NS-3 Consortium
Plenary Talk

Tom Henderson (University of Washington and Boeing Research & Technology)
Walid Dabbous (INRIA)

March 2013

Agenda

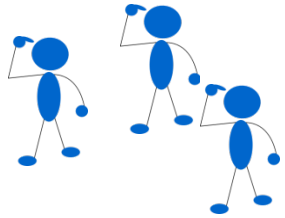
- Opening Remarks
- Meeting Agenda and Logistics
- ns-3: An Overview
- ns-3 Consortium: An Overview
- How to Get Involved

Meeting agenda

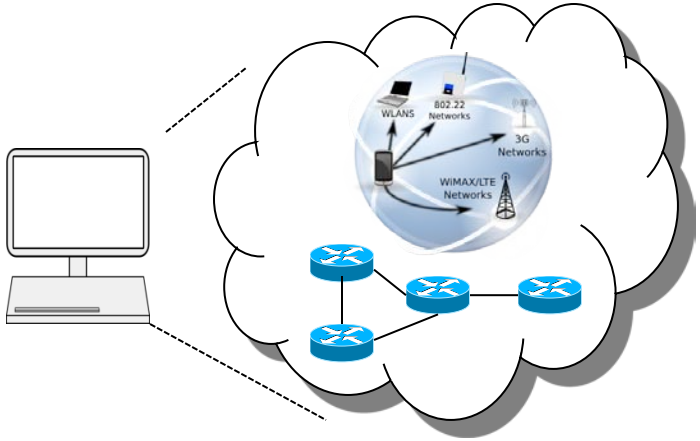
- **Plenary talks** (09h00-12h00)
  - Introduction to the NS-3 Consortium (Walid Dabbous and Tom Henderson)
  - The LENA Project (Nicola Baldo)
  - Direct Code Execution with ns-3 (Mathieu Lacage and Hajime Tazaki)
  - Using Network Simulation in Classroom Education (George Riley)
  - The Evolution of a Computer Aided Simulation System (Felipe Perrone)
- Lunch (courtesy of INRIA) (12h00-13h00)
- **Tutorial Session 1** (13h00-15h00)
  - 13h00-15h00: ns-3 introductory tutorial (Part 1)
  - 13h00-14h00: A technical overview of the ns-3 LTE module by the LENA project
  - 14h00-15h00: Direct Code Execution
- **Tutorial Session 2** (15h30-17h00)
  - 15h30-17h00: ns-3 introductory tutorial (Part 2)
  - 15h30-16h15: NEPI
  - 16h15-17h00: Visualization and data collection
- Cocktail (17h00-18h00)
- Coffee breaks will additionally be provided.

ns-3: An Open Source Network Simulator

- ns-3 is a ***discrete-event network simulator*** targeted for ***research and educational use***



model developers



ns-3 software

Research

NS-3 Consortium

ns-3 maintainers

Education

ns-3 project goals

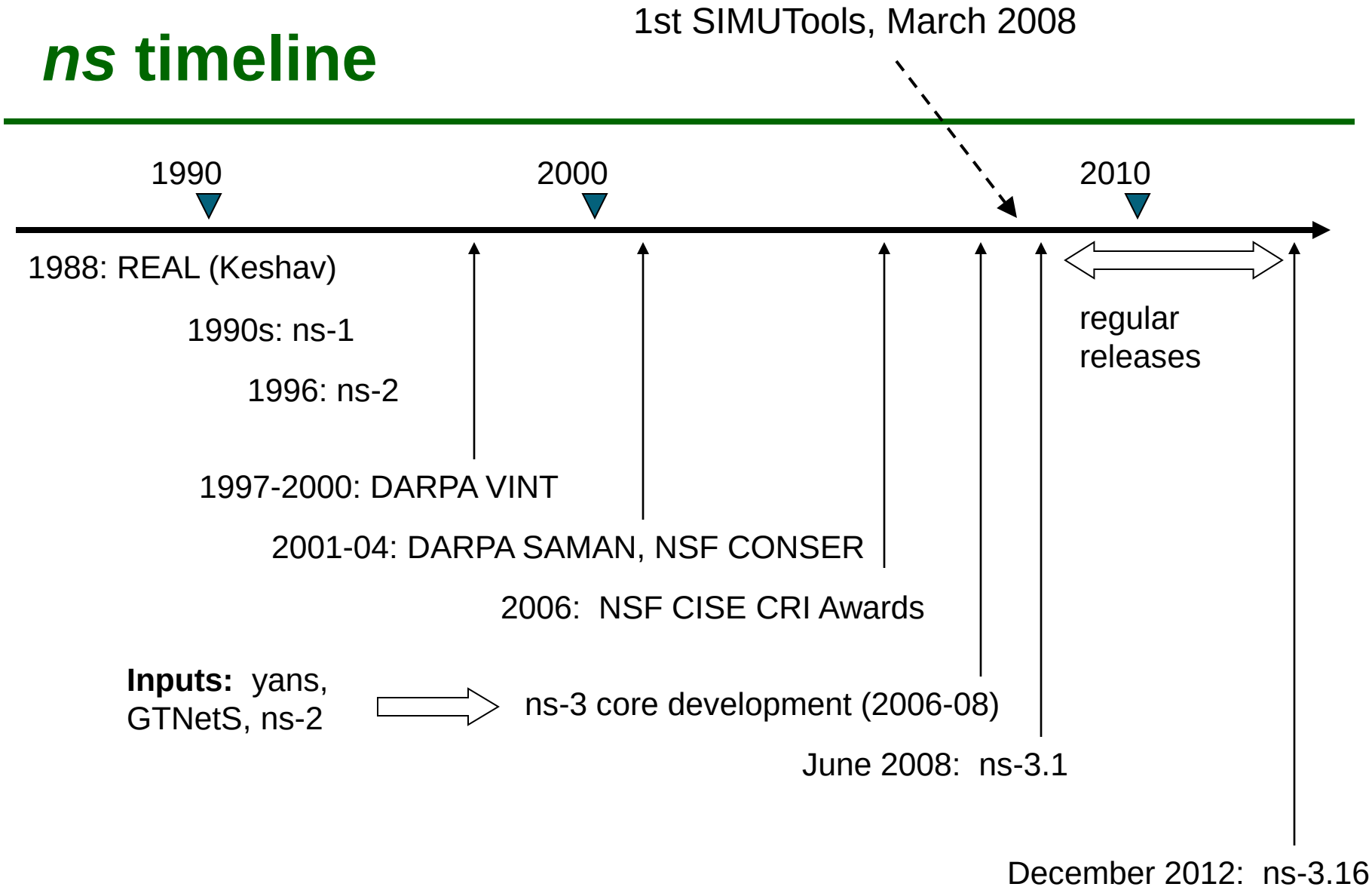
Develop an extensible simulation environment for networking research

1) a tool aligned with the experimentation needs of modern networking research

2) a tool that elevates the technical rigor of network simulation practice

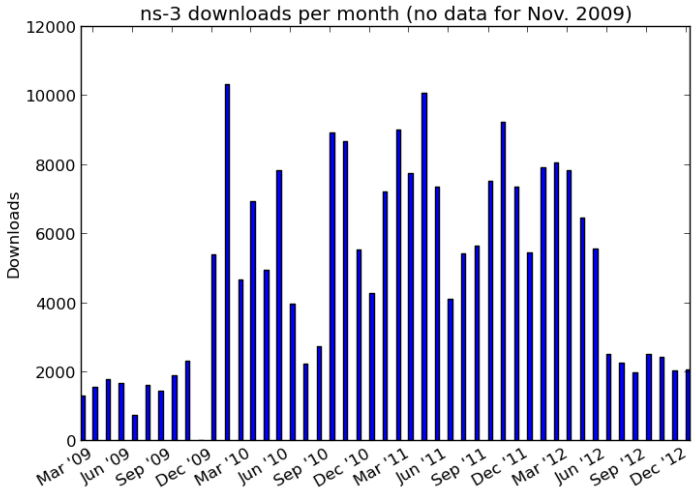
3) an open-source project that encourages community contribution, peer review, and long-term maintenance and validation of the software

ns timeline

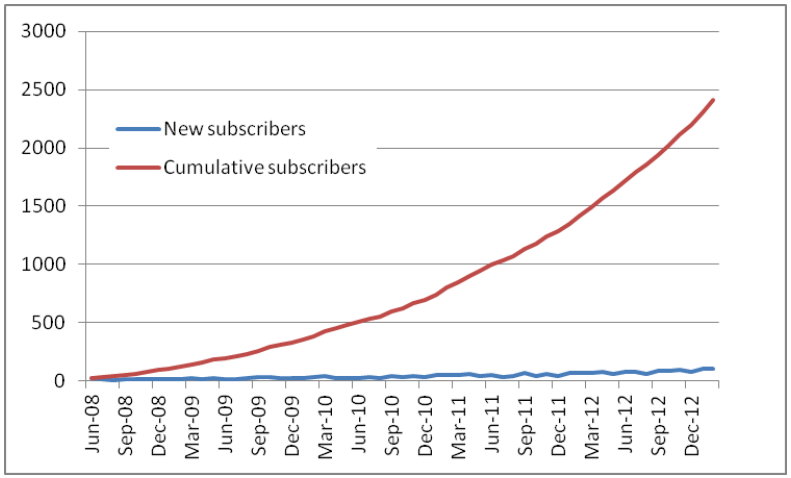

1st SIMUTools, March 2008
1990
2000
2010
1988: REAL (Keshav)
1990s: ns-1
1996: ns-2
1997-2000: DARPA VINT
2001-04: DARPA SAMAN, NSF CONSER
2006: NSF CISE CRI Awards
regular releases
Inputs: yans, GTNetS, ns-2
ns-3 core development (2006-08)
June 2008: ns-3.1
December 2012: ns-3.16

Recent statistics

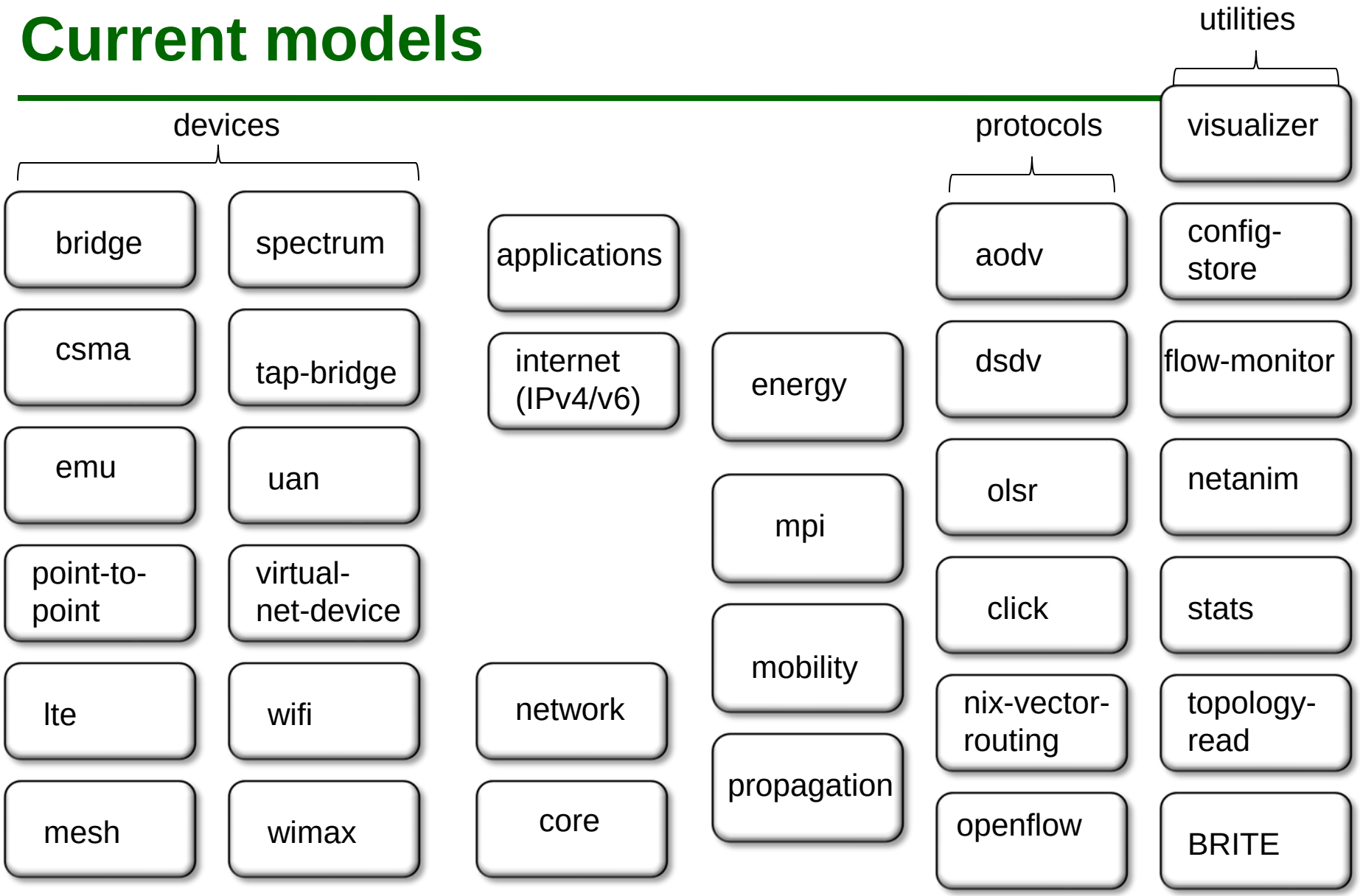
- 50,000 downloads in 2012
- ~ 20 maintainers, ~100 contributors
- 2400 subscribers to ns-3-users
- 1300 subscribers to ns-developers
- ~300 citations in ACM and IEEE digital libraries
  - search 'ns-3 simulator' keyword



ns-3-users list subscribers vs time



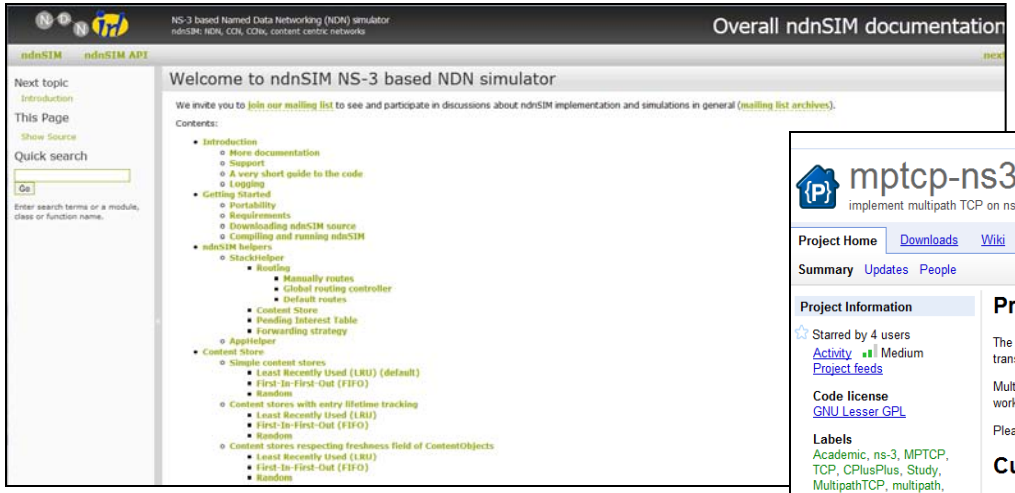
Current models

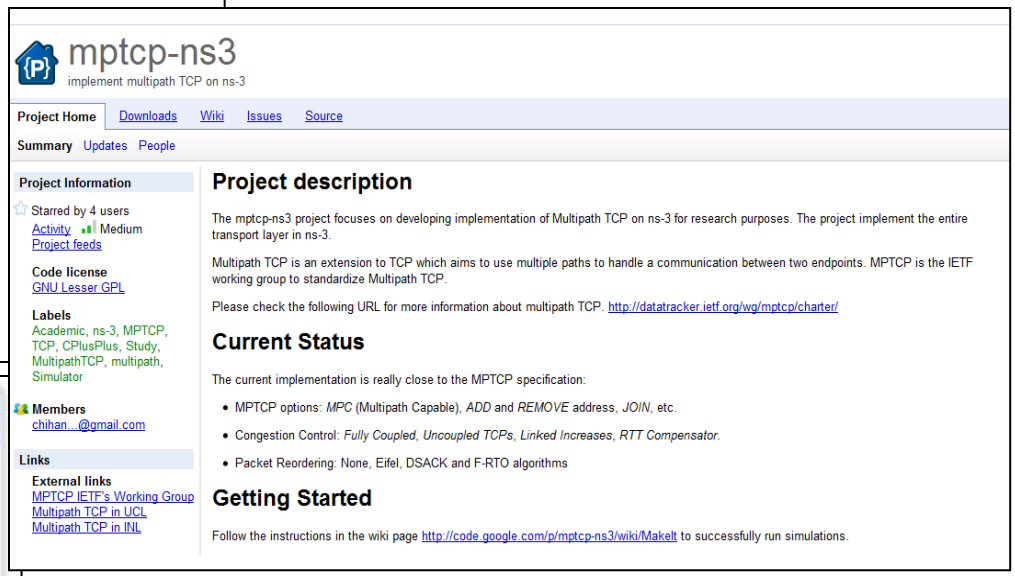


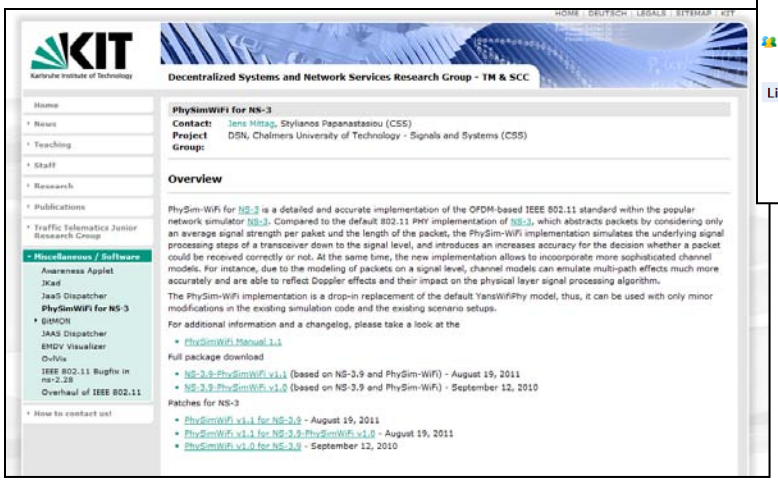
Models under current review

- TCP Westwood and Westwood+
- IEEE 802.11n extensions
- General purpose emulation device (FDNetDevice)
- BitTorrent clients and servers
- SMECN (Small Minimum Energy Communication Network) / RNS (Redundant Node Selection)
- Directional antenna models
- Longley-Rice and ITU terrain-aware propagation models
- Low resolution radio model
- Wideband propagation model
- IEEE 802.11b indoor wireless channel models
- HTTP traffic generator
- GPSR routing
- TMIX and DelayBox
- Basic TDMA model
- Poisson Pareto Burst Process traffic generator
- CLWPR (Cross Layer, Weighted, Position-based, Routing)
- Virtual Access Points (VAP) for WiFi
- Directional antenna models
- TCP Options
- Switched Ethernet Device

Contributed code and associated projects





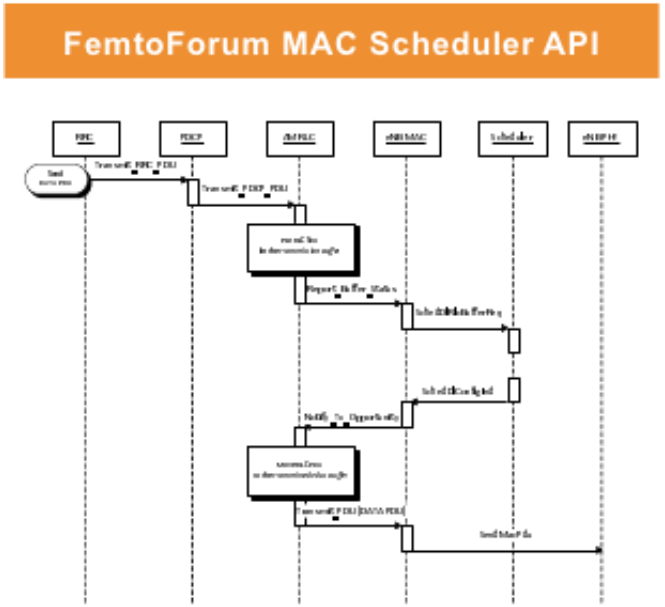


How the project operates

- Project provides three annual software releases
- Users interact on mailing lists and using Bugzilla bug tracker
- Code may be proposed for merge
  - Code reviews occur on a Google site
- Maintainers (one for each module) fix or delegate bugs, participate in reviews
- Project has been conducting annual workshop and developer meeting around SIMUTools
  - Some additional meetings on ad hoc basis
- Google Summer of Code (March-August) four of the past five summers

LTE Medium Access Control (MAC) Schedulers

- **Student:** Dizhi Zhou
- **Mentors:** Nicola Baldo,
  Marco Miozzo



- **Project rationale:** Improve the accuracy and realism of the MAC scheduling models in ns-3 LTE
- **Accomplishments:** Implemented, tested, documented eight new schedulers for the LTE MAC

Maintenance load

Project funding is needed for the core project maintenance

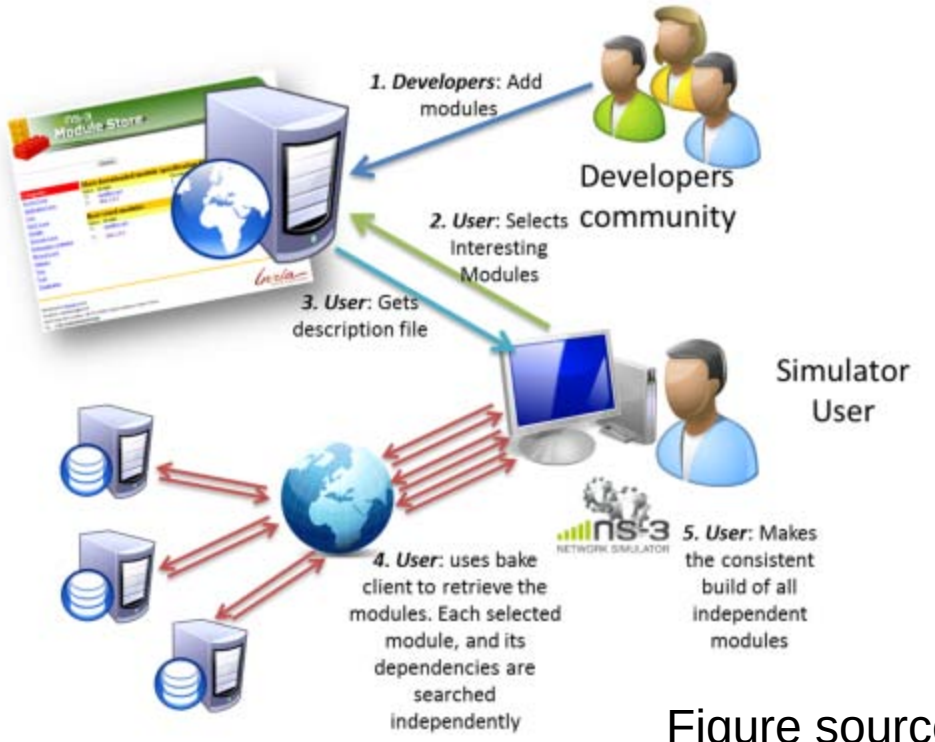
- Core software maintenance
- New code integration and review
- Usability and documentation improvements

Roadmap Priorities

- Software modularity and long-term maintenance
- Integration of direct code execution
- Integration with container-based and testbed-based experiment infrastructures
- Simulation-based experiment management
- Usability

Modularity

- Open source project maintains a (more stable) core
- Models migrate to a more federated development process



"bake" tool (Lacage and Camara)

Components:

- build client
- "module store" server
- module metadata

Figure source: Daniel Camara

Direct Code Execution

- Developed by Mathieu Lacage and Frederic Urbani, INRIA, Hajime Tazaki (NICT)
- Run unmodified application binaries in ns-3
  - Also, can run entire Linux stack in ns-3

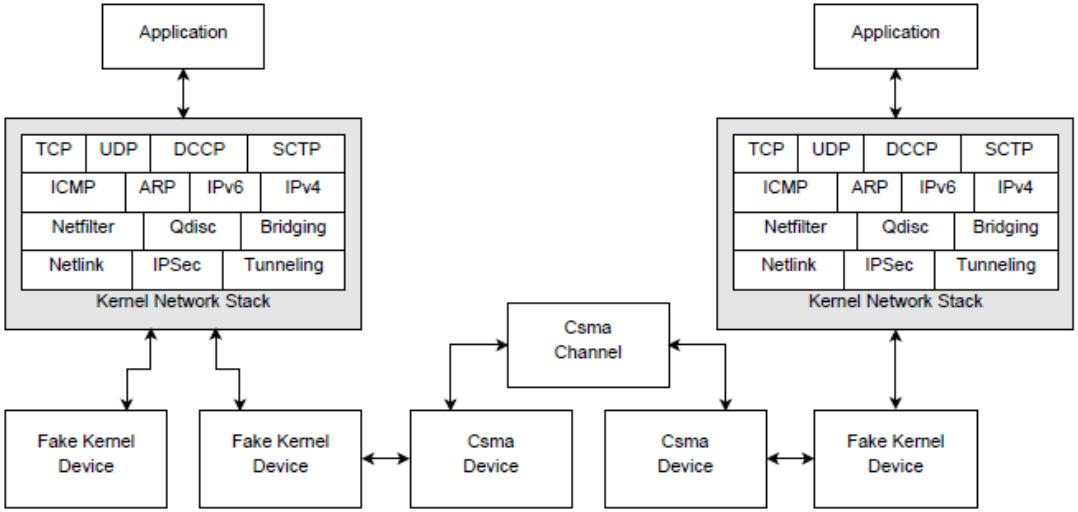


Figure 4.6: The Linux network stack running inside ns-3

Figure source: Mathieu Lacage

http://www-sop.inria.fr/members/Frederic.Urbani/ns3dceccnx/index.html

Container-based Integration

- Common Open Research Emulator (CORE)
  - http://pf.itd.nrl.navy.mil
- Python-based framework using ns-3 Python bindings, distributed computing library, and ns-3 TapBridge framework

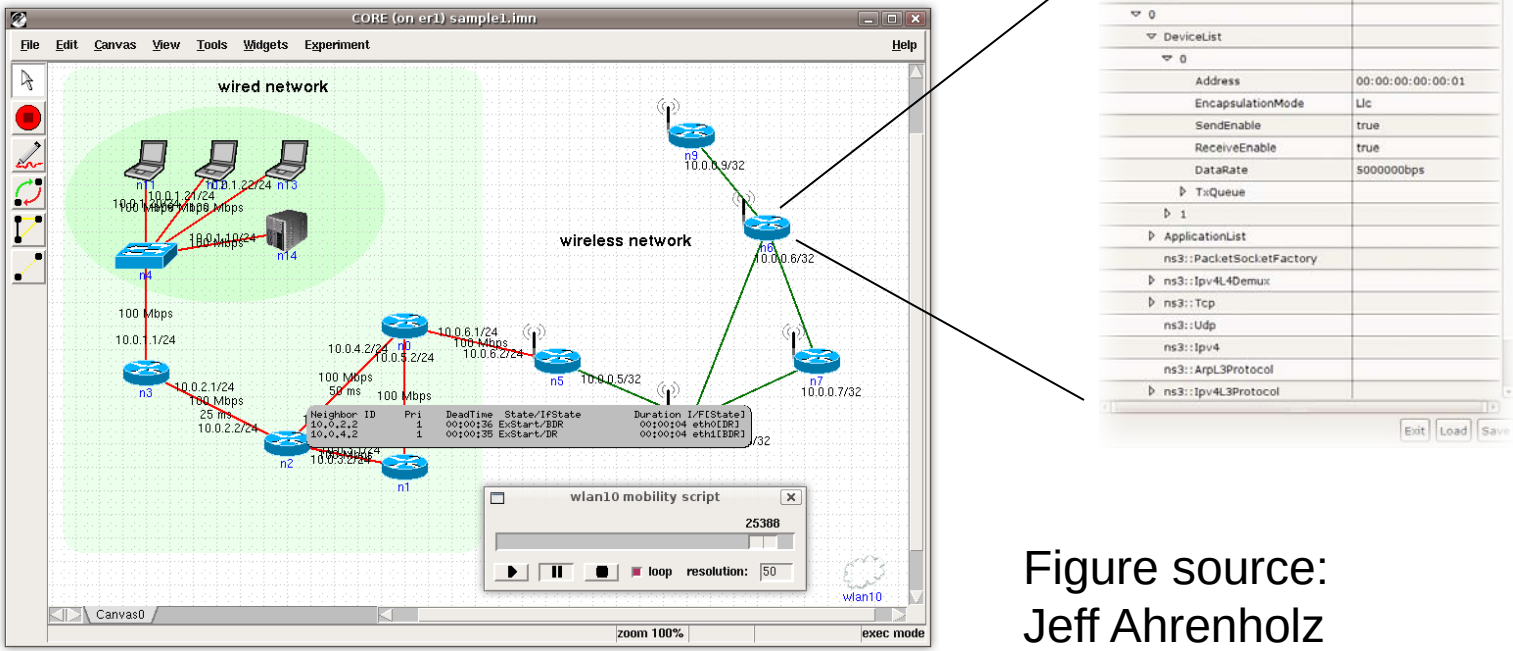


Figure source:
Jeff Ahrenholz

Network Experiment Management Framework (NEPI)

- Network experiment management framework to automate experiment life-cycle
- Allows scenarios involving heterogeneous resources (ns-3, PlanetLab, netns, …)
- Wiki: http://nepi.inria.fr

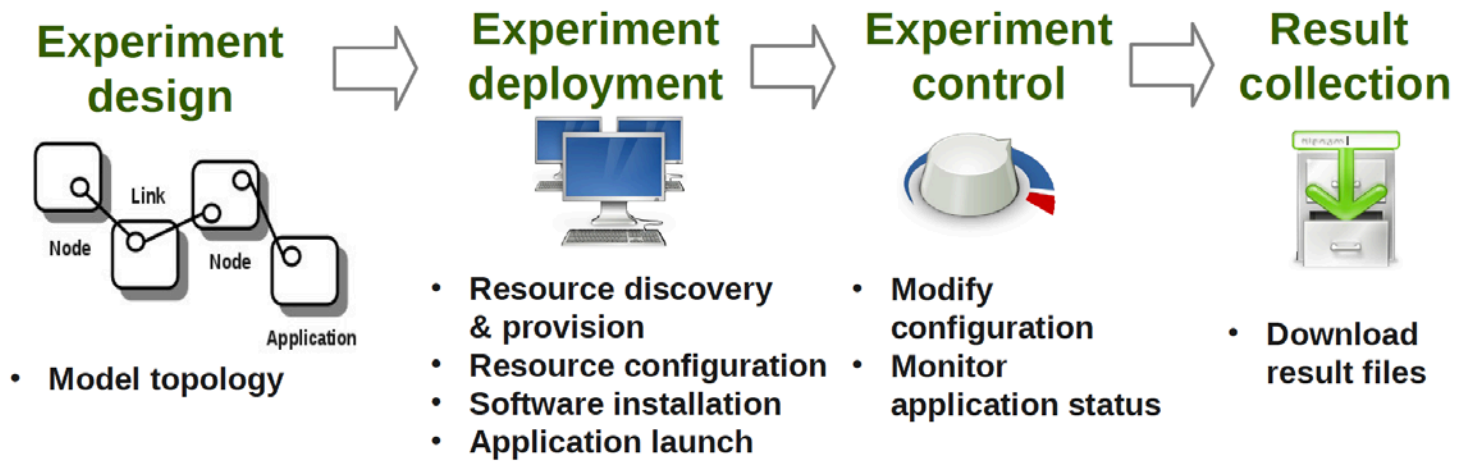


Figure source: Alina Quereilhac, INRIA

Global Environment for Network Innovations (GENI)

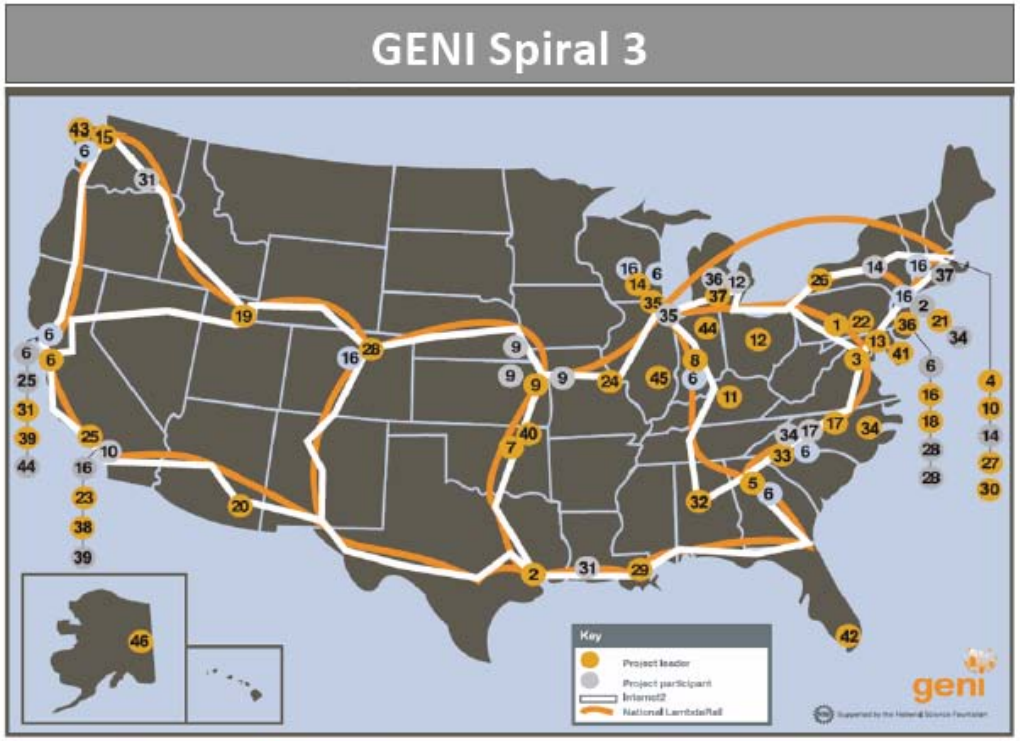


Figure source: GENI at a Glance.pdf
URL: http://www.geni.net

General issues with hybrid environments

- Ease of use
  - Configuration management and coherence
  - Information coordination (two sets of state)
    - e.g. IP/MAC address coordination
  - Output data exists in two domains
  - Debugging
- Error-free operation (avoidance of misuse)
  - Synchronization, information sharing, exception handling
    - Checkpoints for execution bring-up
    - Inoperative commands within an execution domain
    - Deal with run-time errors
  - Soft performance degradation (CPU) and time discontinuities

SAFE: Simulation Automation Framework

- Data collection, transient analysis, management of independent replications, graphical configuration and visualization
- In ns-2 realm, similar to projects like ANSWER, ns2measure, and Akaroa2

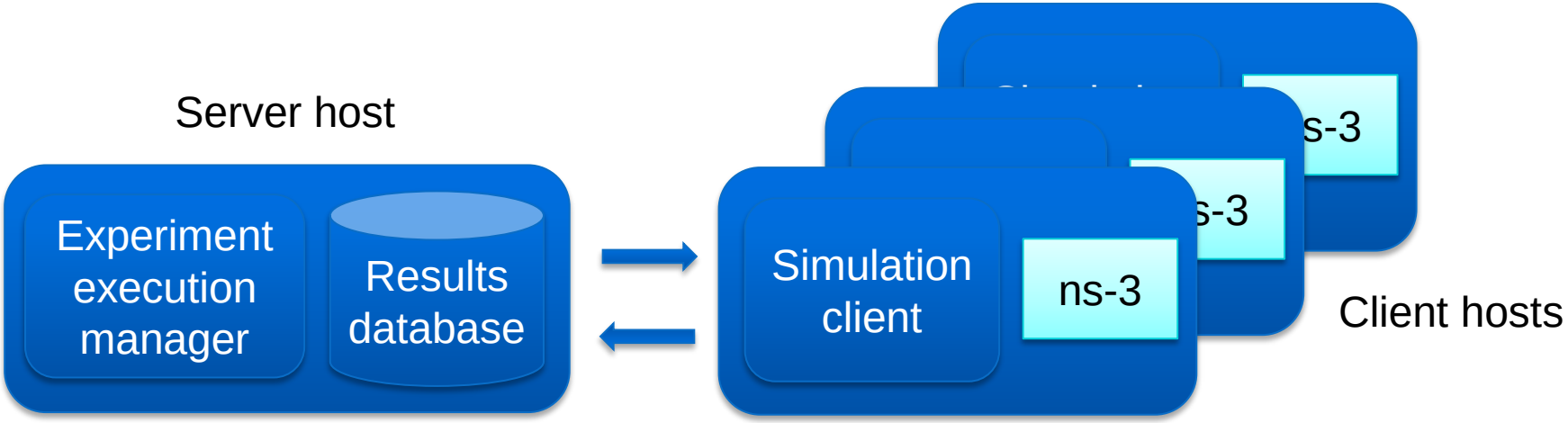
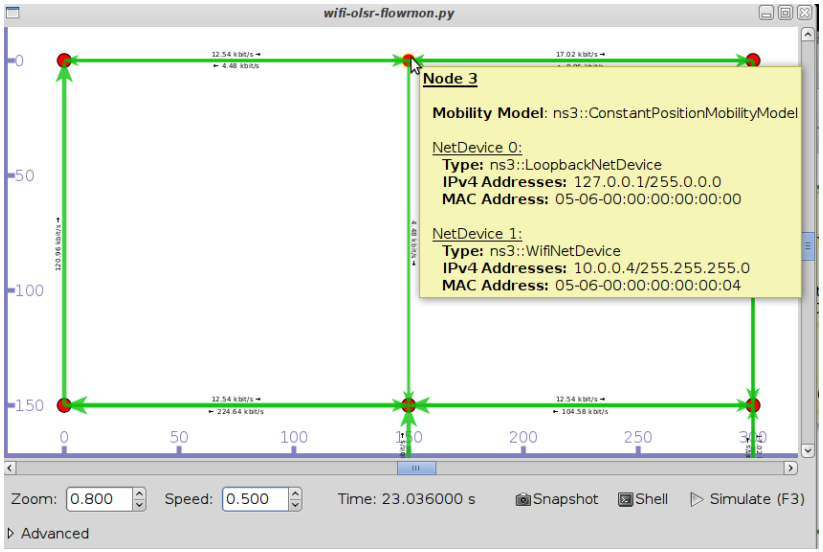


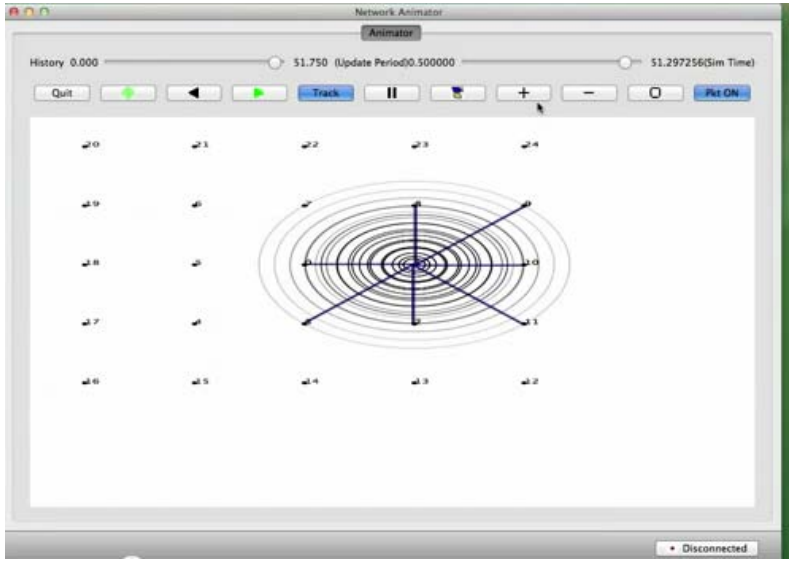
Figure source: Felipe Perrone

Usability

- Animation and visualization



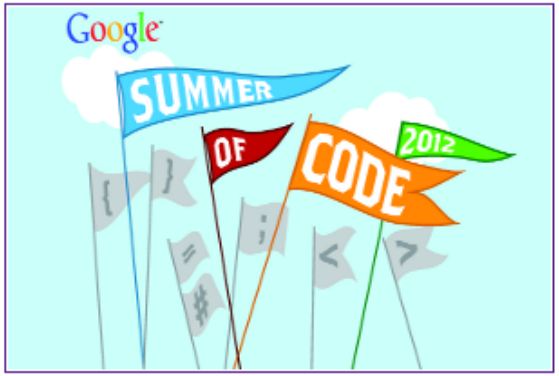
PyVis (Carneiro)

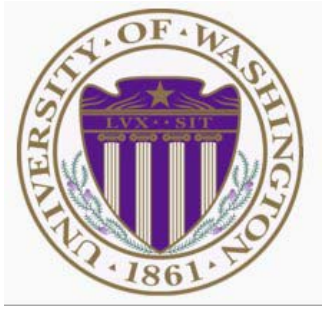


NetAnim (Riley and Abraham)

- Linkage to external tools (topology, mobility, statistics)
- Improved helper APIs

Acknowledgment of support





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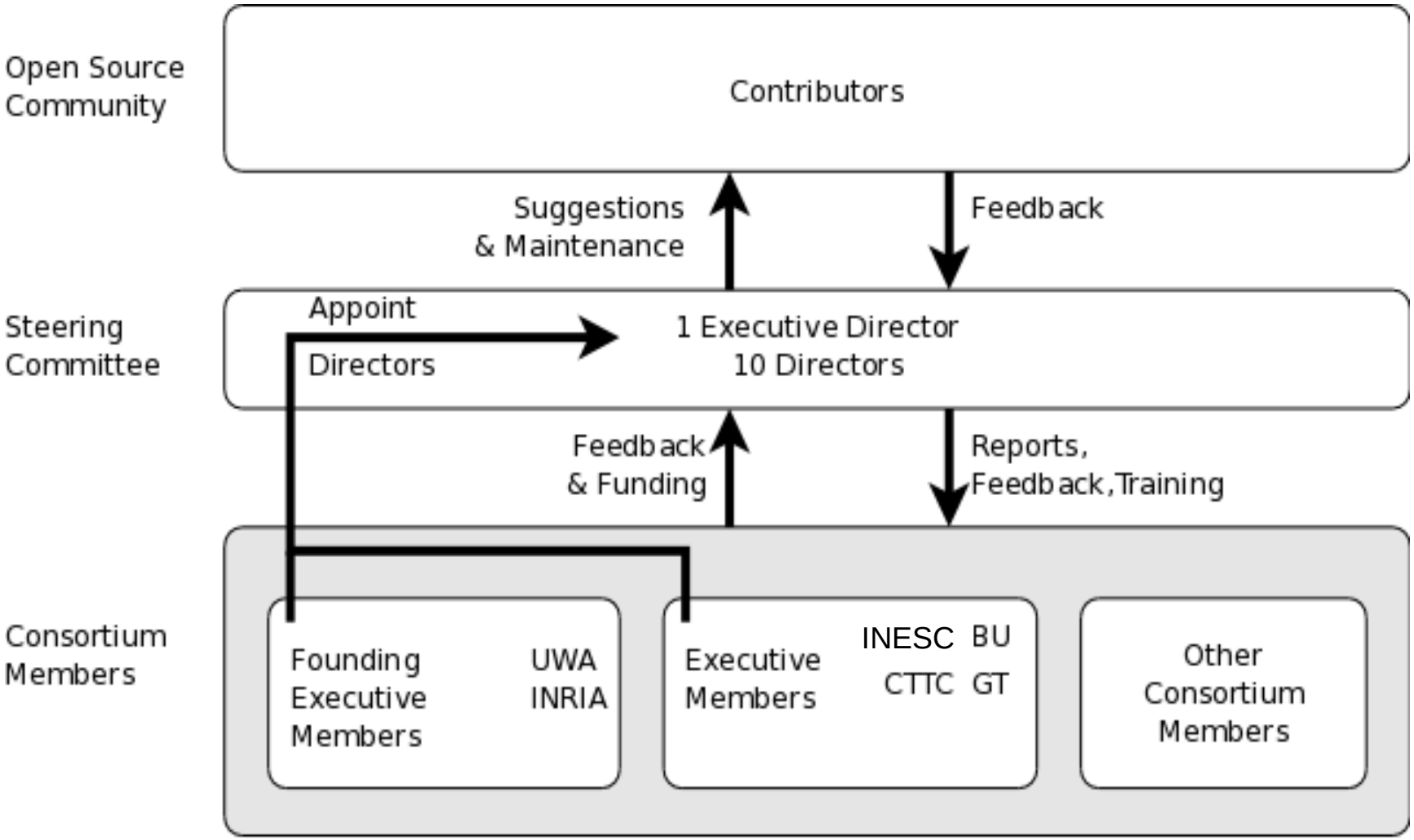
- ns-3 Consortium: An Overview
- How to Get Involved

Goals of the consortium

- The NS-3 Consortium is a collection of organizations cooperating to support and develop the ns-3 software.
- It operates in support of the open source project
  - by providing a point of contact between industrial members and ns-3 developers,
  - by sponsoring events in support of ns-3 such as users' days and workshops,
  - by guaranteeing maintenance support for ns-3's core, and
  - by supporting administrative activities necessary to conduct a large open source project.

Governance


Open Source Community
Contributors
Suggestions & Maintenance
Feedback
Steering Committee
Appoint Directors
1 Executive Director
10 Directors
Feedback & Funding
Reports, Feedback, Training
Consortium Members
Founding Executive Members
UWA
INRIA
Executive Members
INESC
BU
CTTC
GT
Other Consortium Members

Membership

- The Consortium is governed by an agreement established between the founding members: INRIA and the University of Washington.
- Membership to the Consortium is open to those institutions that sign the member application form
- The Consortium is overseen by a Steering Committee composed of individuals appointed by Executive Members of the Consortium.

The Steering Committee

- Initially composed of six directors appointed by the Founding Executive Members (three directors each).
- Including one rotating Executive Director
- Additional institutions may be be invited to become Executive Members by the Steering Committee.
- Executive Members who are not Founding Executive Members (UW and INRIA) may appoint one individual to serve on the Steering Committee.
- The initial Steering Committee consists of:
  - Tom Henderson (director), Sumit Roy, Mike Clarke (University of Washington)
  - Walid Dabbous, Gérard Giraudon, Marc Barrett (INRIA)

New Executive Members

- Two new Executive Members joined in February 2013:
  - Centre Tecnològic de Telecomunicacions de Catalunya (CTTC)
  - INstituto de Engenharia de Sistemas e Computadores do Porto (INESC Porto)

New Executive Members

- Two other Executive members are joining the consortium:
  - Georgia Institute of Technology (George Riley)
  - Bucknell University (Felipe Perrone)

Role of the Steering Committee

- Making decisions on how the Consortium's funds shall be expended, accordingly with its objectives
  - organization of training courses, workshops, etc.
- Supervising the roadmap of the software maintenance.
- Organizing the various events in relation to the NS-3 Consortium.
- Receiving and collecting Consortium Members' feedback and suggestions concerning NS-3 software development.
- Submit suggestions made by Consortium Members to NS-3 Maintainers.
- Preparing a yearly scientific, technical and financial report.
- Accepting new Members

Consortium Members

- Not-for-profit organizations, small, and large companies may apply to become Consortium Members.
- Each Consortium Member may:
  - Submit suggestions, requests and feedback concerning the ns-3 software development directions and roadmap, to be discussed during the yearly plenary assembly.
  - Attend the Consortium annual meeting during which the ns-3 most recent release shall be presented and during which a sample of suggestions made by Consortium Members shall be discussed.
  - Designate attendees (1 for small companies and universities and 2 for large companies) to attend a yearly, one day ns-3 training course.
  - Receive yearly Consortium financial and technical summary report.
  - Have their name, including logo, placed on the ns-3 website www.nsnam.org.

Financial

- Finances are managed by the Steering Committee
- Financial goal is to ultimately support two full-time software maintainers
- Provide other financial support for smaller items (e.g. DNS registration, software, events, etc.)
- Support sponsored research expenditures as needed

Cost structures

Three ways to contribute funding

- 1) unrestricted gift
- 2) membership dues (subject to low institutional overhead)
- 3) sponsored research project (subject to regular institutional overhead)

Activities

- Annual meeting and tutorials
- Maintenance of the ns-3 website
- Student travel grants
  - Vedran Miletić (WNS3 2013)
- Other activities anticipated

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How to Get Involved

- Membership
- Sponsored research
- Unrestricted gifts
- Summer of Code program
- Participation in the open source project

Membership

- Membership is a way for your organization to sponsor recurring investment in the open source project

Inria's dues and overhead for Inria-based Consortium Members:

	Dues Before Overhead	Overhead (15%)*	VAT	Total Dues
Universities and non-profit	€1 000	€176	VAT will be applied pursuant to territoriality rules.	€1 176 + VAT
Very small companies	€1 000	€176		€1 176 + VAT
Small companies	€5 000	€882		€5 882 + VAT
Large companies	€10 000	€1 765		€11 765 + VAT

*For Inria, overhead is assessed on total payment.

University of Washington's dues and overhead for University of Washington-based Consortium Members:

	Dues Before Overhead	Overhead (20%)**	Taxes	Total Dues
Universities and non-profit	$1,250	$250	Taxes will be applied pursuant to U.S. rules.	$1,500 + Taxes
Very small companies	$1,250	$250		$1,500 + Taxes
Small companies	$6,250	$1,250		$7,500 + Taxes
Large companies	$12,500	$2,500		$15,000 + Taxes

**For the University of Washington, overhead is assessed on expenditures.

Sponsored Research and Gifts

- Sponsored research (request for specific development) incurs the research overhead rate

- One-time gifts (unrestricted) are not subject to overhead and can be made at any time

Summer of Code Program

- Looking to develop a program combining industry and ns-3 mentoring, through the consortium
- 10 week program, student paired with a mentoring team (1 ns-3 maintainer, 1 industry mentor)
  - ns-3 maintainer focuses on ns-3 development
  - industry mentor provides guidance on modeling and validation

Benefits to membership

- Send attendees to (annual) Consortium meetings for training
- (Optionally) place your logo on the website as a member/supporter of ns-3

Questions?