

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?

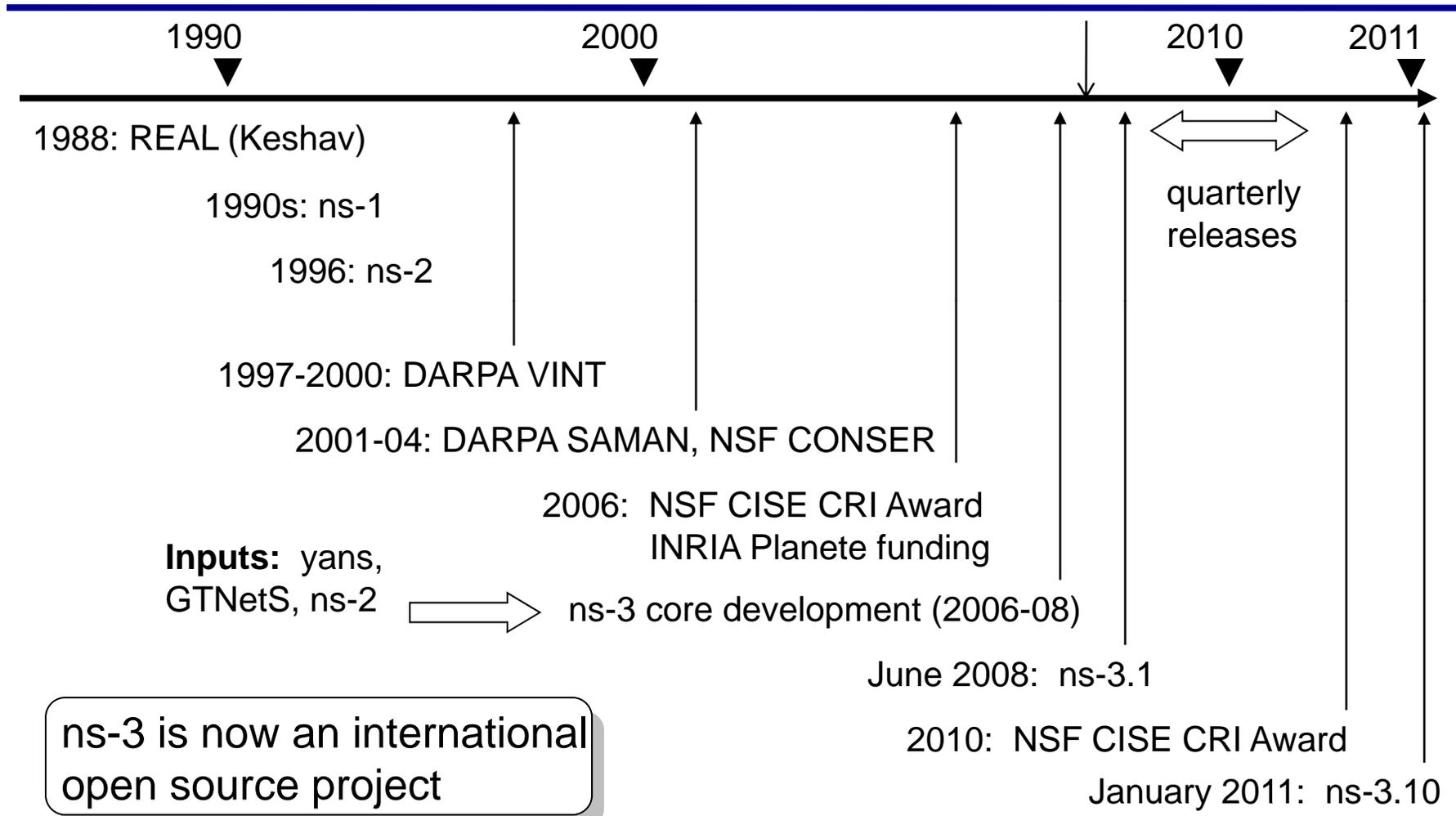
ns-3 is a free, open source software project building and maintaining a discrete-event network simulator for research and education

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

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



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

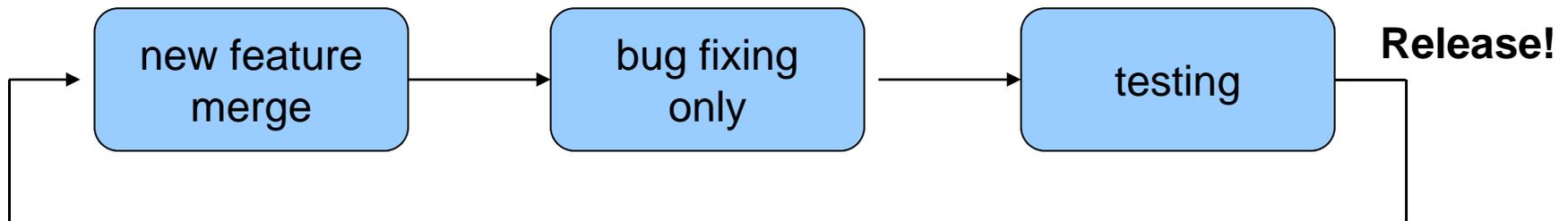
ns-3 development process

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

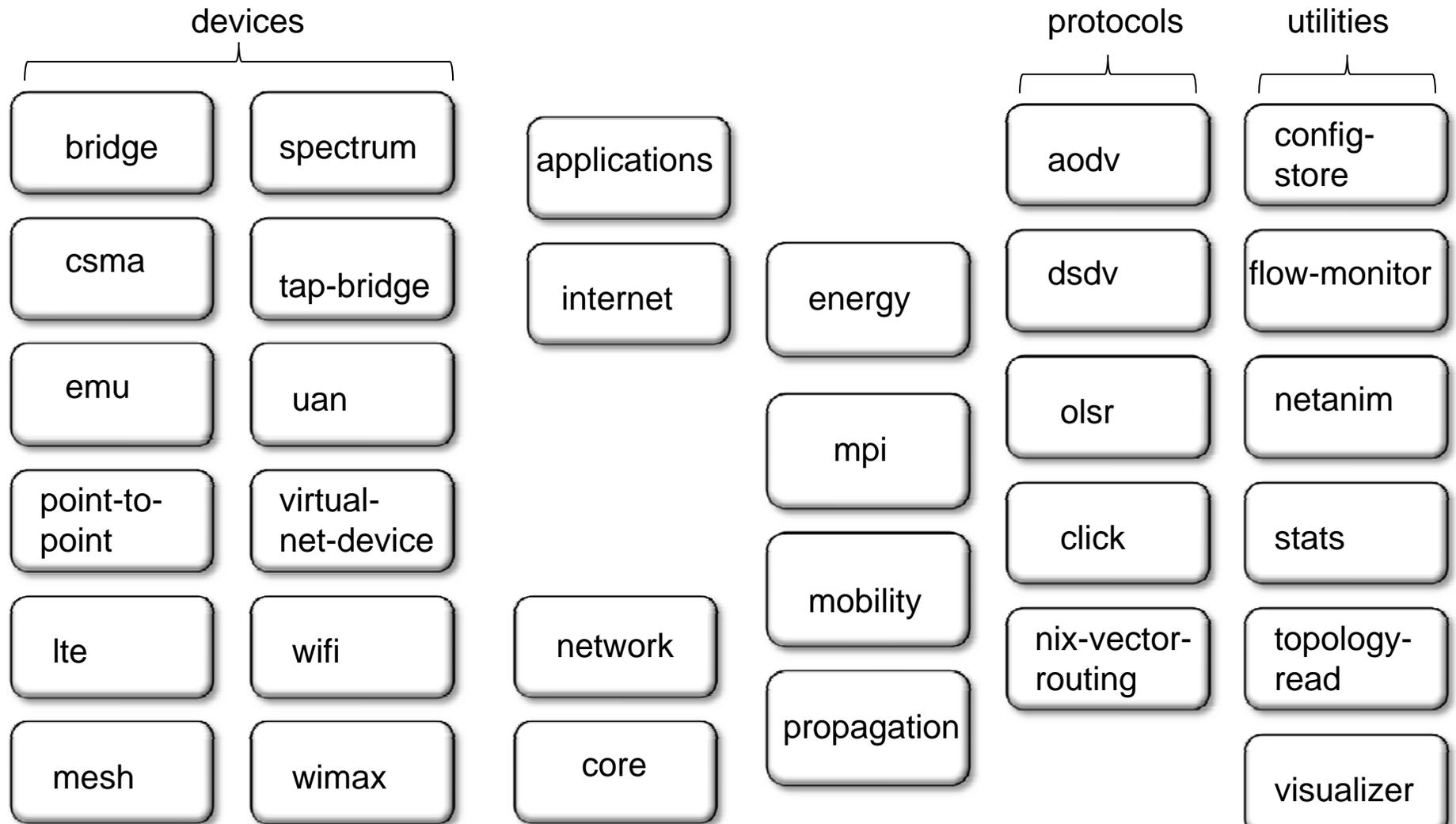
ns-3 development process

- date-driven quarterly releases



- 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)



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

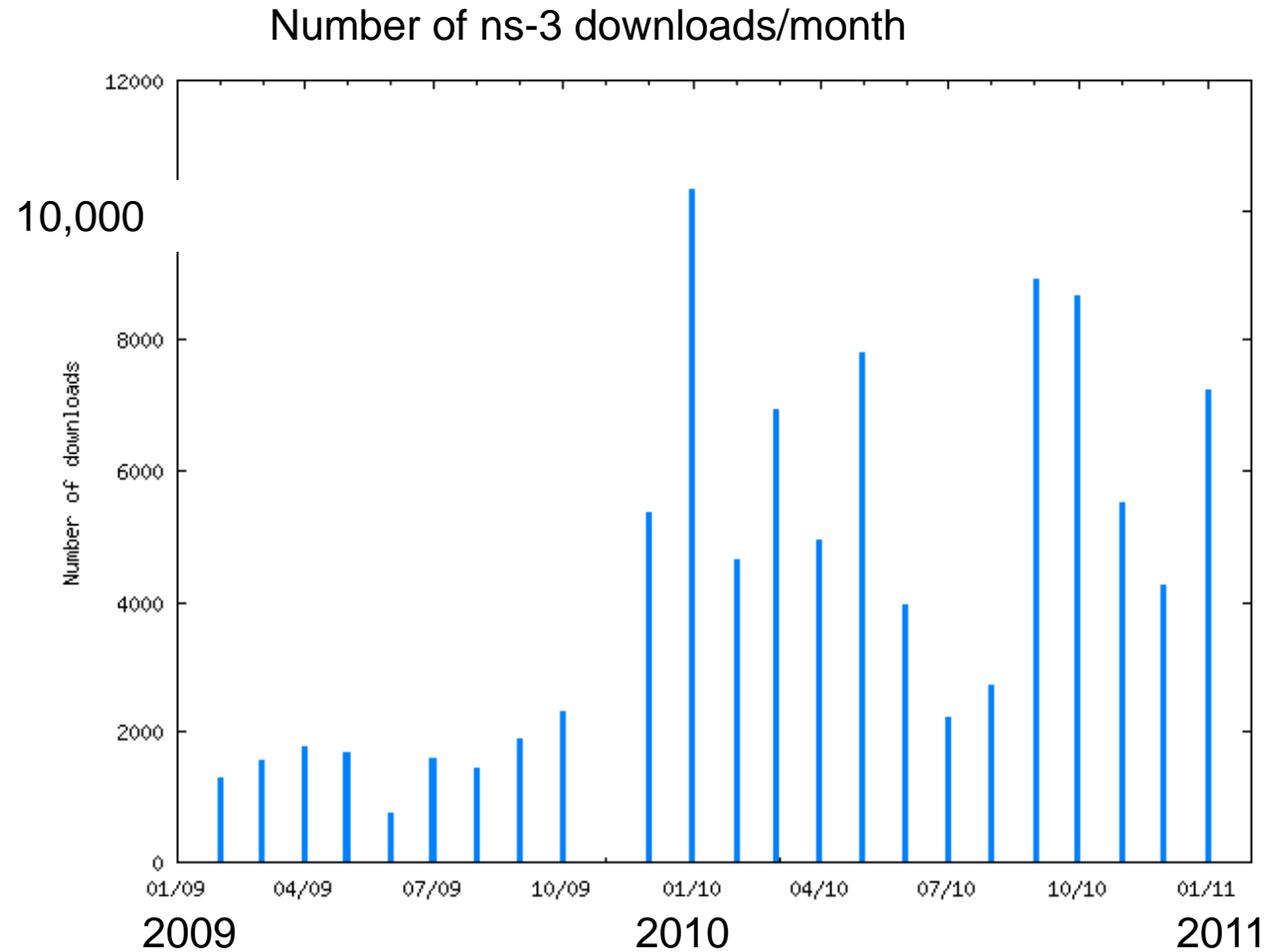
Analytics

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.

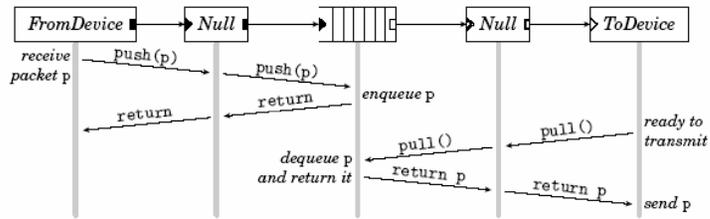
ns-3.9 (August 2010)

- **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**

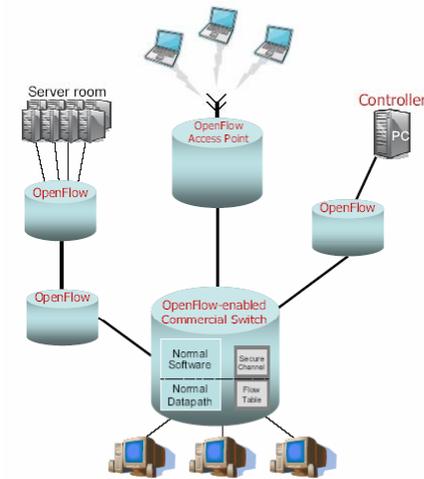
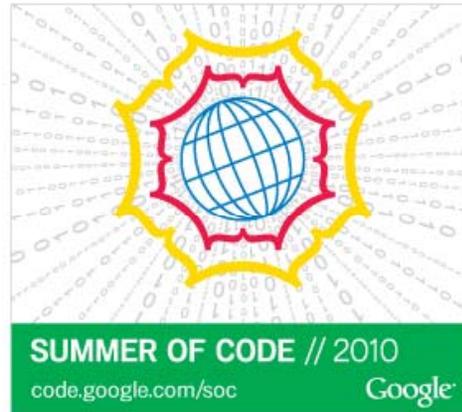
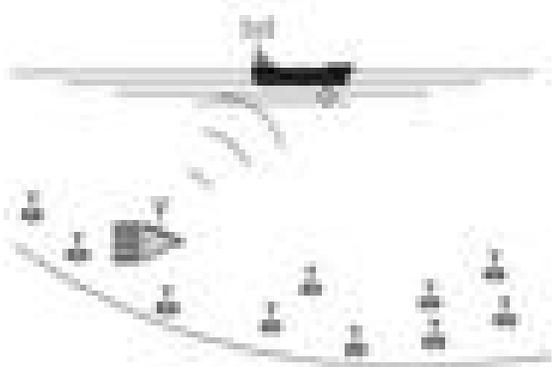
ns-3.10 (January 2011)

- **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



ns-3 OpenFlow
Blake Hurd

Underwater Acoustic Networking
Andrea Sacco



ns-3 LTE
Giuseppe Piro

ns-3

Workshop on ns-3, March 2011

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>
- **SliceTime:** time synchronization between Xen PVMs and ns-3
 - <http://www.comsys.rwth-aachen.de/research/projects/slicetime/>
- **Multipath TCP:** IETF TCP extensions
 - <http://code.google.com/p/mptcp-ns3/>
- **LENA project:** LTE/EPC network simulator
 - <http://www.ubiquisys.com/femtocell-media-press-releases-id-203.htm>
- **ns-3 DCE:** Direct Code Execution environment
 - <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/>
- **NEMO/Mobile IP:** based on ns-3 direct code execution, zebra routing, and umip mobile IP
 - <http://mailman.isi.edu/pipermail/ns-developers/2010-November/008455.html>
- **Content Addressable Networks DHT**
 - <http://mailman.isi.edu/pipermail/ns-developers/2010-November/008460.html>

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 `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

<u>ns-3.10</u>	<u>ns-3-dev (full)</u>	<u>wifi + internet</u>
<ul style="list-style-type: none">• default build<ul style="list-style-type: none">• <code>./waf configure && time ./waf build</code>• 119 seconds• touch model file<ul style="list-style-type: none">• <code>time ./waf build</code>• 72 seconds• touch test suite<ul style="list-style-type: none">• <code>time ./test.py -s object-name-service</code>• 74 seconds	<ul style="list-style-type: none">• 95 seconds• 43 seconds• 3 seconds	<ul style="list-style-type: none">• 12 seconds• 2.5 seconds• 1.2 seconds

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):

```
from ns3 import Node
```
- modular (ns namespace):

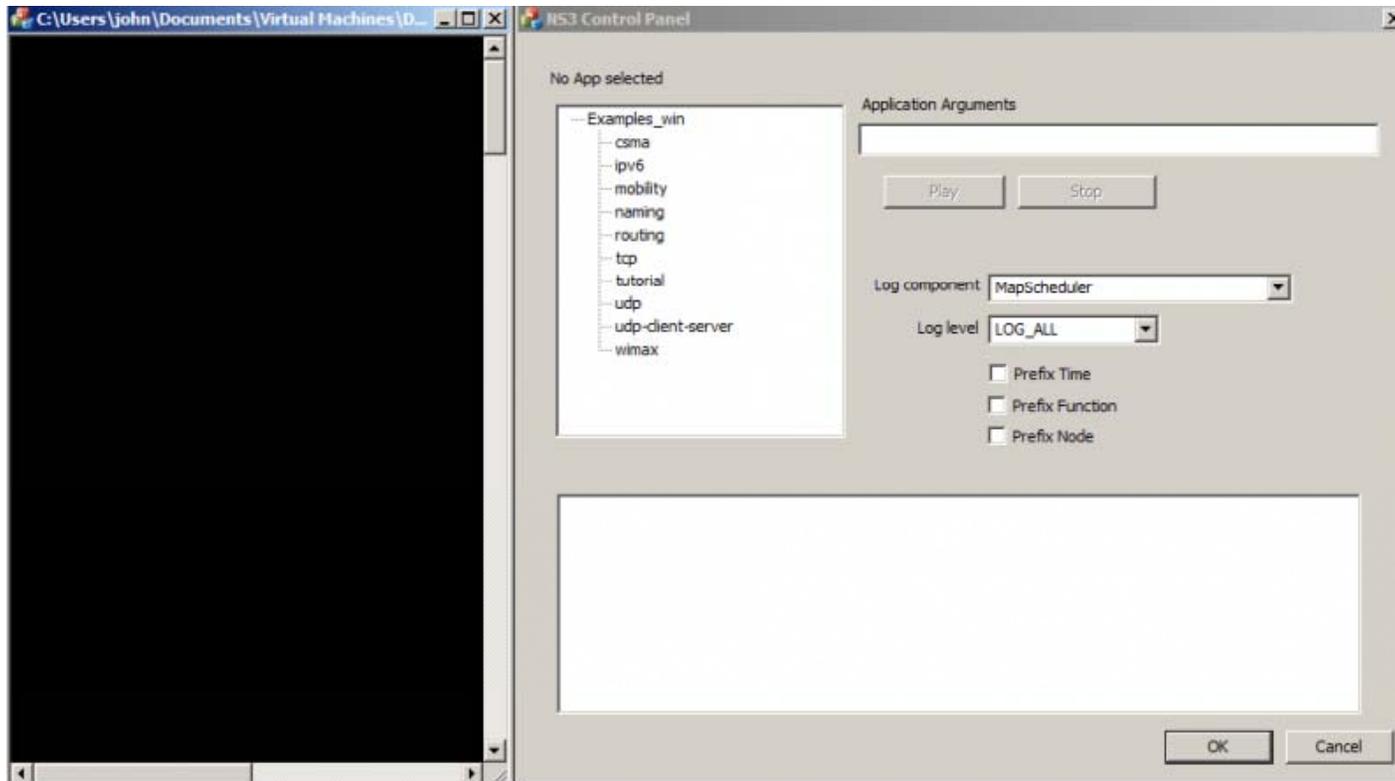
```
from ns.network import Node
```

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`)?

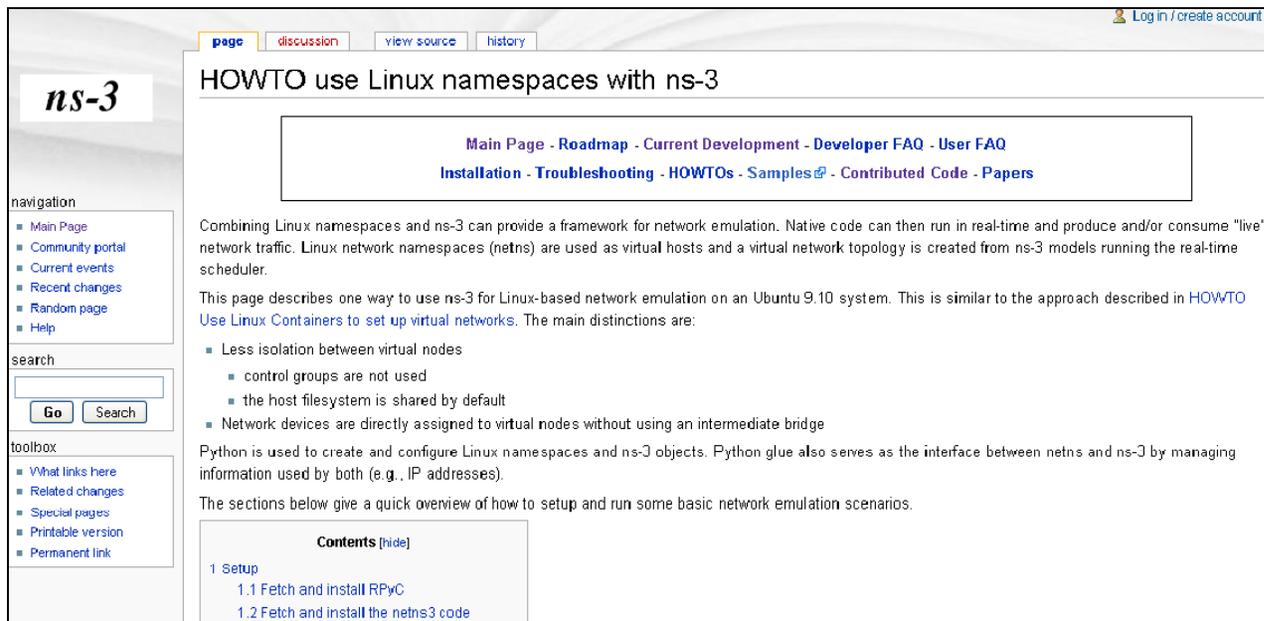
ns-3.10 on Windows (experimental)

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



netns3 (experimental)

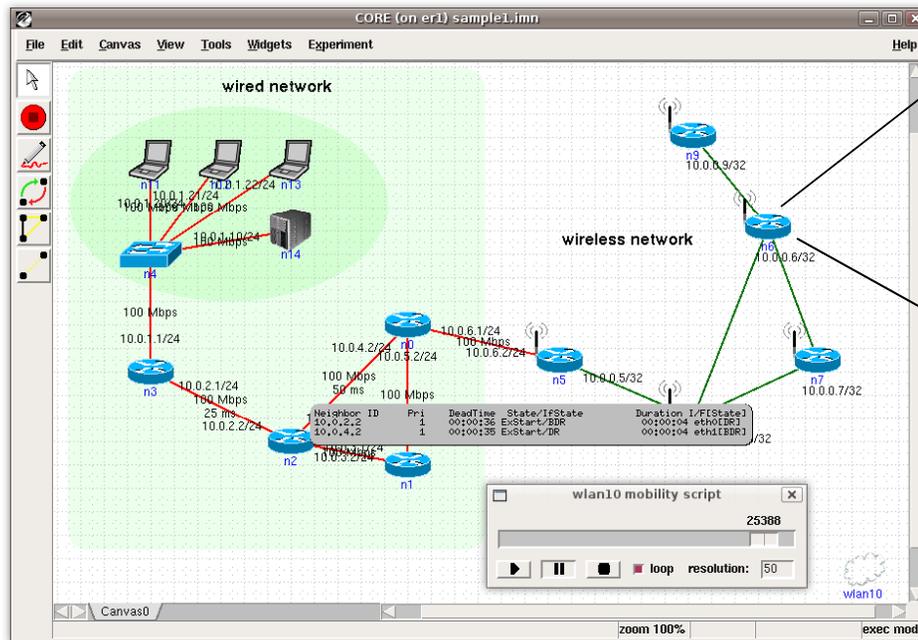
- Written by Tom Goff (Boeing)
 - Documentation and prototype posted on wiki
- Basic Python-based framework using ns-3 Python bindings, RPyC distributed computing library, and ns-3 tap bridge framework



The screenshot shows a wiki page titled "HOWTO use Linux namespaces with ns-3". The page content includes a navigation menu on the left, a search box, and a main text area. The main text area contains a list of links (Main Page, Roadmap, Current Development, Developer FAQ, User FAQ, Installation, Troubleshooting, HOWTOs, Samples, Contributed Code, Papers) and a paragraph of text describing the framework. The text mentions that combining Linux namespaces and ns-3 can provide a framework for network emulation, and that Python is used to create and configure Linux namespaces and ns-3 objects. The page also includes a "Contents" section with a list of sections: 1 Setup, 1.1 Fetch and install RPyC, and 1.2 Fetch and install the netns3 code.

Integrating ns-3 and CORE emulator

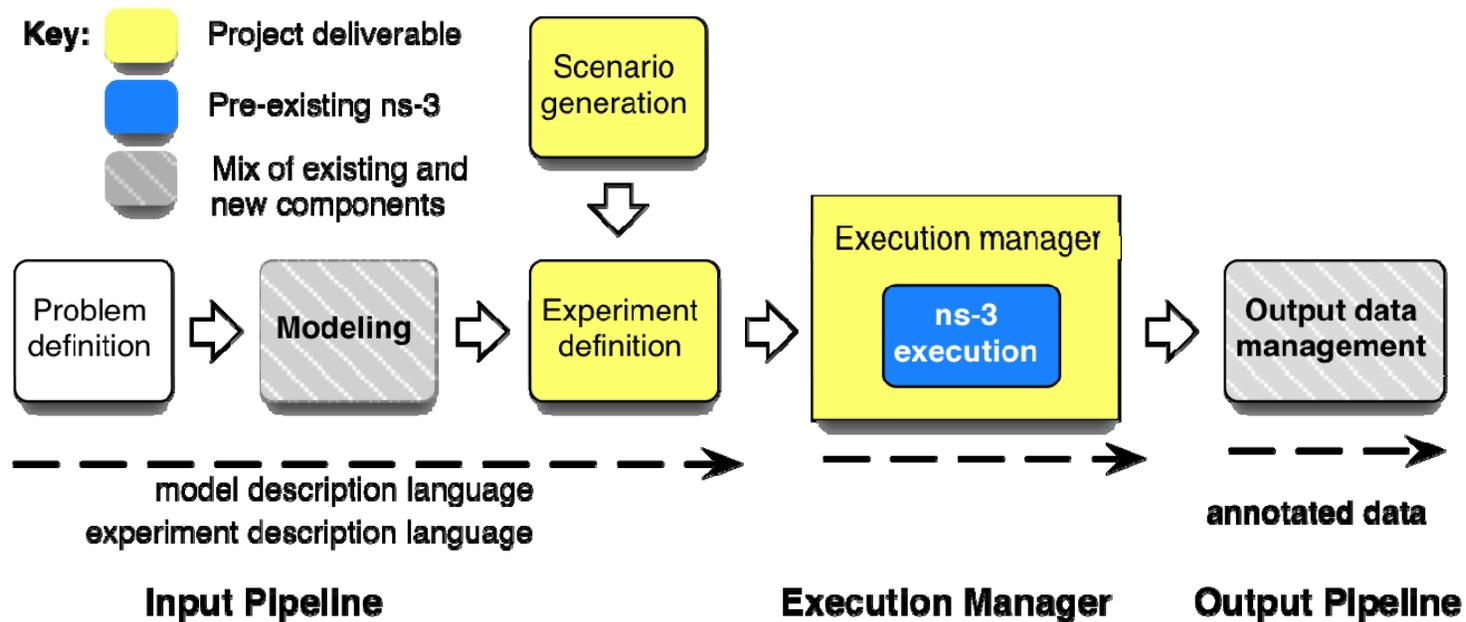
- Prototyped by Craig Dowell in 2010
 - ad hoc WiFi ns-3 with quagga routing in Linux containers



Object Attributes	Attribute Value
ns3::NodeListPriv	
NodeList	
0	
DeviceList	
0	
Address	00:00:00:00:00:01
EncapsulationMode	Llc
SendEnable	True
ReceiveEnable	true
DataRate	5000000bps
TxQueue	
ApplicationList	
ns2::PacketSocketFactory	
ns3::Ipv4L4Demux	
ns3::Tcp	
ns3::Udp	
ns3::Ipv4	
ns2::ArpL3Protocol	
ns3::Ipv4L3Protocol	

Frameworks for ns-3

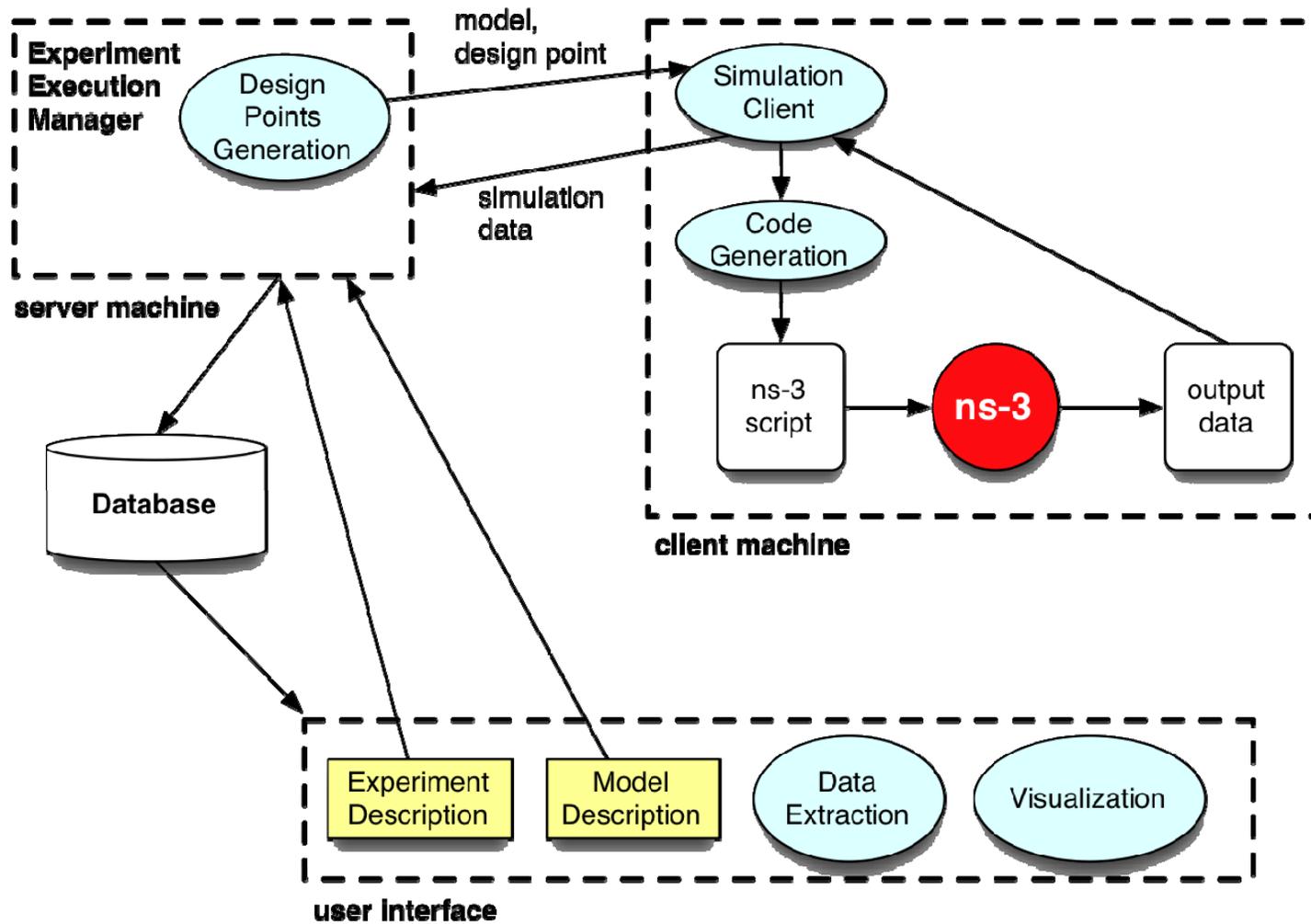
- NSF CISE Community Research Infrastructure
 - University of Washington (Tom Henderson), Georgia Tech (George Riley), Bucknell Univ. (Felipe Perrone)
 - Project timeline: 2010-14



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

The screenshot shows a web browser window with the URL "The ns-3 network simulator". The website has a dark header with the "ns-3" logo and a navigation menu with links for OVERVIEW, RELEASES, DOCUMENTATION, DEVELOPERS, and SUPPORT. A "Subscribe to post" button is visible in the top right.

The main content area features a large introductory text block: "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 GPLv2 license](#), and is publicly available for research, development, and use." This is accompanied by a 3D bar chart graphic.

Below this are two columns of content:

- Developers:** A section titled "Developers:" with the text "Building a great network simulator for research and education requires many contributions from the networking community." and a link "→ How to contribute". It includes a network diagram icon.
- Download latest release:** A section titled "Download latest release:" with the text "The most recent stable release (currently ns-3.10) or another archived release" and a link "→ All downloads". It features a CD-ROM icon with the ns-3 logo.

On the right side, there is a "Recent Posts:" sidebar with a list of posts:

- January 2011 Pyviz added to ns-3** : As of ns-3 10, Gustavo Carneiro's pyviz has been ad...
- January 2011 ns-3 developers meeting** : A face-to-face developers meeting is planned for end of...
- January 2011 Release 3.10** : Release 3.10 Availability This release is available a...
- October 2010 Call for Papers: Workshop on ns-3, 25 March 2011, Barcelona** : The WNS'11 workshop will be collocated with SMUTOOLS...
- August 2010 Release 3.9** : Availability This release is immediately available fro...
- May 2010 Release 3.8** : Availability This release is immediately available fro...

At the bottom of the sidebar is a link "→ 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

