

QualNet: Overview and Examples

Roman Dunaytsev

The Bonch-Bruевич Saint-Petersburg
State University of Telecommunications

roman.dunaytsev@spbgut.ru

Lecture № 9

Outline

- 1 Introduction
- 2 Installation of QualNet 4.5.1
- 3 Simulation workflow
- 4 Example 1
- 5 Example 2
- 6 Large networks
- 7 Sample scenarios
- 8 Installation of QualNet 7.1

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- **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**

- **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**



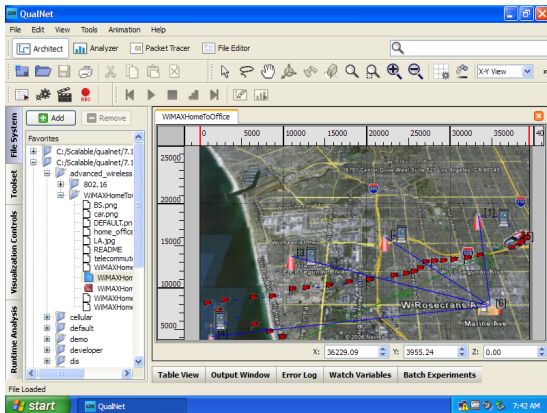
- Customers:
 - 1 **Service providers**
 - AT&T, France Telecom, NTT DoCoMo, ...
 - 2 **Enterprises**
 - Microsoft, Panasonic, TOSHIBA, TOYOTA, ...
 - 3 **Network equipment manufacturers**
 - Lucent Technologies, ...
 - 4 **Defense and homeland security**
 - NASA, US Air Force, US Army, US Navy, ...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



- **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

- 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

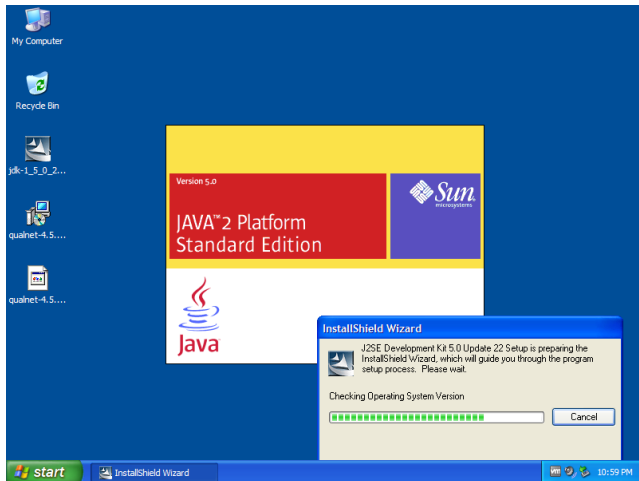
- 1 Introduction
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Installation of QualNet 4.5.1

- 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

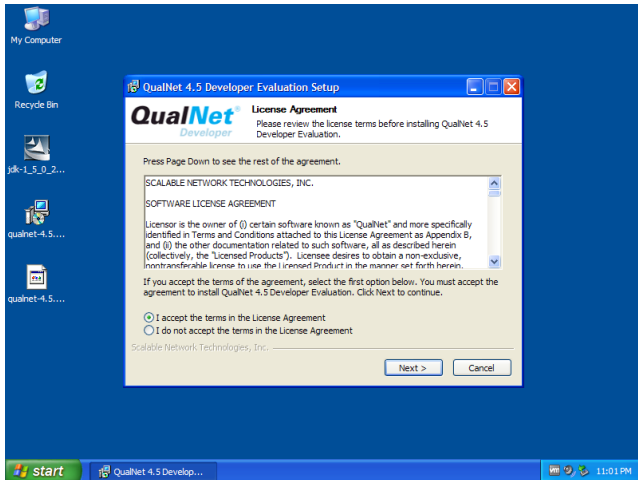
Installation of QualNet 4.5.1 (cont'd)

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



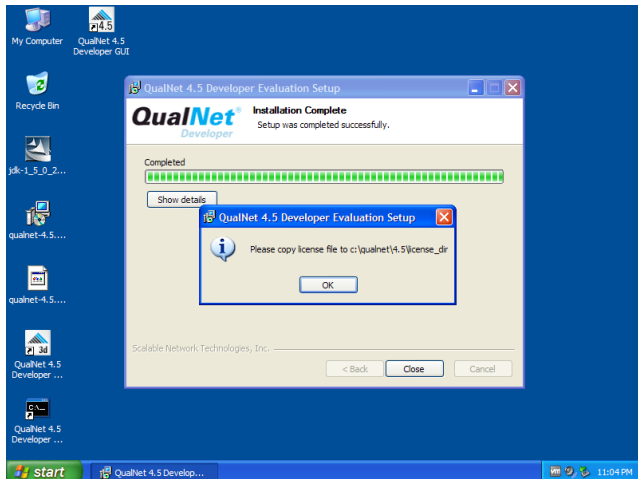
Installation of QualNet 4.5.1 (cont'd)

- Install **QualNet 4.5.1**
 - qualnet-4_5_1-evaluation-installer.exe



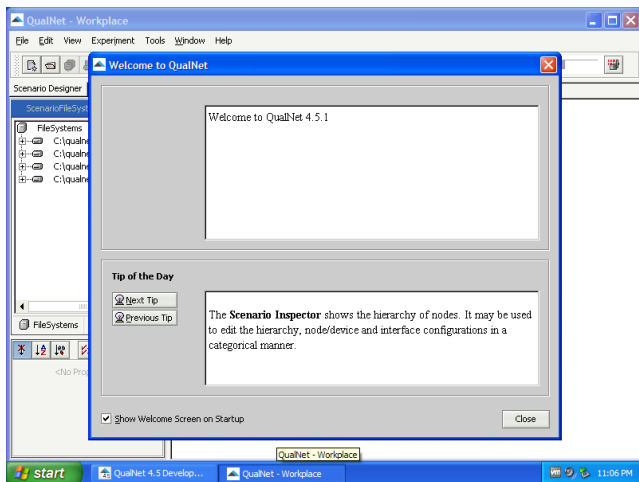
Installation of QualNet 4.5.1 (cont'd)

- Copy license file
 - qualnet-4_5_1-eval-YYYY.MM.DD.lic



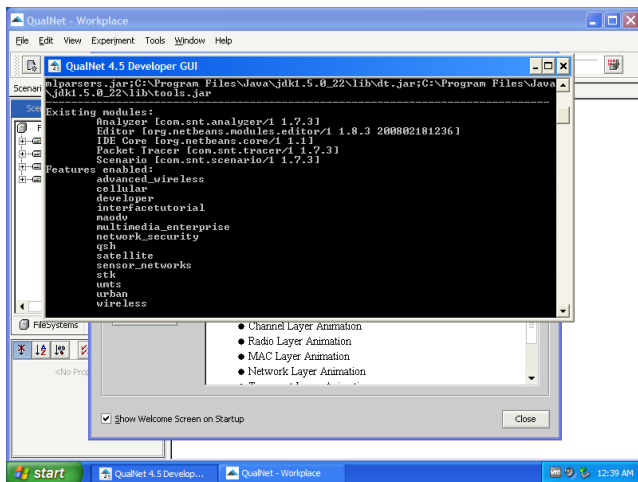
Installation of QualNet 4.5.1 (cont'd)

- Done!



Installation of QualNet 4.5.1 (cont'd)

- Installed modules and features enabled



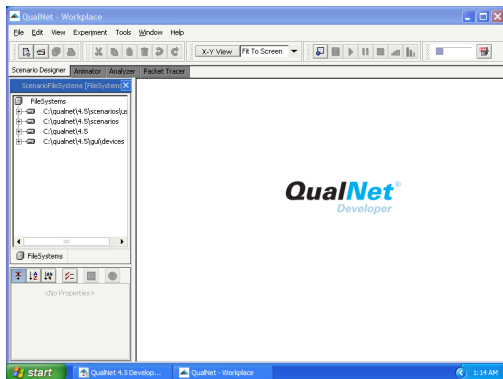
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- **QualNet simulation workflow** :
 - 1 Create a baseline scenario
 - Define the network topology
 - Create traffic
 - Choose statistics to be collected
 - Run the simulation
 - View the results
 - 2 Duplicate the scenario
 - Make changes
 - Re-run 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

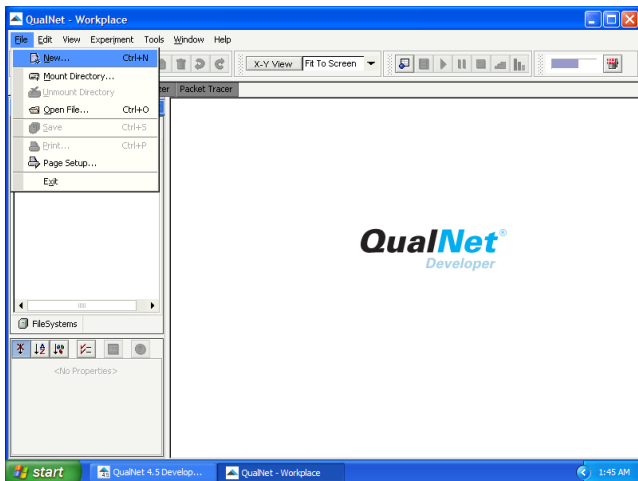


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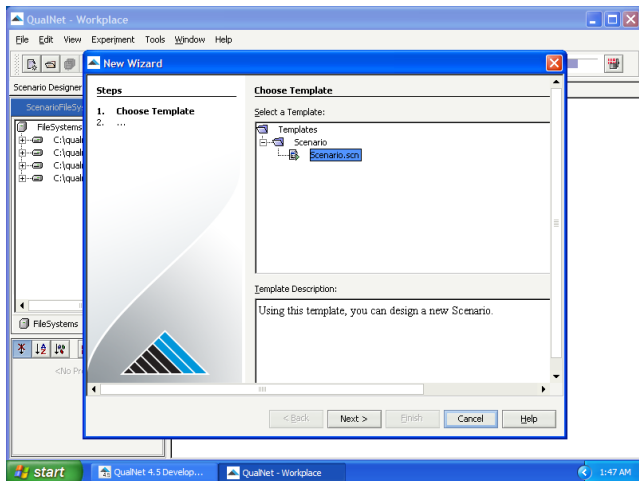
Example 1

- Create a new scenario



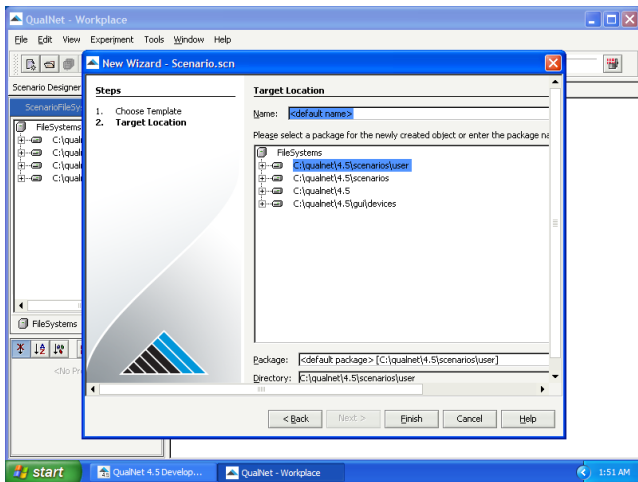
Example 1 (cont'd)

- Create a new scenario



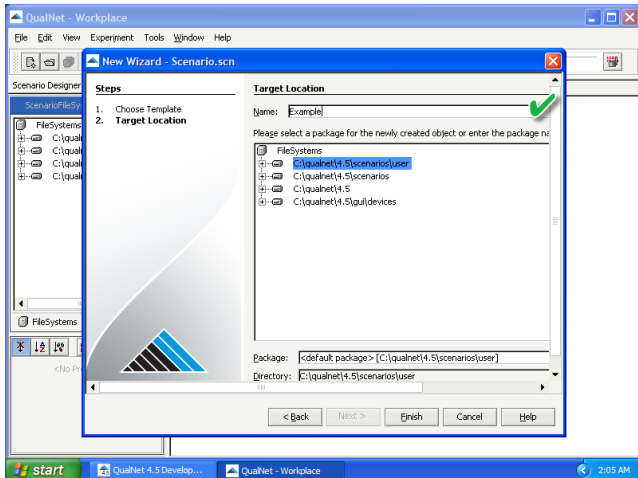
Example 1 (cont'd)

- Create a new scenario



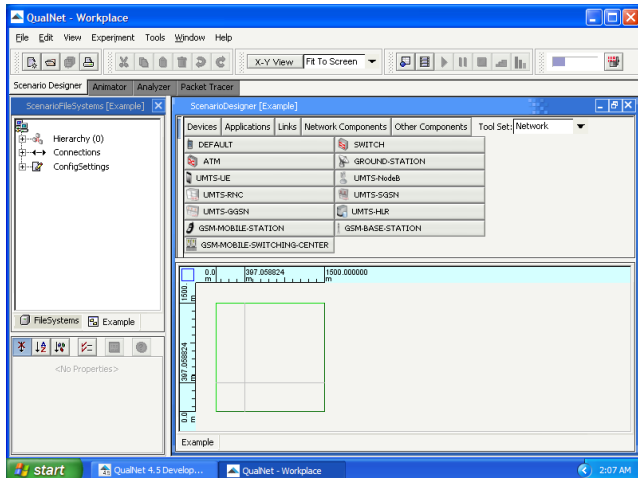
Example 1 (cont'd)

- Save as 'Example'



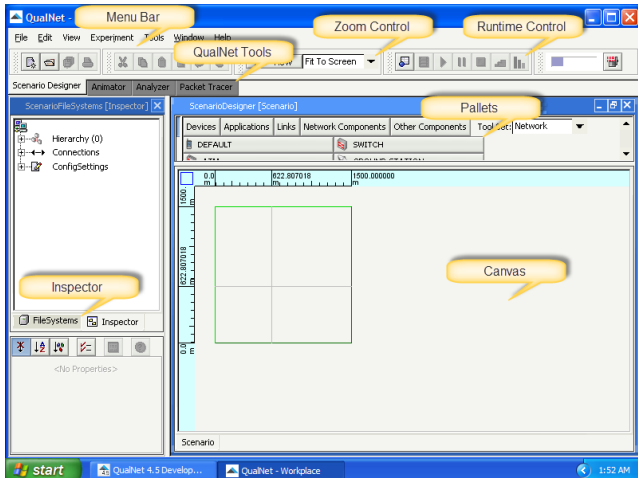
Example 1 (cont'd)

- Scenario 'Example'



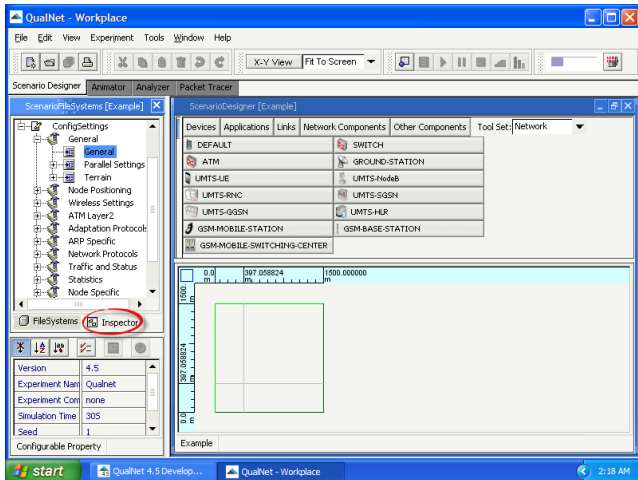
Example 1 (cont'd)

- QualNet 4.5.1 workspace



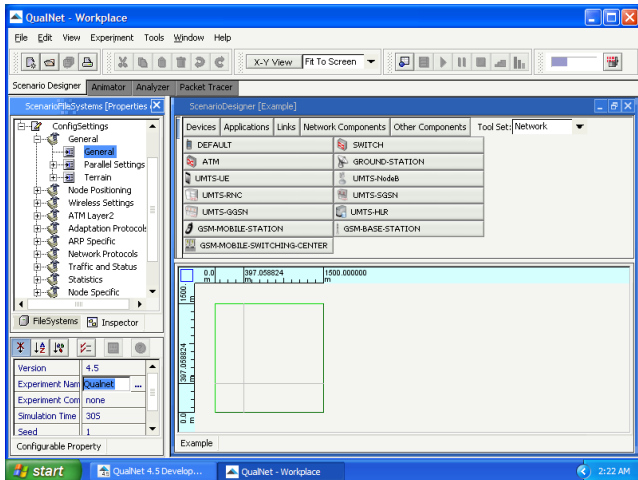
Example 1 (cont'd)

- Save output as 'Example.date_time.stat'



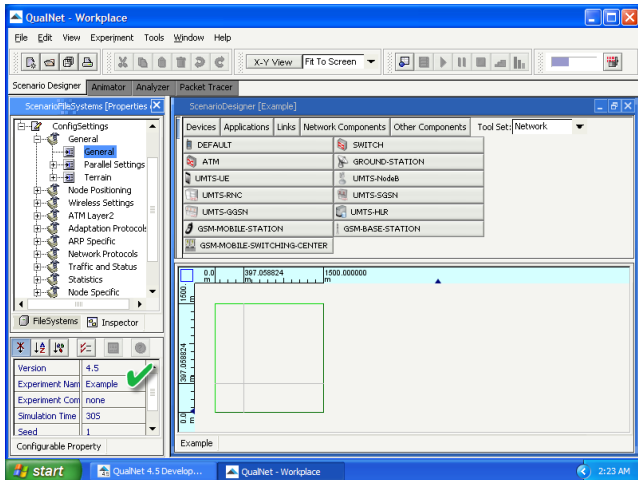
Example 1 (cont'd)

- Save output as 'Example.date_time.stat'



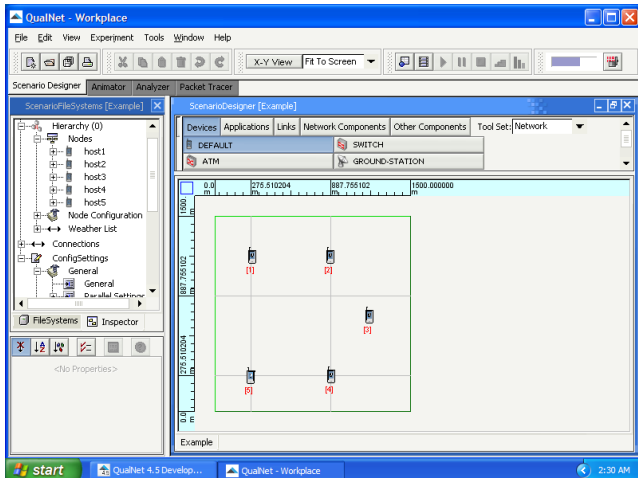
Example 1 (cont'd)

- Save output as 'Example.date_time.stat'



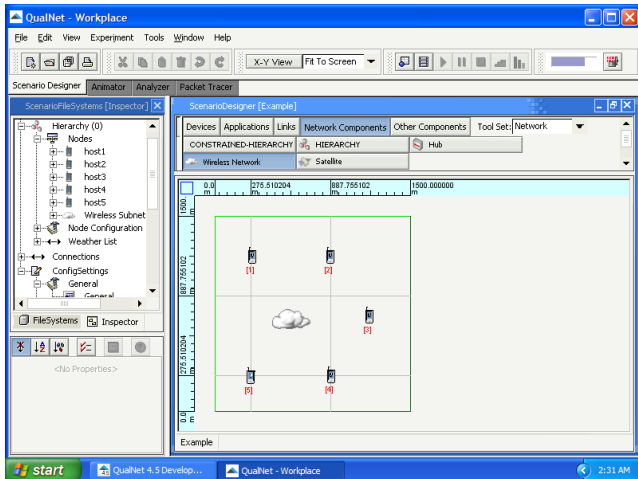
Example 1 (cont'd)

- Define the topology of a wireless network



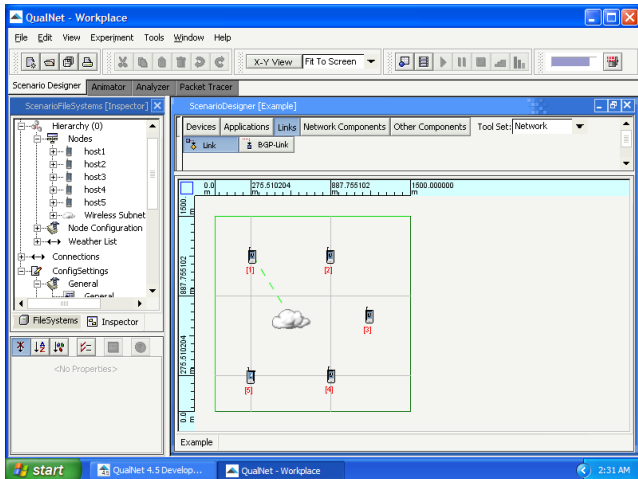
Example 1 (cont'd)

- Define the topology of a wireless network



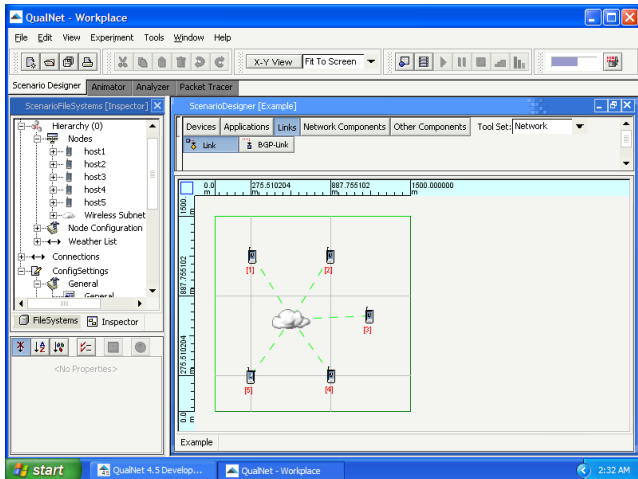
Example 1 (cont'd)

- Define the topology of a wireless network



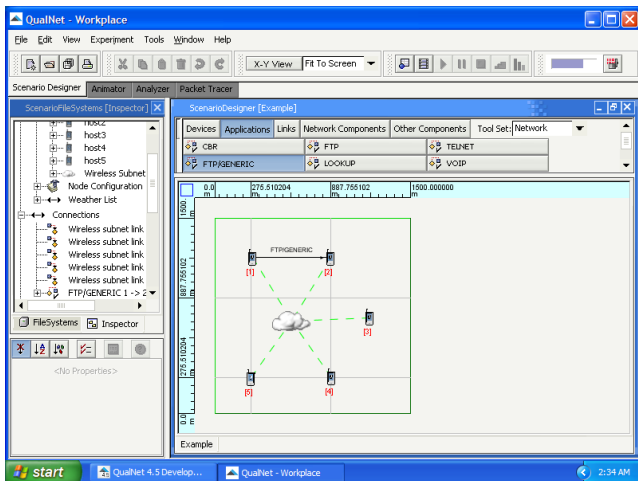
Example 1 (cont'd)

- Define the topology of a wireless network



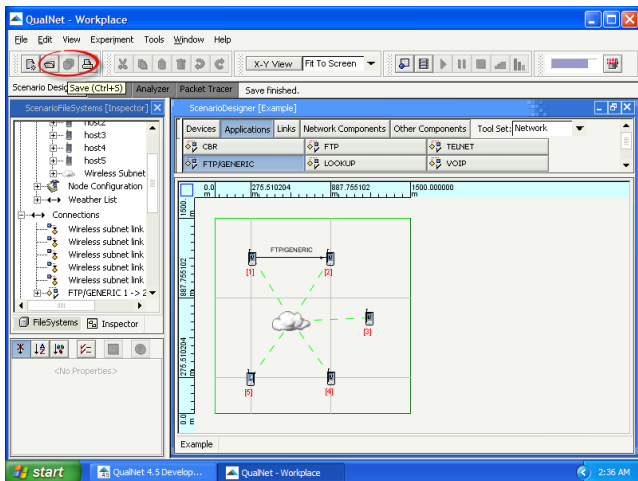
Example 1 (cont'd)

- Create traffic



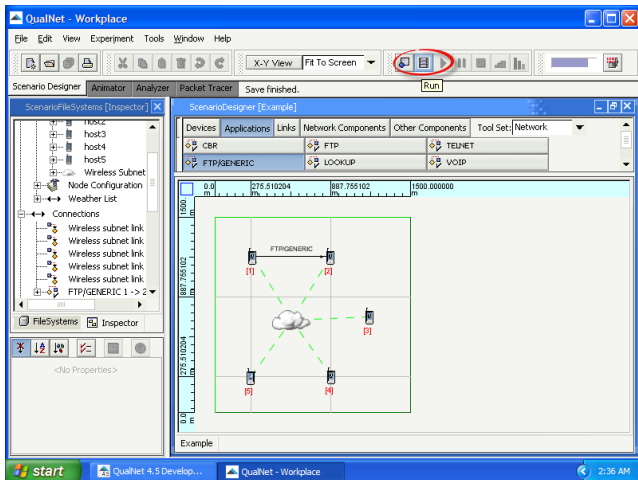
Example 1 (cont'd)

- Save the scenario



Example 1 (cont'd)

- Run the simulation



Example 1 (cont'd)

- View the network animation

The screenshot displays the QualNet - Workplace application window. The interface is divided into several panes:

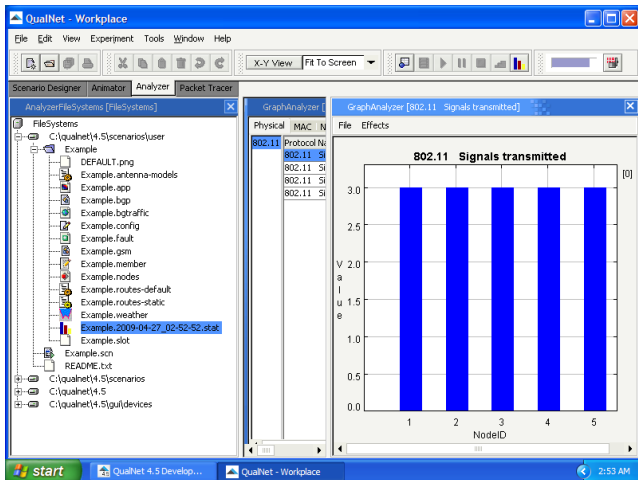
- Scenario Designer:** Shows the current scenario named "Example_run_1 [Interactive]".
- Animator Window:** Displays a 2D network topology with five nodes (labeled [1] through [5]) and their connections. The nodes are represented by mobile phone icons. The connections are shown as dashed green lines. The window includes a coordinate system with axes ranging from 0.0 to 1500.0 meters.
- Simulation Controls:** Located on the right side, it includes:
 - Simulation Time:** 00:08:55ms:347us
 - Real Time:** 00h:00m:00s
 - Speed:** A slider control.
 - Progress:** A progress bar.
 - Animation Filters:** A list of filters including "Node Mobility Animation", "Node Link Animation", and "Broadcast Packet Animation".
- Output Window:** Located at the bottom, it shows simulation logs:

```
Current Sim Time[s] = 0.469980903 Real Time[s] = 109 Completed 1%
Current Sim Time[s] = 0.657044662 Real Time[s] = 109 Completed 2%
```

The Windows taskbar at the bottom shows the Start button, the QualNet 4.5 Development environment, and the QualNet - Workplace application. The system clock indicates 2:48 AM.

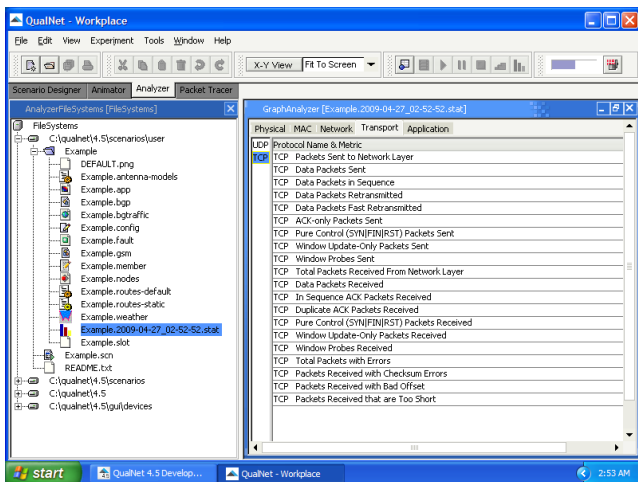
Example 1 (cont'd)

- View the results



Example 1 (cont'd)

- Available TCP statistics

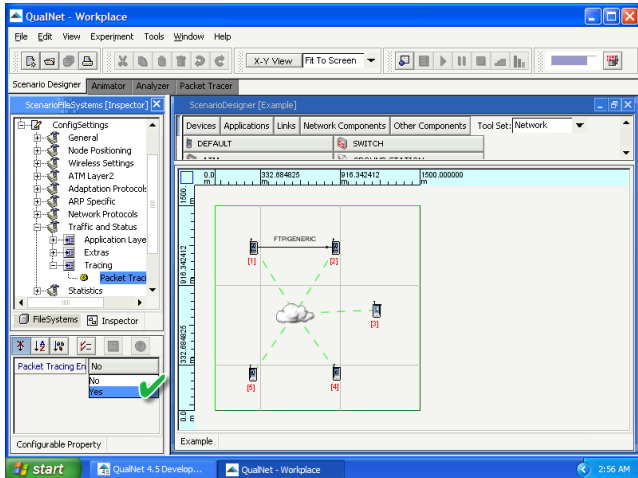


The screenshot shows the QualNet software interface. The main window is titled "QualNet - Workplace" and contains several panes. On the left is the "Scenario Designer" pane showing a file system tree with "Example, 2009-04-27_02-52-52.stat" selected. The right pane is the "GraphAnalyzer" window, which displays a list of TCP statistics under the "TCP" protocol. The statistics are organized into a table with columns for "Physical", "MAC", "Network", "Transport", and "Application".

Physical	MAC	Network	Transport	Application
UDP				Protocol Name & Metric
TCP				TCP Packets Sent to Network Layer
				TCP Data Packets Sent
				TCP Data Packets in Sequence
				TCP Data Packets Retransmitted
				TCP Data Packets Fast Retransmitted
				TCP ACK-only Packets Sent
				TCP Pure Control (SYN FIN RST) Packets Sent
				TCP Window Update-Only Packets Sent
				TCP Window Probes Sent
				TCP Total Packets Received From Network Layer
				TCP Data Packets Received
				TCP In Sequence ACK Packets Received
				TCP Duplicate ACK Packets Received
				TCP Pure Control (SYN FIN RST) Packets Received
				TCP Window Update-Only Packets Received
				TCP Window Probes Received
				TCP Total Packets with Errors
				TCP Packets Received with Checksum Errors
				TCP Packets Received with Bad Offset
				TCP Packets Received that are Too Short

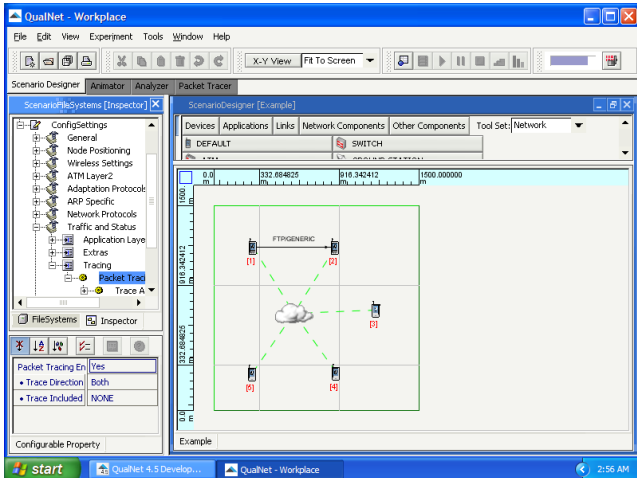
Example 1 (cont'd)

- Capture packets



Example 1 (cont'd)

- Capture packets



Example 1 (cont'd)

- Transmitted packets

The screenshot shows the QualNet - Workplace interface. The Packet Tracer window displays a table of transmitted packets. The table has columns for S... (Source), T... (Destination), CheckTracing..., Tracing..., Sim. Time, Originati..., Messag..., Originati..., and Action. The data rows show a sequence of packets from source 1 to 3, with various protocols (UDP, IPv4) and actions (SEND, ENQUEUE, DEQUEUE).

S...	T...	CheckTracing...	Tracing...	Sim. Time	Originati...	Messag...	Originati...	Action	
1	2	<input type="checkbox"/>	<input type="checkbox"/>	1	BELLMA...	0.0	1	0	BELLMA... SEND
2	2	<input type="checkbox"/>	<input type="checkbox"/>	2	BELLMA...	0.0	2	0	BELLMA... SEND
3	3	<input type="checkbox"/>	<input type="checkbox"/>	3	BELLMA...	0.0	3	0	BELLMA... SEND
4	4	<input type="checkbox"/>	<input type="checkbox"/>	4	BELLMA...	0.0	4	0	BELLMA... SEND
5	5	<input type="checkbox"/>	<input type="checkbox"/>	5	BELLMA...	0.0	5	0	BELLMA... SEND
6	4	<input type="checkbox"/>	<input type="checkbox"/>	4	UDP	0.01044...	4	0	BELLMA... SEND
7	4	<input type="checkbox"/>	<input type="checkbox"/>	4	IPv4	0.01044...	4	0	BELLMA... SEND
8	4	<input type="checkbox"/>	<input type="checkbox"/>	4	IPv4	0.01044...	4	0	BELLMA... ENQUEUE
9	4	<input type="checkbox"/>	<input type="checkbox"/>	4	IPv4	0.01044...	4	0	BELLMA... DEQUEUE
10	5	<input type="checkbox"/>	<input type="checkbox"/>	5	UDP	0.04648...	5	0	BELLMA... SEND
11	5	<input type="checkbox"/>	<input type="checkbox"/>	5	IPv4	0.04648...	5	0	BELLMA... SEND
12	5	<input type="checkbox"/>	<input type="checkbox"/>	5	IPv4	0.04648...	5	0	BELLMA... ENQUEUE
13	5	<input type="checkbox"/>	<input type="checkbox"/>	5	IPv4	0.04648...	5	0	BELLMA... DEQUEUE
14	2	<input type="checkbox"/>	<input type="checkbox"/>	2	UDP	0.05370...	2	0	BELLMA... SEND
15	2	<input type="checkbox"/>	<input type="checkbox"/>	2	IPv4	0.05370...	2	0	BELLMA... SEND
16	2	<input type="checkbox"/>	<input type="checkbox"/>	2	IPv4	0.05370...	2	0	BELLMA... ENQUEUE
17	2	<input type="checkbox"/>	<input type="checkbox"/>	2	IPv4	0.05370...	2	0	BELLMA... DEQUEUE
18	3	<input type="checkbox"/>	<input type="checkbox"/>	3	UDP	0.11252...	3	0	BELLMA... SEND
19	3	<input type="checkbox"/>	<input type="checkbox"/>	3	IPv4	0.11252...	3	0	BELLMA... SEND
20	3	<input type="checkbox"/>	<input type="checkbox"/>	3	IPv4	0.11252...	3	0	BELLMA... ENQUEUE

Example 1 (cont'd)

- Transmitted packets

The screenshot shows the QualNet - Workplace interface. The 'Packet Tracer' pane is active, displaying a table of transmitted packets. The table has the following columns: S... (Sequence), T... (Time), CheckTracing..., Tracing..., Sim. Time, Originati..., Messag..., Originati..., and Action. The table contains 15 rows of data, with the 29th row highlighted in blue.

S...	T...	CheckTracing...	Tracing...	Sim. Time	Originati...	Messag...	Originati...	Action	
15		<input type="checkbox"/>	<input type="checkbox"/>	2	IPv4	0.05370...	2	0	BELLA... SEND
16		<input type="checkbox"/>	<input type="checkbox"/>	2	IPv4	0.05370...	2	0	BELLA... ENQUEUE
17		<input type="checkbox"/>	<input type="checkbox"/>	2	IPv4	0.05370...	2	0	BELLA... DEQUEUE
18		<input type="checkbox"/>	<input type="checkbox"/>	3	UDP	0.11252...	3	0	BELLA... SEND
19		<input type="checkbox"/>	<input type="checkbox"/>	3	IPv4	0.11252...	3	0	BELLA... SEND
20		<input type="checkbox"/>	<input type="checkbox"/>	3	IPv4	0.11252...	3	0	BELLA... ENQUEUE
21		<input type="checkbox"/>	<input type="checkbox"/>	3	IPv4	0.11252...	3	0	BELLA... DEQUEUE
22		<input type="checkbox"/>	<input type="checkbox"/>	1	UDP	0.14966...	1	0	BELLA... SEND
23		<input type="checkbox"/>	<input type="checkbox"/>	1	IPv4	0.14966...	1	0	BELLA... SEND
24		<input type="checkbox"/>	<input type="checkbox"/>	1	IPv4	0.14966...	1	0	BELLA... ENQUEUE
25		<input type="checkbox"/>	<input type="checkbox"/>	1	IPv4	0.14966...	1	0	BELLA... DEQUEUE
26		<input type="checkbox"/>	<input type="checkbox"/>	1	TCP	1.0	1	1	TCP SEND
27		<input type="checkbox"/>	<input type="checkbox"/>	1	IPv4	1.0	1	1	TCP SEND
28		<input type="checkbox"/>	<input type="checkbox"/>	1	IPv4	1.0	1	1	TCP DROP
29		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	1	TCP	6.65372...	1	2	TCP SEND
30		<input type="checkbox"/>	<input type="checkbox"/>	1	IPv4	6.65372...	1	2	TCP SEND
31		<input type="checkbox"/>	<input type="checkbox"/>	1	IPv4	6.65372...	1	2	TCP DROP
32		<input type="checkbox"/>	<input type="checkbox"/>	5	BELLA...	10.0283...	5	1	BELLA... SEND
33		<input type="checkbox"/>	<input type="checkbox"/>	4	BELLA...	10.0474...	4	1	BELLA... SEND
34		<input type="checkbox"/>	<input type="checkbox"/>	3	BELLA...	10.0661...	3	1	BELLA... SEND

Outline

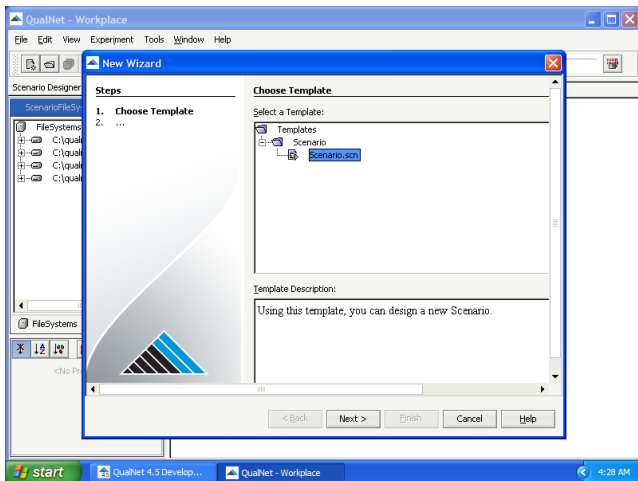
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Example 2

- **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

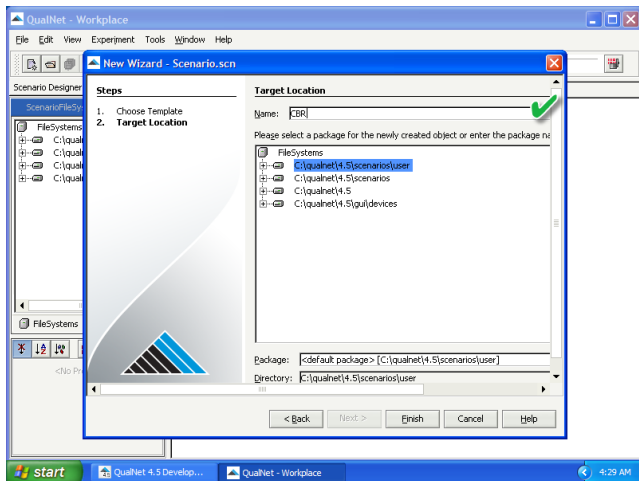
Example 2 (cont'd)

- Create a new scenario



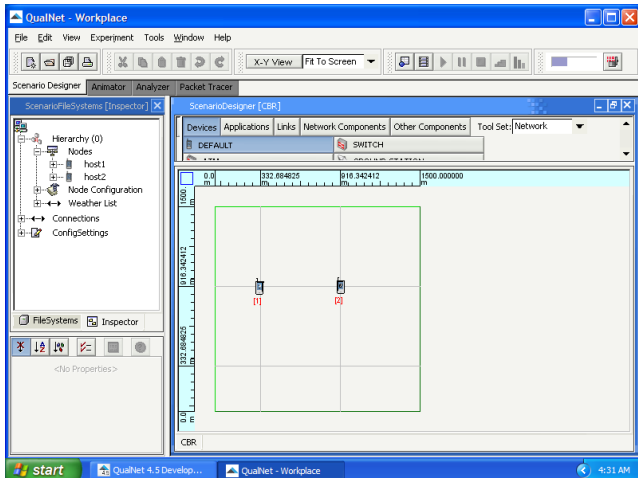
Example 2 (cont'd)

- Save as 'CBR'



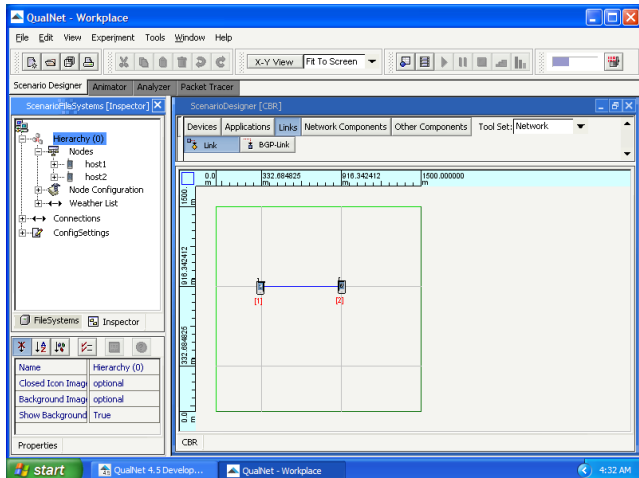
Example 2 (cont'd)

- Create the point-to-point topology



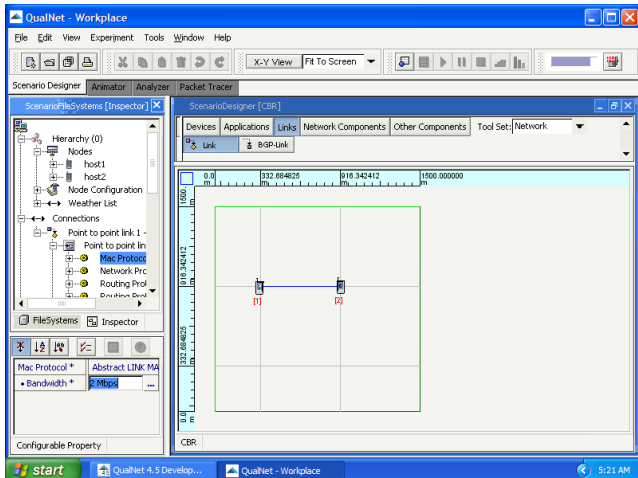
Example 2 (cont'd)

- Create the point-to-point topology



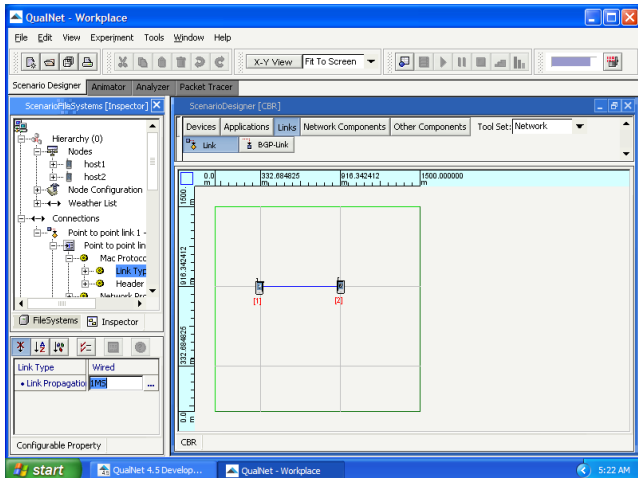
Example 2 (cont'd)

- Set the bandwidth of the point-to-point link



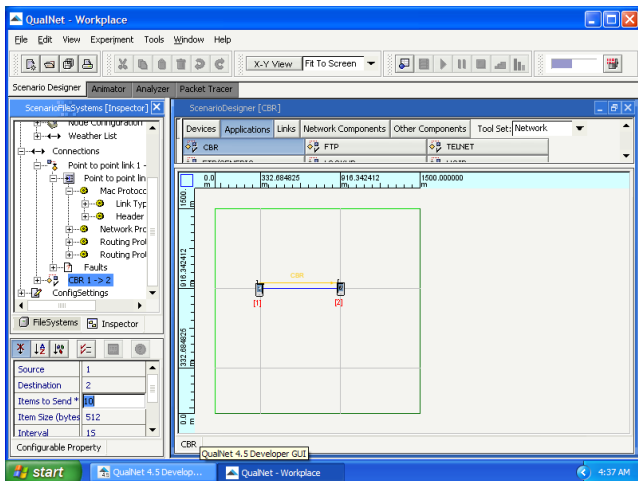
Example 2 (cont'd)

- Set the link propagation time



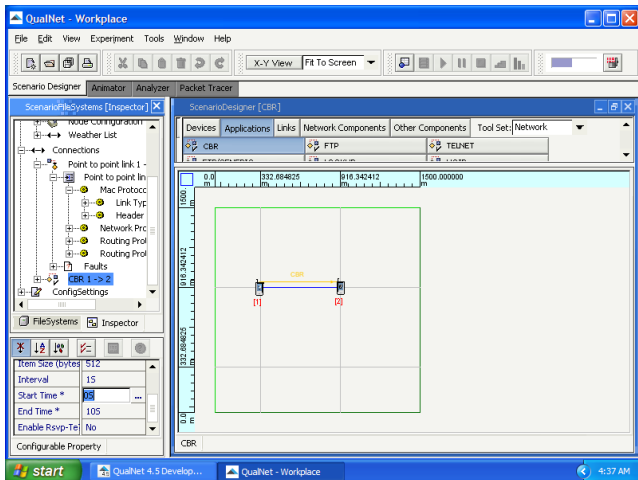
Example 2 (cont'd)

- Create traffic



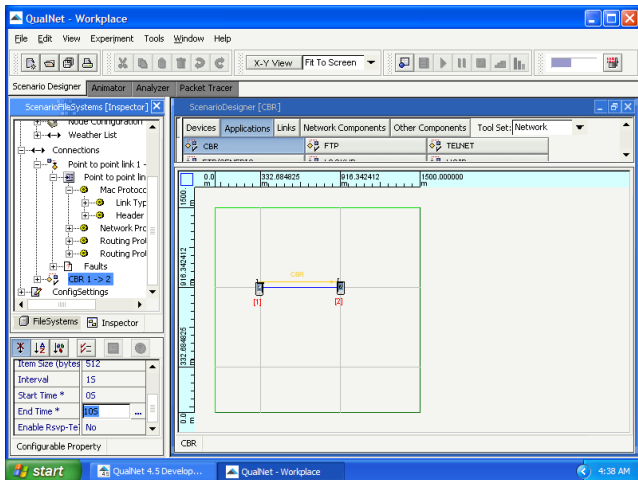
Example 2 (cont'd)

- Set the start time



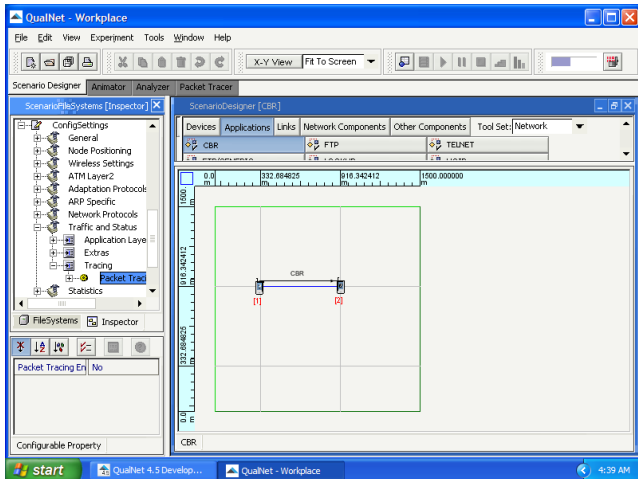
Example 2 (cont'd)

- Set the end time



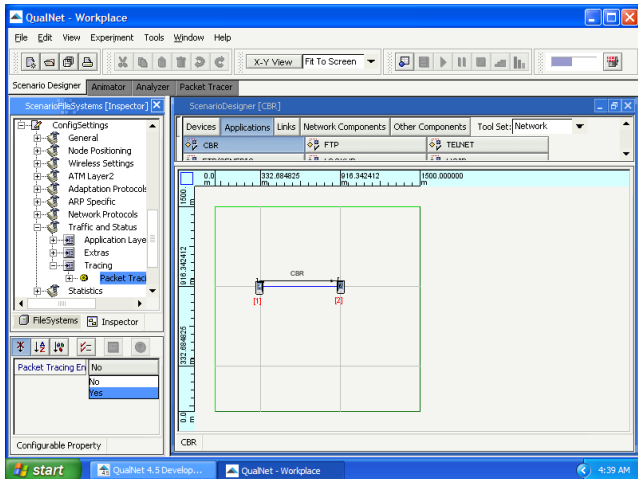
Example 2 (cont'd)

- Capture packets



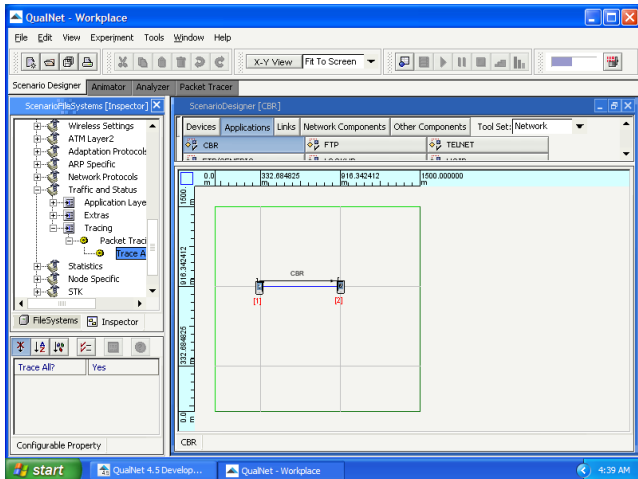
Example 2 (cont'd)

- Capture packets



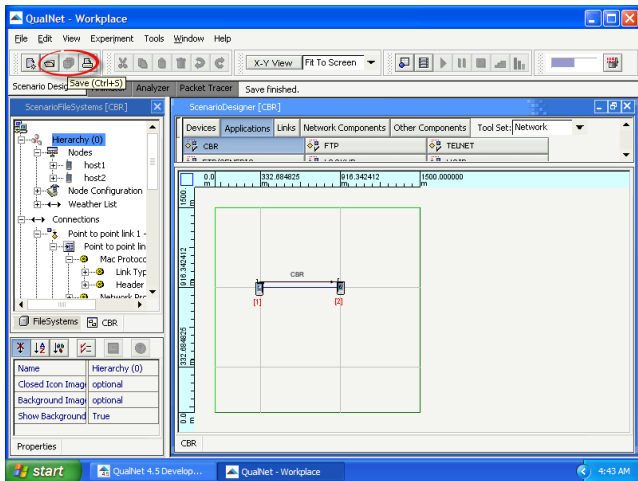
Example 2 (cont'd)

- Capture packets



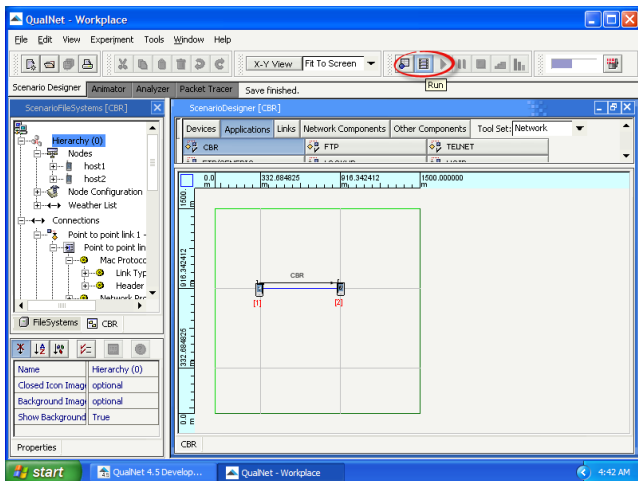
Example 2 (cont'd)

- Save the scenario



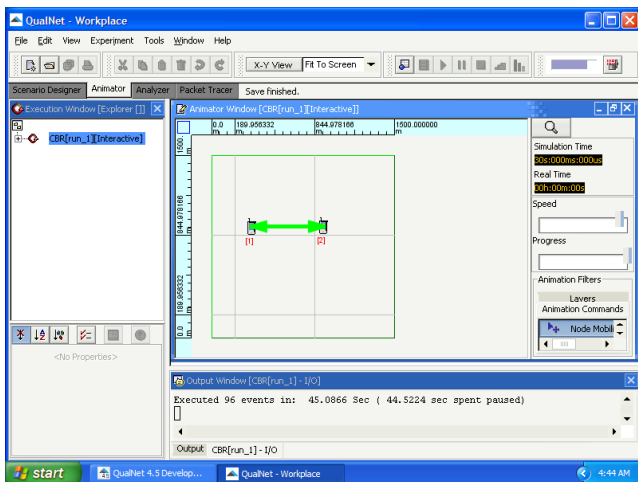
Example 2 (cont'd)

- Run the simulation



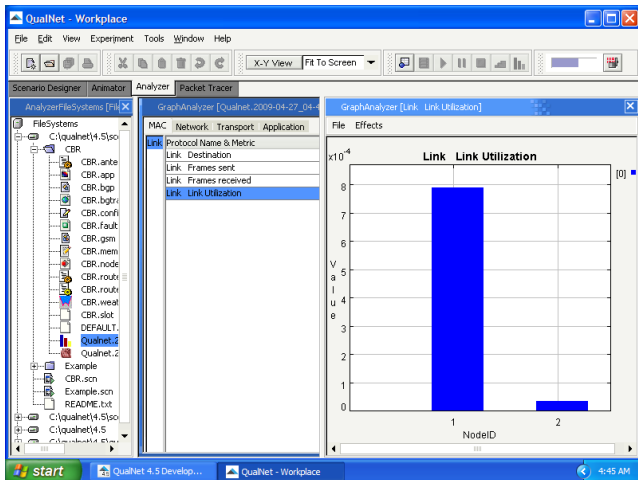
Example 2 (cont'd)

- View the network animation



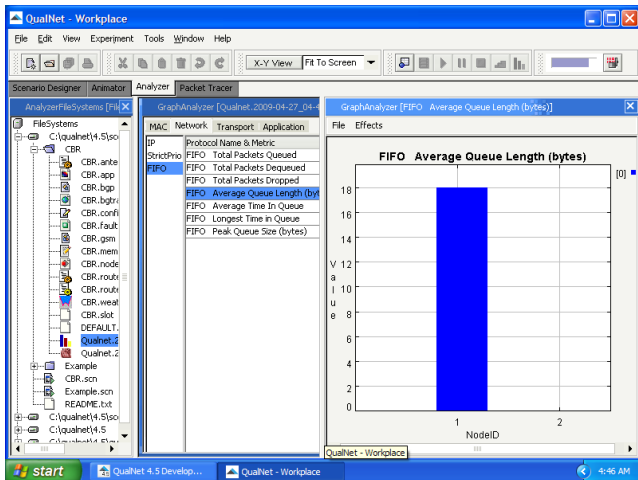
Example 2 (cont'd)

- View the results



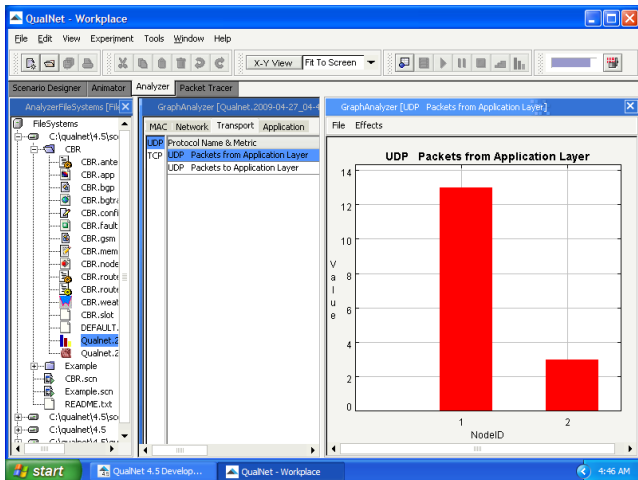
Example 2 (cont'd)

- View the results



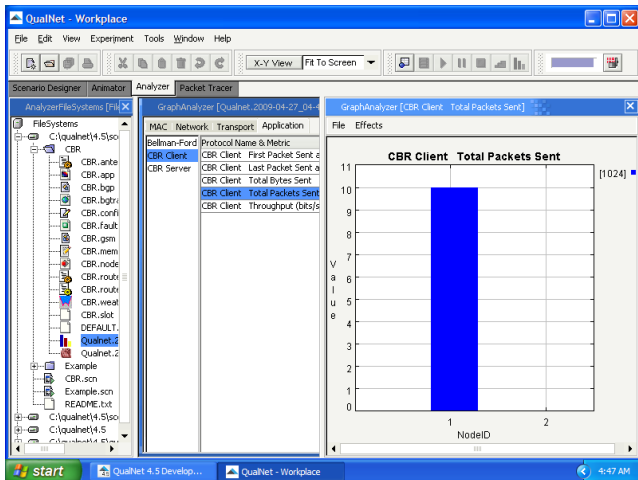
Example 2 (cont'd)

- View the results



Example 2 (cont'd)

- View the results



Example 2 (cont'd)

- Transmitted packets

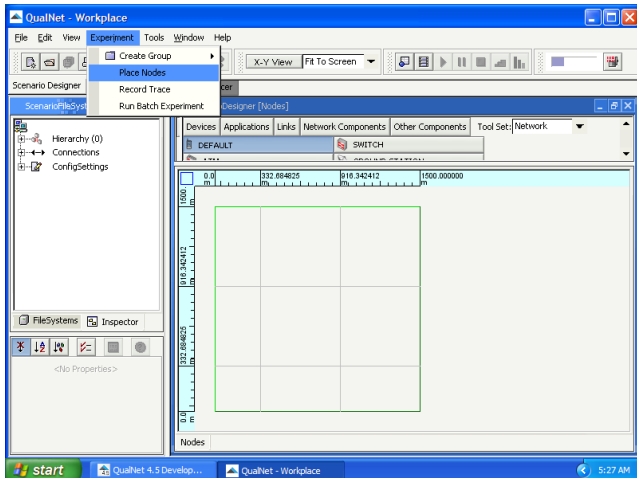
The screenshot shows the QualNet - Workplace interface with the Packet Tracer window active. The Packet Tracer window displays a list of transmitted packets with the following columns: Serial, Type, Check, Tracing Node, Tracing Pr..., Sim. Time, Originating..., Message S..., Originating..., and Action.

Serial	Type	Check	Tracing Node	Tracing Pr...	Sim. Time	Originating...	Message S...	Originating...	Action
1	CBR		1	CBR	0.0	1	0	CBR	SEND
2	UDP		1	UDP	0.0	1	0	CBR	SEND
3	IPv4		1	IPv4	0.0	1	0	CBR	SEND
4	IPv4		1	IPv4	0.0	1	0	CBR	ENQUEUE
5	IPv4		1	IPv4	0.0	1	0	CBR	DEQUEUE
6	BELLMANF...		1	BELLMANF...	0.0	1	0	BELLMANF...	SEND
7	BELLMANF...		2	BELLMANF...	0.0	2	0	BELLMANF...	SEND
8	IPv4		2	IPv4	0.003272	1	0	CBR	RCV
9	UDP		2	UDP	0.003272	1	0	CBR	RCV
10	CBR		2	CBR	0.003273	1	0	CBR	RCV
11	UDP		2	UDP	0.053704...	2	0	BELLMANF...	SEND
12	IPv4		2	IPv4	0.053704...	2	0	BELLMANF...	SEND
13	IPv4		2	IPv4	0.053704...	2	0	BELLMANF...	ENQUEUE
14	IPv4		2	IPv4	0.053704...	2	0	BELLMANF...	DEQUEUE
15	IPv4		1	IPv4	0.055040...	2	0	BELLMANF...	RCV
16	UDP		1	UDP	0.055040...	2	0	BELLMANF...	RCV
17	BELLMANF...		1	BELLMANF...	0.055041...	2	0	BELLMANF...	RCV
18	UDP		1	UDP	0.149668...	1	1	BELLMANF...	SEND
19	IPv4		1	IPv4	0.149668...	1	1	BELLMANF...	SEND
20	IPv4		1	IPv4	0.149668...	1	1	BELLMANF...	ENQUEUE

Outline

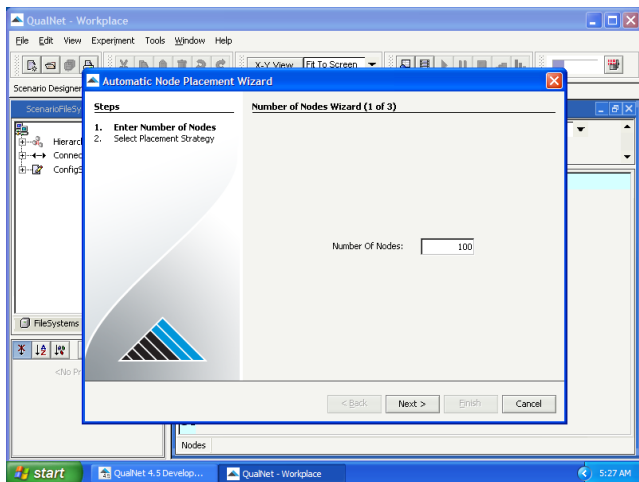
- 1 Introduction
- 2 Installation of QualNet 4.5.1
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- 6 Large networks**
- 7 Sample scenarios
- 8 Installation of QualNet 7.1

- Automatic node placement



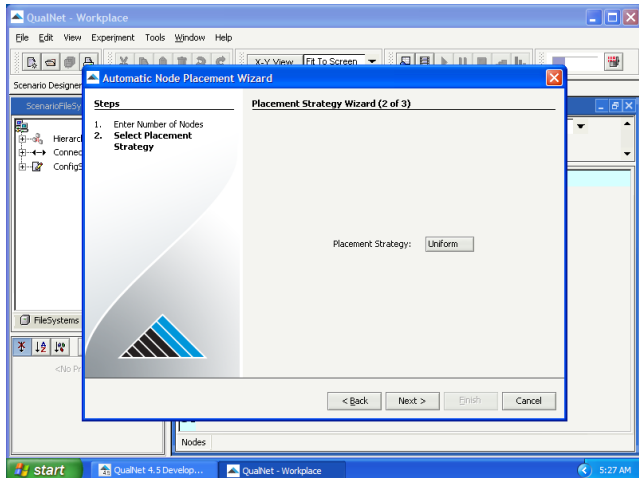
Large Networks (cont'd)

- Number of nodes



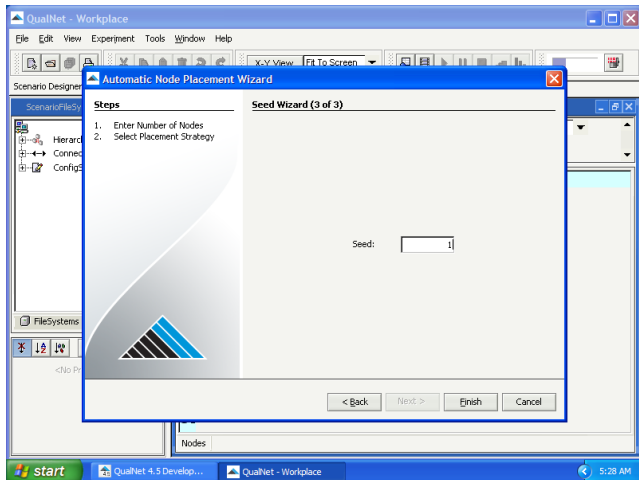
Large Networks (cont'd)

- Placement strategy = uniform



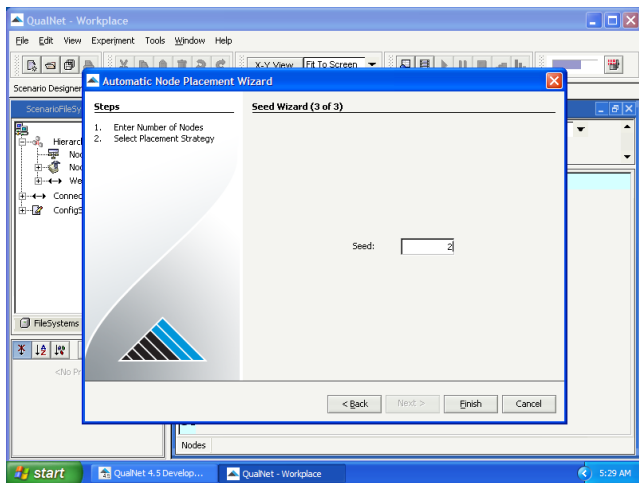
Large Networks (cont'd)

- **Seed** – an integer used to set the starting point for generating a series of random numbers



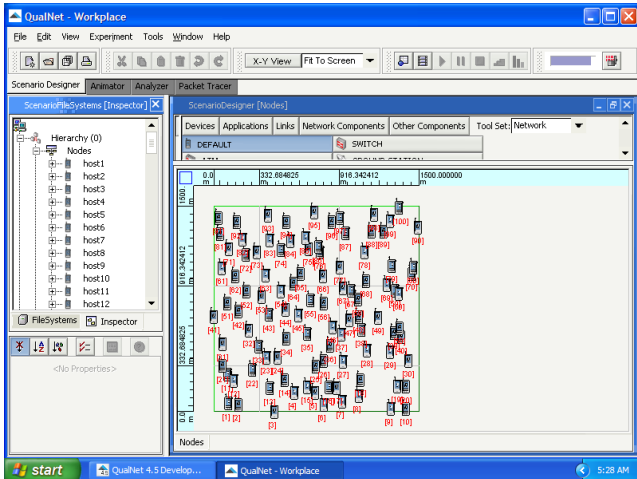
Large Networks (cont'd)

- Another seed value



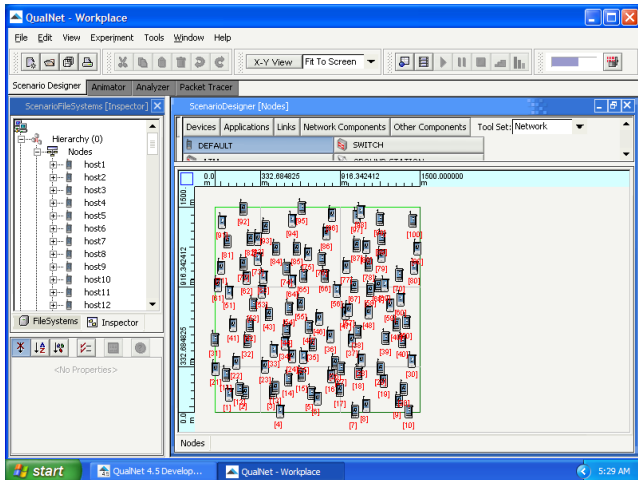
Large Networks (cont'd)

- Uniform, seed = 1



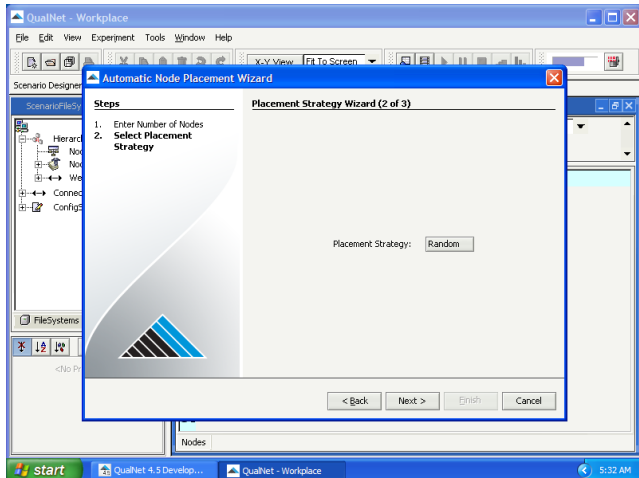
Large Networks (cont'd)

- Uniform, seed = 2



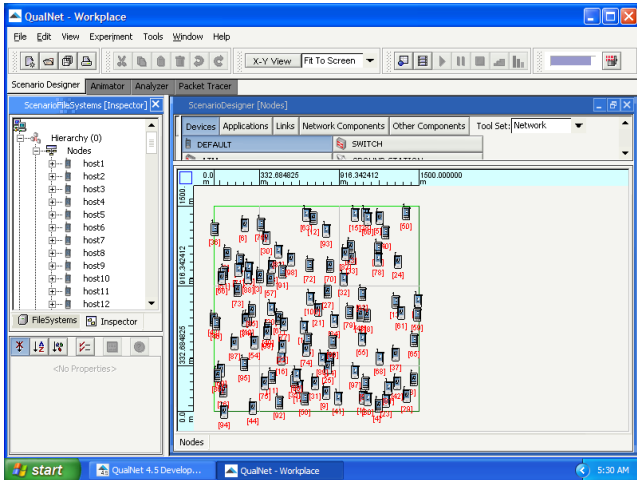
Large Networks (cont'd)

- Placement strategy = random



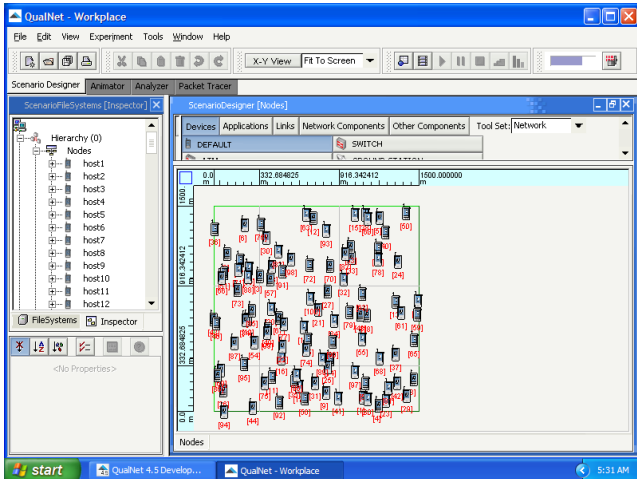
Large Networks (cont'd)

- Random, seed = 3



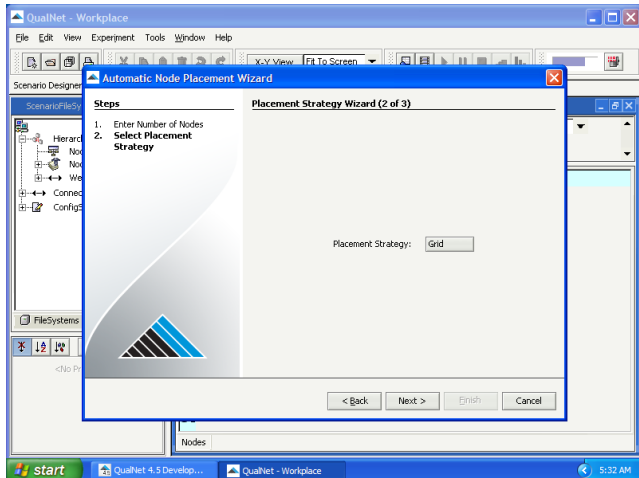
Large Networks (cont'd)

- Random, seed = 3



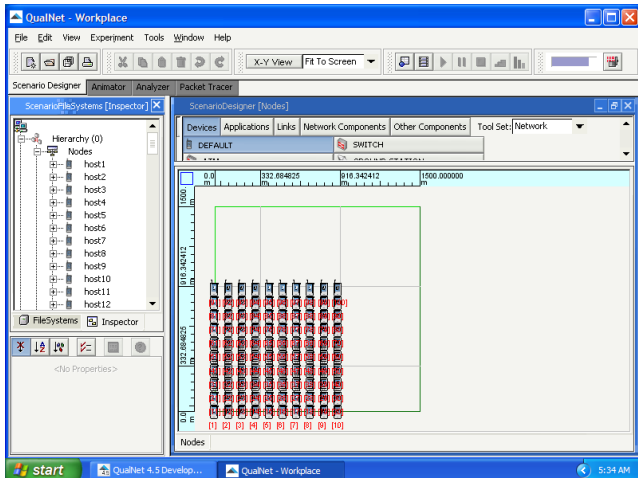
Large Networks (cont'd)

- Placement strategy = grid



Large Networks (cont'd)

- Nodes = 100, step = 100 m

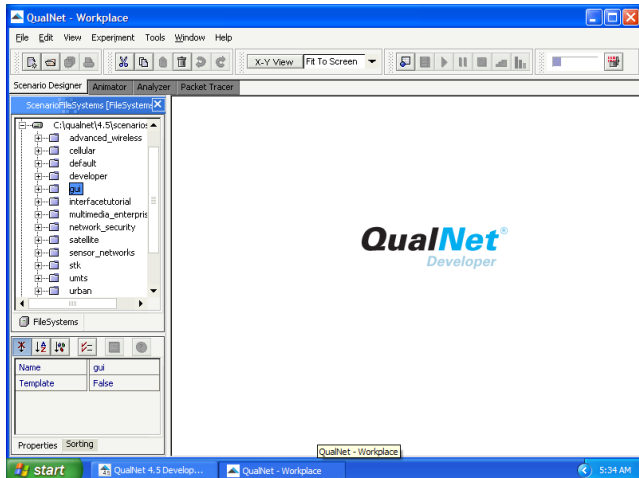


Outline

- 1 Introduction
- 2 Installation of QualNet 4.5.1
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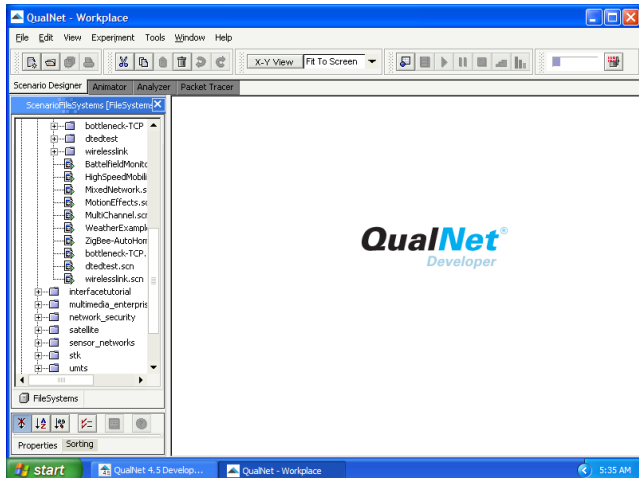
Sample Scenarios

- QualNet includes a number of ready to use sample scenarios



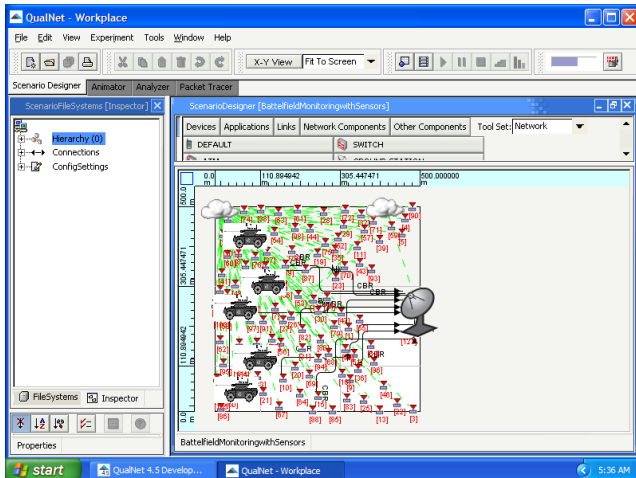
Sample Scenarios (cont'd)

- Some features may require purchasing additional licenses



Sample Scenarios (cont'd)

- **Battelfield Monitoring with Sensors:** scenario



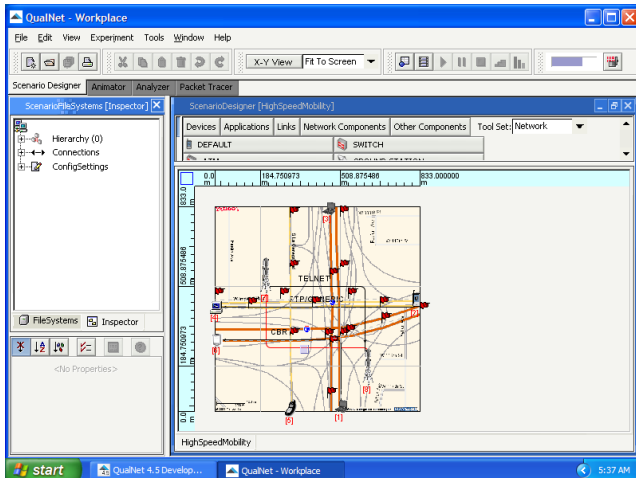
Sample Scenarios (cont'd)

- Battelfield Monitoring with Sensors: animation

The screenshot displays the QualNet - Workplace interface. The main window is titled "Animator Window [BattelfieldMonitoringwithSensors(run_1)[Interactive]]". It shows a 2D plot of a battlefield with various nodes and sensors. The plot includes a coordinate system with X and Y axes ranging from 0.0 to 500.0 meters. A central node is labeled (1,1). Other nodes are labeled with coordinates such as (2,1), (3,1), (4,1), (5,1), (6,1), (7,1), (8,1), (9,1), (10,1), (11,1), (12,1), (13,1), (14,1), (15,1), (16,1), (17,1), (18,1), (19,1), (20,1), (21,1), (22,1), (23,1), (24,1), (25,1), (26,1), (27,1), (28,1), (29,1), (30,1), (31,1), (32,1), (33,1), (34,1), (35,1), (36,1), (37,1), (38,1), (39,1), (40,1), (41,1), (42,1), (43,1), (44,1), (45,1), (46,1), (47,1), (48,1), (49,1), (50,1), (51,1), (52,1), (53,1), (54,1), (55,1), (56,1), (57,1), (58,1), (59,1), (60,1), (61,1), (62,1), (63,1), (64,1), (65,1), (66,1), (67,1), (68,1), (69,1), (70,1), (71,1), (72,1), (73,1), (74,1), (75,1), (76,1), (77,1), (78,1), (79,1), (80,1), (81,1), (82,1), (83,1), (84,1), (85,1), (86,1), (87,1), (88,1), (89,1), (90,1), (91,1), (92,1), (93,1), (94,1), (95,1), (96,1), (97,1), (98,1), (99,1), (100,1). The plot also shows a network of nodes connected by lines, and a sensor icon labeled (1,1) with a range indicator. The interface includes a menu bar (File, Edit, View, Experiment, Tools, Window, Help), a toolbar, and several panels: Execution Window, Animator Window, Output Window, and Animation Filters. The Output Window shows the current simulation time as 0.000000000 seconds and real time as 0 seconds. The Animation Filters panel shows the "Node Mobil" layer selected.

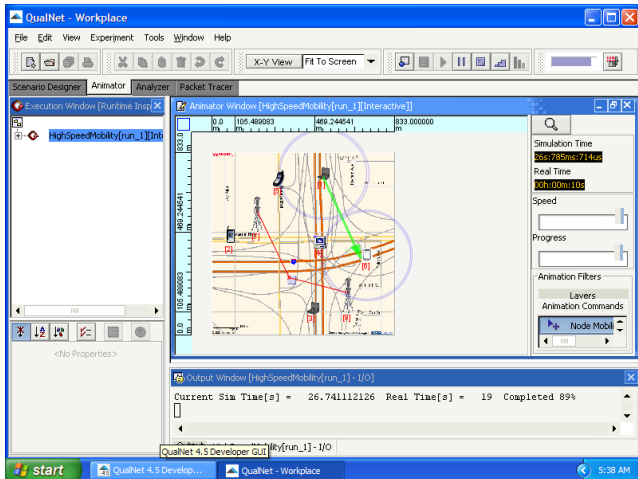
Sample Scenarios (cont'd)

- **High-Speed Mobility:** scenario



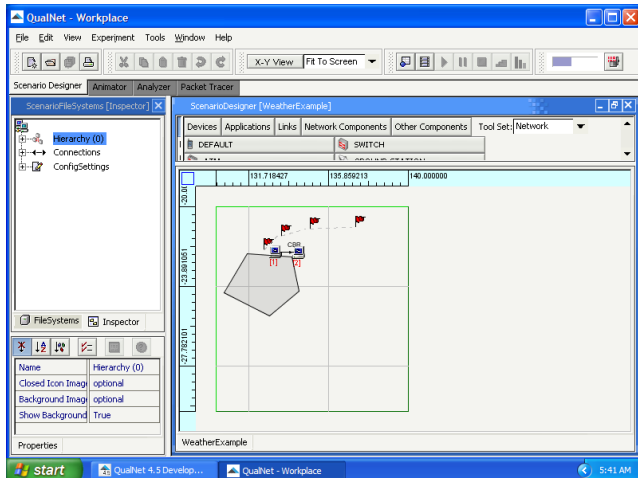
Sample Scenarios (cont'd)

- High-Speed Mobility: animation



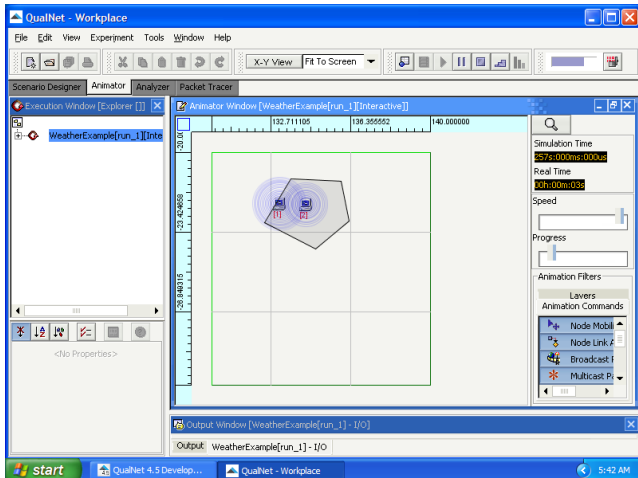
Sample Scenarios (cont'd)

- Weather Example: scenario



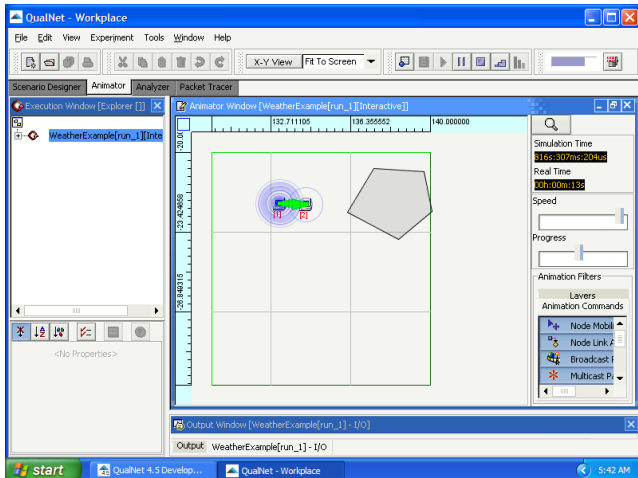
Sample Scenarios (cont'd)

- Weather Example: animation



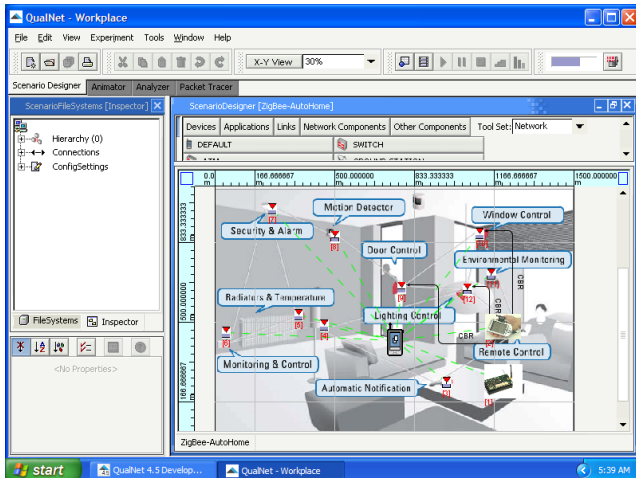
Sample Scenarios (cont'd)

- Weather Example: animation



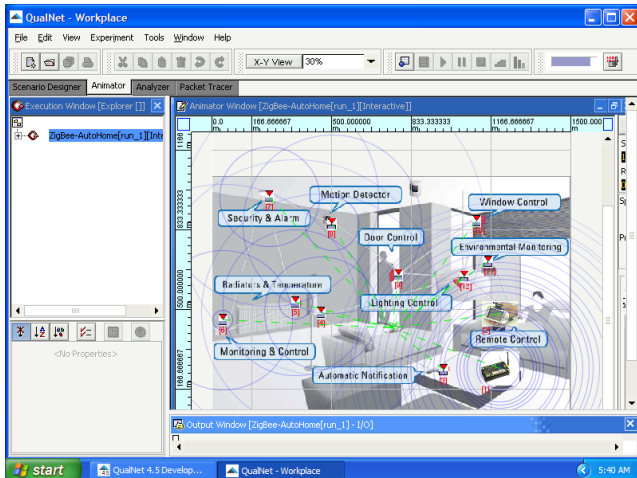
Sample Scenarios (cont'd)

- ZigBee Auto Home: scenario



Sample Scenarios (cont'd)

- ZigBee Auto Home: animation



Outline

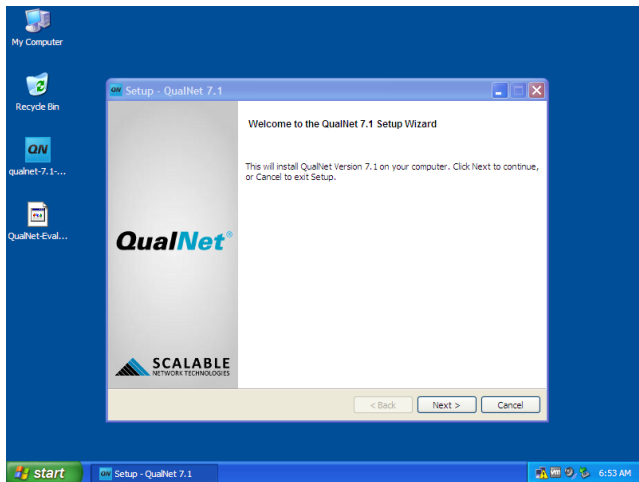
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Installation of QualNet 7.1

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

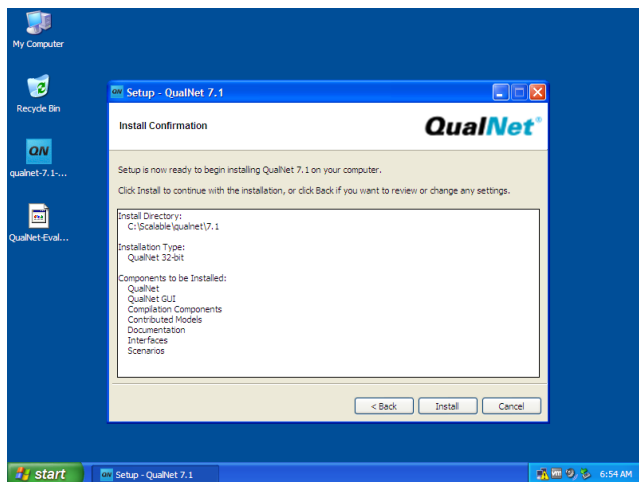
Installation of QualNet 7.1 (cont'd)

- Install **QualNet 7.1**
 - qualnet-7_1-windows-installer.exe



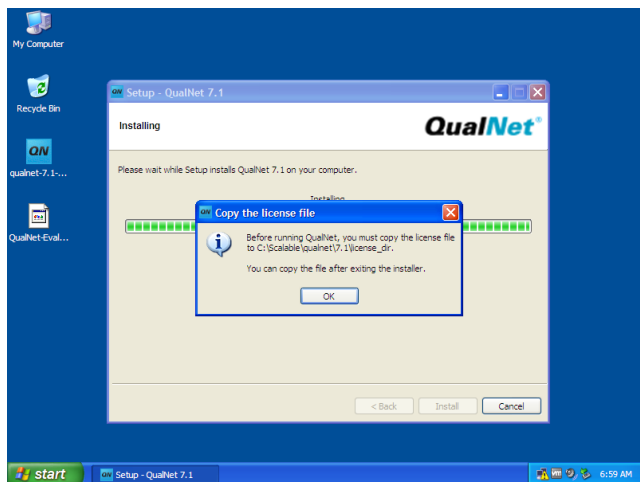
Installation of QualNet 7.1 (cont'd)

- Components to be installed



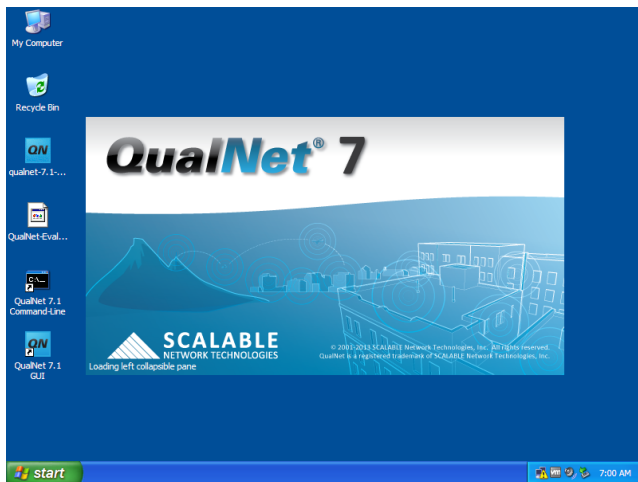
Installation of QualNet 7.1 (cont'd)

- Copy license file



Installation of QualNet 7.1 (cont'd)

- Done!



Installation of QualNet 7.1 (cont'd)

- QualNet 7.1 workspace

