exe
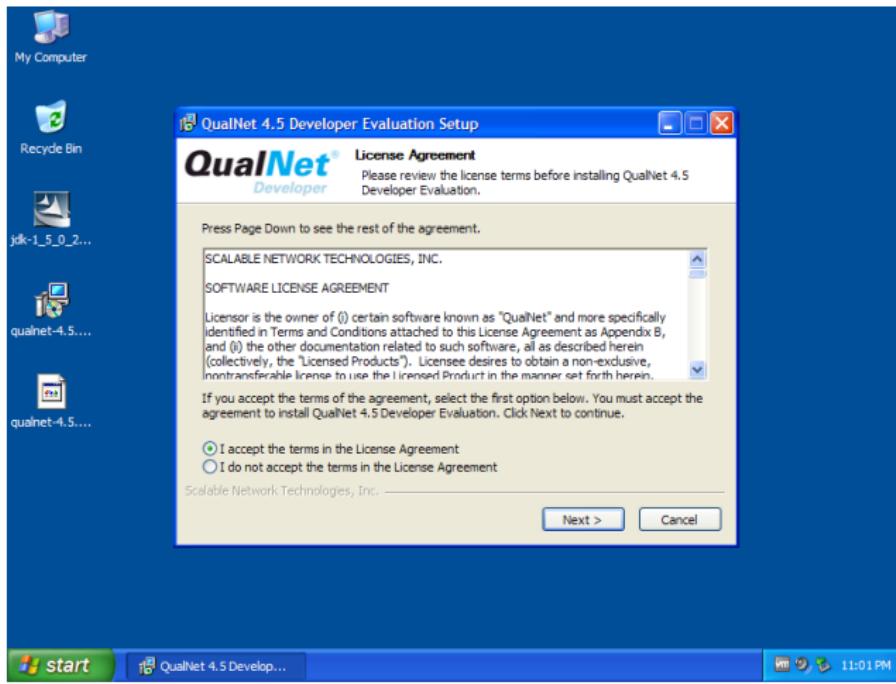
Installation of QualNet 4.5.1 (cont'd)

- Copy **license file**
  - qualnet-4_5_1-eval-YYYY.MM.DD.lic
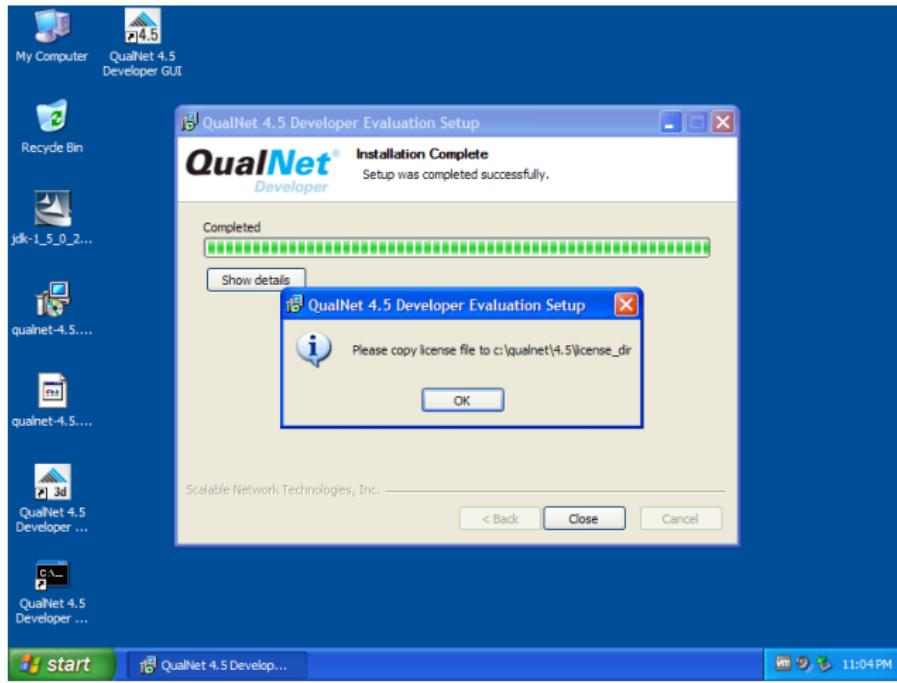
- Done!
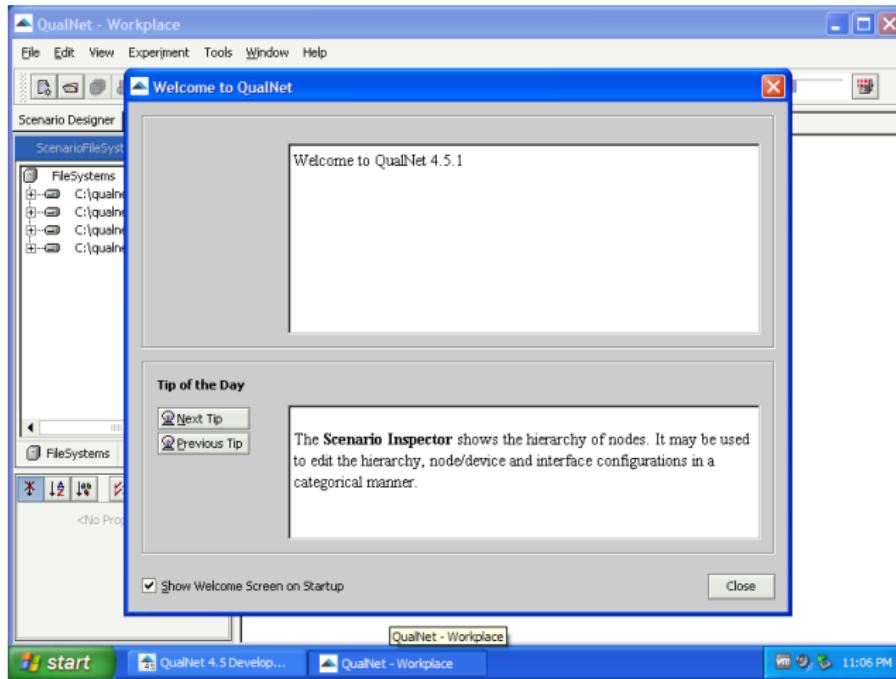
Installation of QualNet 4.5.1 (cont'd)

- Installed modules and features enabled
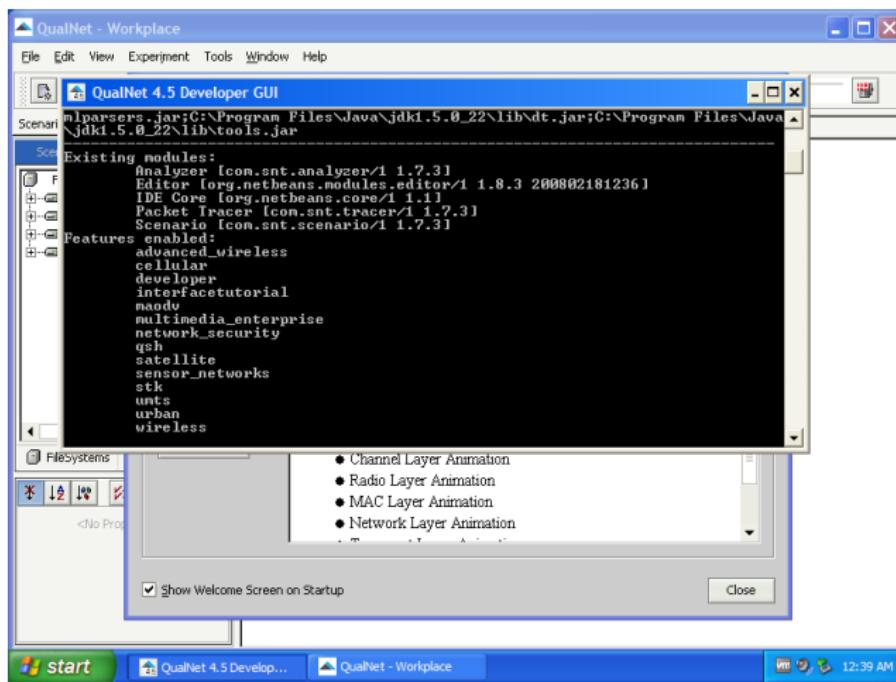
Outline

Simulation Workflow

- **QualNet simulation workflow**:

1. Create a baseline scenario
   - Define the network topology
   - Create 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

Simulation Workflow (cont'd)

- QualNet 4.5 Developer GUI
    - **Scenario Designer** – model setup tool
    - **Animator** – visualization and analysis tool
    - **Analyzer** – statistical graphing tool
    - **Packet Tracer** – packet-level visualization tool
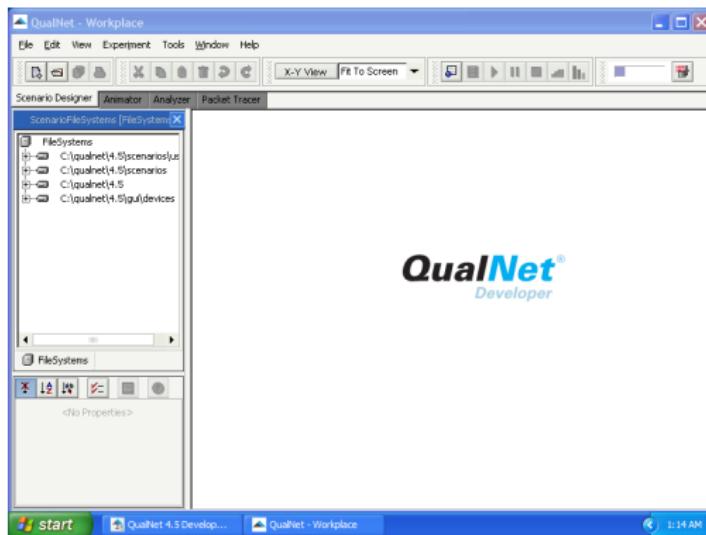
Outline

Example 1

- Create a new scenario
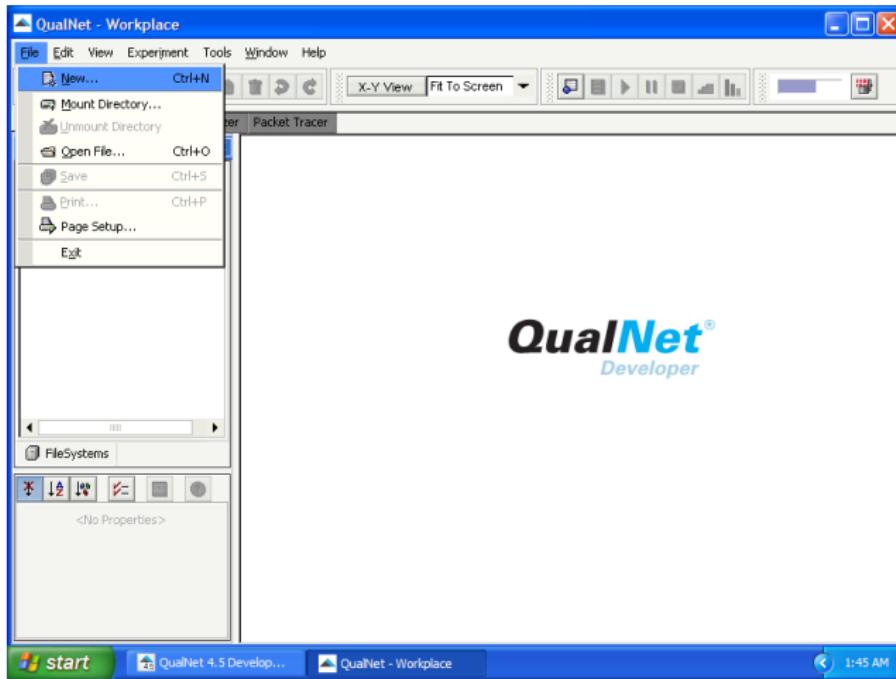
Example 1 (cont'd)

- Create a new scenario
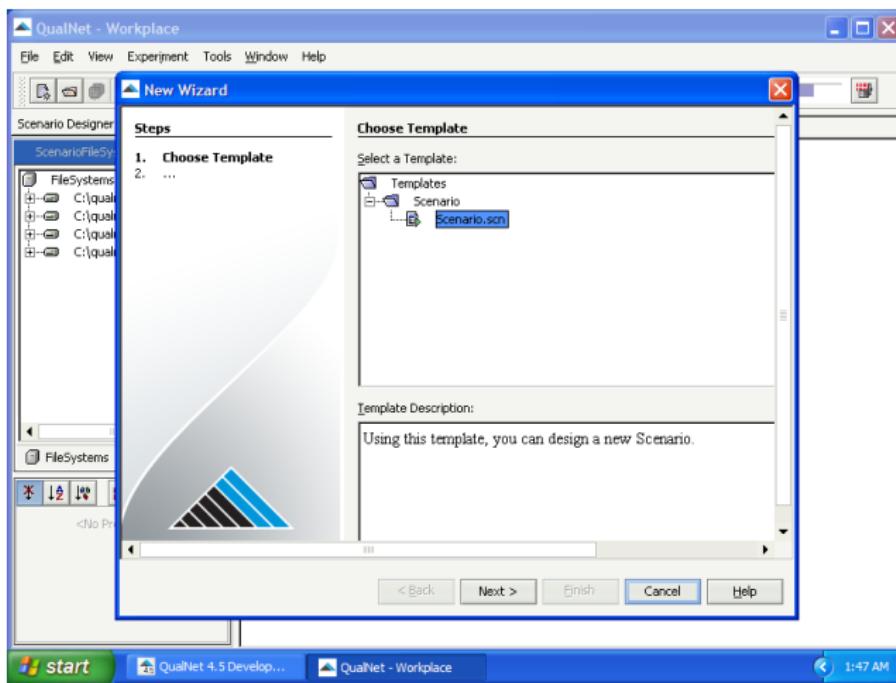
Example 1 (cont'd)

- Create a new scenario
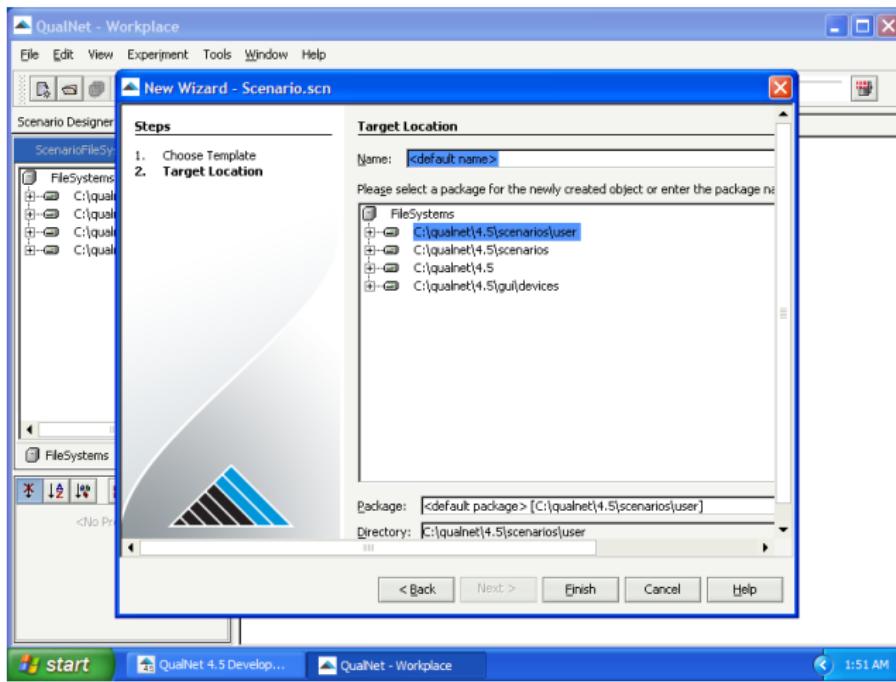
Example 1 (cont'd)

- Save as 'Example'
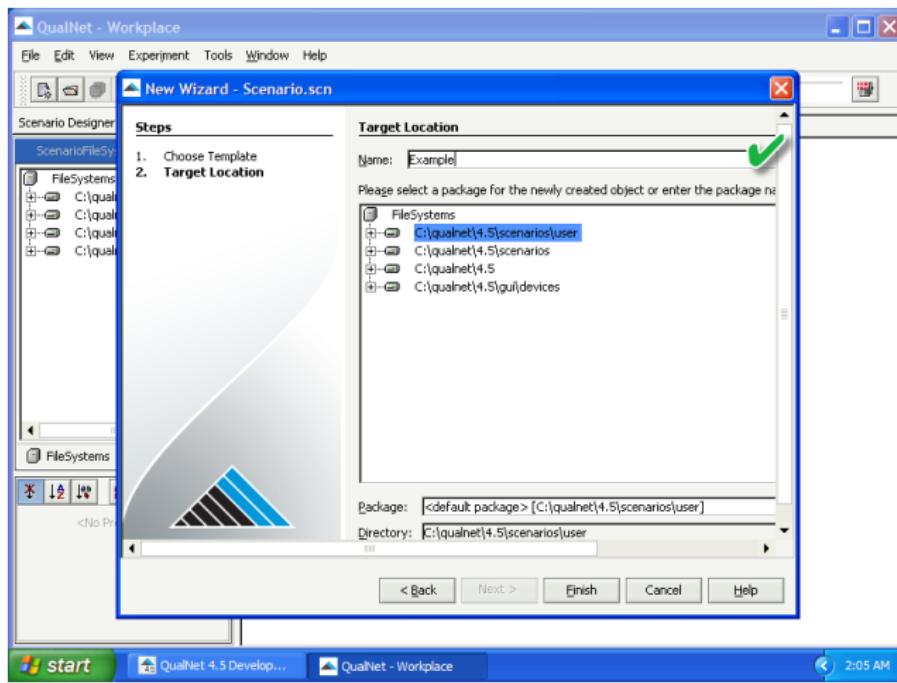
Example 1 (cont'd)

- Scenario 'Example'
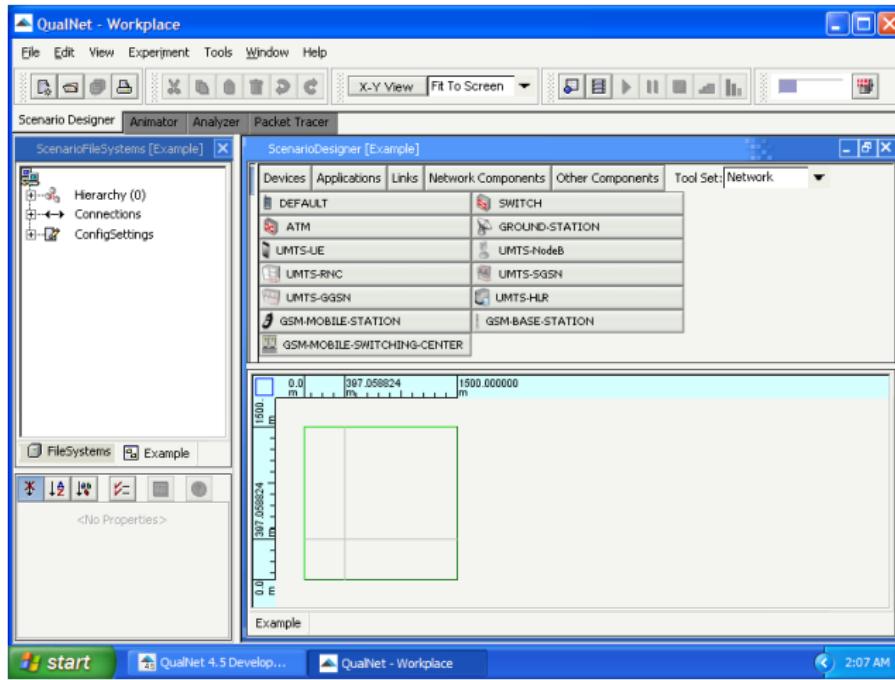
Example 1 (cont'd)

- QualNet 4.5.1 workspace
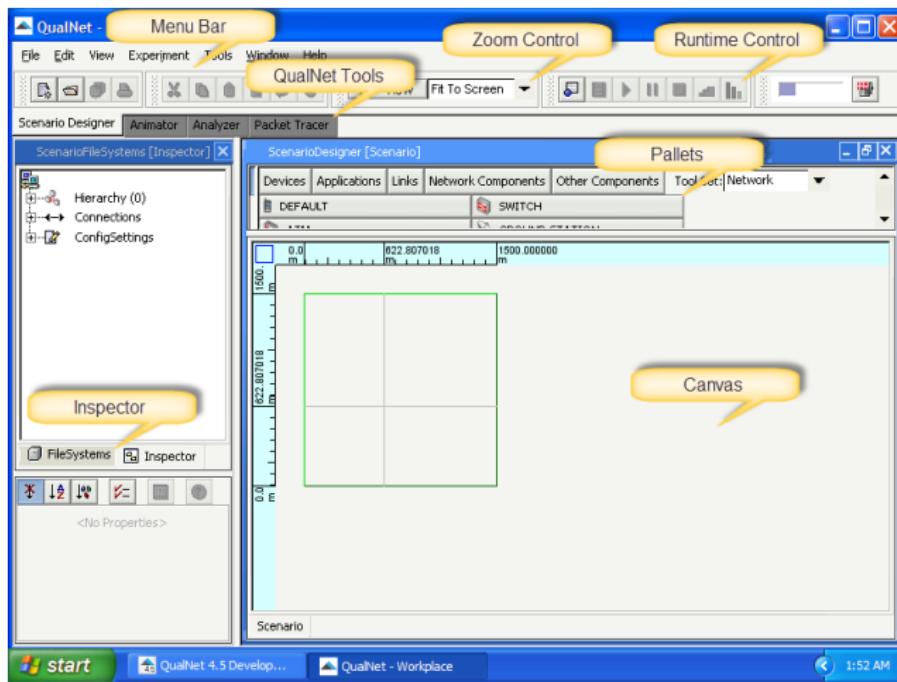
Example 1 (cont'd)

- Save output as 'Example.date_time.stat'
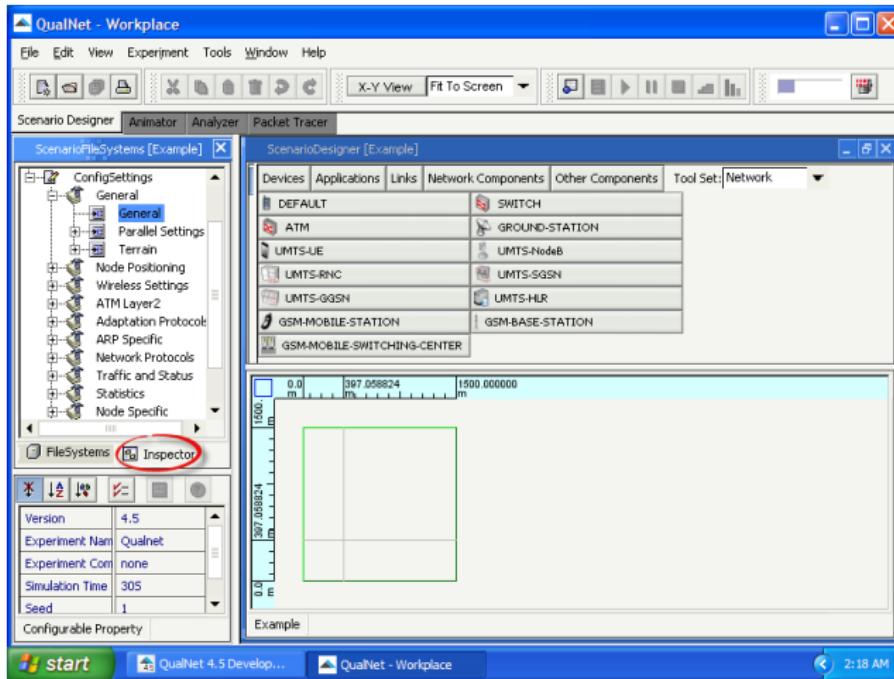
Example 1 (cont'd)

- Save output as 'Example.date_time.stat'
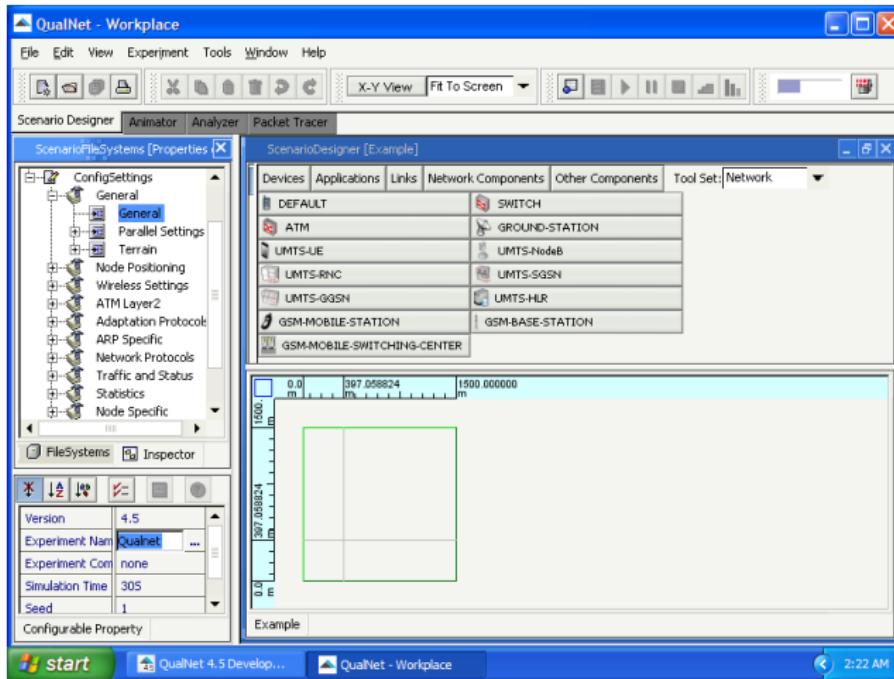
Example 1 (cont'd)

- Save output as 'Example.date_time.stat'
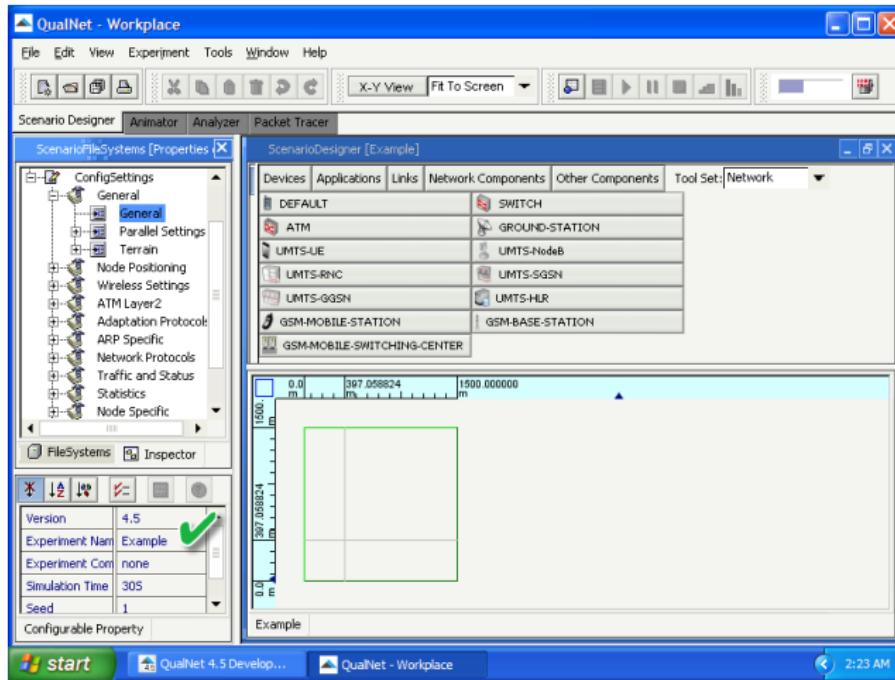
Example 1 (cont'd)

- Define the topology of a wireless network
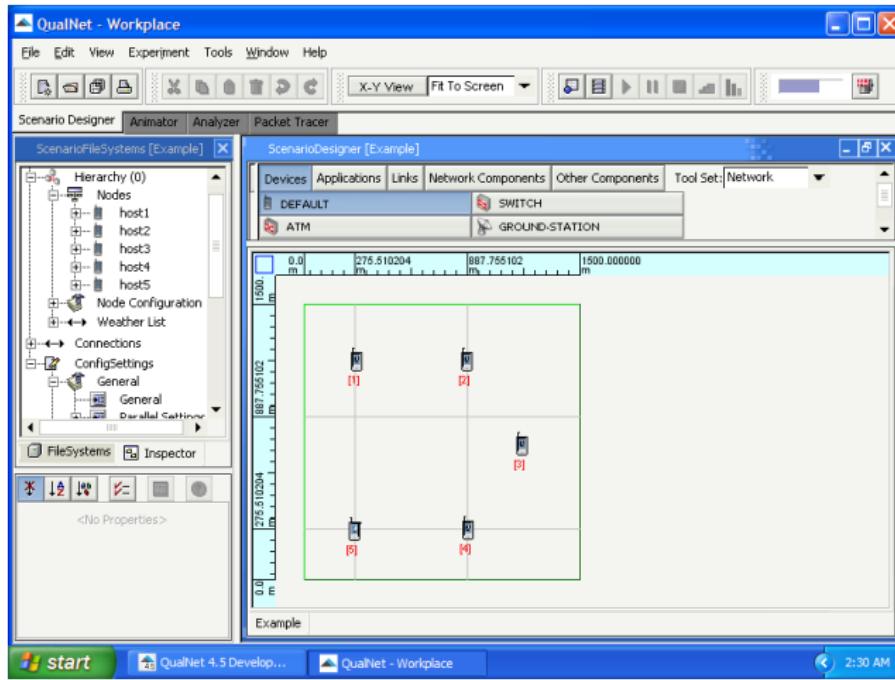
Example 1 (cont'd)

- Define the topology of a wireless network
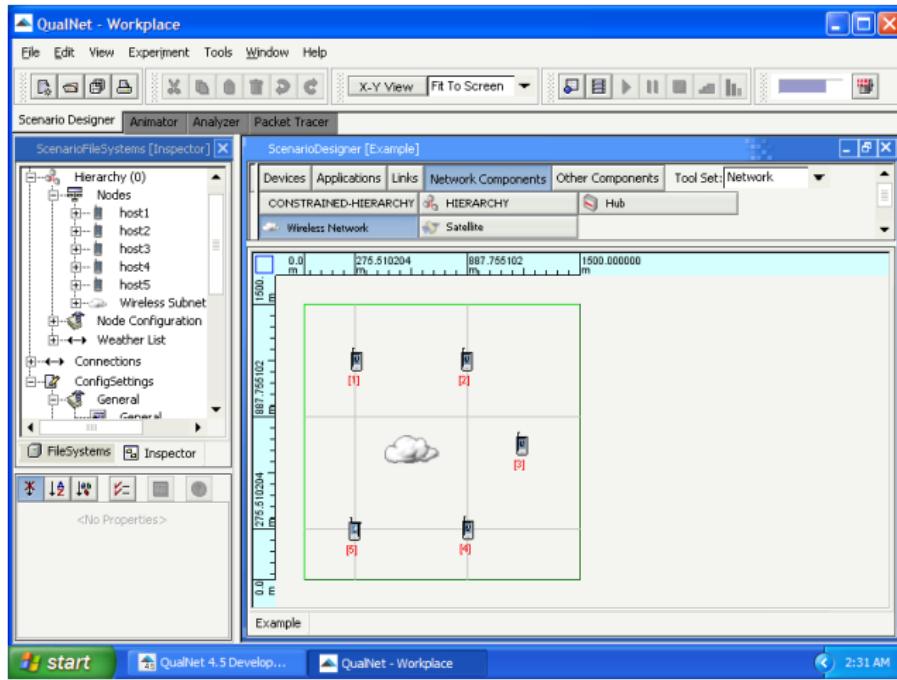
Example 1 (cont'd)

- Define the topology of a wireless network
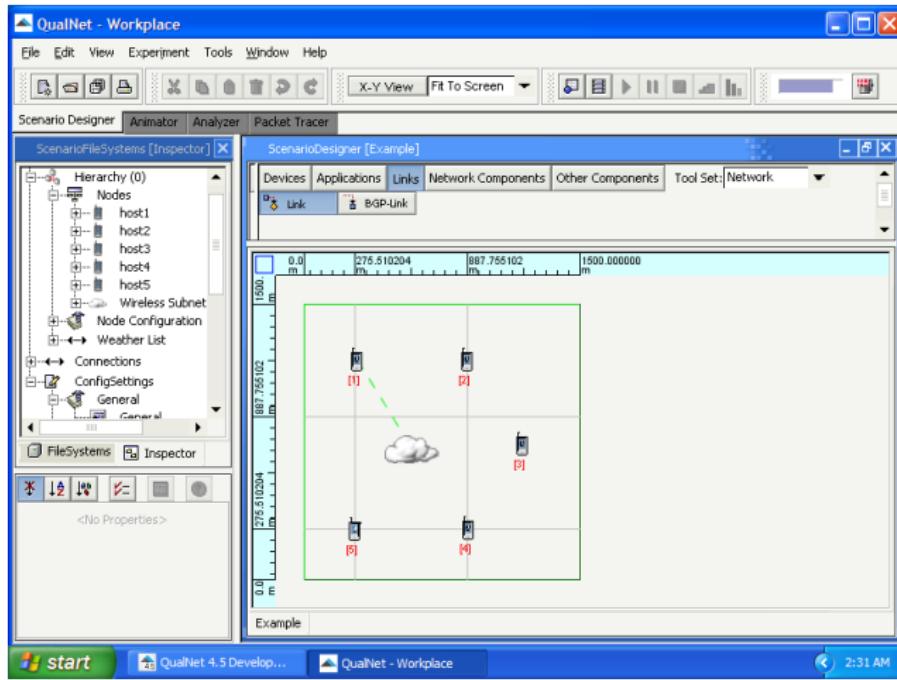
Example 1 (cont'd)

- Define the topology of a wireless network
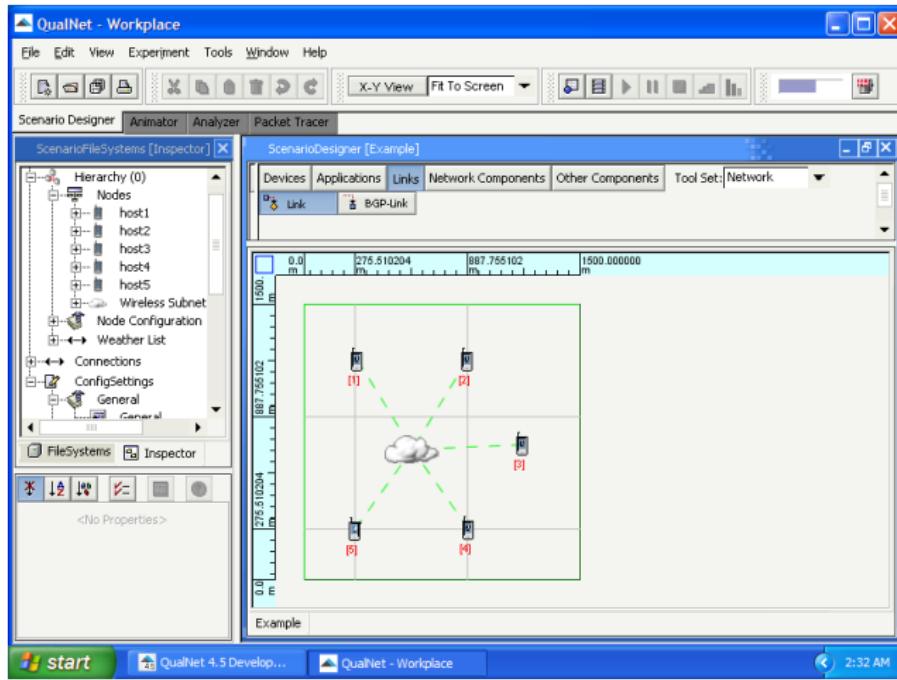
Example 1 (cont'd)

- Create traffic
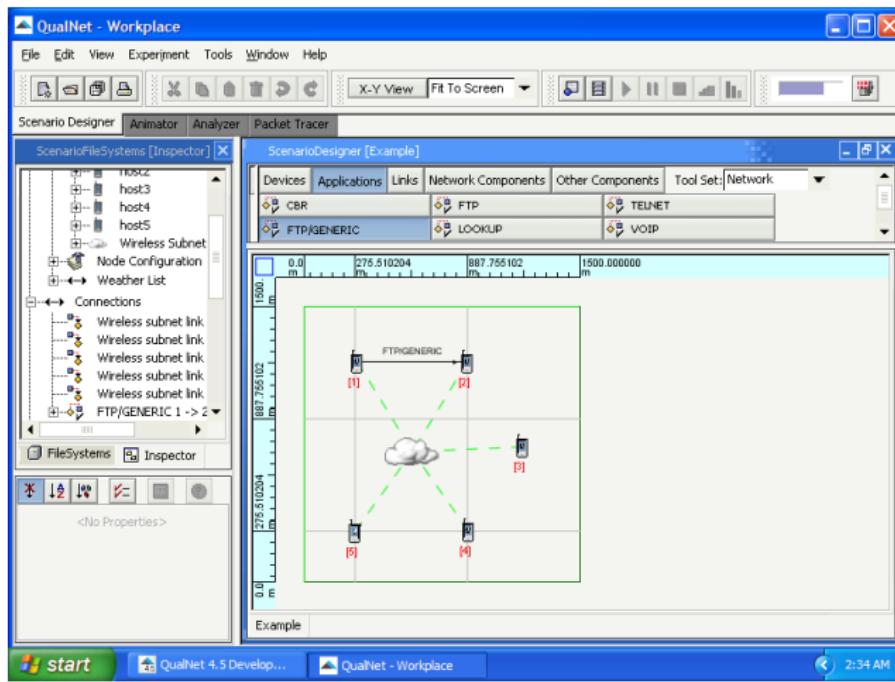
Example 1 (cont'd)

- Save the scenario
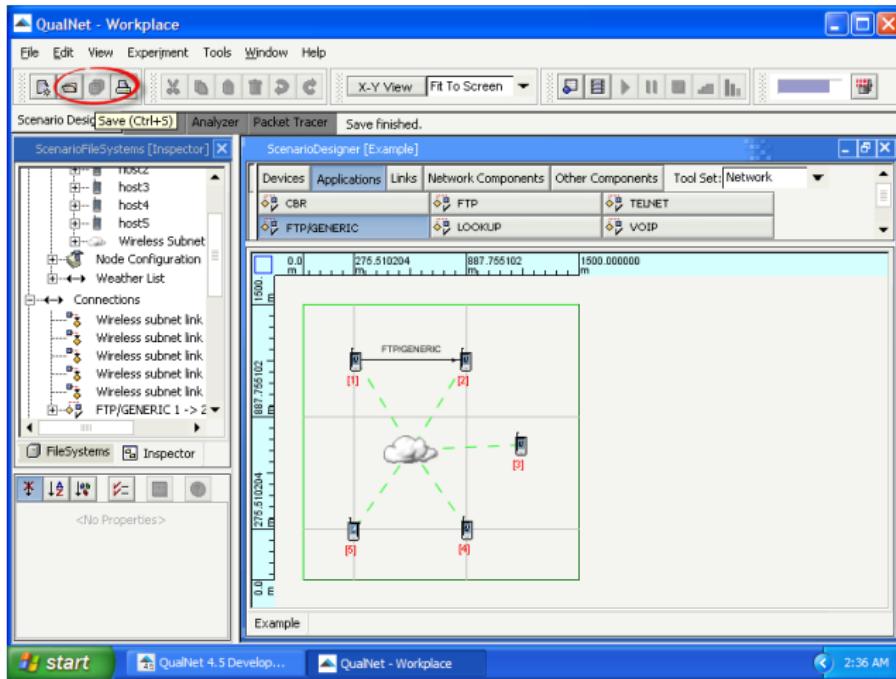
Example 1 (cont'd)

- Run the simulation
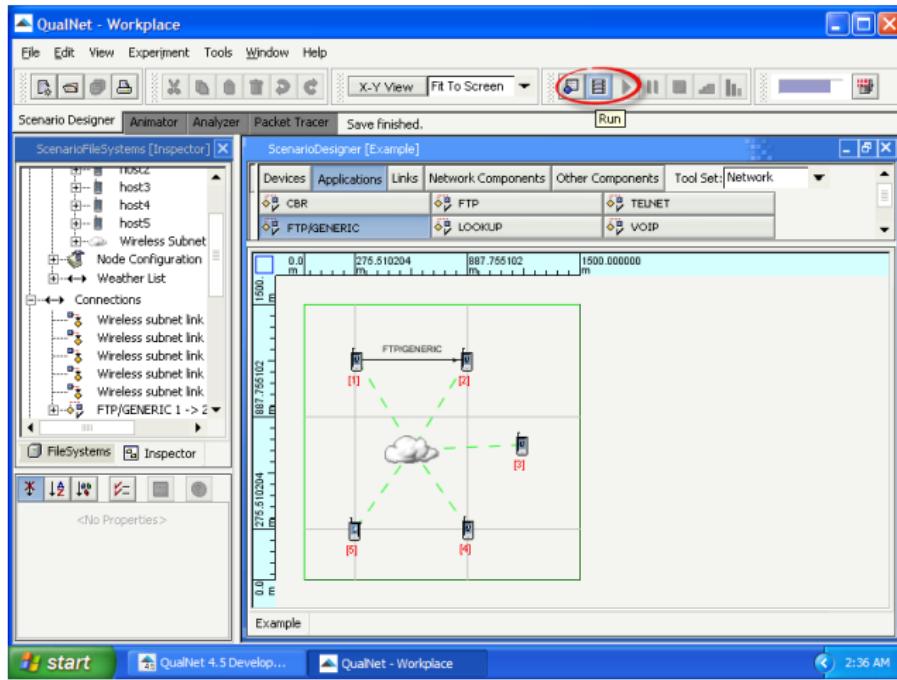
Example 1 (cont'd)

- View the network animation
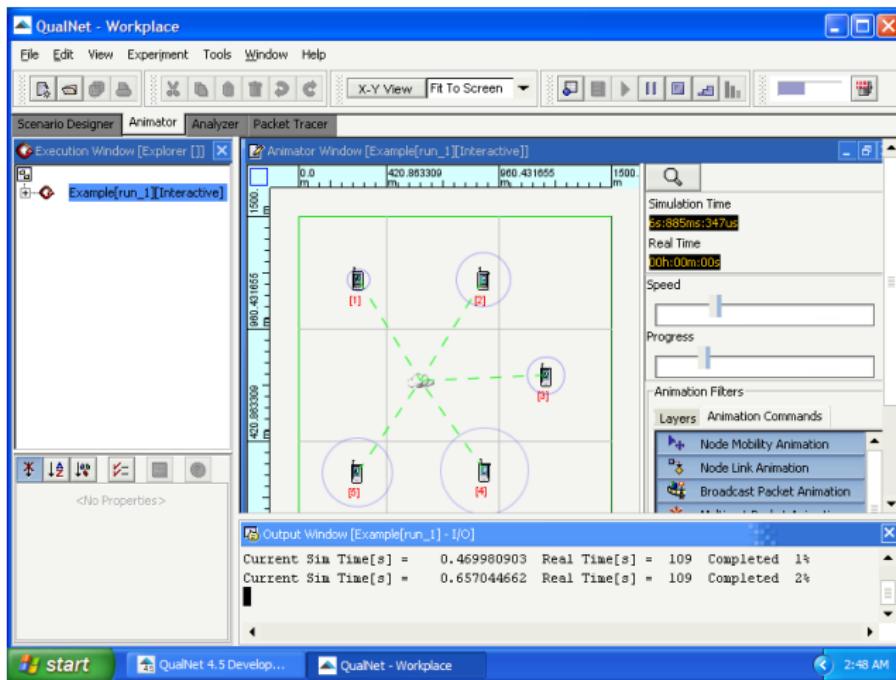
Example 1 (cont'd)

- View the results
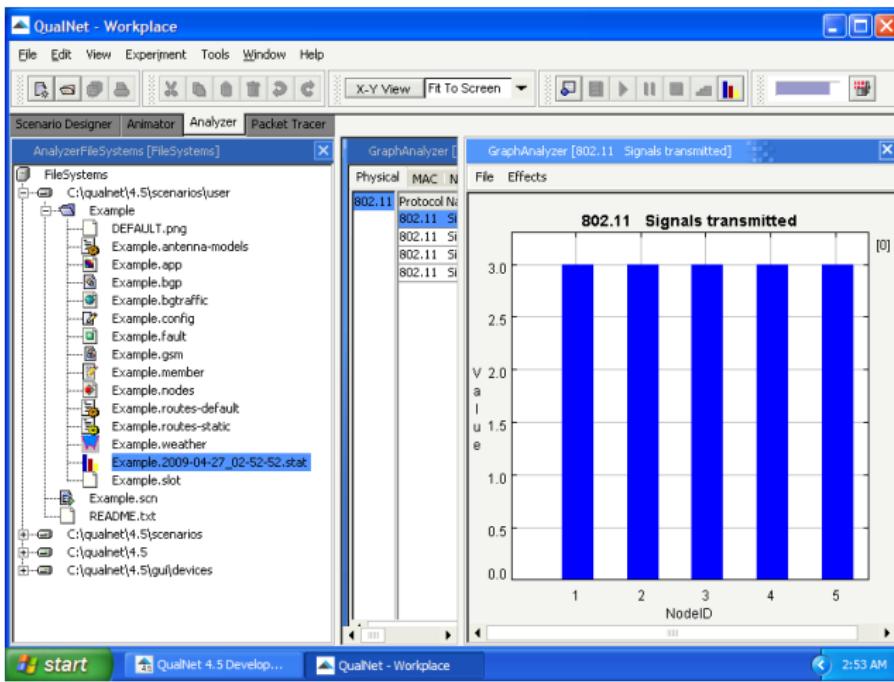
Example 1 (cont'd)

- Available TCP statistics
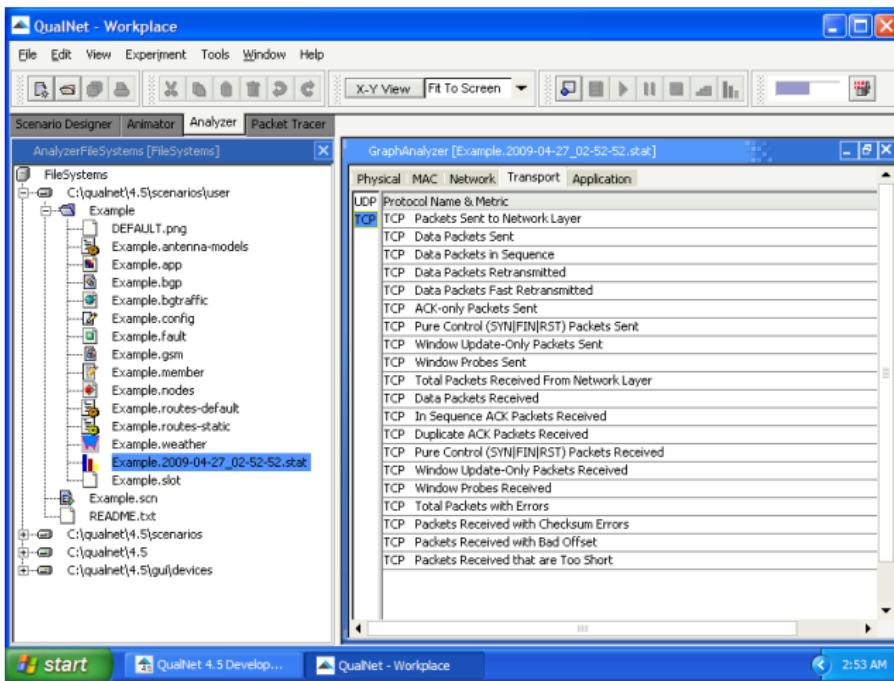
Example 1 (cont'd)

- Capture packets
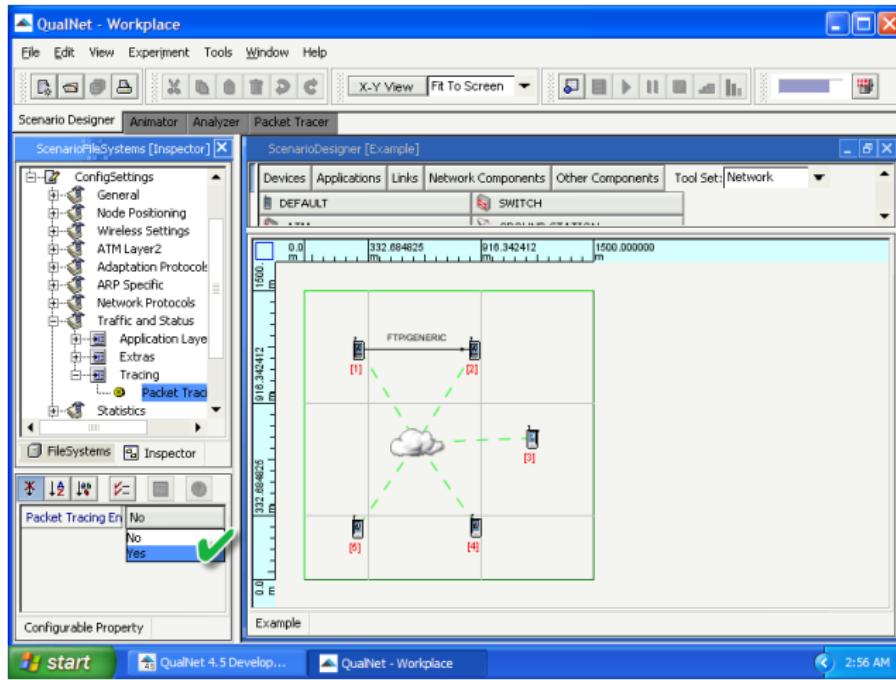
Example 1 (cont'd)

- Capture packets
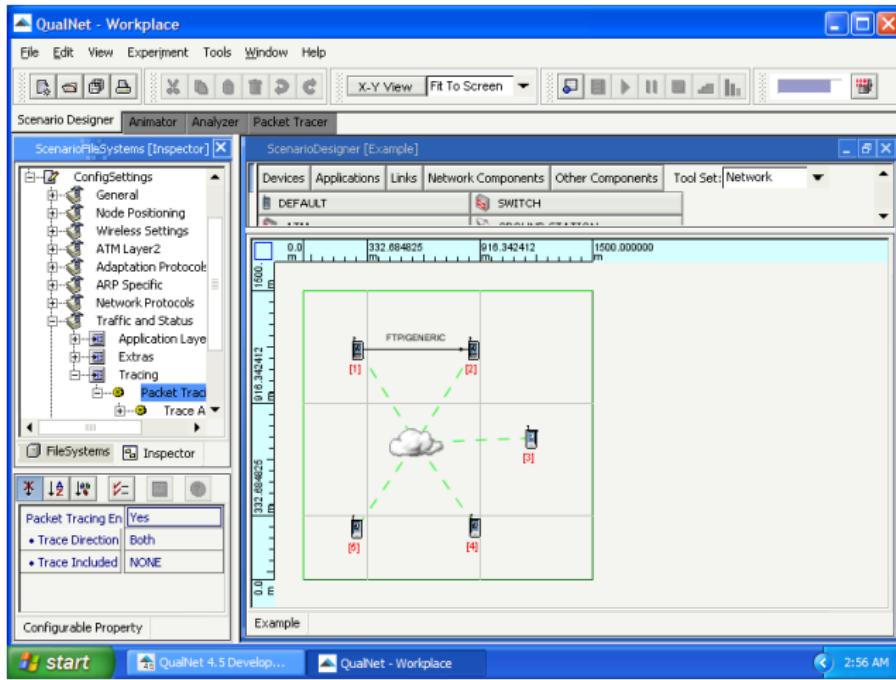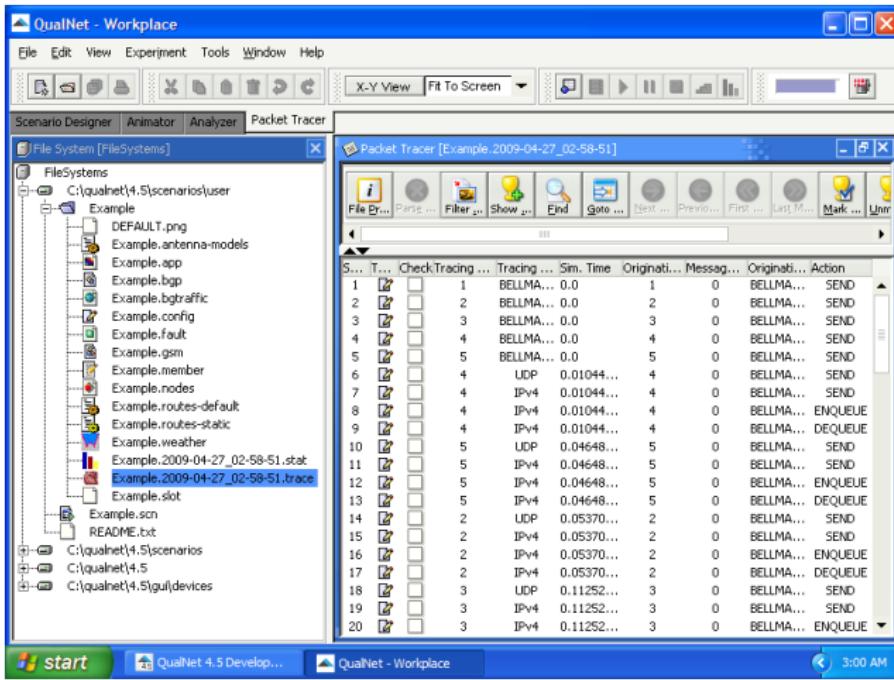
Example 1 (cont'd)

- Transmitted packets

Example 1 (cont'd)
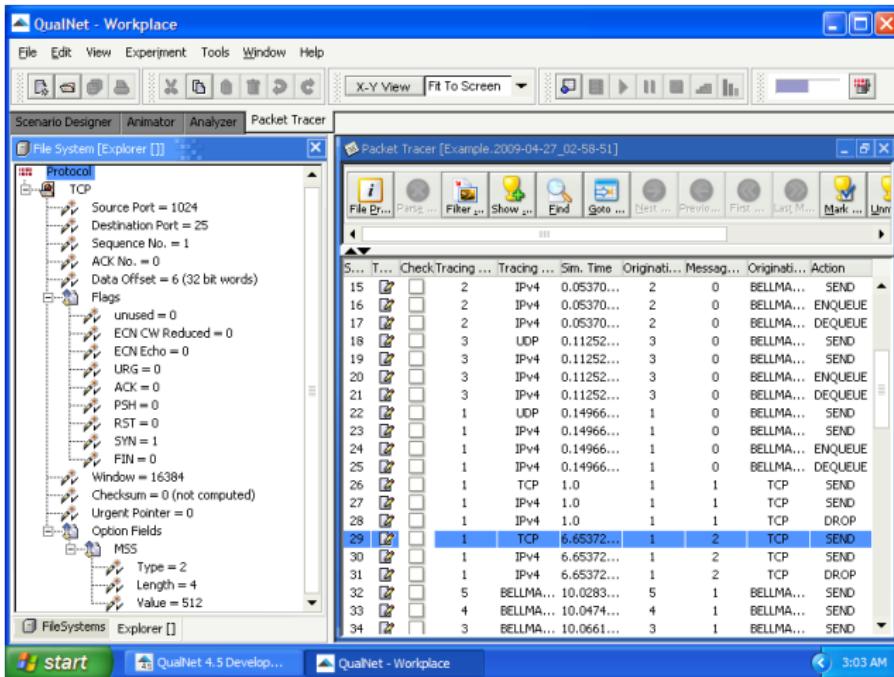
- Transmitted packets

Outline

Example 2

- **Topology:** point-to-point
- **Nodes:** 2
- **Data rate:** 2 Mbps
- **Propagation time:** 1 ms
- **Application:** Constant Bit Rate (CBR)
- **Sender:** node №1
- **Receiver:** node №2
- **Simulation time:** 10 s
- **Traffic:** packets = 10, size = 512 B, inter-departure time = 1 s

Example 2 (cont'd)

- Create a new scenario
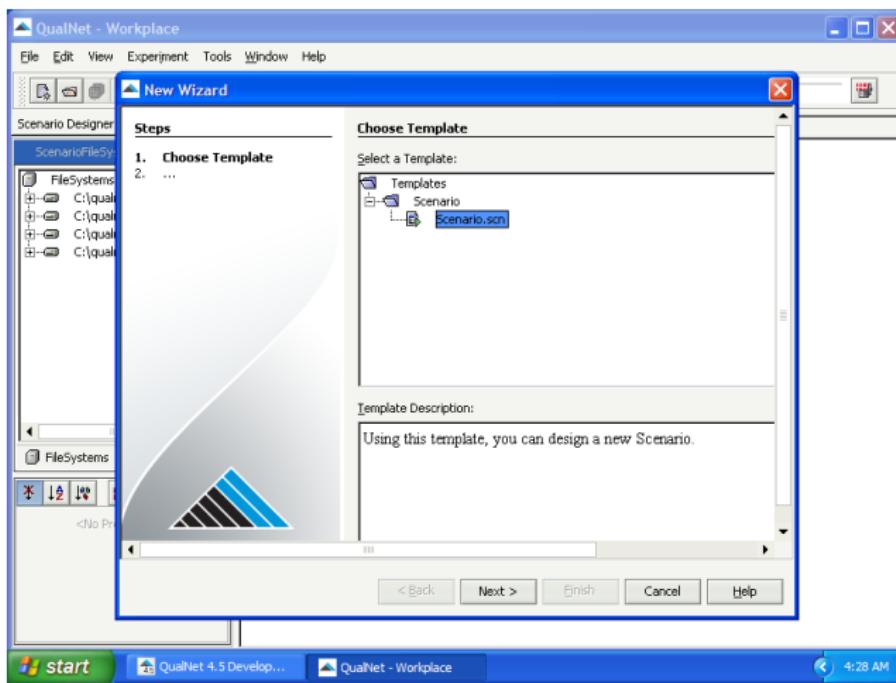
Example 2 (cont'd)

- Save as 'CBR'
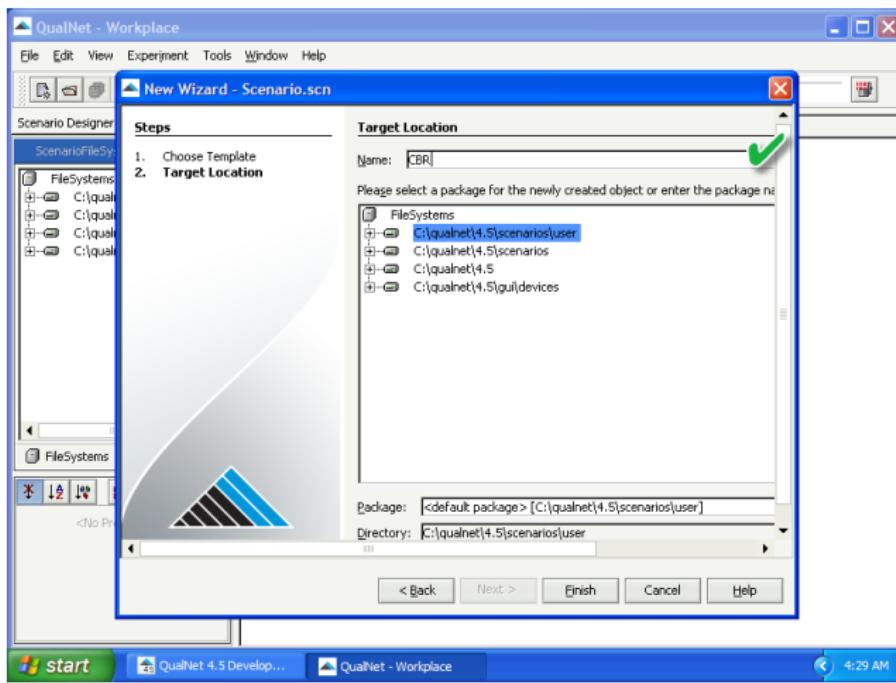
Example 2 (cont'd)

- Create the point-to-point topology
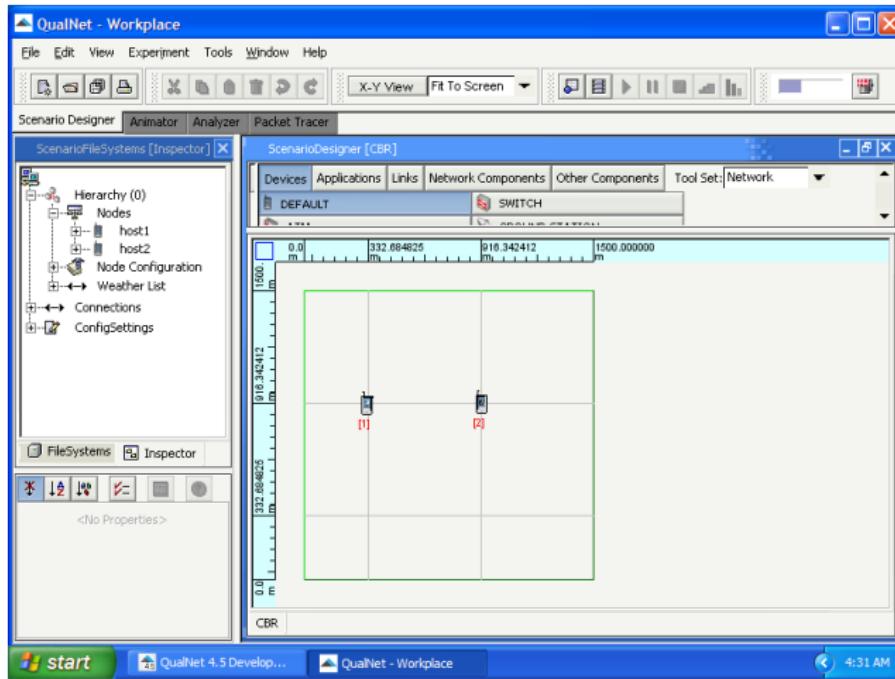
Example 2 (cont'd)

- Create the point-to-point topology
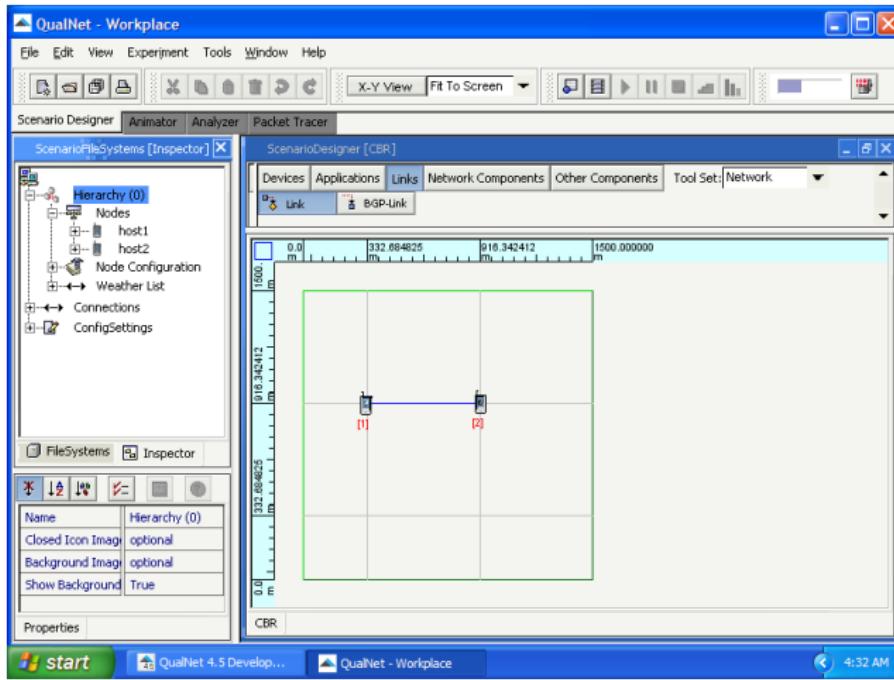
Example 2 (cont'd)

- Set the bandwidth of the point-to-point link
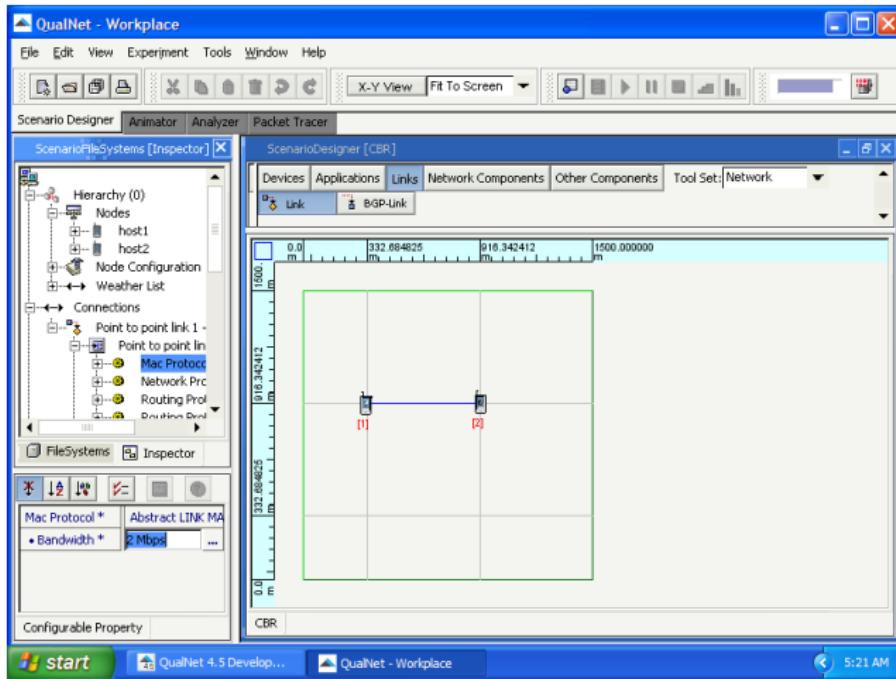
Example 2 (cont'd)

- Set the link propagation time
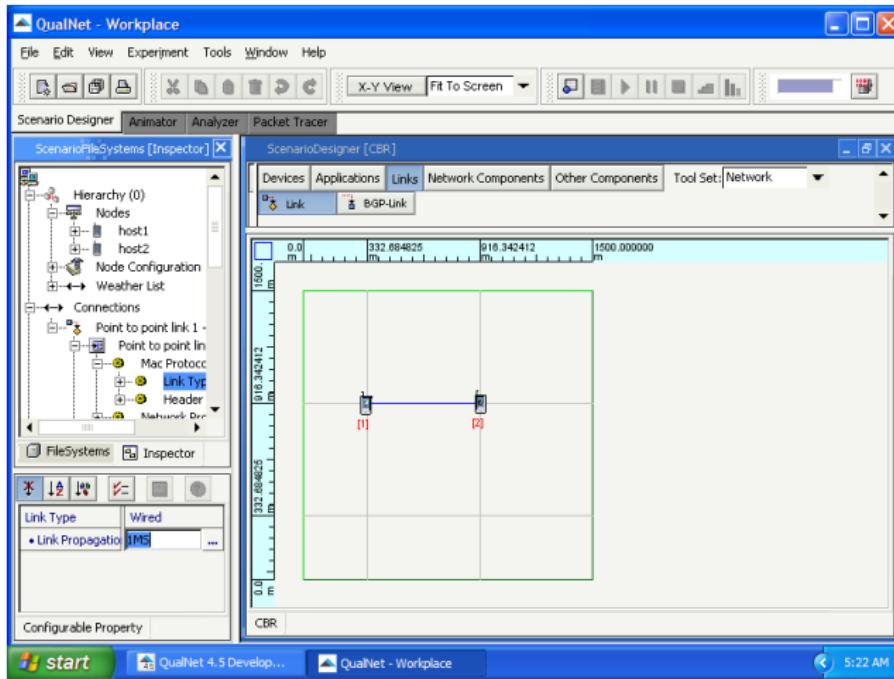
Example 2 (cont'd)

- Create traffic
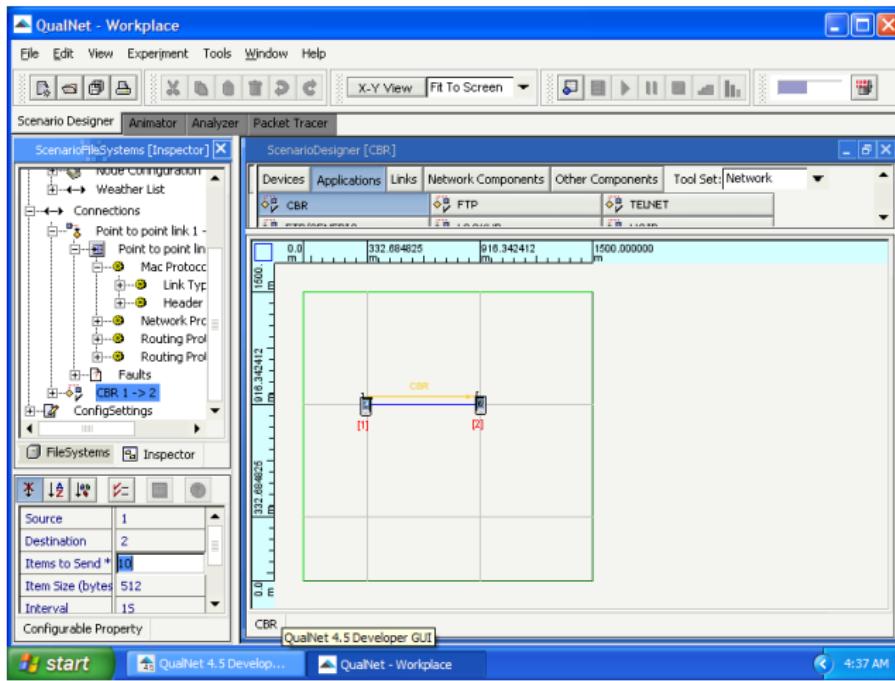
Example 2 (cont'd)

- Set the start time
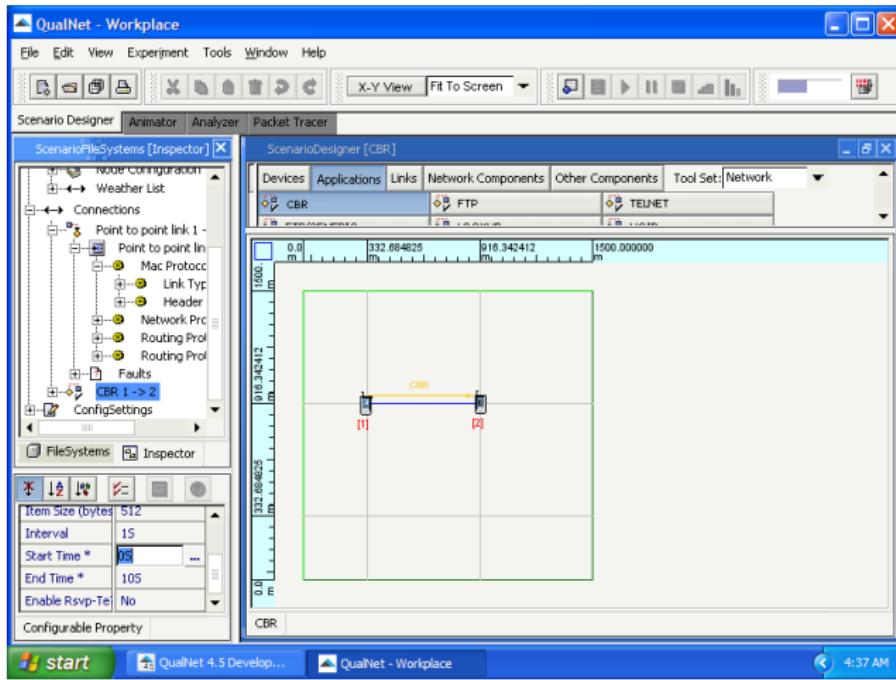
Example 2 (cont'd)

- Set the end time
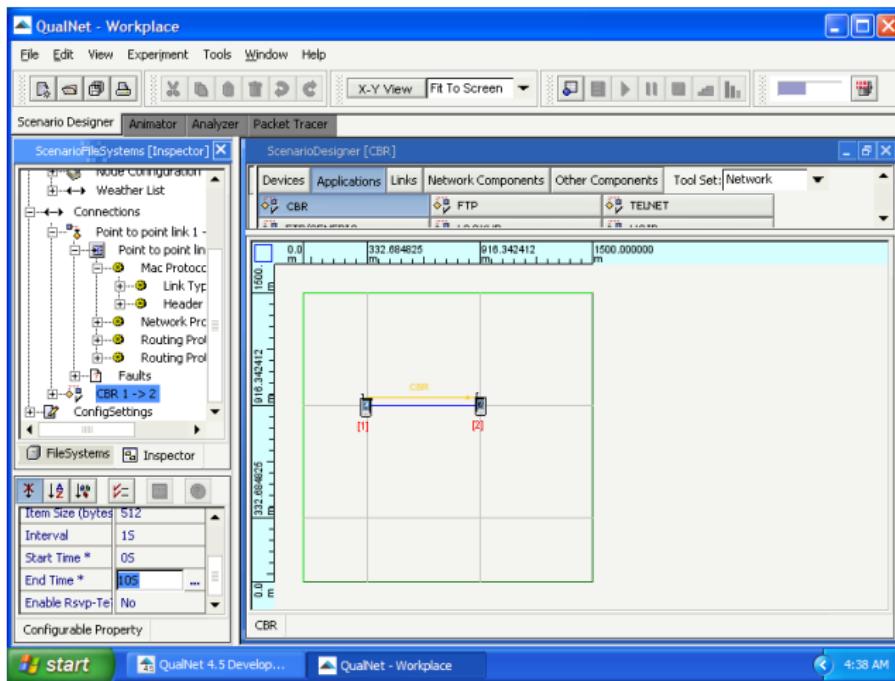
Example 2 (cont'd)

- Capture packets
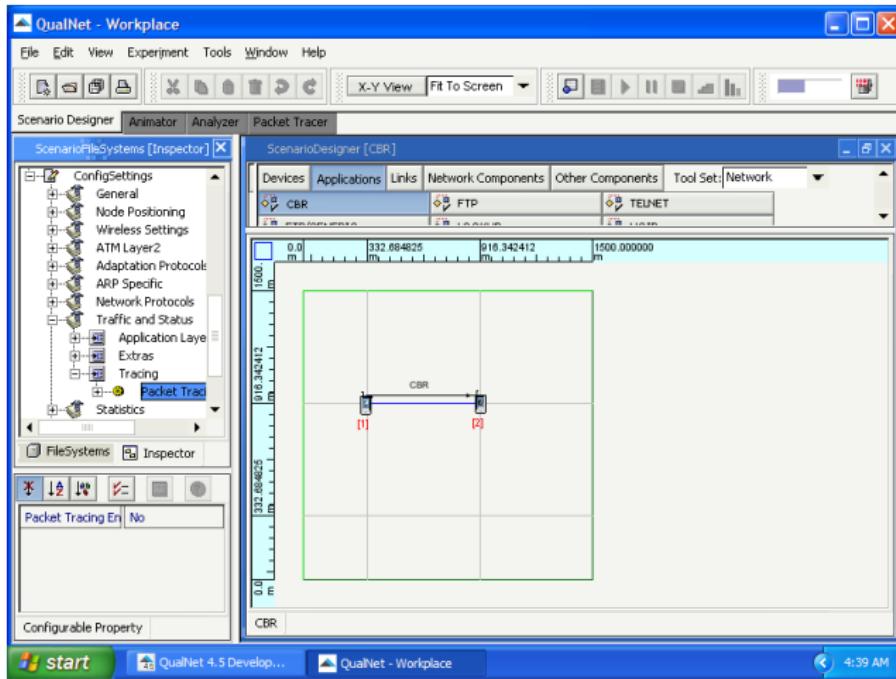
Example 2 (cont'd)
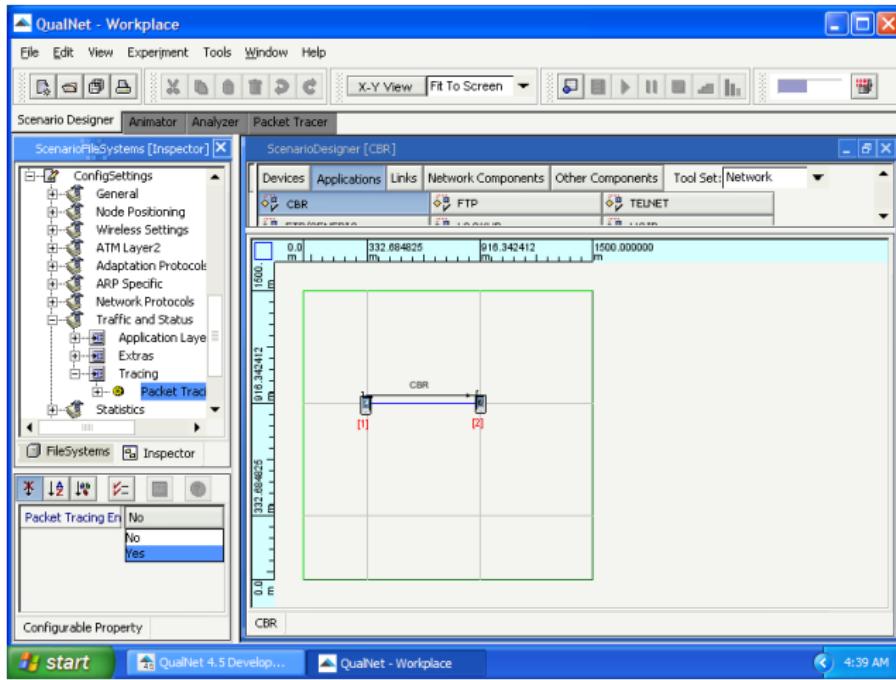
- Capture packets

Example 2 (cont'd)

- Capture packets
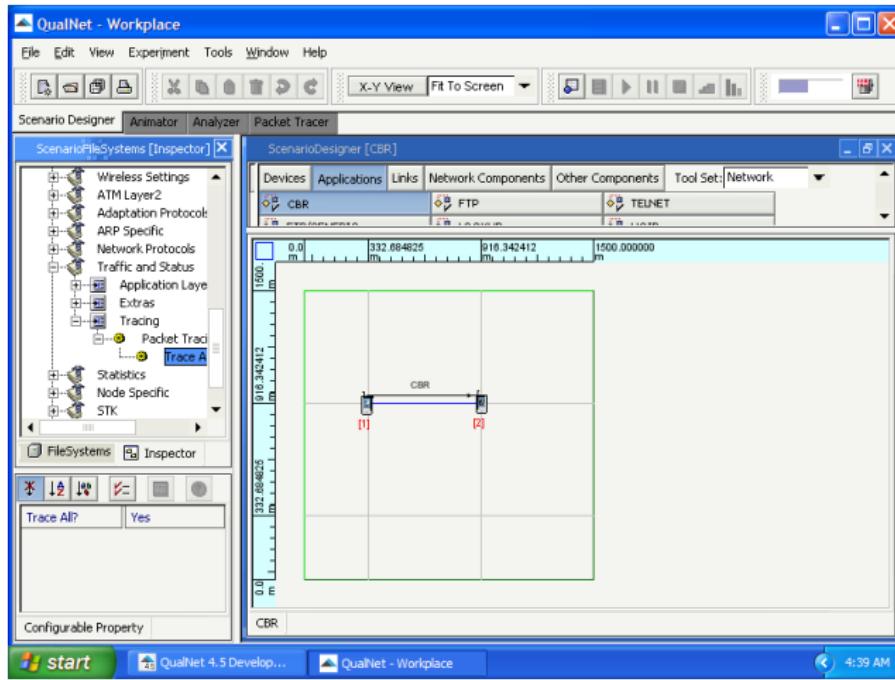
Example 2 (cont'd)

- Save the scenario
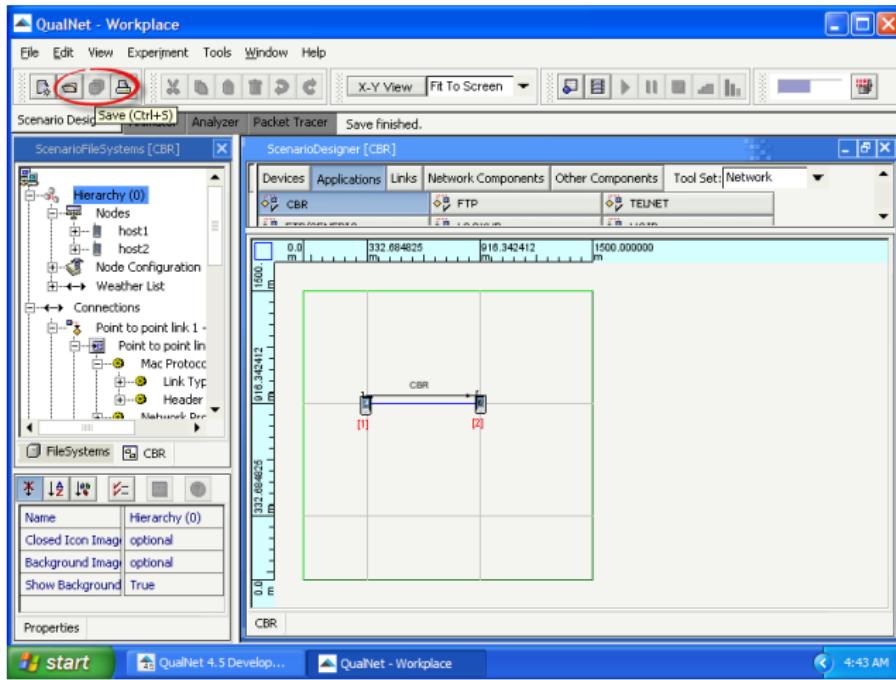
Example 2 (cont'd)

- Run the simulation
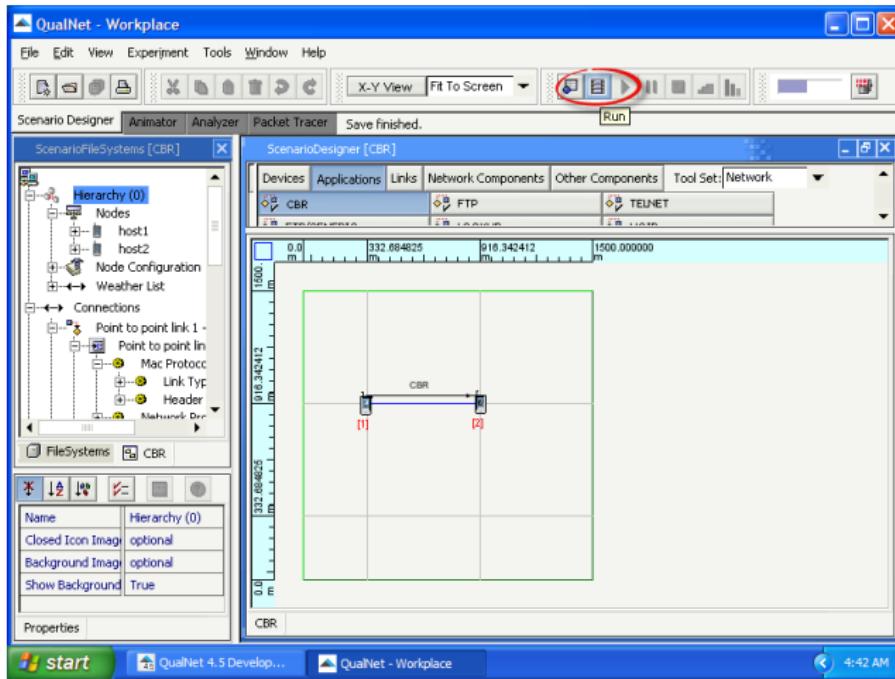
Example 2 (cont'd)

- View the network animation
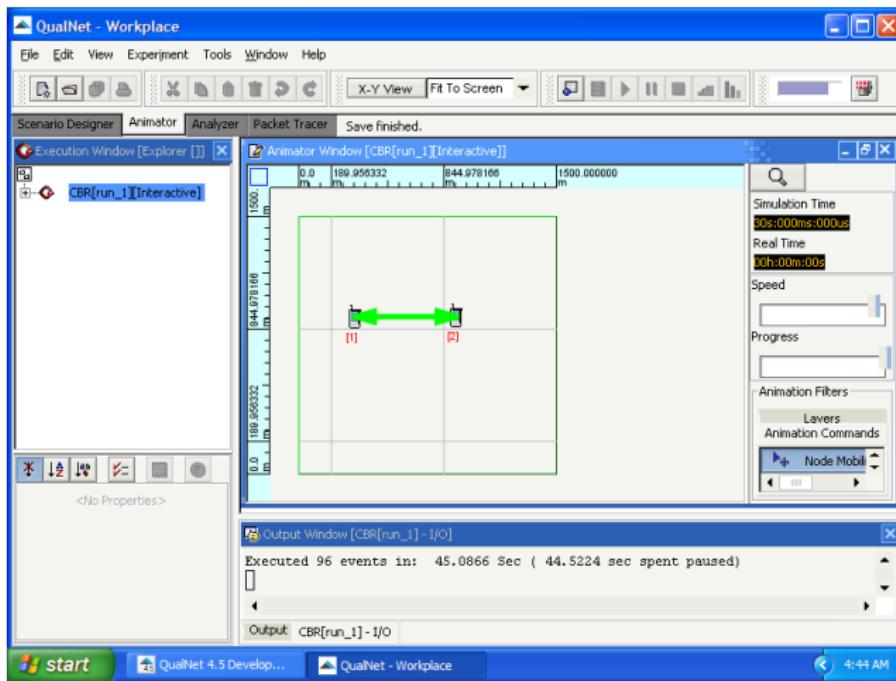
Example 2 (cont'd)
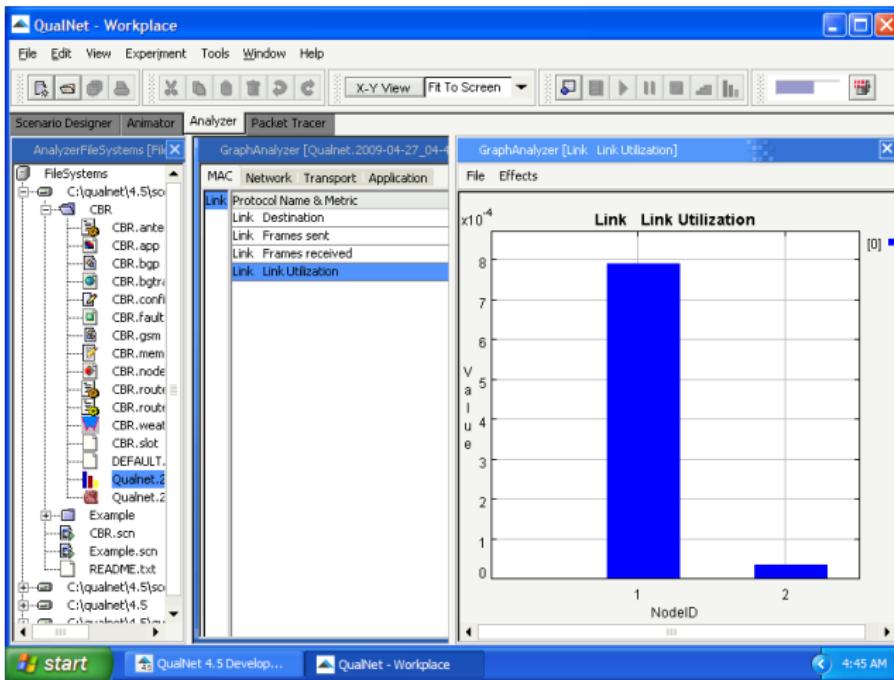
- View the results

Example 2 (cont'd)
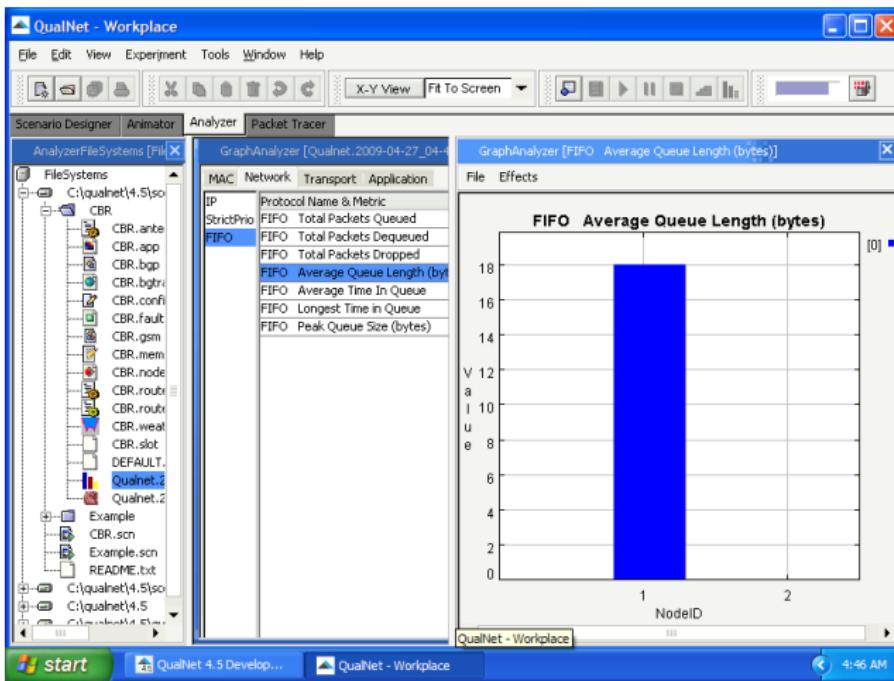
- View the results

Example 2 (cont'd)
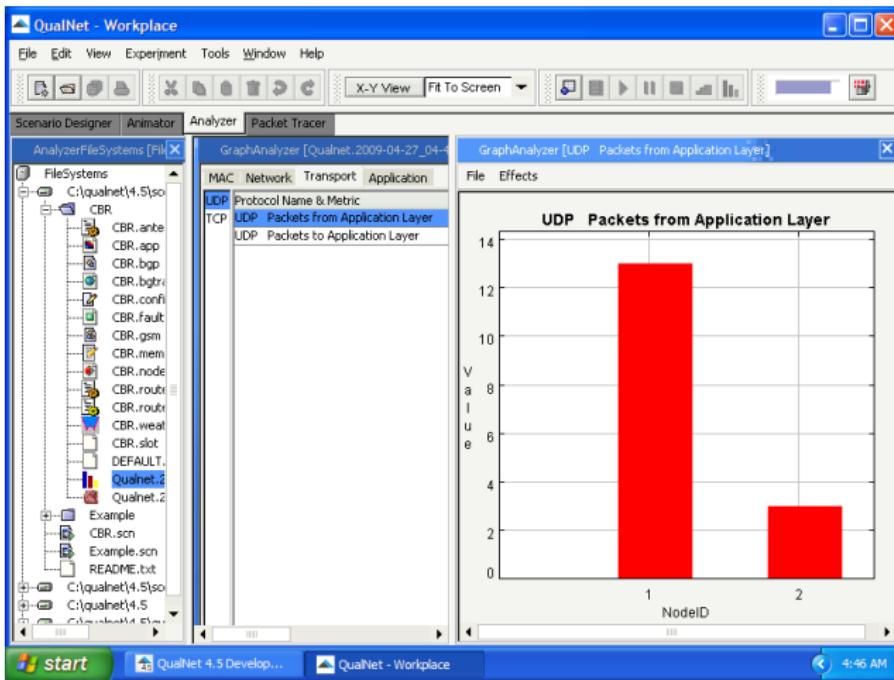
- View the results

Example 2 (cont'd)

- View the results
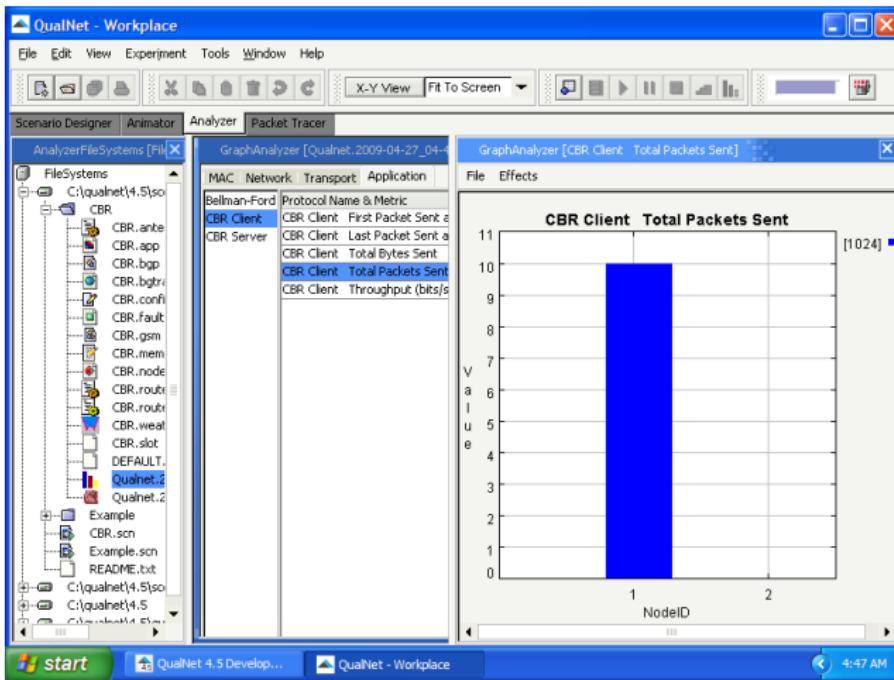
Example 2 (cont'd)

- Transmitted packets
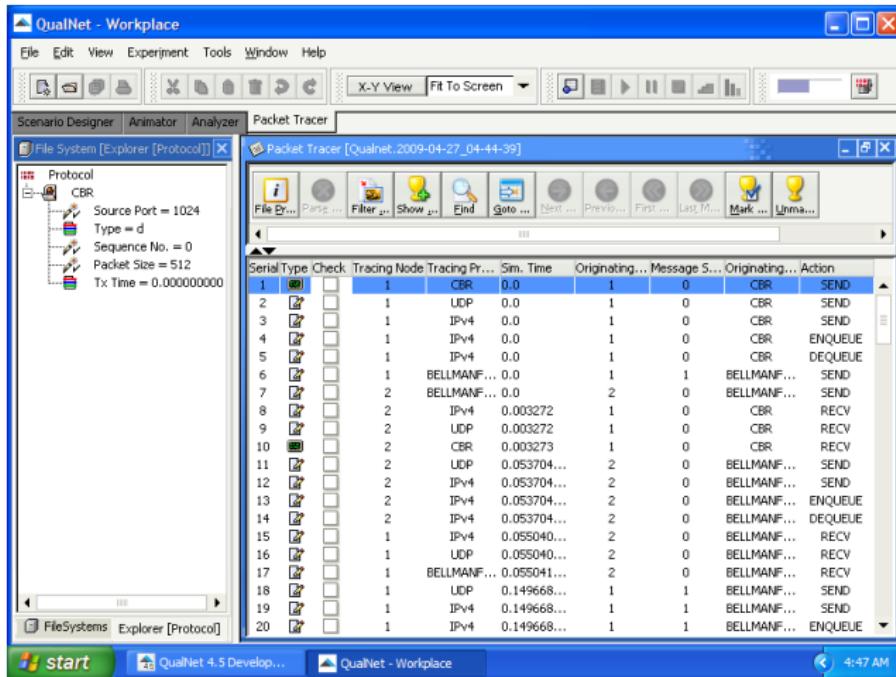
Outline

Large Networks

- Automatic node placement
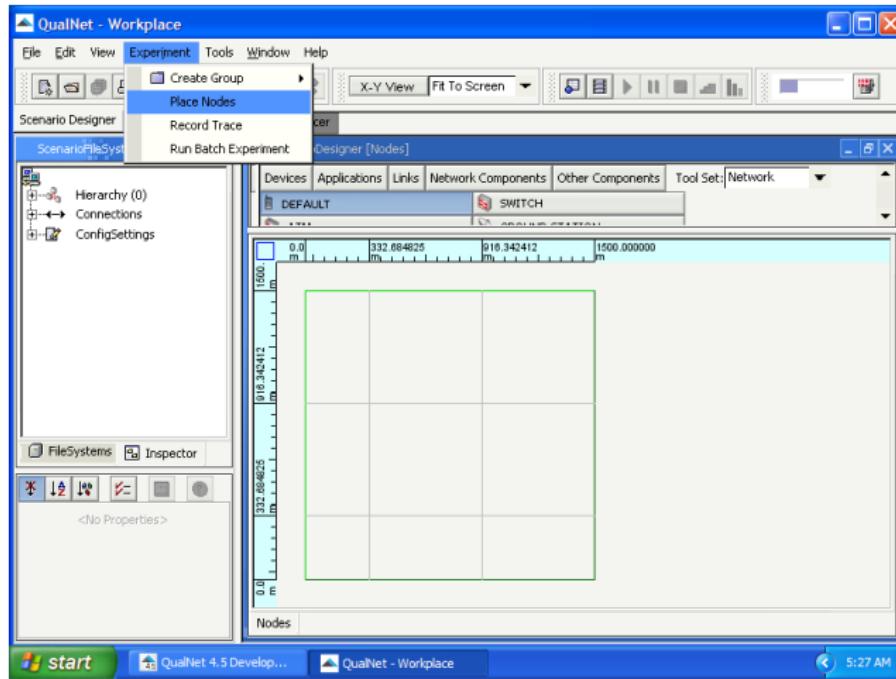
Large Networks (cont'd)

- Number of nodes
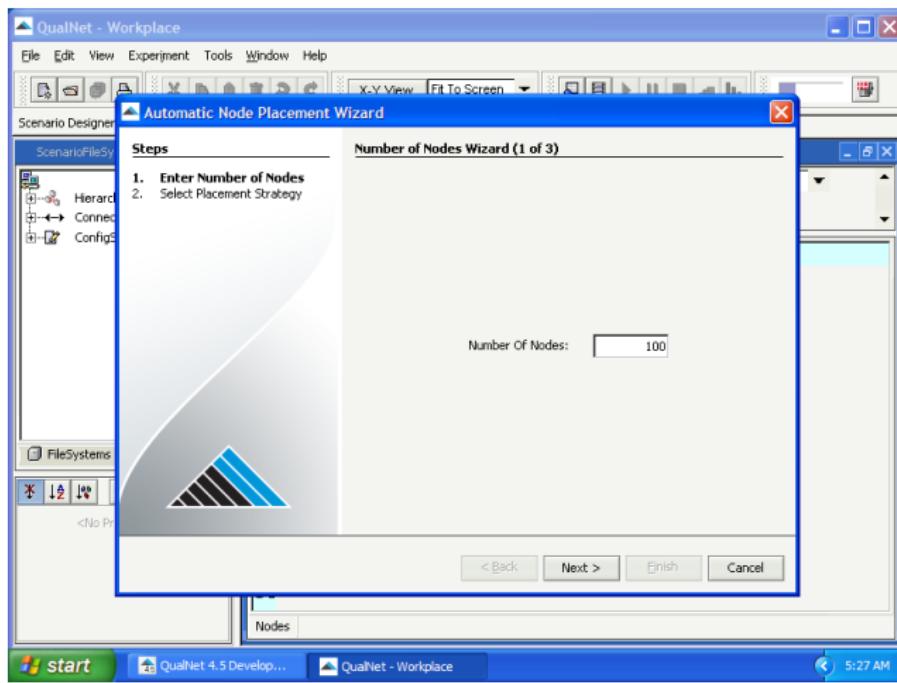
Large Networks (cont'd)

- Placement strategy = uniform
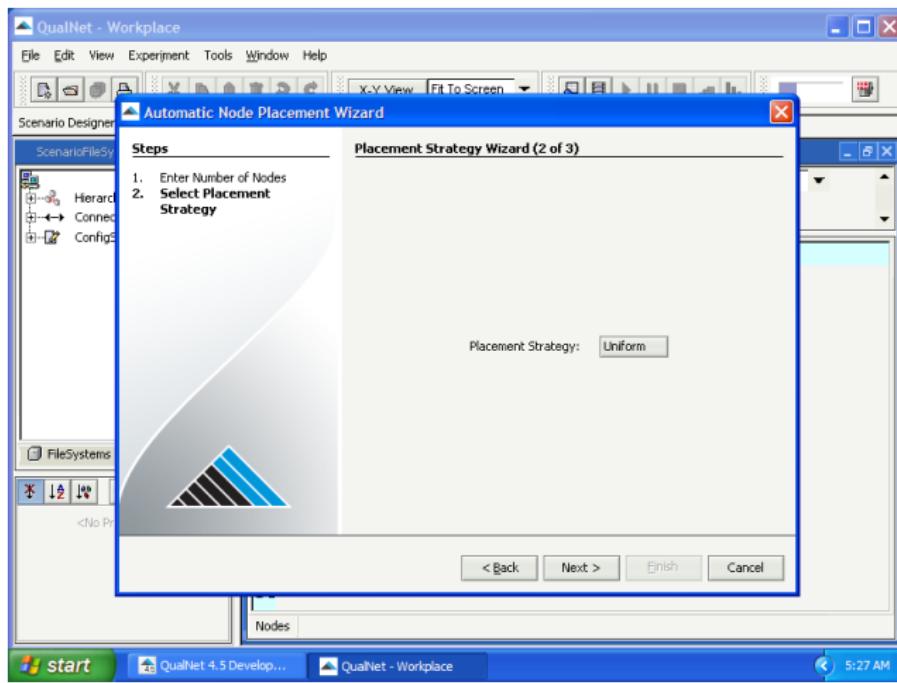
- **Seed** – an integer used to set the starting point for generating a series of random numbers
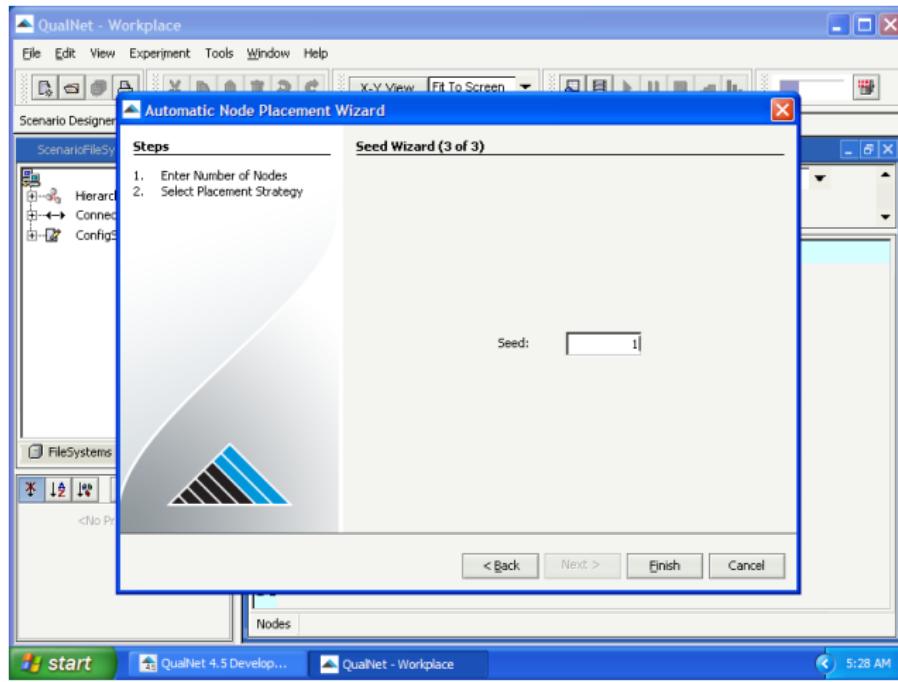
- Another seed value
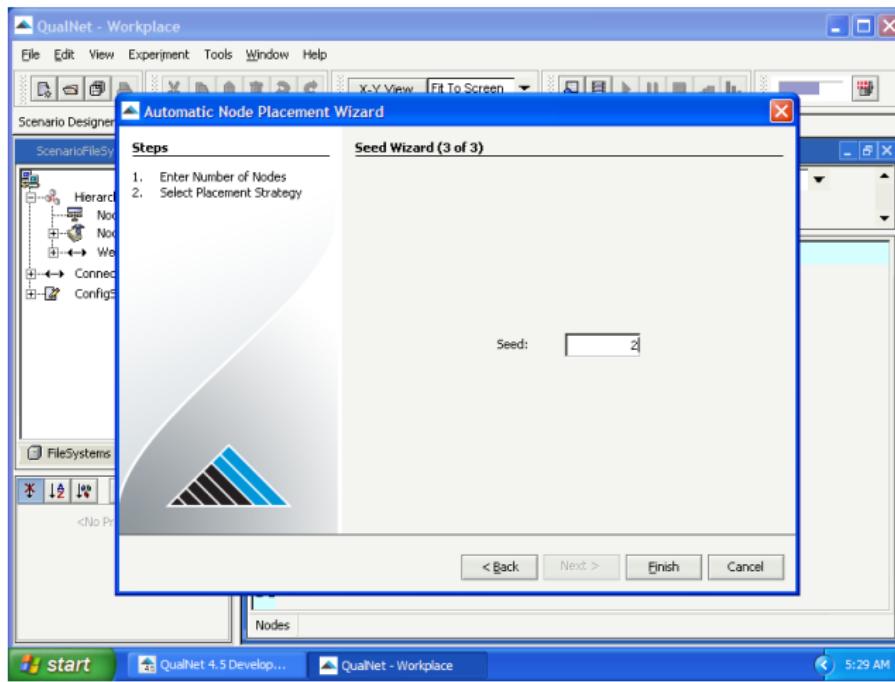
Large Networks (cont'd)

- Uniform, seed = 1
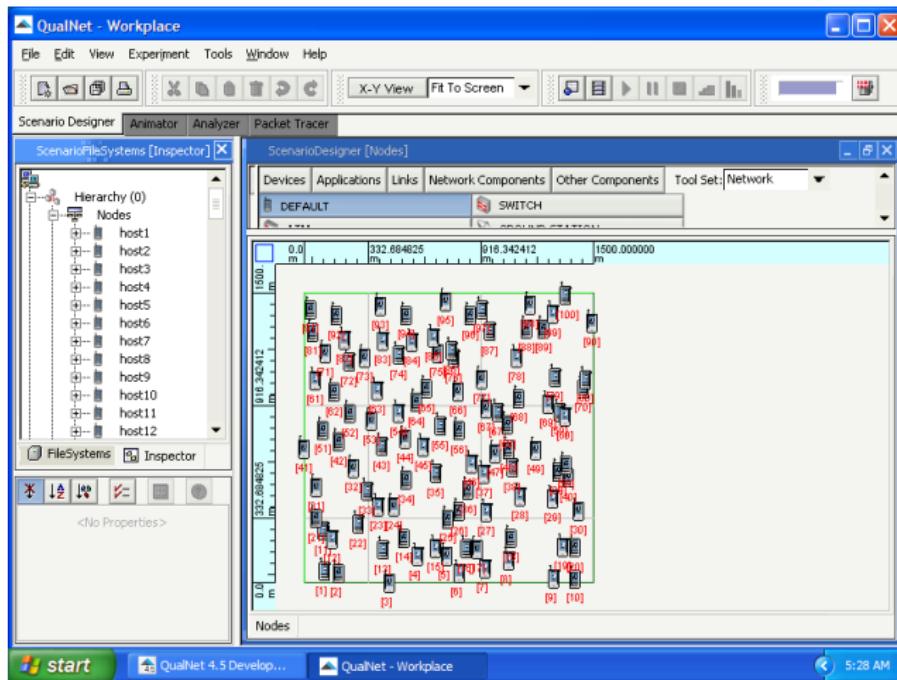
Large Networks (cont'd)

- Uniform, seed = 2

- Placement strategy = random
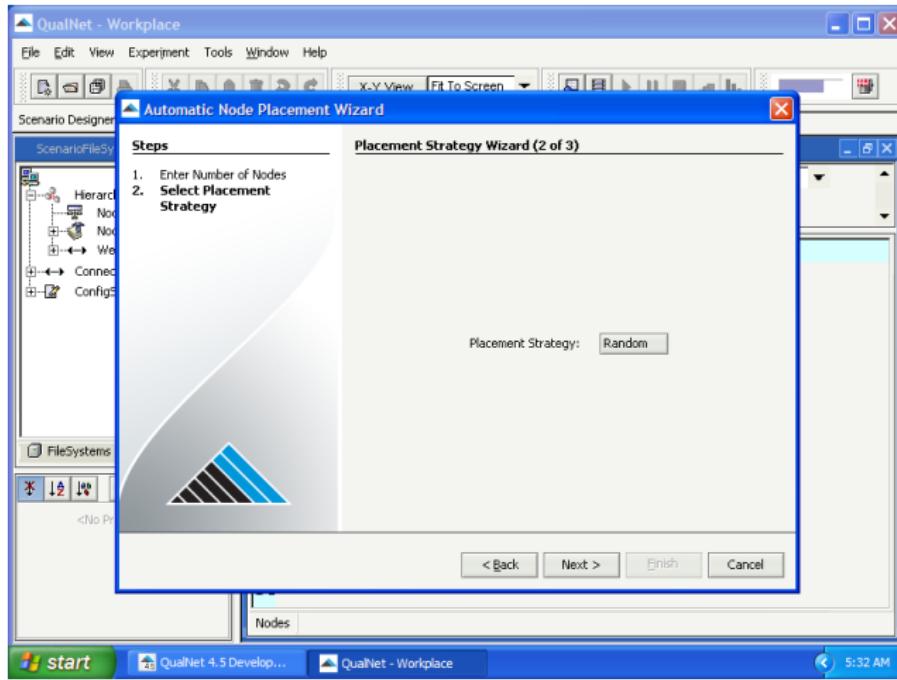
Large Networks (cont'd)

- Random, seed = 3

- Random, seed = 3

- Placement strategy = grid
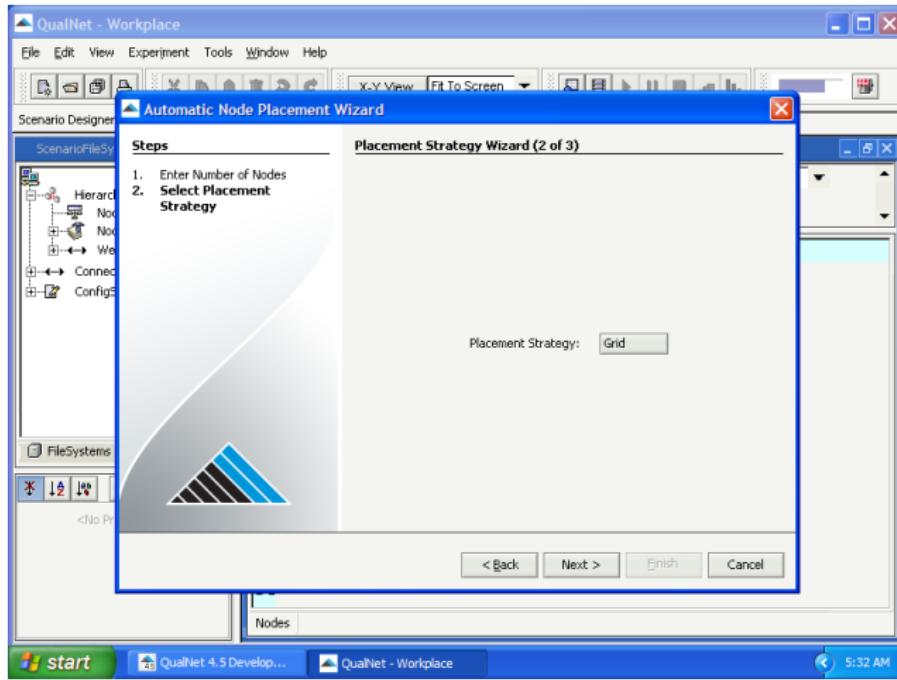
# Large Networks (cont'd)

- Nodes = 100, step = 100 m
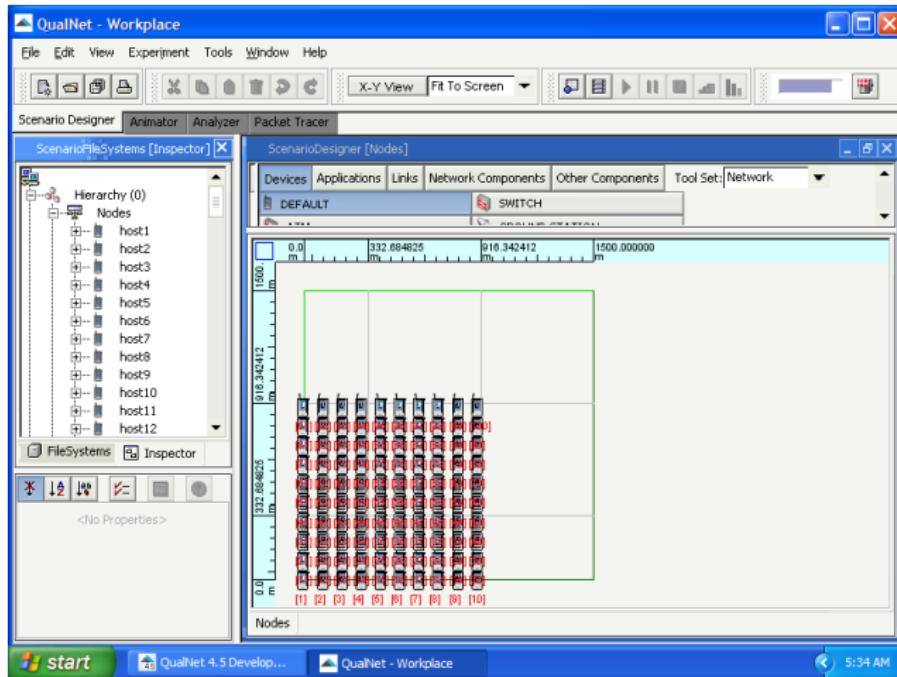
Outline

# Sample Scenarios

- QualNet includes a number of ready to use sample scenarios
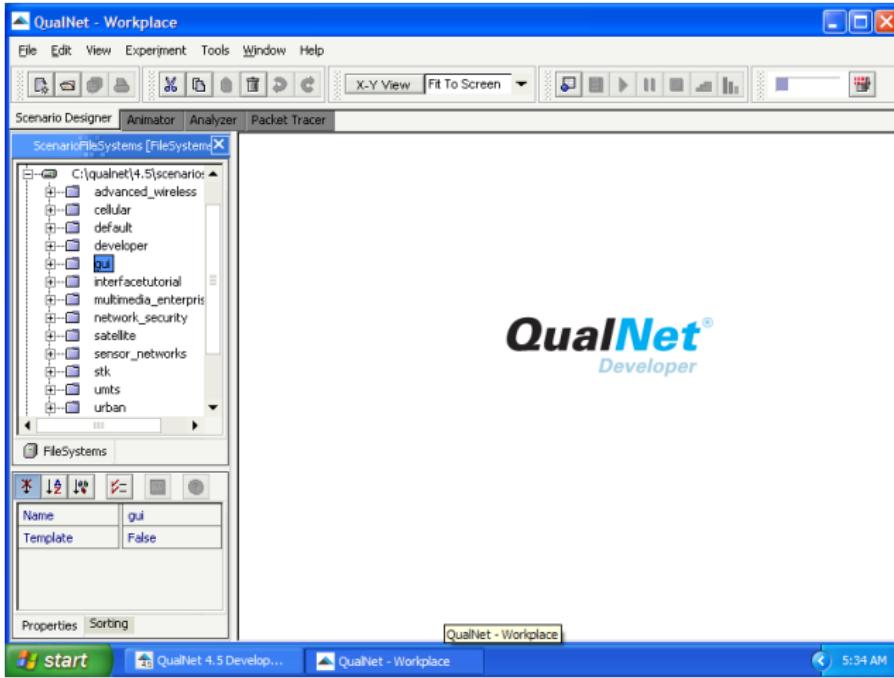
Sample Scenarios (cont'd)

- Some features may require purchasing additional licenses
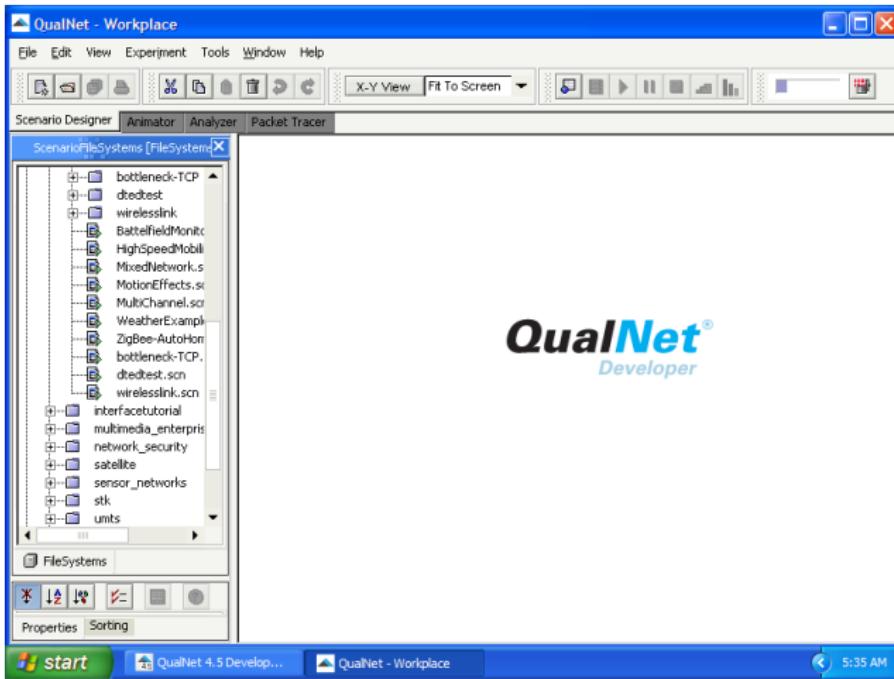
- **Battelfield Monitoring with Sensors**: scenario
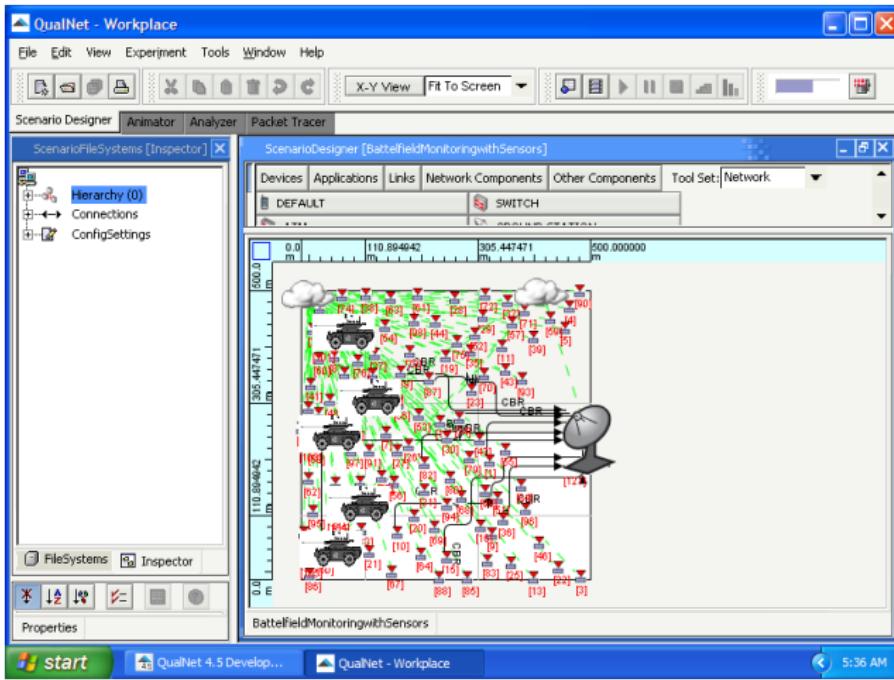
Sample Scenarios (cont'd)

- **Battelfield Monitoring with Sensors**: animation
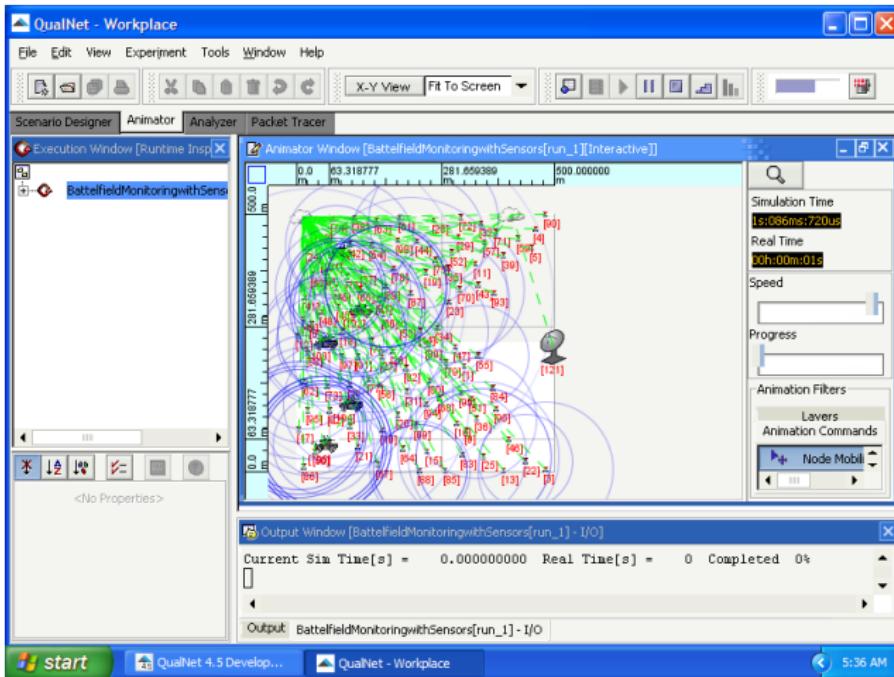
- **High-Speed Mobility:** scenario
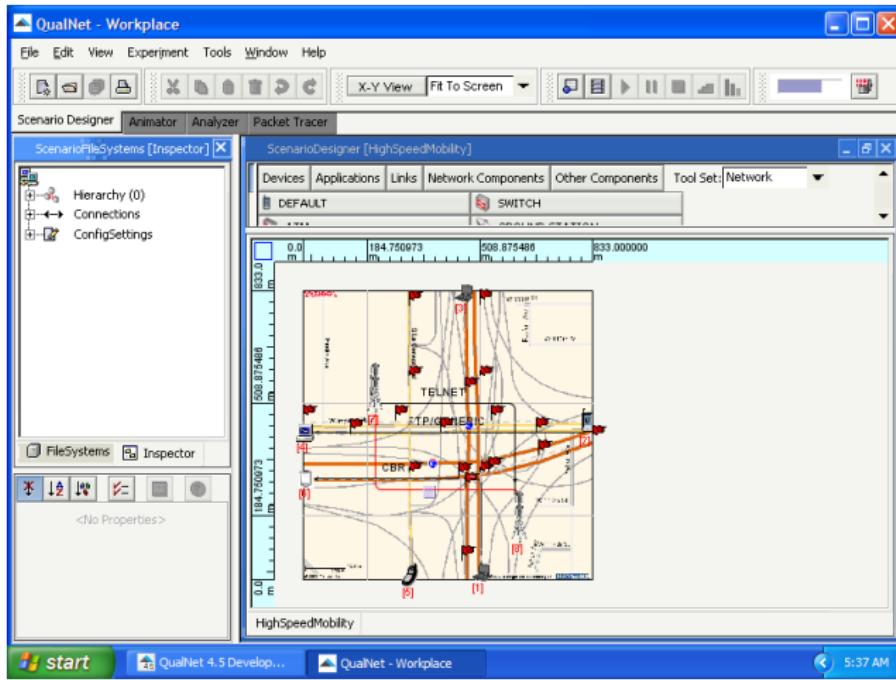
- **High-Speed Mobility**: animation
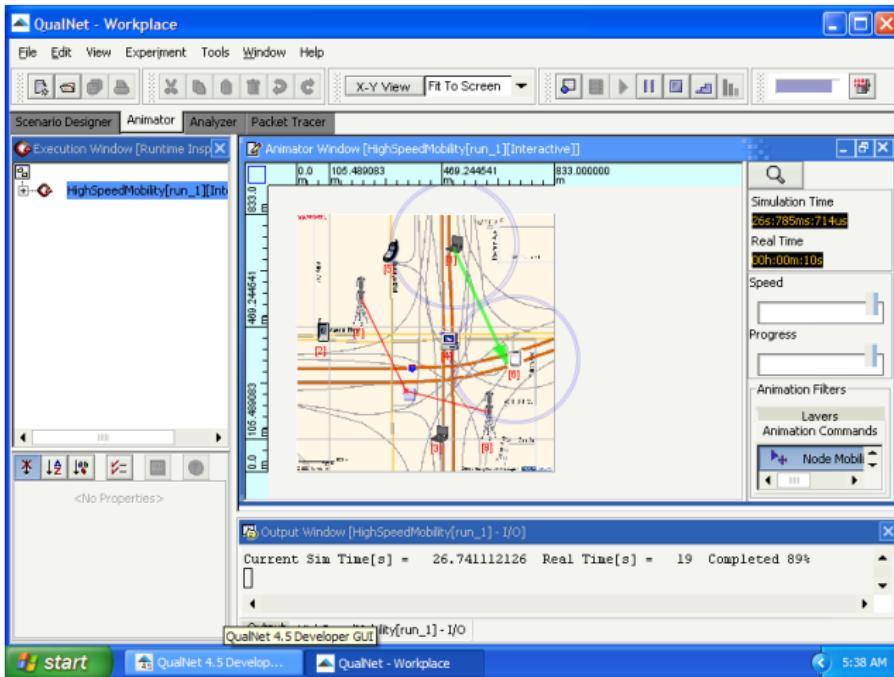
- **Weather Example:** scenario
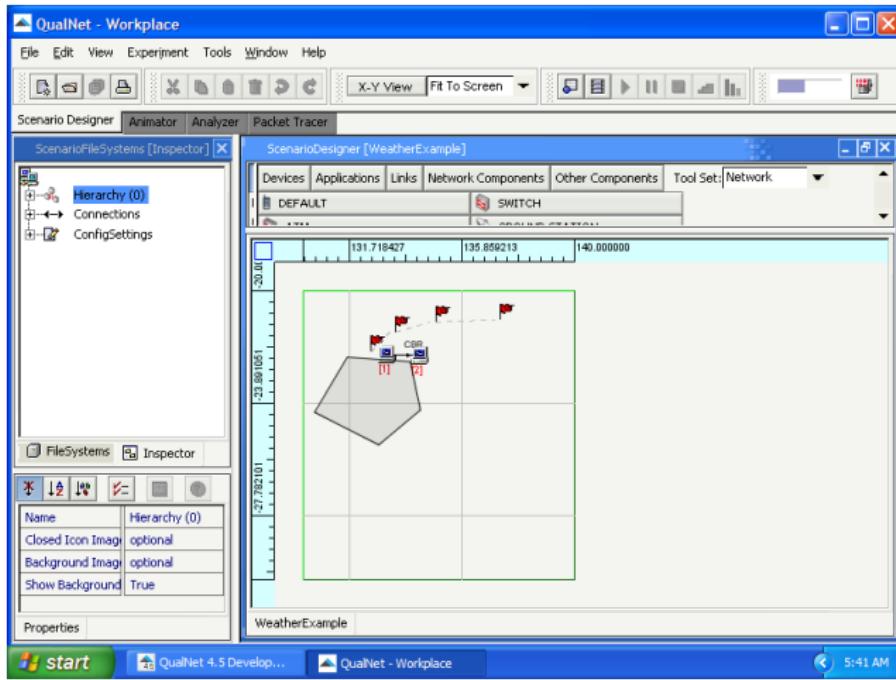
Sample Scenarios (cont'd)
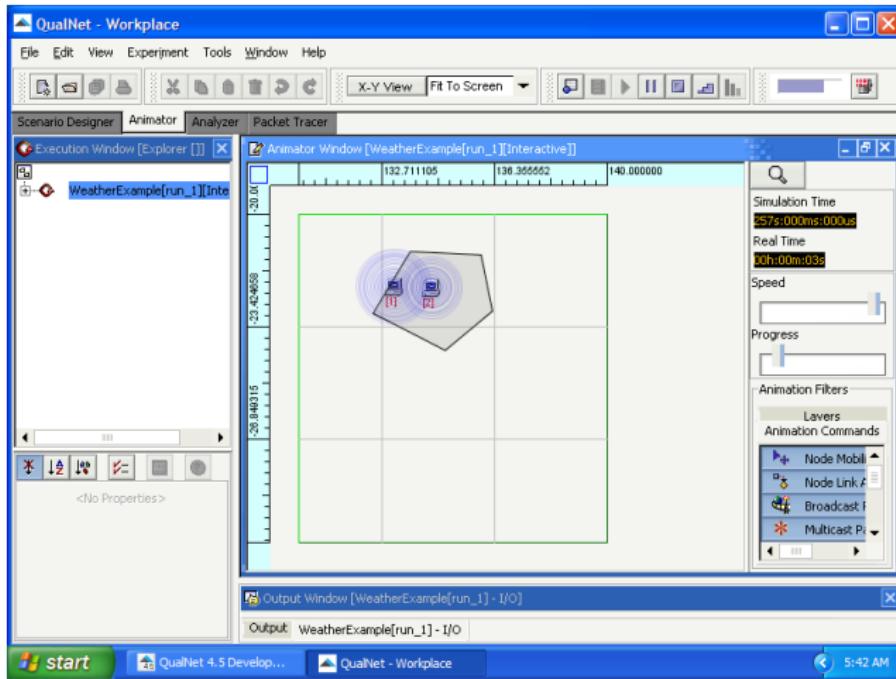
- **Weather Example:** animation

# Sample Scenarios (cont'd)

- **Weather Example:** animation
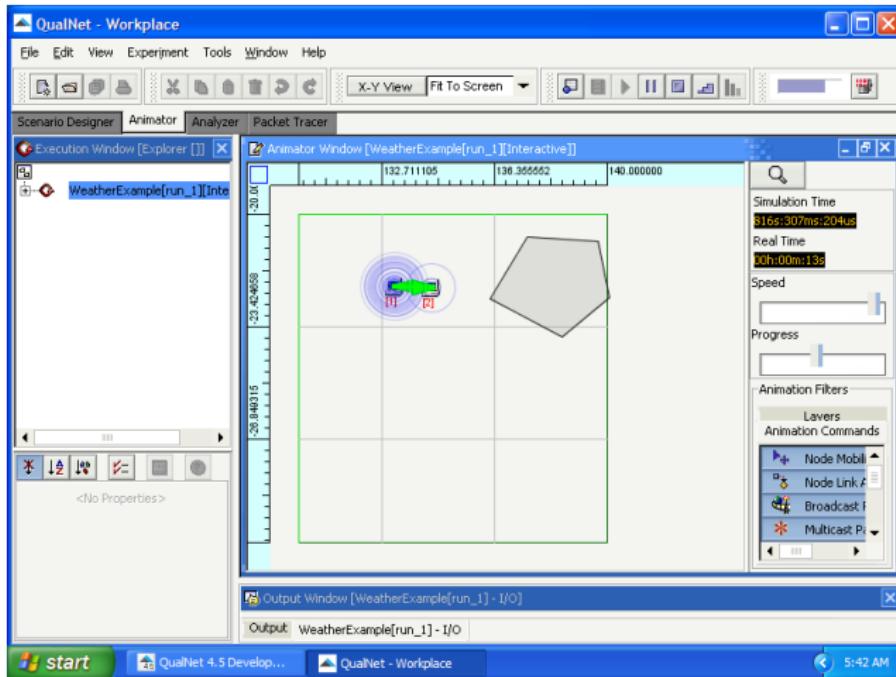
Sample Scenarios (cont'd)

- **ZigBee Auto Home**: scenario
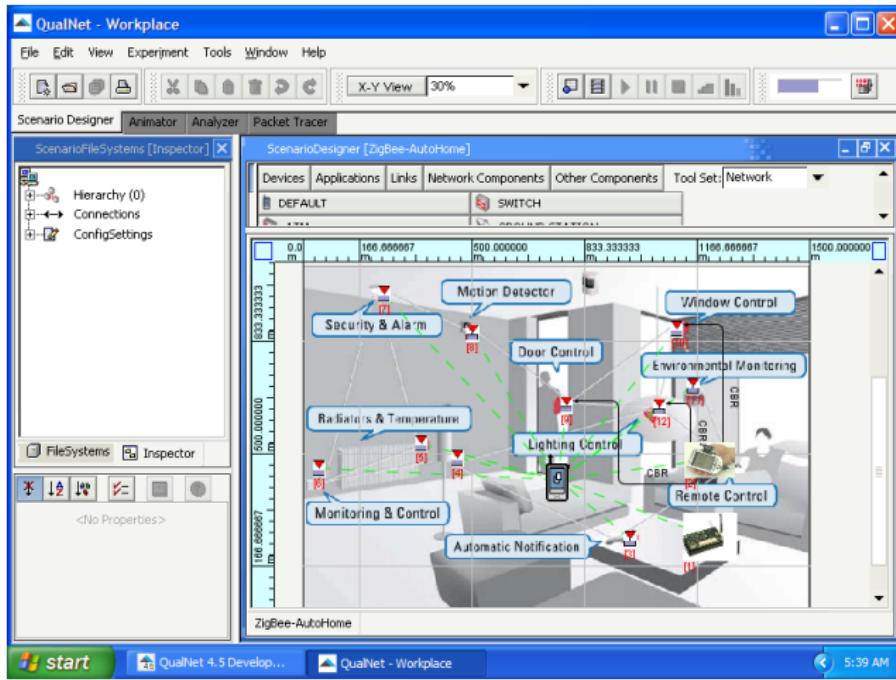
Sample Scenarios (cont'd)

- **ZigBee Auto Home**: animation
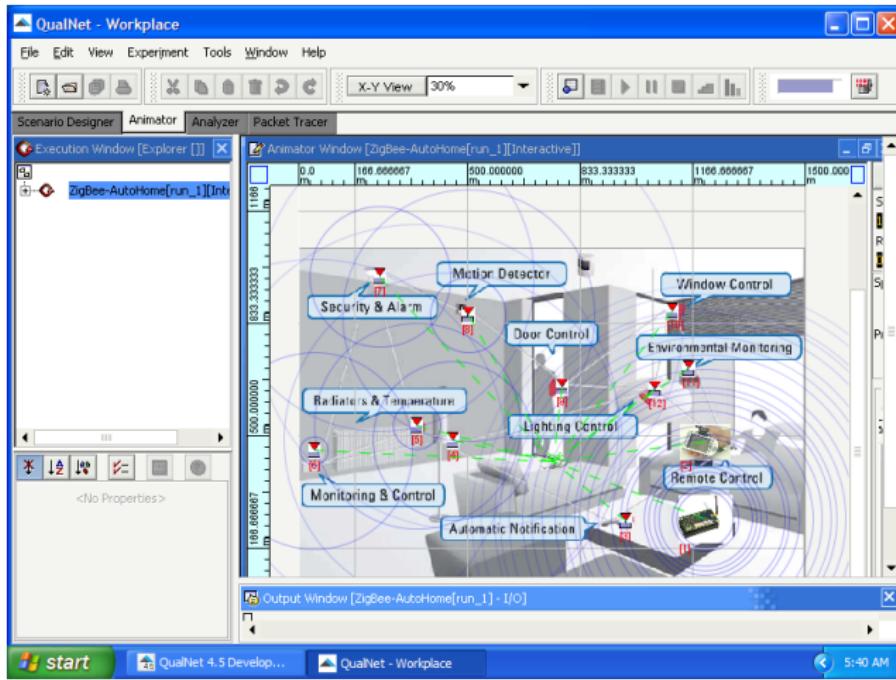
Outline

Installation of QualNet 7.1

- System requirements:
  - CPU: 32- or 64-bit
  - Memory: 2-4 GB
  - Disk: 1 GB free disk space

- Installation order:
  1. QualNet
  2. License

- Install **QualNet 7.1**
  - qualnet-7_1-windows-installer.exe
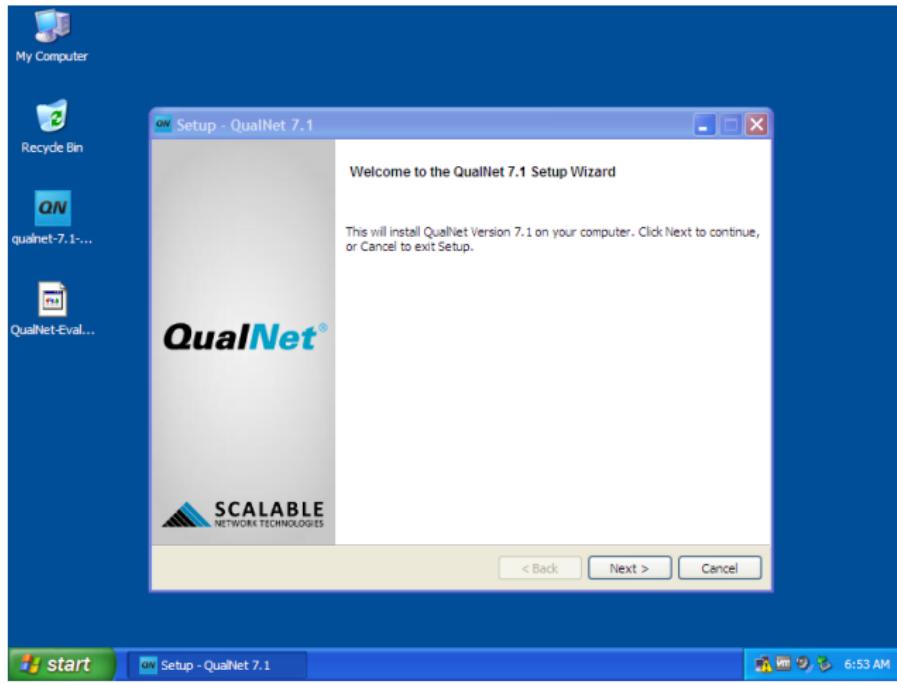
- Components to be installed

- Copy **license file**

- Done!

- QualNet 7.1 workspace