



Model Libraries for **QualNet**[®] & *EXata*[®]

Model Libraries for QualNet and EXata greatly extend the base capabilities of the software. From supporting specialized networks, such as WiFi, sensor networks, cellular, MANET, WiMAX, and satellite, to enabling software-in-the-loop, Model Libraries add significant capabilities to QualNet Developer and EXata.

The Model Libraries consist of the following:

- **Developer Library**, included with QualNet Developer and EXata, for modeling a large variety of networks, including WANs, LANs, IPv6, abstract satellite, etc.,
- **Wireless Library**, included with QualNet Developer and EXata, for 802.11a/b/g and mobile ad-hoc networks,
- **Multimedia and Enterprise Library**, included with QualNet Developer and EXata, for modeling VoIP, queuing, scheduling, MPLS, and other Quality of Service capabilities,
- **Advanced Wireless Library** for Fixed and Mobile WiMAX, based on IEEE 802.16d and 802.16e standards, respectively,
- **Cellular Library** for modeling GSM cellular networks,
- **Network Security Library** for modeling networks with encryption, authentication, security keys, certificates, as well as attackers and eavesdroppers,
- **Military Radios Library**† for Link-11, Link-16, surrogate JTRS (WNW) radios, and other standards and models,
- **Propagation Library: ALE/ASAPS**† for modeling HF radio MAC and propagation effects,
- **Propagation Library: TIREM**† for terrain and propagation effects based on the Terrain Integrated Rough Earth Model,
- **Propagation Library: Urban** for urban pathloss and terrain effects,
- **Standard Interfaces Library** for integrating QualNet to a number of complimentary simulators such as SAF and CGF via HLA or DIS.
- **Satellite Library** for satellite and ground station communication,
- **Sensor Networks Library** for IEEE 802.15.4 (ZigBee) and sensor networks, and

Key Capabilities of Model Libraries

- Detailed wireless models including signal-to-noise interference, path loss, terrain, modulation, mobility, and antennas
- Mobile ad-hoc network models enable modeling of existing network infrastructure from every major program, legacy or future, and protocol/device standard
- Terrain models including TIREM, DTED, and DEM mean QualNet is able to source terrain from most COTS vendors including indoor, urban, suburban, and forested.
- Detailed models with parameters such as signal power levels, data rates, routing protocols, antenna weighting, link scheduling, and scalability enable identification and correction of weak performance in specific network components
- Quality of Service modeling capabilities for multimedia and mission-critical applications enables incremental “what if” scenario testing to identify conditions that threaten service level performance
- Models for sensor networks, urban terrain, and directional antennas support new network-centric war doctrines by matching conditions in specific battle fronts
- Models are provided in source code for customized solutions
- **UMTS Library** for for third Generation (3G) mobile broadband networks.

† These libraries are subject to export restriction under the International Traffic in Arms Regulations (ITAR) 22 CFR 120-130. International sales of these modules require authorization from the US Department of State.

QualNet Model Libraries By Layer (part 1 of 3)

	Application Protocols	QoS Protocols	Transport Protocols	Queueing and Scheduling	Network Protocols	Routing Protocols	
Developer Library (included with QualNet & EXata)	<ul style="list-style-type: none"> ✓ CBR ✓✓ FTP / Generic ✓✓ HTTP ✓ LOOKUP MCBR ○✓ Ping ✓ Super Application ○✓ SNMP ✓ TcpIib ✓ FTP ✓✓ Telnet ○✓ Traceroute Traffic-Gen <i>updated</i> ✓ Traffic-Trace ✓ VBR 		<ul style="list-style-type: none"> Abstract TCP ✓✓ TCP ✓ TCP Dump ✓ TCP Variants ✓ Lite ✓ New Reno ✓ Reno ✓ SACK ✓ Tahoe ✓✓ UDP 	<ul style="list-style-type: none"> CBQ ✓ FIFO RED RIO Round Robin SCFQ ✓ Strict Priority WFQ WRED WRR 	<ul style="list-style-type: none"> ✓ ARP <i>updated</i> ATM IP over ATM Dual-IP Stack <i>new</i> ✓ HDP ✓ ICMP ✓ ICMPv6 IPsec <i>updated</i> ✓ IPv4 <i>updated</i> ✓ IPv6 <i>updated</i> 	<ul style="list-style-type: none"> Bellman-Ford RIP v1 ✓ v2 <i>updated</i> ✓ ng ✓ Static Routing <i>updated</i> 	
Multimedia & Enterprise Library (included with QualNet & EXata)	<ul style="list-style-type: none"> VoIP H225 H323 SIP 	<ul style="list-style-type: none"> DiffServ <i>updated</i> Per Hop Behavior MPLS <i>updated</i> LDP RSVP-TE 	<ul style="list-style-type: none"> VoIP RTCP <i>updated</i> RTP <i>updated</i> 			<ul style="list-style-type: none"> BGP v4 ✓ BGP v6 (MBGP) <i>new</i> EIGRP HSRP IGRP ✓ OSPF v2 <i>updated</i> 	<ul style="list-style-type: none"> ✓ OSPF v3 Policy Based Routing QOSPF Router Access Lists Route Map
Wireless Library (included with QualNet & EXata)						<ul style="list-style-type: none"> ✓ AODV BRP DSR ✓ DYMO Fisheye IARP IERP LANMAR LAR1 Mobile IPv4 ✓✓ OLSR INRIA ✓ OLSRv2 <i>updated</i> STAR ZRP 	
Advanced Wireless Library				<ul style="list-style-type: none"> UGS ertPS rtPS nrtPS BE 			
Sensor Networks Library							
Military Radios Library †	<ul style="list-style-type: none"> MGEN† PDEF† <i>updated</i> SDF† <i>updated</i> Threaded Comms† 				<ul style="list-style-type: none"> Link-16 and IP Gateway† <i>new</i> 		
Cellular Library	GSM Cellular				<ul style="list-style-type: none"> Abstract Layer 3 Cellular <i>updated</i> GSM Layer 3 <i>updated</i> 		
UMTS Library	<ul style="list-style-type: none"> UMTS Voice Call <i>new</i> All IP Applications in QualNet & EXata <i>new</i> 			<ul style="list-style-type: none"> Conversational <i>new</i> Streaming <i>new</i> Interactive <i>new</i> Background <i>new</i> 	<ul style="list-style-type: none"> UMTS Layer 3 <i>new</i> Connection Mgmt GMM/MM <i>new</i> GTP <i>new</i> NBAP <i>new</i> RANAP <i>new</i> RRC <i>new</i> 		
Network Security Library					<ul style="list-style-type: none"> ISAKMP <i>new</i> WTLS Certificate <i>new</i> 	<ul style="list-style-type: none"> Secure & Anonymous Routing <i>new</i> 	

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✓ IPv6 compliant ✓ Emulation quality models ○ EXata only models *new* for QualNet version 4.5 *updated* for QualNet version 4.5

QualNet Model Libraries By Layer (part 2 of 3)

	Multicast Protocols	MAC Protocols	Physical Models	Modulation Schemes	Propagation Models	Mobility Models	Device Models	Terrain Models
Developer Library <small>(included with QualNet & EXata)</small>	IGMP ✓ Static Multicast updated	✓ 802.3 / Wired Bus ✓ Gigabit Ethernet Abstract Satellite ATM Faults LLC new Wired Point-to-Point Link Wireless Point-to-Point Link						
Multimedia & Enterprise Library <small>(included with QualNet & EXata)</small>	DVMRP MOSPF PIM-DM PIM-SM	✓ Detailed Switch ✓ GARP ✓ GVRP ✓ Spanning Tree ✓ VLAN ✓ Switched Ethernet					Routers Switches	
Wireless Library <small>(included with QualNet & EXata)</small>	ODMRP	✓ 802.11 updated ✓ 802.11e 802.11s (Mesh) new Aloha ✓ CSMA Generic MAC ✓ MACA TDMA	802.11a/g 802.11b Abstract PHY Antenna Models NMSA Omnidirectional Open ASCII Directional Steerable Beam Switched Beam Patterned Battery Model new Microwave Link Radio Energy Consumption new	BPSK BPSK Turbo CCK DPSK DPSK Turbo DQPSK Forward Error Correction FSK FSK-Golay GMSK QAM QAM-Convolution	Pathloss 2-Ray Free Space Path Loss Matrix Fading Fast Rayleigh Rayleigh Ricean ITM Lognormal Shadowing Weather	Group Mobility Pedestrian Mobility Random Waypoint File-based Mobility Dead Reckoning new		1-degree DEM Cartesian DTED Urban Terrain Format
Advanced Wireless Library		802.16d updated 802.16e updated	802.16d updated 802.16e (OFDMA) updated					
Sensor Networks Library		802.15.4 (Zigbee) new	802.15.4 (Zigbee) TI CC2420 new					
Military Radios Library †		EPLRS† FCSC, FCSC CSMA † Link-11† Link-16† updated SINCGARS†	Surrogate JTRS (WNW) Radio† new WNW PHY characteristics† new USAP MAC† new					CTDB 7† CTDB 8†
Cellular Library		GSM	GSM			User Behavior updated		
UMTS Library		UMTS Layer 2 new RLC new MAC new	UMTS PHY (WCDMA) new HSDPA new				UE new Node B new RNC new SGSN new GGSN new HLR new	
Network Security Library		CCMP new Eavesdropper Adversary new Secure Neighbor new WEP new Wormhole Adversary new						

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		QoS Capabilities	MAC Capabilities	Physical Capabilities	Device Capabilities	Propagation Models	Interfaces / Application Protocols
Satellite Library ✓ : IPv6 Compliant		Dynamic Forward Signaling Rate Dynamic Return Signaling Rate Filtered Bandwidth Limiting Strict Traffic Bandwidth Limiting	Multiple Return Links per Forward Link Ranging Overhead Support Request-grant Scheduler Send When Ready	✓ Configurable Reed-Soloman Viterbi updated Threshold-based Packet Reception	Processor Payload Gateway-based Services Multi-beam Satellite	Abstract Propagation Free-space Propagation	
Standard Interfaces Library							DIS HLA
Propagation Libraries Each sold separately: Urban		ALE/ASAPS †	ALE †	ALE †		ASAPS	
		TIREM †				TIREM †	
						Suburban Urban COST231-Hata COST231-WI Lee's Street Microcell Model updated Okumura-Hata Street Mobile to Mobile updated	
Sensor Networks Library			802.15.4 (Zigbee) MAC new	802.15.4 (Zigbee) PHY (CC2420) new			

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QualNet Model Libraries Alphabetized

Model Name	Explanation	Library
2-Ray Pathloss	2-Ray Pathloss Propagation Model	Wireless
802.11 a/g OFDM	802.11 a/g Orthogonal Frequency Division Multiplexing	Wireless
802.11 DCF	802.11 Distributed Coordination Function Medium Access Control Protocol	Wireless
802.11 PCF, 802.11b	802.11 Point Coordinated Function Medium Access Control Protocol, 802.11b Physical Model	Wireless
802.11a/g	802.11a/g Physical Model	Wireless
802.11e EDCA	QoS Extension to 802.11 MAC - Enhanced Distributed Channel Access	Wireless
802.11e HCCA	Hybrid Coordination Function Controlled Channel Access MAC Protocol	Wireless
802.11s (Mesh)	802.11 s MAC Model	Wireless
802.15.4 (Zigbee) PHY (CC2420)	802.15.4 Physical Model for CC2420 RF Transceiver	Sensor Networks
802.15.4 (Zigbee) MAC	802.15.4 MAC Model	Sensor Networks
802.16, 802.16e MAC	802.16 MAC for fixed broadband wireless, 802.16 MAC extensions for mobile broadband wireless	Advanced Wireless
802.16, 802.16e OFDMA PHY	The OFDMA PHY model of 802.16, OFDMA PHY extensions for 802.16e	Advanced Wireless
802.3 / Wired Bus	802.3 / Wired Bus Medium Access Control Protocol	Developer
Abstract Layer 3	Abstract Network Model	Cellular
Abstract PHY	Abstract Physical Model	Wireless
Abstract Satellite	Abstract Satellite Physical Model	Developer

Model Name	Explanation	Library
Abstract TCP	Abstract Transmission Control Protocol Application Protocol	Developer
ALE	Automatic Link Establishment Medium Access Control and Physical Model	Propagation: ALE/ASAPS
Aloha	Aloha Medium Access Control Protocol	Wireless
AODV	Ad-hoc On-demand Distance Vector Routing Protocol	Wireless
ARP	Address Resolution Protocol	Developer
ASAPS	Advanced Stand Alone Prediction Service Propagation Model	Propagation: ALE/ASAPS
ATM	Asynchronous Transfer Mode Multi-layer Model	Developer
Battery Model	Battery Physical Model	Wireless
Bellman-Ford	Bellman-Ford Routing Protocol	Developer
BGP v4	Border Gateway Protocol Routing Protocol	Multimedia & Enterprise
BGP v6 (MBGP)	Multiprotocol Border Gateway Protocol Routing Protocol	Multimedia & Enterprise
BPSK, BPSK Turbo	Binary Phase-shift Keying Modulation Scheme for 802.11a/g and 802.16 with and without Turbo Coding	Wireless
BRRP	Bordercast Resolution Protocol Routing Protocol	Wireless
Cartesian	Cartesian Terrain Model	Wireless
CBQ	Class Based Queueing Model	Developer
CBR	Constant Bit Rate Traffic Generator	Developer
CCK	Complementary Code Keying Modulation Scheme for 802.11b	Wireless
CCMP	Counter Mode with Cipher Block Chaining Message Authentication Code MAC Protocol	Network Security
COST231-Hata	COST-231 Hata Propagation Model	Propagation: Urban
COST231-WI	COST-231 WI Propagation Model	Propagation: Urban
CSMA	Carrier Sense Multiple Access Medium Access Control Protocol	Wireless
CTDB 7, 8	Compact Terrain Database 7, 8 Model	Military Radios
Dead Reckoning	Dead Reckoning Mobility Model	Wireless
DEM	1-degree Digital Elevation Model Terrain Model	Wireless
Detailed Switch	Detailed Layer 2 Switch Model	Multimedia & Enterprise
DiffServ	Differentiated Services Quality of Service Protocol	Multimedia & Enterprise
Directional	Directional Antenna Physical Model	Wireless
DIS	Distributed Interactive Simulation Framework	Standard Interfaces
DPSK	Differential Phase-Shift Keying Modulation Scheme for 802.11b	Wireless
DPSK Turbo	Differential Phase-Shift Keying Modulation Scheme with Turbo Coding for 802.11b	Wireless
DQPSK	Differentially Encoded Binary Phase-shift Keying Modulation Scheme for 802.11b	Wireless
DSR	Dynamic Source Routing Protocol	Wireless
DSSS	Direct Sequence Spread Spectrum Physical Model	Wireless
DTED	Digital Terrain Elevation Data	Wireless
Dual-IP Stack Support	Dual-IP (IPv4, IPv6) Stack Network Protocol	Developer
DVMRP	Distance Vector Multicast Routing Protocol	Multimedia & Enterprise
DYMO	Dynamic MANET On-demand Routing Protocol	Wireless
Eavesdropper Adversary Model	Eavesdropper Adversary Model	Network Security
EIGRP	Enhanced Interior Gateway Routing Protocol	Multimedia & Enterprise
EPLRS	Enhanced Position Location Reporting System Radio	Military Radios
Fast Rayleigh Fading	Fast Rayleigh Fading Propagation Model	Wireless
Faults	Enable/Disable Interfaces or Nodes	Developer
FIFO	First In First Out Queueing and Scheduling Model	Developer
Fisheye	Fisheye Routing Protocol	Wireless
Forward Error Correction	Forward Error Correction for Modulation Schemes	Wireless
Free Space Pathloss	Free Space Pathloss Propagation Model	Wireless
FSK, FSK-Golay	Frequency Shift Keying Modulation Scheme with and without Golay	Wireless
FTP, FTP/Generic	File Transfer Protocol Application Protocol, Generic FTP Application Protocol	Developer
GARP	Generic Attribute Registration Protocol for switch	Multimedia & Enterprise
Generic MAC	Generic Medium Access Control Protocol	Wireless
Gigabit Ethernet	Gigabit Ethernet Medium Access Control Protocol	Developer
GMSK	Gaussian Minimum Shift Keying Modulation Scheme for Cellular GSM	Wireless
Group Mobility	Group Mobility Model	Wireless
GSM	Global System for Mobile communication MAC Protocol	Cellular
GVRP	GARP VLAN Registration Protocol for switch	Multimedia & Enterprise
H225 VoIP	A key protocol for Voice Over Internet Protocol	Multimedia & Enterprise
H323 VoIP	A key protocol in the H.323 architecture for Voice Over Internet Protocol	Multimedia & Enterprise
HDP	Hierarchical Distributed Protocol	Developer
HLA	High Level Architecture Simulation Framework	Standard Interfaces
HSRP	Hot Standby Router Protocol	Multimedia & Enterprise
HTTP	HyperText Transfer Protocol Application Protocol	Developer
IARP	Intrazone Routing Protocol	Wireless
ICMP	Internet Control Message Protocol	Developer
ICMPv6	Internet Control Message Protocol for IPv6	Developer
IERP	Interzone Routing Protocol	Wireless
IGMP	Internet Group Management Protocol	Developer
IGRP	Interior Gateway Routing Protocol	Multimedia & Enterprise
IP over ATM	Internet Protocol over Asynchronous Transfer Mode Network Model	Developer
IPSec	Internet Protocol Security	Developer
IPv4	Internet Protocol Version 4 Network Protocol	Developer
IPv6	Internet Protocol Version 6 Network Protocol	Developer
ISAKMP	Internet Security Association and Key Management Network Protocol	Network Security
ITM	Irregular Terrain Model Propagation Model	Wireless
LANMAR	Landmark Routing Protocol	Wireless
LAR1	Location-Aided Routing Protocol	Wireless
Lee's Street Microcell Model	Lee's Street Microcell Model Propagation Model	Propagation: Urban
Link-11	Link-11 Military Radio Model	Military Radios
Link-16	Link-16 Military Radio Model	Military Radios
Link-16 & IP Gateway	Gateway to link Link-16 Radios with IP Networks	Military Radios
LLC	Logical Link Control MAC Model	Developer
Lognormal Shadowing	Lognormal Shadowing Propagation Model	Wireless
LOOKUP	LOOKUP Application Protocol	Developer
MACA	Medium Access Collision Avoid Medium Access Control Protocol	Wireless

Model Name	Explanation	Library
MCBR	Multicast Constant Bit Rate Traffic Generator	Developer
MGEN	Multi-Generator Toolset by US Naval Research Laboratory	Military Radios
Microwave Link	Microwave Link Physical Model	Wireless
Mobile IPv4	IP Mobility Support	Wireless
MOSPF	Multicast Open Shortest Path First Multicast Protocol	Multimedia & Enterprise
MPLS:LDP	Label Distribution Protocol for Multiprotocol Label Switching	Multimedia & Enterprise
MPLS:RSVP-TE	Resource Reservation Protocol with Traffic Engineering extensions for Multiprotocol Label Switching	Multimedia & Enterprise
NMSA	NMSA Antenna Physical Model	Wireless
ODMRP	On-Demand Multicast Routing Protocol	Wireless
OLSR Inria	Optimized Link State Routing Protocol ported from INRIA implementation	Wireless
OLSRv2	Optimized Link State Routing Protocol version 2	Wireless
Omnidirectional	Omnidirectional Antenna Model	Wireless
Open ASCII	Open ASCII Antenna Model	Wireless
OSPF v2	Open Shortest Path First Routing Protocol Version 2	Multimedia & Enterprise
OSPF v3	Open Shortest Path First Routing Protocol Version 3	Multimedia & Enterprise
Path Loss Matrix	Path Loss Matrix Propagation Model	Wireless
PDEF	Platform Description Files Simulation Framework	Military Radios
Pedestrian Mobility	Pedestrian Mobility Model	Wireless
Per Hop Behavior	Per Hop Behavior Quality of Service Protocol	Multimedia & Enterprise
PIM-DM, PIM-SM	Protocol-Independent Multicast Protocol: Dense Mode and Sparse Mode	Multimedia & Enterprise
Policy Based Routing	Policy Based Routing Protocol	Multimedia & Enterprise
QAM	Quadrature Amplitude Modulation Scheme	Wireless
QAM-Convolution	Quadrature Amplitude Modulation Scheme with Convolution	Wireless
QOSPF	Quality of Service Extensions to OSPF Routing Protocol	Multimedia & Enterprise
QualNet Building Format	QualNet Building Format Urban Terrain Model	Wireless
Radio Energy Consumption	Radio Energy Consumption Physical Model	Wireless
Random Waypoint	Random Waypoint Mobility Model	Wireless
Rayleigh Fading	Rayleigh Fading Propagation Model	Wireless
RED	Random Early Detection Queueing Model	Developer
Ricean Fading	Ricean Fading Propagation Model	Wireless
RIO	Random Early Detection In/Out Queueing Model	Developer
RIP ng	Routing Information Protocol - next generation	Developer
RIP v1, v2	Routing Information Protocol Routing Protocol versions 1 and 2	Developer
Round Robin	Round Robin Scheduling Model	Developer
Route Map	Route Map	Multimedia & Enterprise
Router Access Lists	Router Access Lists	Multimedia & Enterprise
Routers	Router Device Model	Multimedia & Enterprise
RTCP VoIP	RTP Control Protocol for Voice Over Internet Protocol	Multimedia & Enterprise
RTP VoIP	Real-Time Transport Protocol for Voice Over Internet Protocol	Multimedia & Enterprise
Satellite	Satellite Model	Satellite
SCFQ	Self-clocked Fair Queueing Model	Developer
SDF	Simulation Description Files Simulation Framework	Military Radios
Secure & Anonymous Routing	Secure and Anonymous Routing Protocol	Network Security
Secure Neighbor	Secure Neighbor MAC Model	Network Security
SINCGARS	Single Channel Ground and Airborne Radio System Model	Military Radios
SIP	Session Initiation Protocol for Voice Over Internet Protocol	Multimedia & Enterprise
Spanning Tree	Spanning Tree for switch	Multimedia & Enterprise
STAR	Source Tree Adaptive Routing Protocol	Wireless
Static Multicast	Static Multicast Protocol	Developer
Static Routing	Static Routing Protocol	Developer
Steerable Beam	Steerable Beam Directional Antenna Model	Wireless
Strict Priority	Strict Priority Scheduling Model	Developer
Super Application	Super Application Protocol	Developer
Surrogate JTRS (WNW) Radio	Surrogate Joint Tactical Radio System Wideband Network Waveform Radio Model	Military Radios
Switched Beam	Switched Beam Directional Antenna Model	Wireless
Switched Ethernet	Switched Ethernet Medium Access Control Protocol	Multimedia & Enterprise
Switches	Switch Device Model	Multimedia & Enterprise
TCP	Transmission Control Protocol Transport Protocol	Developer
TCP Dump	TCPDump Compatible Trace	Developer
TCP Variants	Lite, New Reno, Reno, SACK, and Tahoe Transmission Control Protocol Variants	Developer
tcplib	A Library of Internetwork Traffic Characteristics	Developer
TDMA	Time Division Multiple Access Medium Access Control Protocol	Wireless
telnet	TELNET Remote Access Protocol	Developer
Threaded Comms	Threaded Communication Model	Military Radios
TIREM	Terrain Integrated Rough Earth Model	Propagation: TIREM
Traffic-Gen	Traffic Generation Application Protocol	Developer
Traffic-Trace	Traffic Trace Application Protocol	Developer
UDP	User Datagram Protocol Transport Protocol	Developer
UMTS	Universal Mobile Telecommunications System Model	UMTS
USAP Radio	Unifying Slot Allocation Protocol Physical Model	Military Radios
User Behavior	User Behavior Mobility Model	Cellular
VBR	Variable Bit Rate Traffic Generator	Developer
VLAN	Virtual LAN Protocol	Multimedia & Enterprise
VoIP	Voice Over Internet Protocol Model	Multimedia & Enterprise
Weather	Weather Effects Propagation Model	Wireless
WEP	Wired Equivalent Privacy MAC Protocol	Network Security
WFQ	Weighted Fair Queueing Model	Developer
Wired, Wireless Point to Point Link	Wired and Wireless Point to Point Link Physical Model	Developer
Wormhole Adversary Model	Wormhole Adversary Model	Network Security
WRED	Weighted Random Early Detection Queueing Model	Developer
WRR	Weighted Round Robin Scheduling Model	Developer
WTLS Certificate	Wireless Transport Layer Security Certificate Protocol	Network Security
ZRP	Zone Routing Protocol	Wireless