INET Framework Evolution

András Varga

OMNeT++ Workshop March 23, 2012 Desenzano, Italy

1

Topics from the last Workshop

Current Status of the INET/INETMANE

The size code continues growing ...



... and the problems are beginning to appear

INET Roadmap

- Release OMNeT++ 4.2
 - includes the "project features" fe
- INET
 - 1.99.0 (released)
 - 1.99.1, 1.99.2, ... -- developmen
 - 2.0.0 stable
 - · still without (many) extensions integ
 - extension-friendly
 2.1.x unstable
 - 2.2.0 -- integrates many extensio

INET Development

A new version of INET is cooking!

"integration" branch on github

- 1. Change in version numbering
- 2. What's been implemented/changed so far
- 3. Modularization of the codebase
- 4. Integration of forks and extensions
- 5. Documenting INET
- 6. Validation / Regression Testing

Validation / Regression Testing

Project Features in the IDE · Needed for credibility Available in the Project · Fingerprints are too fragile Properties dialog Instead: simulation + result evaluation script Shows feature lets the use er **Documentation** Example criteria: features "TCP overall throughput should be between 50kbs and 52kbps "Hosts get a fair share of the throughput, e.g. each within 10% of the average" Dependency h Evaluation script: use GNU R (r-project.org) with the "omnetpp" R package Modifies CDT INET Manual and NED exclu list - concepts, architectural overview onlinear modelling, statistical tests, time series analysis, classification, clustering, etc · the "omnetpp" package provides loadDataset() and other functions - high-level protocol descriptions · loadDataset(): loads vector and scalar files in whole or filtered - useful for newcomers · loaded data can be processed and evaluated using R's capabilitie mostly TBD Neddoc useful as reference OK Cancel

2

What do we want INET to be?

- What should be INET's role and scope?
 - SOLID FOUNDATION for network research
 - well-tested set of standard protocols (IPv4/v6, TCP, UDP, Ethernet, 802.11, ...)
 - **infrastructure** (radio, mobility, configuration, failure/recovery, statistics, cross-layer communication,...)
 - serve as a base for active projects: INETMANET, OverSim, Veins, ...
 - absorp and integrate useful model code from finished or inactive projects, and maintain them as part of INET (e.g. VoIPTool, HttpTools)

What We Need for INET

- 1. Protocols need to be reviewed
 - for correctness and completeness
- 2. Infrastructural features
 - e.g. modularity, failure/recovery, flexible network configuration, battery, obstacles, etc.
- 3. Documentation
- 4. Testing / validation
 - to build confidence in the models
- 5. Animation/visualization capability
- 6. More, and more organized, community participation

What Happened Since Last Time?

ł	1.99.0 (Mar 3, 2011)	revised NED for hosts, routers, NICs; signal-based statistics recording; multi-radio; TCP improvements (e.g. added lwIP); added BGPv4
Ŧ	1.99.1 (May 27, 2011)	introduced Project Features; revised host, router, AP, NIC compound modules; added VoIPTool, xMIPv6
Ŧ	1.99.2 (Nov 18, 2011)	revised UDP; revised mobility models (sync with MiXiM); revised apps parametrization; added HttpTools
+	1.99.3 (Feb 22, 2012)	revised IPv4 (fragmentation, multicast, etc.) and Ethernet; UDP improved; test framework, ChangeLogs
ł	1.99.4 (March 20, 2012)	revised IPv4 multicast routing; added IGMPv2, network configurator for IPv4 (replaces .irt files and FlatNetwork-Configurator)
	•	 For 2.0: revise IPv6; add node failure/recovery, DiffServ
+	2.0	infrastructure, battery, IPv6 network configurator; integrate DHCP, STP; merger with MiXiM (!)
		maybe: revise xMIPv6, OSPF, BGP, MPLS/RSVP/LDP; integrate more contributed components 5

PROTOCOL REVIEWS

Protocol Reviews

Reviewed/extended:

- TCP (review; added SACK; TCP_lwIP, TCP_NSC)
- UDP (bugfixes, refactoring; socket options support; multicast revised)
- IPv4 (bugfixes, refactoring; multicast revised; added IGMP)
- Ethernet (extensive refactoring, bugfixes; 40G/100G Ethernet implemented)



Planned reviews:

- **IPv6**
- IEEE 802.11
- OSPFv2, BGPv4
- MPLS and related protocols



INFRASTRUCTURE

Infrastructure

Available

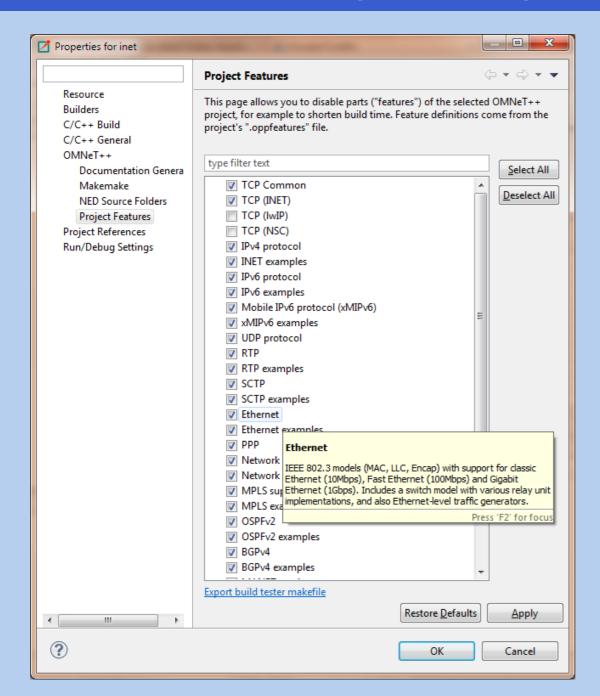
- Modularity*
 - Project Features
- Statistics
 - signal-based statistics recording
- NED refactoring
 - for consistency and extensibility
- Flexible network configuration* (IPv4)
- Multi-radio

Missing (in INET)

- Detailed physical layer modeling (MiXiM)
- Node failure/recovery
- Battery
- Obstacles, etc.



Modularity: Project Features



Currently 39 features:

- 23 protocols
- 16 examples



Flexible Network Configuration

GOAL:

Replace routing files and *FlatNetworkConfigurator* with something better...

• Problem with FlatNetworkConfigurator:

- all-or-nothing
- no subnetting
- per-node addresses instead of per-interface

- ...

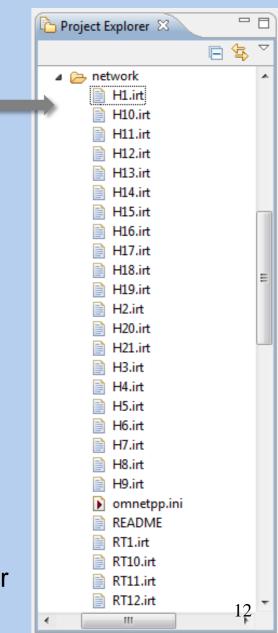
- Problem with routing files
 - (on the next slide)

Flexible Network Configuration

- Problem with routing files (.irt/.mrt):
 - too many of them (one per router/host)
 - contains concrete IP addresses and interface names:

bgrouter3.irt 🕺	UDPSo	cket.h	UDP(ControlInfo	.msg		IPv4Cc
	inet_addr: 1 inet_addr: 1			1: 1200 1: 1200		ric: ric:	-
route: 172.0.0.0 default: routeend.	172.0.2. 172.1.0		255.255 0.0.0.0		G G	0 0	ррр0 ррр1

→like a puzzle! Good luck getting an overview without pen and paper



Flexible Network Configuration

The new network configurator:

- Replaces other configurators AND routing files
- For manual configuration:
 - all configuration input in one file, not in 1000!
 - symbolic names instead IP addresses wherever possible!
 - more intuitive interface selection ("the interface towards "router7" instead of interface name "ppp2")
- For automatic configuration:
 - per-interface addresses, subnetting support, all steps of configuration optional, optimized routing tables,...
- All config in a single XML file

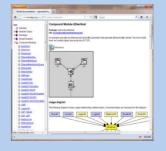


DOCUMENTATION

Documentation

• INET Manual:

- chapters already covered: base architecture, IPv4, Ethernet, PPP, UDP, TCP
- note: source code of components needs to be reviewed before documentation can be written
- help welcome
- NED documentation:
 - some of the models are fairly well documented
 - others have no or inappropriate (copy/pasted) comment block





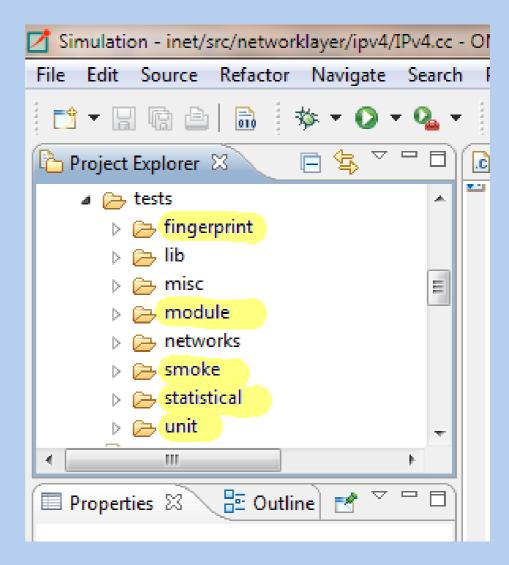


TESTING AND VALIDATION

INET Test Suite

Purpose: to create and maintain confidence in the models ONE KIND OF TEST DOESN'T CUT IT!

- 1. Smoke tests
- 2. Fingerprint tests
- 3. Unit tests
- 4. Module tests
- 5. Statistical tests



Smoke Tests

 Run the simulation for a while, and see if it crashes or stops with a runtime error



- simplest kind of test, provides low confidence in the models
- crude but easy to implement
- INET smoke tests:
 - smoketest script + csv file (columns: working-dir, command-to-run)
 - script runs all example simulations with cpu-time-limit=3s

Fingerprint Tests

- "What is fingerprint again?"
 - hash of certain properties of the simulation, currently (time, module ID) for each event
 - designed to change if simulation trajectory changes
 - suitable for regression testing
- Fingerprint tests:
 - fingerprints script; runs example simulations plus some test simulations; input in CSV

# workingdir,	args,	simtimelimit,	fingerprint
<pre>/examples/adhoc/ieee80211/,</pre>	-f fingerprints.ini -c Ping1 -r 0,	1000s,	621c-2640
<pre>/examples/adhoc/ieee80211/,</pre>	-f omnetpp.ini -c Pingl -r 0,	100s,	0cad-2371
<pre>/examples/adhoc/mf80211/,</pre>	-f fingerprints.ini -c Pingl -r 0,	1000s,	a867-4a02
<pre>/examples/bgpv4/BGP3Routers/,</pre>	-f omnetpp.ini -c config1 -r 0,	1000s,	3fac-2c12
<pre>/examples/bgpv4/BGPand0SPF/,</pre>	-f omnetpp.ini -c configl -r 0,	1000s,	5161-8ab8
<pre>/examples/ethernet/arptest/,</pre>	-f omnetpp.ini -c ARPTest -r 0,	500s,	elf3-3cal
<pre>/examples/ethernet/lans/,</pre>	-f bus.ini -c BusLAN -r 0,	100s,	9999-0785
			10



Unit Tests

For testing individual classes

 MACAddress, IPv4FragmentationBuffer, TCPMsgBaseReceiveQueue, ByteArrayPacket, HeaderSerializer, Coords, ErrorRateModel, etc.



use OMNeT++ unit test framework (opp_test) and .test files

```
%description:
Tests TCPMsgBasedSendQueue, TCPMsgBasedRcvQueue classes
%activity:
...
enqueue(sq, "msg1", 100); // 1000..1100
enqueue(sq, "msg2", 400); // 1100..1500
...
%contains: stdout
[1000..1000), 0 packets
rcv_nxt=1000 0 msgs
SQ:enqueue("msg1", 100): --> [1000..1100), 1 packets
SQ:enqueue("msg2", 400): --> [1000..1500), 2 packets
SQ:enqueue("msg3", 600): --> [1000..2100), 3 packets
...
```

Module Tests

- Functional test of individual modules, typically protocol implementations
 - send the module some input, then check how it reacts (messages and/or log output)
 - OMNeT++ unit testing framework (opp_test) can be used
 - we are also considering Python for scripting

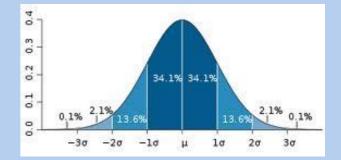


Statistical Tests

- Statistical regression tests
 - check that model produces statistically the same results as before
 - e.g. perform 100 runs "before" and "after" a change, and use Student t-test [for mean] and F-test [for variance] to check that both set of results are from the same distribution

implementation: inet/tests/misc/statistical/test.R

- Validation tests
 - e.g. performance tests: throughput corresponds to expectation (theoretical values, physical measurements, or other simulator's results)
 - we have such tests for Ethernet (implemented using R)
 - TODO: reuse results of 802.11 model validation workshop paper







Benefits:

- build errors and broken test cases are usually detected earlier
 - (even though our INET tests run only once a day)
- tests for you on other platforms
 - i.e. develop on Windows, test on Linux or vice versa
- it is for the lazy
 - after a change, it is less effort to push "Start Build" button on a web page than run the test suite manually on your own computer!



We use:



"An extendable open source continuous integration server"

- Packaged for multiple Linux distros, Windows, OS X, etc. (we use it on Ubuntu)
- Web-based administration; builds can be triggered by scheduling (cron), by commit, or manually; lots of plug-in extensions for various purposes (400+)
- How we use it for INET: checks out latest INET (given branch) from github repo, builds it with different feature combinations, runs test suite, reports results; runs once every night
- IF YOU WANT TO SET UP YOUR OWN JENKINS: our Jenkins config file is available from the INET repo

Firefox 🔻		_							x
INET_build [Jenkins]	+								
(192.168.1.76 :8080/job/INET_	build/		☆ ⊽ C'	Soogle •	:			۶ 🎓	
🟂 Google Maps 🧕 [Jenkins] 🗌 Spir	nalis Ergonomic 直 Asus Eee Pad Transfor 🔧 Dashboar	d 🚼 G	Google Takeout	🗌 Edzők 🚻	ANSAWiki	Main / Ab		» 🖪 Bookm	arks
Jenkins					🔍 sea	rch		0	Â
Jenkins » INET build							Ē	NABLE AUTO REFRESH	1
<u>Back to Dashboard</u> Image: Status	Project INET_build								
Changes	Tests the INET framework. Builds specified branches	and th	ien the unit, si	moke, fingerpr	rint, statistica	and modul	le tests.	Wedit description	
Workspace								Disable Project	
Build Now			1	Com	npiler Warı	nings Tren	nd		
Oelete Project	Workspace								
💥 <u>Configure</u>	0000000								
GitHub	Recent Changes	o							Ξ
Git Polling Log	Permalinks	ŏ							
😸 Build History (trend)									
#143 Mar 1, 2012 4:32:02 PM	 Last build (#143), 1 day 1 hr ago Last stable build (#143), 1 day 1 hr ago 		± υ	v		0	0		
#142 Mar 1, 2012 4:30:57 PM	 Last successful build (#143), 1 day 1 hr ago Last failed build (#141), 1 day 1 hr ago 		#134	#136	#137	#139	#140	#142	
#141 Mar 1, 2012 4:30:38 PM	Last unsuccessful build (#141), 1 day 1 hr age	0						Enlarge Configure	
#140 Mar 1, 2012 4:30:17 PM									
#139 Mar 1, 2012 4:29:25 PM									
#138 Mar 1, 2012 4:28:47 PM									
 #137 Mar 1, 2012 4:28:03 PM #136 Mar 1, 2012 4:27:01 PM 									
#135 Mar 1, 2012 4:26:18 PM									
#134 Mar 1, 2012 4:25:46 PM									5

Firefox •		
(Jenkins	+	
(192.168.1.76 :8080/job/INET_	build/build?delay=0sec	
🟂 Google Maps 🧕 [Jenkins] 🗌 Spin	alis Ergonomic 🧾 Asus Eee Pad	Transfor 🔧 Dashboard 🔧 Google Takeout 🔅 Edzők 👖 ANSAWiki Main / Ab 🛛 🔹 🛛 Bookmarks
Jenkins		Search 🕐 🔶
Jenkins » INET build		
<u>Back to Dashboard</u> O Status	Project INET	build
Changes	This build requires parameter	-
Workspace	MODE	debug 🔻
Build Now	BRANCH	Build mode to test (debug or release) Origin/integration
Delete Project		The branch(es) that should be tested
	TEST_DEFAULT_MAKEFILE	V Build the project with the default Makefile to make sure it compiles out of the box.
Git Polling Log	RUN_FEATURE_BUILD_TEST	S 📝 Build all feature combinations
Build History (trend)	BUILD_BEFORE_TESTING	If build tests are disabled, it is possible to spare the build step before running fingerprint, statistical etc tests by clearing this
 #143 Mar 1, 2012 4:32:02 PM #142 Mar 1, 2012 4:30:57 PM 	UNIT_TESTS	checkbox.
 #141 Mar 1, 2012 4:30:38 PM #140 Mar 1, 2012 4:30:17 PM 	SMOKE_TESTS	Run smoke tests on INET (examples run for a few seconds to see if there are crashes)
#139 Mar 1, 2012 4:29:25 PM	FINGERPRINT_TESTS	
 #138 Mar 1, 2012 4:28:47 PM #137 Mar 1, 2012 4:28:03 PM 	STATISTICAL_TESTS	Run examples and calculate fingerprints. Mismatches will be reported as errors.
 #136 Mar 1, 2012 4:27:01 PM #135 Mar 1, 2012 4:26:18 PM 	MODULE_TESTS	Run module tests.
#134 Mar 1, 2012 4:25:46 PM RSS for all RSS for failures	Build	2

COMMUNITY INVOLVEMENT

Community Involvement

We need to agree on:

- how do new protocols make it into INET?
 - code review
 - formal requirements* (documentation, commenting, code style, existence of examples and tests)
- how do patches make it into INET?
 - formal requirements (clear statement of what it solves, etc.)
 - code review
 - tests* (to demonstrate that it solves the problem, and doesn't break anything else)

* if author does not provide them, someone else has to do it 28

Community Involvement

- The OMNeT++ team can do much, but...
 - some tasks require domain knowledge, i.e. help from the community
 - code review (for conformance)
 - validation
 - setting priorities
- Forum, tools
 - inetframework-devel@googlegroups.com
 - Gerrit code review tool (if proves useful)
 - Is there interest / willingness to participate?



Animation

What do we want to animate/visualize?

- frame transmissions, wired/wireless
 - wireless: dest node? successful?
- node movement, e.g. trajectories
- higher-level information: reachability, routing, overlay network topology, ...
- vital statistics (as annotation, graph, chart, gauge or meter)

- ...

– [you name it]

Animation

- Animation Framework
 - extends the IDE

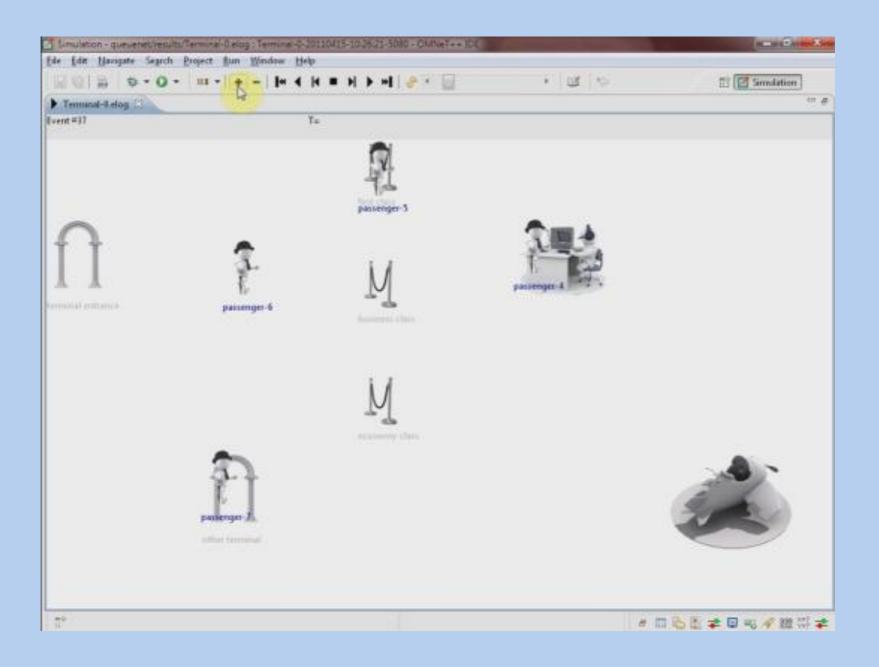


- input: eventlog files + model specific files
- like an interactive video player
 - time linear/nonlinear
 - content can be filtered
 - can be interactive!
- extensible with model- (INET-) specific animations
 - support for new animation effects, visualizations, layers, interactivity, etc.
 - Java API
 - can be deployed with the model

Animation Demo: Aloha

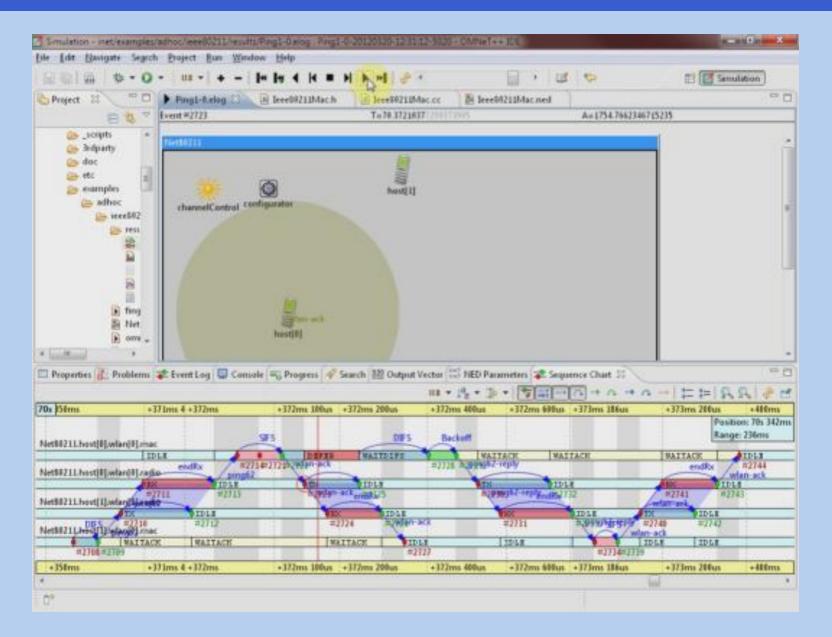
Johannel orrendetpuire Tet 2013 Tet 201 Tet 2	10 m # • 0	· III · + - P	• bu 4 (4 = b) k ml 🤗	* 101 · · ·	13 5		Seculation
te 133 Te - 243 INTERNATION INTERNATION ACTION OF A CONTRACT OF A CONTRA	and the second se	and the second second	and the second				F
Notes Notes <td< td=""><td>tt ≈135</td><td></td><td>T=9.203111111111111111</td><td>As</td><td>115.86866649201249</td><td></td><td></td></td<>	tt ≈135		T=9.203111111111111111	As	115.86866649201249		
Notes Notes <td< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td></td<>							
Note Note Note Note Note Note Note Note Note Note Note Note Note Note Note N				11:			
Notifie Notifie Notifie Notifie Notifie house Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie N			1 10				
heatil heatil		TROUGHT	(D)				
heatil heatil	9	hosti		in I w	a1		
North North North North North North North North North North North North North North North <td></td> <td></td> <td>save.</td> <td>2</td> <td></td> <td></td> <td></td>			save.	2			
hosts ho				host			
Notifie Notifie Notifie Notifie Notifie Notifie Notifie hostifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie hostifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie hostifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Notifie Noti			O / (m)				
Notifier Notifier Notifier Notifier Notifier Notifier Notifie			hen				
Notifie Notifie nohlems ⇒ Event Log Comole Search Search Output Vector ThED Parameters ⇒ Sequence Chart The search The			1		hest5		
Notifie Notifie neblem 20 Event Log Comole Toppensi Search Search Output Vector NED Parameters Sequence Chart If							
host3 host3 host3 host3 host3 host3 host3 host4 host3 host4							
Notifier Program Search Search Dotput Vector NED Parameters Sequence Chart Net Program Program <td< td=""><td></td><td>1.00</td><td></td><td></td><td></td><td></td><td></td></td<>		1.00					
100mm 1a 700ma 1a 1a 200ma 1a 500ma 1b 500ma 1b 500ma 1b 500ma 1b 500ma 1b 500ma 1b 100ma			C.F.M.S.	A hort2			
100mm 1a 700ma 1a 1a 200ma 1a 500ma 1b 500ma 1b 500ma 1b 500ma 1b 500ma 1b 500ma 1b 100ma			C.S.	A hort2			
Interview of the property of the			S.A.	A hort2			
Solume La 700ma Pa Pa 200ma Pa 200ma Pa 500ma Dit 560ma Dit 560ma <thdit 560ma<="" th=""> Dit 560ma Dit 560ma<td>hostő -</td><td>hest</td><td>Y Mar St</td><td>hesti</td><td></td><td></td><td></td></thdit>	hostő -	hest	Y Mar St	hesti			
end reception and reception an	hotti	hest	Y Mar St	hesti	#		7/#
2107 B128 B108	hotti	hest	Y Mar St	D Parameters 📽 Sequence Chart	D	173-1 == ==	
al period and and a second and	hostli robilerna 🚁 Event Log	Camale ¹⁴ 6 Program	イ Search 短 Output Vector 部 NE	D Parameten Sequence Chart III + (9g + 3) + 12 (11)		and the second se	8 A I 2
sendrentis philipping and and a sendrentis and and a send and a se	hostő reblema 🐲 Event Lag 808ma 🔒 700ma	Camale ¹⁴ 6 Program	A Search (12) Output Vector (12) NE Bs 200ms Ss 500ms end reception	D Parameters 2 Sequence Chart 10 + 192 - 3 + 192 111	In Here	10x 906ms	R. R. 2 11: 200
Image: state state Image: state state Image: state I	hostfi relaterns 2 Event Log 800mn & 700ma end-reception end-rec	Progress Comole ¹⁰ Progress Progress eption end inception	ダ Search 短 Output Vector 部 NE Ss 200ms Ss 500ms until end Dr	D Parameten Sequence Chart III + 1% + 3 + 100ms IIIs 560ms IIIs 700ms end-reception end seception	Ib Hims	10: 500ms end-receptio Pes	R. R. 2 11s 200 diana 7s 766m nge: 3s 559ms
rendfa and endfa at 12.02 at 14.02.01 at 12.02 at 14.02.01 at 12.01 and endfa at 14.02.01 at 12.01 and endfa at 14.02.01 at 14	hosti noblema Z Event Log 800ma Is 700ma end-reception end-rec 20172 1012 11	Camale 5 Program Pro	Search 20 Output Vector 20 NE	D Patameten Sequence Chart 10 Patameten Sequence Chart 10 Storms IIIs Toloms end-reception end-reception	10 Homs end reception	10: 300ms and receptio Per and send Ray	R. R. 2 11s 200 diam 7s 7600 oge: 3s 55500s
and and end a differential and end to develop and end to end end to end to develop and to de	hosti noblems Event Lag 800ma & Tooma end-reception end-rec 2 2177 0128 01 30	Camale 5 Program Pro	A Search III Output Vector III hit Bs 200ms Bs 500ms end reception sent end reception	D Patameten Sequence Chart 10 Patameten Sequence Chart 10 Storms IIIs Toloms end-reception end-reception	ib Homa end reception addition bits with the west	ID: 598ms end-receptio Per send Rar SISDemitiSt fill	A A 200
and and ends wedfeedfa (see feedfeedfeed ends	hostő holslema 2 Event Lag 1000mn 1s 700ma end reception end rec 1000m 1010 11 1000m	Progress Camole % Progress eption end reception 21 million architecture 21 mil	A Search 20 Output Vector 20 hill 95 200ms 95 500ms senti end reception senti end reception pt 1-5 Judi wall's	D Patameten 2 Sequence Chart 10 Patameten 2 Sequence Chart 10 Storms 10 Toloms end-reception end-reception 2 Dent Patameter 2 Dent 2 Dent 2 Dent		105 900ms end receptio Peo send send send for 5-2 for	R R 200
	hosti holdenn 2 Event Log 800m Is 700ms end reception end rec 1 2177 1178 11 30 1 2177 1178 11 30 1 2177 11 30 1 3177 11 30 1 3177 11 3177 11 31777 11 3177 11 31777 11 31777 11 3177 11 3177 11 3177 11 3177 11 3177 11 31777 11	Progress Camole % Progress eption end reception 21 million architecture 21 mil	A Search 20 Output Vector 20 NE 9s 200ms 9s 500ms send reception send reception s	D Patameten 2 Sequence Chart 10 Patameten 2 Sequence Chart 10 Storms 10 Toloms end-reception end-reception 2 Dent Patameter 2 Dent 2 Dent 2 Dent		105 900ms end receptio Peo send send send for 5-2 for	R R 200
Tel27 Tel28 Tel42 Tel43 Tel43 Tel43	hosti holikemi 2 Event Lag 2002mn & Tooma end-roteption end-rot 1 2017 01128 01 30 1 10 10 21 30 1 10 10 10 10 10 10 30 1 10 10 10 10 30 1 10 10 10 30 1 10 10 10 30 1 10 10 10 30 1 10 10 1 10 10 1 10 1	Progress Comole % Progress eption end inception 35 million and inception at 12 million at 12	A Search 20 Output Vector 20 NE 96 200ms 96 500ms send reception send reception at 1-5 And could a set from the send to be set for the set of the send to be set for the set of the send to be set of the set of the set of the send to be set of the set of the set of the send to be set of the set of	D Parameters Sequence Chart 10 Parameters Sequence Chart 10 S S60ms IBS 700ms end-reception end-reception 2 Prot Parameters 2 Parameters 2 Sequence Chart 10 S S60ms IBS 700ms 2 Parameters 2		ID 300ms end receptio Pes- send send Ran Si50-mm(53 All 10 202 All	A A Siles
809ma 8x 700ma 9x 9x 9x 200ma 5x 500ma 10x 500ma 10x 800ma 10x 800ma 10x 800ma 10x 900ma 11x 280m	hosti holikemi 2 Event Lag 2002mn & Tooma end-roteption end-rot 1 2017 01128 01 30 1 10 10 21 30 1 10 10 10 10 10 10 30 1 10 10 10 10 30 1 10 10 10 30 1 10 10 10 30 1 10 10 10 30 1 10 10 1 10 10 1 10 1	Camole 5 Progress Progres	A Search 20 Output Vector 20 NE 96 200ms 96 500ms send reception send reception at 1-5 And could a set from the send to be set for the set of the send to be set for the set of the send to be set of the set of the set of the send to be set of the set of the set of the send to be set of the set of	D Parameten 2 Sequence Chart 10 Parameten 2 Sequence Chart 10 Storms 10 Toloms 10 Storms 10 Toloms 10 Toloms 10 Toloms 10 Toloms 10 Toloms 10 Toloms		ID 300ms end receptio Pes- send send Ran Si50-mm(53 All 10 202 All	A A Siles

Animation Demo: Flight Terminal

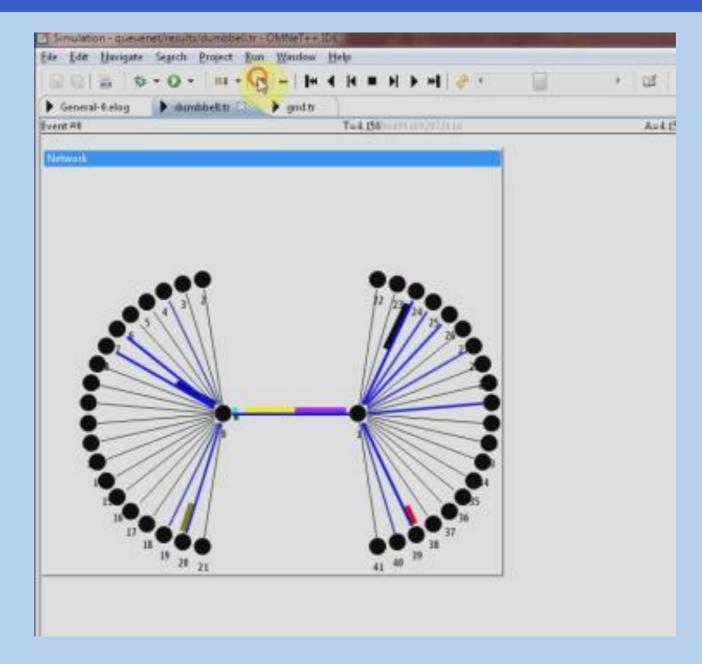


34

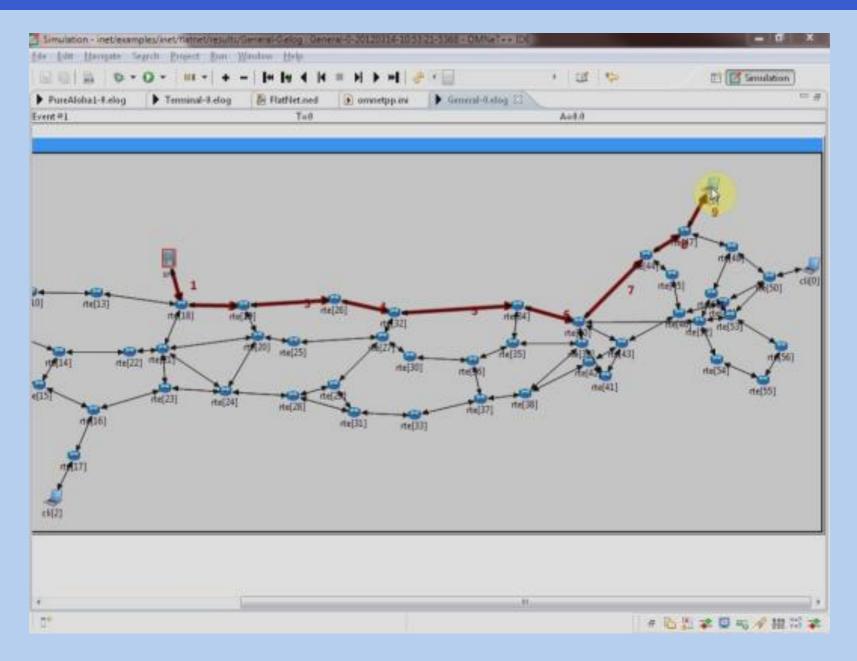
Animation Demo: 802.11



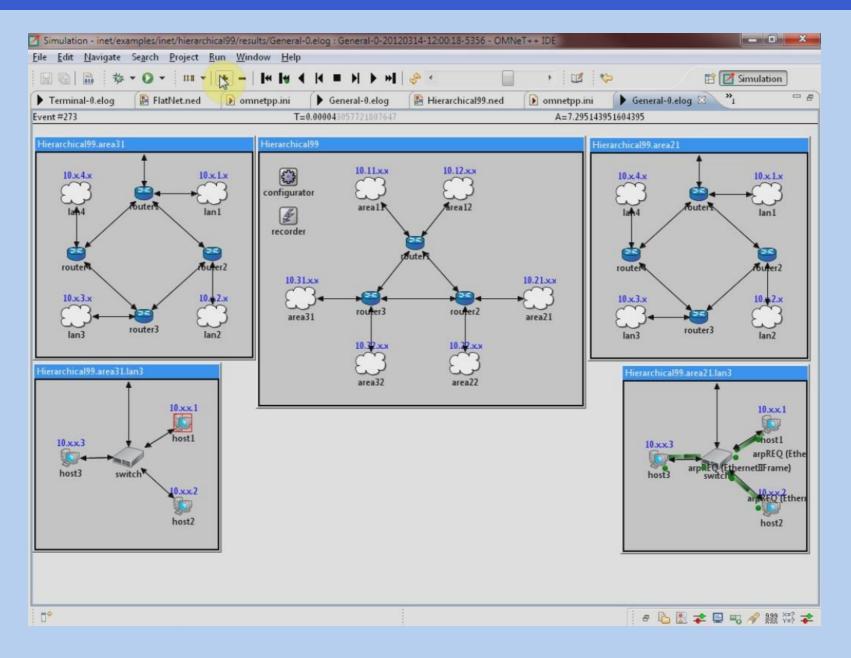
Animation Demo: Dumbbell



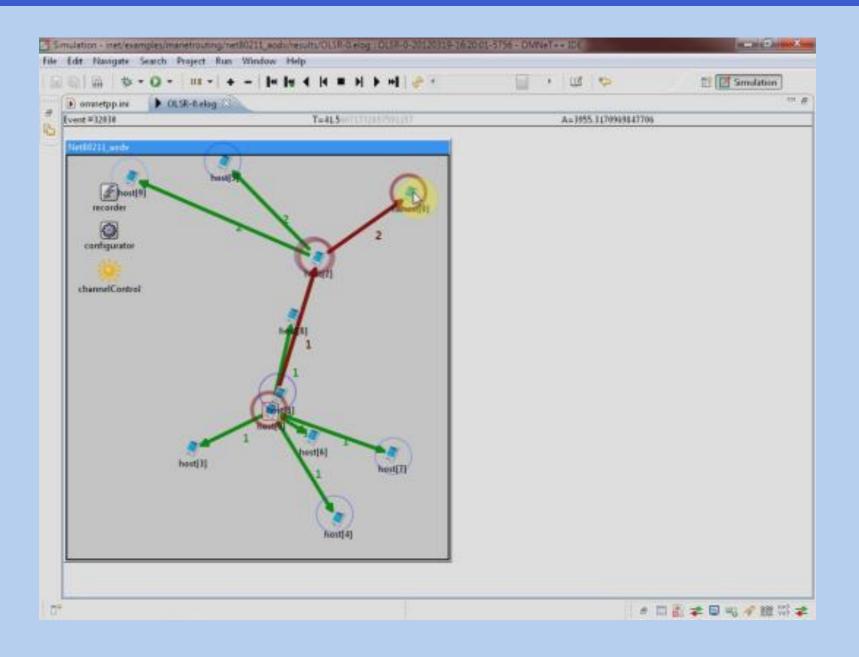
Animation Demo: Routing



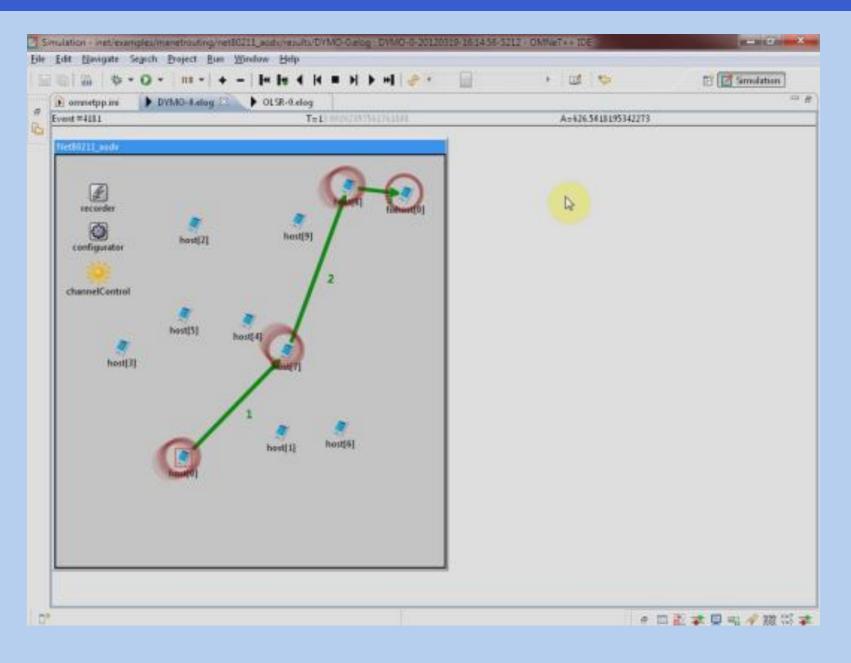
Animation Demo: Routing



Animation Demo: OLSR Routing



Animation Demo: DYMO Routing



Discussion

We only have a few minutes now, but



we can continue in the Closing Session, 17.30-18.00