ns-3 project update

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March 25, 2011

ns-3 Workshop on ns-3, March 2011
Talk outline

- ns-3 project goals
- progress since last WNS3
- new and forthcoming features
- developer meeting, and loose ends
- Q&A, feedback
What is ns-3?

ns-3 is a free, open source software project building and maintaining a discrete-event network simulator for research and education.

Technical goals:

- Build and maintain a simulation core aligned with the needs of the research community.
- Help to improve the technical rigor of network simulation practice.
ns-3: a brief history

1988: REAL (Keshav)
1990s: ns-1
1996: ns-2
1997-2000: DARPA VINT
2001-04: DARPA SAMAN, NSF CONSER

Inputs: yans, GTNetS, ns-2

2006: NSF CISE CRI Award
INRIA Planete funding
ns-3 core development (2006-08)

June 2008: ns-3.1

2010: NSF CISE CRI Award
January 2011: ns-3.10

SIMUTools "1"
(March 2008, ns-3 tutorial)

ns-3 is now an international open source project

ns-3

Workshop on ns-3, March 2011
ns-3 themes

• Research and education focus
  – Build and maintain simulation core, integrate models developed by other researchers
  – Support research-driven workflows

• Open source development model
  – Research community maintains the models

• Leverage available tools and models
  – Write programs to work together

• Enforce core coding/testing standards
ns-3 software overview

• ns-3 is written in C++, with bindings available for Python
  – simulation programs are C++ executables or Python programs
  – Python is often a glue language, in practice
• ns-3 is a GNU GPLv2-licensed project
• ns-3 lacks an integrated development/visualization environment (IDE)
• ns-3 is not backwards-compatible with ns-2
ns-3 development process

ns-3 is run as an open source project backed by research funding

- GPLv2 licensing stance
- open mailing lists
- uses standard tools (Mercurial, Bugzilla, Mediawiki, GNU/Linux development)
- ~20 maintainers worldwide
ns-3 development process

• date-driven quarterly releases

- new feature merge
- bug fixing only
- testing
- Release!

• All code for merge to ns-3 is openly reviewed by maintainers
  - Syntactic (style) reviews
  - Design reviews
  - Documentation and tests
Available modules (ns-3.11 May 2011)

- **devices**
  - bridge
  - csma
  - emu
  - point-to-point
  - lte
  - mesh
  - spectrum
  - tap-bridge
  - uan
  - virtual-net-device
  - wifi
  - wimax

- **protocols**
  - aodv
  - dsdv
  - olsr
  - mpi
  - mobility
  - network
  - core

- **energy**
  - propagation

- **config-store**
  - flow-monitor
  - netanim
  - stats
  - topology-read
  - visualizer

**ns-3**

Workshop on ns-3, March 2011
Current and recent ns-3 maintainers

- Kirill Andreev
- Nicola Baldo
- Elena Buchatskaya
- Pavel Boyko
- Gustavo Carneiro
- Craig Dowell
- Joe Kopena
- Flavio Kubota
- Tom Goff
- Tom Henderson
- Blake Hurd
- Mathieu Lacage
- Hemanth Narra
- Tommaso Pecorella
- Josh Pelkey
- George Riley
- Lalith Suresh
- Adrian Tam
- Leonard Tracy
- Sebastien Vincent
- Mitch Watrous
- Florian Westphal
- Michele Weigle
- Tony Wu
Analytics

Mailing list subscriptions:
- ns-3-users: 963
- ns-developers: 1176

Downloads:
- 6000/month in 2010
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ns-3.8 (April 2010)

- **WiMAX Net Device**: Simulate IEEE 802.16 point to multi-point based networks
- **Distributed simulation**: Support for point-to-point-based simulations for decomposition to multiple machines using Message Passing Interface (MPI)
- **Topology reader**: Allows quick and easy creation of large topologies by reading Inet or Orbis files.
- **Two-ray ground propagation loss model**: Calculates the crossover distance under which the Friis model is used.
- **Tracing support**: Unified tracing across all NetDevice models.
ns-3.9 (August 2010)

• **Spectrum Framework**: Allow modeling of spectrum-aware devices, and allow cross-system interference
• **OFDM error rate models for WiFi**: 802.11a/g
• **ns-2 mobility trace reader**: For BonnMotion, SUMO, TraNS, etc.
• **Energy model framework**: Energy sources and devices, and initial models
• **Rocketfuel topology dataset support**
• **Underwater Acoustic Network (UAN) models**
• **WiFi mode/rate reorganization**
ns-3.10 (January 2011)

- **Pyviz:** Python-based visualizer with interactive python console (runtime introspection)
- **3GPP LTE:** Initial support for 3GPP LTE devices
- **new TCP:** Modular TCP congestion control
- **Energy model extensions:** R-V battery model, support for WiFi
- **Destination Sequenced Distance Vector (DSDV) routing**
- **Documentation moved to Sphinx format**
ns-3 and Google Summer of Code

Click Modular Router
Lalith Suresh

Underwater Acoustic Networking
Andrea Sacco

ns-3 OpenFlow
Blake Hurd

ns-3 LTE
Giuseppe Piro

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Additional third-party project releases

- **PhySim**: high-fidelity physical layer model for 5 GHz OFDM
  - [http://dsn.tm.uni-karlsruhe.de/english/ns3-physim.php](http://dsn.tm.uni-karlsruhe.de/english/ns3-physim.php)
- **SliceTime**: time synchronization between Xen PVMs and ns-3
- **Multipath TCP**: IETF TCP extensions
- **LENA project**: LTE/EPC network simulator
- **ns-3 DCE**: Direct Code Execution environment
  - [http://www-sop.inria.fr/members/Mathieu.Lacage/dce.html](http://www-sop.inria.fr/members/Mathieu.Lacage/dce.html)
Additional third-party project releases

- **LTE:** Univ. of Padua, HARQ and MOBILITY modules
  - [https://sourceforge.net/projects/ns3-lte/](https://sourceforge.net/projects/ns3-lte/)
- **NEMO/Mobile IP:** based on ns-3 direct code execution, zebra routing, and umip mobile IP
- **Content Addressable Networks DHT**
Course usage

Three courses taught using ns-3

- Georgia Tech (George Riley)
  - ECE 6110; http://users.ece.gatech.edu/~riley/ece6110/
- University of Kansas (James Sterbenz)
  - EECS 882; http://www.ittc.ku.edu/~jpgs/courses/mwnets/
- University of Pennsylvania (Boon Thau Loo)
  - CIS553; http://netdb.cis.upenn.edu/cis553projects/
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ns-3.11 (May 2011)

- modular build system
- Click Modular Routing
- OpenFlow switch support
Modular build goals

• Phase 1: make existing ns-3 modular
  – remove circular build dependencies between modules
  – consistent module layout
  – ability to disable modules from build
  – decouple tests from models

• Phase 2: "app store" model
  – modules may be maintained elsewhere
  – support multiple build systems
Consistent module layout

• Flattened module layout under \texttt{src/}
• (Mostly) uniform layout

  bindings/
  doc/
  examples/
  helper/
  model/
  test/
  wscript
Disable modules from build

- Default: all modules
- `./waf configure --enable-modules=a,b,c`
  - implicit dependencies are picked up
  - not persistent across configurations
- `.ns3rc` file in `src/utils`
  - top-level ns-3 directory
  - home directory `~`
## Modular build, user experience

- Intel(R) Core(TM)2 Quad CPU Q6600 @ 2.40GHz
- **ns-3.10** ns-3-dev (full) wifi + internet

<table>
<thead>
<tr>
<th>Build Type</th>
<th>Command</th>
<th>Time 1</th>
<th>Time 2</th>
<th>Time 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>default</td>
<td>./waf configure &amp;&amp; time ./waf build</td>
<td>119s</td>
<td>95s</td>
<td>12s</td>
</tr>
<tr>
<td>touch model file</td>
<td>time ./waf build</td>
<td>72s</td>
<td>43s</td>
<td>2.5s</td>
</tr>
<tr>
<td>touch test suite</td>
<td>time ./test.py -s object-name-service</td>
<td>74s</td>
<td>3s</td>
<td>1.2s</td>
</tr>
</tbody>
</table>
Python bindings

- There is one separate Python extension module for each ns-3 module
- Scanning API definitions (apidefs) is done on a per ns-module basis
- Each module's apidefs files are stored in a 'bindings' subdirectory of the module directory
- Monolithic (ns3 namespace):
  ```python
  from ns3 import Node
  ```
- Modular (ns namespace):
  ```python
  from ns.network import Node
  ```
Open issues

- What to do about certain examples and samples?
- Should we clean up coding style during this release cycle?
- What should the default module list be for ns-3.11 (if not all_modules)?
ns-3.10 on Windows (experimental)

- Use MS Visual Studio 2010
- Provide execution GUI
- Developed by John Abraham (Georgia Tech.)
netns3 (experimental)

- Written by Tom Goff (Boeing)
  - Documentation and prototype posted on wiki
- Basic Python-based framework using ns-3 Python bindings, RPyC distributed computing library, and ns-3 tap bridge framework

**ns-3 Workshop on ns-3, March 2011**
Integrating ns-3 and CORE emulator

- Prototyped by Craig Dowell in 2010
  - ad hoc WiFi ns-3 with quagga routing in Linux containers
Frameworks for ns-3

- NSF CISE Community Research Infrastructure
  - University of Washington (Tom Henderson), Georgia Tech (George Riley), Bucknell Univ. (Felipe Perrone)
  - Project timeline: 2010-14
Status

• **Data Collection Framework** (Felipe Perrone-- short talk later)

• **High-level model description**; XML schemas and parsers (Andrew Hallagan, Bucknell)

• **Experiment Execution Manager**; experiment description, execution across clusters, transient and run-length detection plugins, managing combinatorial design points, web interface (Bryan Ward, Bucknell)

• **BRITE** (Boston Univ. topology generator) (George Riley and Josh Pelkey)
General architecture
New Wordpress-based site preview

ns-3 is a discrete-event network simulator for Internet systems, targeted primarily for research and educational use. ns-3 is free software, licensed under the GNU GPL v2 license, and is publicly available for research, development, and use.

Developers:
Building a great network simulator for research and education requires many contributions from the networking community. → How to contribute

Download latest release:
The most recent stable release (currently ns-3.10)
or another archived release → All downloads

Recent Posts:
- January 2011 Pmviz added to ns-3: As of ns-3.10, Gustavo Carneiro's pymviz has been added.
- January 2011 ns-3 developers meeting: A face-to-face developers meeting is planned for end...
- January 2011 Release 3.10: Release 3.10 is available. This release is available for...
- October 2010 Call for Papers: Workshop on ns-3, 25 March 2011, Barcelona: The WNS'11 workshop will be colocated with SIMUTOOLS...
- August 2010 Release 3.9: Availability This release is immediately available fro...
- May 2010 Release 3.8: Availability This release is immediately available fro...

→ All news & events
Other announced projects

- Wireless jamming model
- MPLS
- VANET mobility model
- TDMA
- TCP Vegas
- DSR routing
- SimpleWireless model
- 6LOWPAN
- Chord/DHash DHT
- 802.11n
- TMix and DelayBox
- multi-core parallelization
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Meeting goals

- review/feedback on data collection frameworks
- review/feedback on modular builds
- revisit open technical issues
  - processing delays
  - starting and stopping of objects
- review new website and logo
- documentation review
- usability review
- mentored projects, unofficial SoC
Mentoring

- ns-3 *not* selected to GSoC 2011, ending a 3-year run
  - 175/417 accepted, 50 new organizations
- Discussing options for unofficial SoC and mentoring projects at developers meeting
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Acknowledgment of support