ns-3 development overview

ns-3 tutorial agenda

- 3:00-4:30: ns-3 current capabilities
  - Project overview
  - Walkthrough of basic simulation scenario
  - Parallel simulations and visualization
  - Emulation
- 4:30-4:40: 10-minute break
- 4:40-5:45: Work in progress
  - ns-3 development process
  - Automation
  - Direct code execution
  - Virtual machine and testbed integration
- 5:45-6:00: Q & A

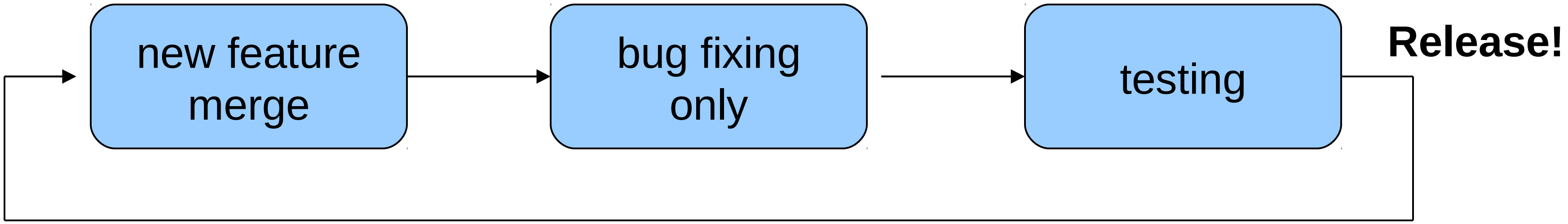
ns-3 development process

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

- GPLv2 licensing stance
- open mailing lists
- use standard tools (Mercurial, Bugzilla, Mediawiki, GNU/Linux development)
- 13 maintainers worldwide

ns-3 development process

- date-driven quarterly releases

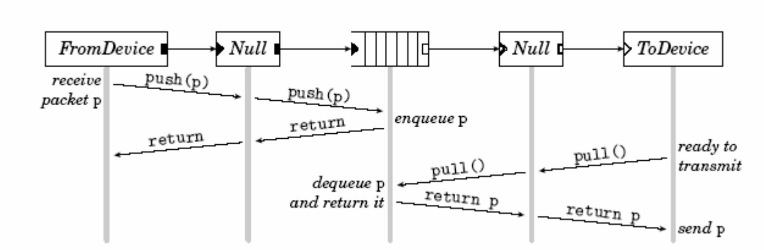


- All code for merge to ns-3 is openly reviewed by maintainers
  - Syntactic (style) reviews
  - Design reviews
  - Documentation and tests
  -

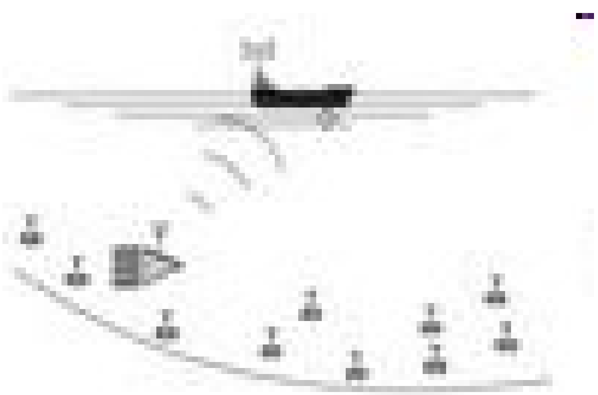
current merge queue

- ns-3.10 release (January 2010)
  - new TCP model with modular congestion control
  - Virtual Access Point (VAP) for WiFi
  - BulkSend application
  - Pyviz visualizer
  - Energy model for WiFi
  - DSDV routing for IPv4
  - PhySim for WiFi

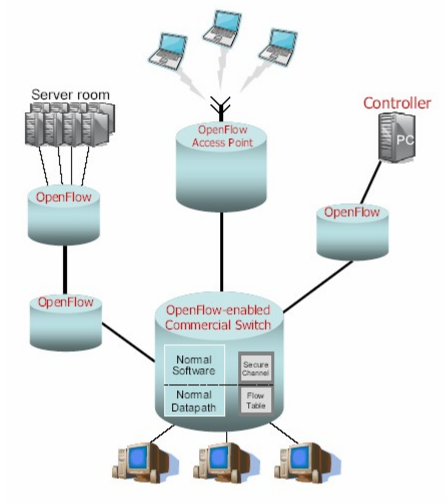
ns-3 and Google Summer of Code



Click Modular Router
Lalith Suresh



SUMMER OF CODE // 2010
code.google.com/soc
Google



ns-3 OpenFlow
Blake Hurd

Underwater Acoustic Networking
Andrea Sacco

ns-3 LTE
Giuseppe Piro

Other announced projects

- Wireless jamming model
- MPLS
- VANET mobility model
- TDMA
- TCP Vegas
- DSR routing
- SimpleWireless model
- Zigbee, WPAN, and 6LOWPAN
- Chord/DHash DHT
- Synchronized emulation
- 802.11n
- TMix and DelayBox
- ns-3-simu
- multi-core parallelization

Modularity and model store

- Moving to a modular build and package management system
  - ns-3 project maintains the core
  - models may be enabled/disabled
  - other research groups may separately maintain their own models
    - maintainers can still provide reviews
    - common package metadata format used to inform ns-3 build system

automation

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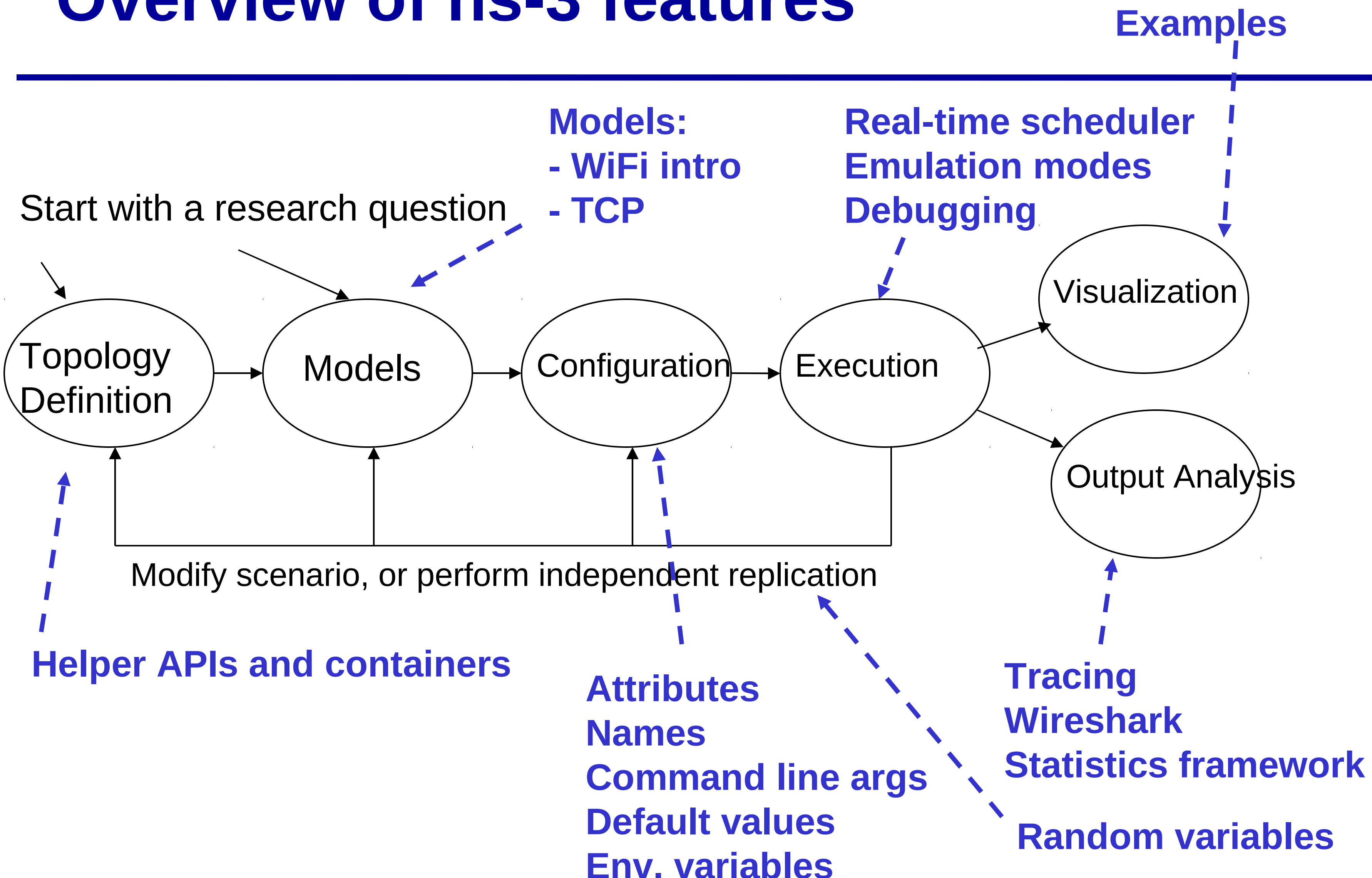
Overview of ns-3 features



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Motivation

Network simulation is no easy business. One must:

- Build a model that is consistent.
- Describe the simulation model for a given simulator.
- Design and execute experiments.
- Process output data using sound methodologies.

We raise the level of abstraction on the user interface to the network simulator to support the needs of both experts and novices.

We can address issues that undermine credibility.

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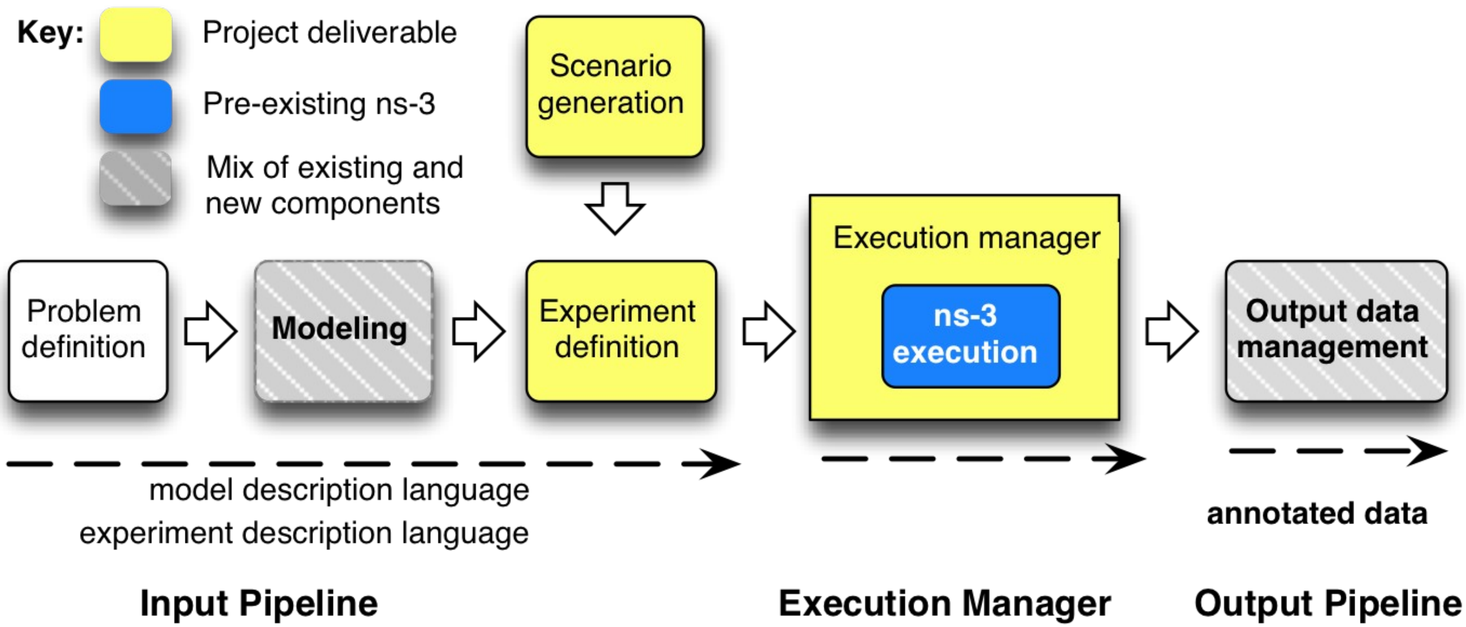
Frameworks for ns-3

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



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Automation

- Task led by Felipe Perrone, Bucknell Univ.
- Inspired by SWAN-Tools and ANSWER frameworks.
- User interfaces, description languages, and tools for automation of experiments.
- Model composition, structural validation, control of experiments, data processing and storage, and archiving experimental setup.

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Topology generation

- Integrate BRITE topology generator (Boston Univ.) into framework.
- BRITE is downloaded into distribution and compiled by the ns-3 build system.
- The ns-3 simulation script uses a topology *helper* which reads a BRITE configuration file, receives results from BRITE, and builds the ns-3 topology.

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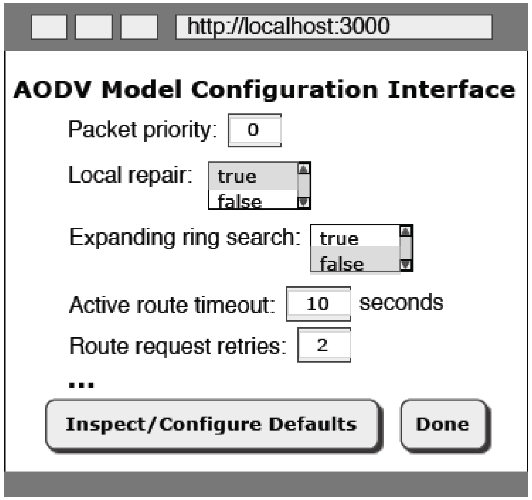
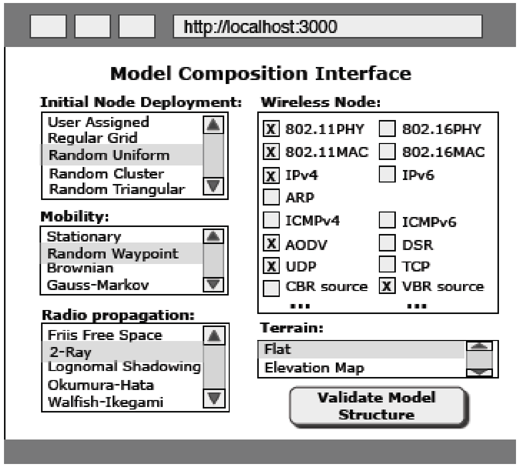
Broader use case

- Provide a model and a description of experiment.
- Framework generates design of experiment space, distribute simulation runs to machines, collect results and archive in persistent storage.
- User mines storage to find, extract, and visualize results.





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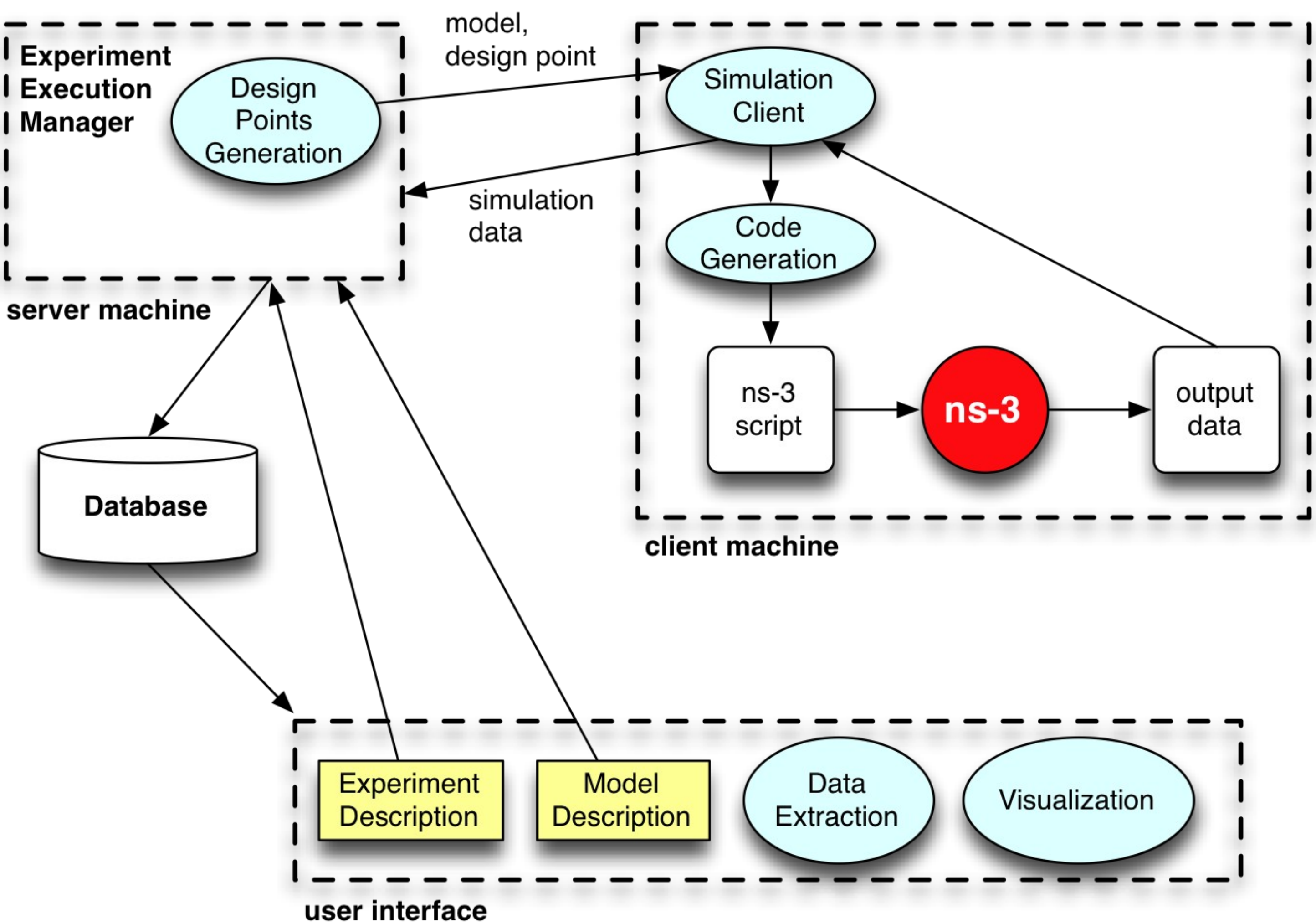
General architecture



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Direct Code Execution

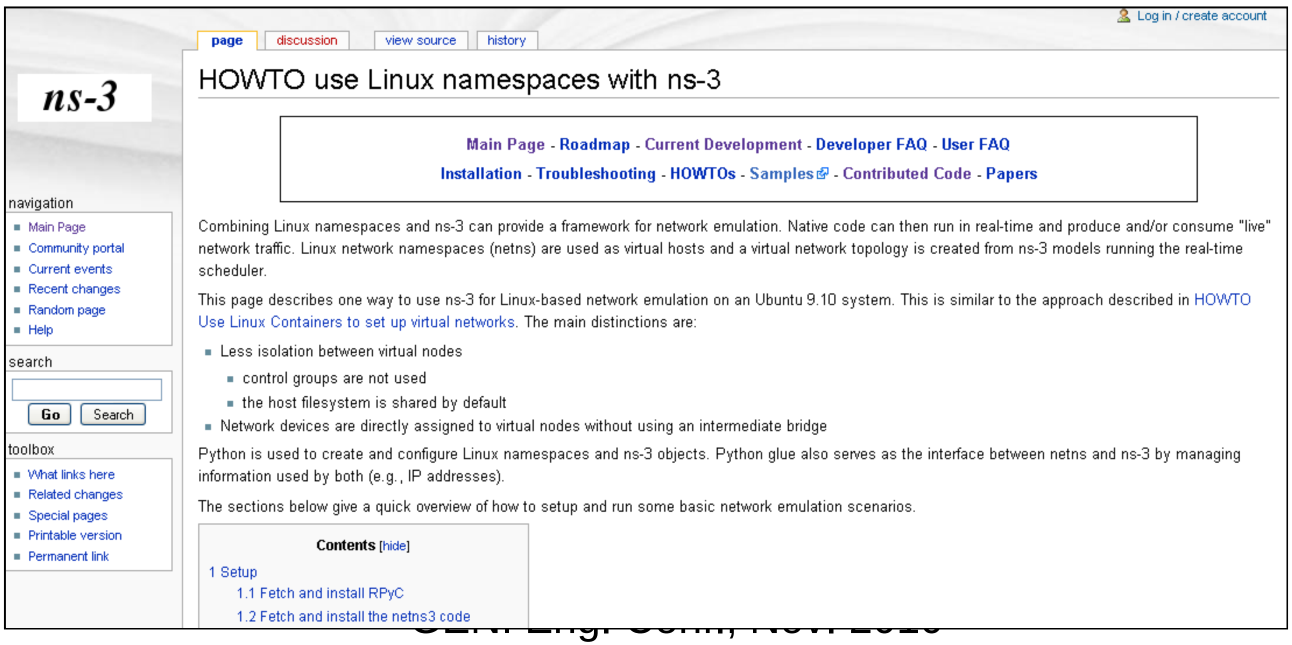
Virtual machines and ns-3

Goals

- Lightweight virtualization of kernel and application processes, interconnected by simulated networks
- Benefits:
  - Implementation realism in controlled topologies or wireless environments
  - Model availability
- Limitations:
  - Not as scalable as pure simulation
  - Runs in real-time
  - Integration of the two environments

netns3

- 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



netns3 demo

File Edit View Terminal Help

```
# Miscellaneous helpers

import ns3
import netns
import subprocess
import optparse
from threading import Thread

ns3.GlobalValue.Bind("SimulatorImplementationType",
                     ns3.StringValue("ns3::RealtimeSimulatorImpl"))

ns3.GlobalValue.Bind("ChecksumEnabled", ns3.BooleanValue("true"))

class Ns3Netns(netns.Netns):

    def addnetif(self, ifname, ipaddrs = [],
                 rename = "eth0", up = True, now = False):
        """\
        Add a network interface to the netns and do basic
        configuration.  By default, the given network interface is
        renamed eth0, given IP address(es), and brought up at when the
        simulation starts.  Waiting until the simulation runs ensures
        tap devices created by ns-3 exist.
        """
        def doaddnetif():
            self.acquire_netif(ifname, rename)
            if rename:
                name = rename
            else:
                name = ifname
            if up:
                self.ifup(name)
            for ipaddr in ipaddrs:
                self.add_ipaddr(name, ipaddr)
        if now:
            doaddnetif()
        else:
            # schedule when simulation starts
            ns3.Simulator.Schedule(ns3.Time("0"), doaddnetif)

class NetnsNode(ns3.Node, Ns3Netns):
                                                  1,1           Top
```

tomh@u94-desktop: ~/wns3/ns3netns/examples

File Edit View Terminal Help

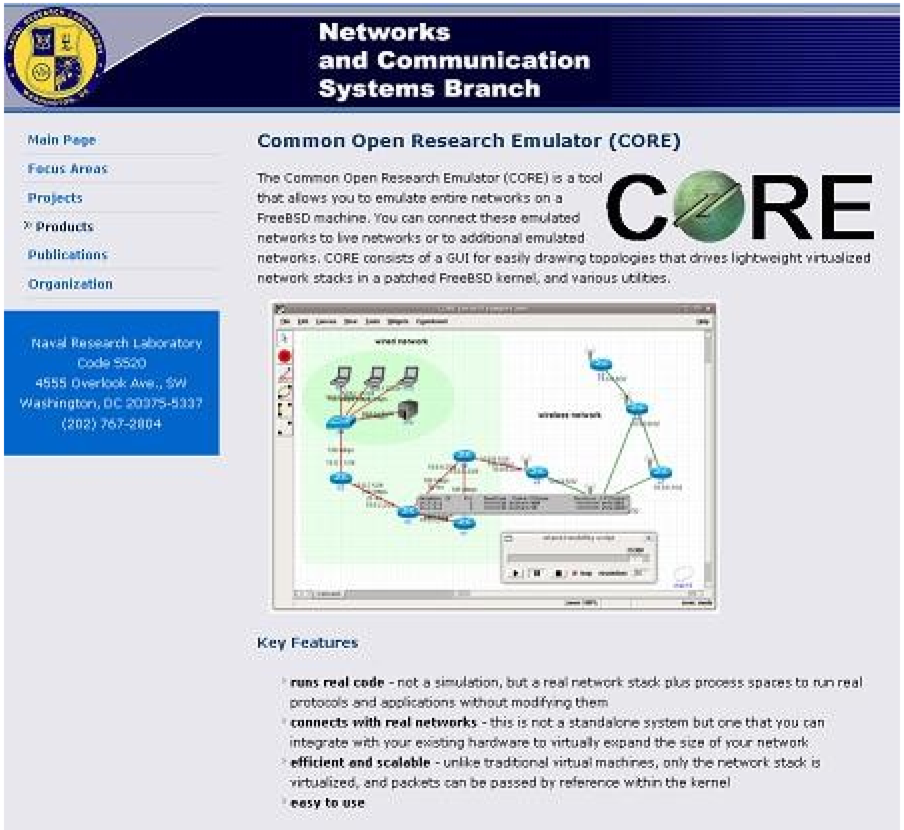
```
    def createnet(self, devhelper, nodecontainer,
                  addrhelper, mask, ifnames = []):
        tapbridge = ns3.TapBridgeHelper()
        devices = devhelper.Install(nodecontainer)
        for i in xrange(nodecontainer.GetN()):
            n = nodecontainer.Get(i)
            dev = devices.Get(i)
            tap = tapbridge.Install(n, dev)
            tap.SetMode(ns3.TapBridge.CONFIGURE_LOCAL)
            tapname = "ns3tap%d" % i
            tap.SetAttribute("DeviceName", ns3.StringValue(tapname))
            addr = addrhelper.NewAddress()
            tap.SetAttribute("IpAddress", ns3.Ipv4AddressValue(addr))
            tap.SetAttribute("Netmask", ns3.Ipv4MaskValue(mask))
            if ifnames:
                ifname = ifnames[i]
            else:
                ifname = "eth0"
            n.addnetif(tapname,
                       ipaddrs = ["%s/%s" % (addr, mask.GetPrefixLength())],
                       rename = ifname)
            n.ipaddr = str(addr)

    def createnodes(self, numnodes, devhelper, prefix = "10.0.0.0/8",
                    nodenum = 0):
        addrhelper, mask = parseprefix(prefix)
        nc = ns3.NodeContainer()
        for i in xrange(numnodes):
            name = "n%s" % nodenum
            n = NetnsNode(name, logfile = "/tmp/%s.log" % name)
            self.nodes.append(n)
            nc.Add(n)
            nodenum += 1
        self.createnet(devhelper, nc, addrhelper, mask)

    def run(self):
        self.setup()
        print "running simulator for %s sec" % self.options.simtime
        t = self.simthread(self.options.simtime)
        t.join()
                                                  81,0-1        43%
```

CORE is an open source project

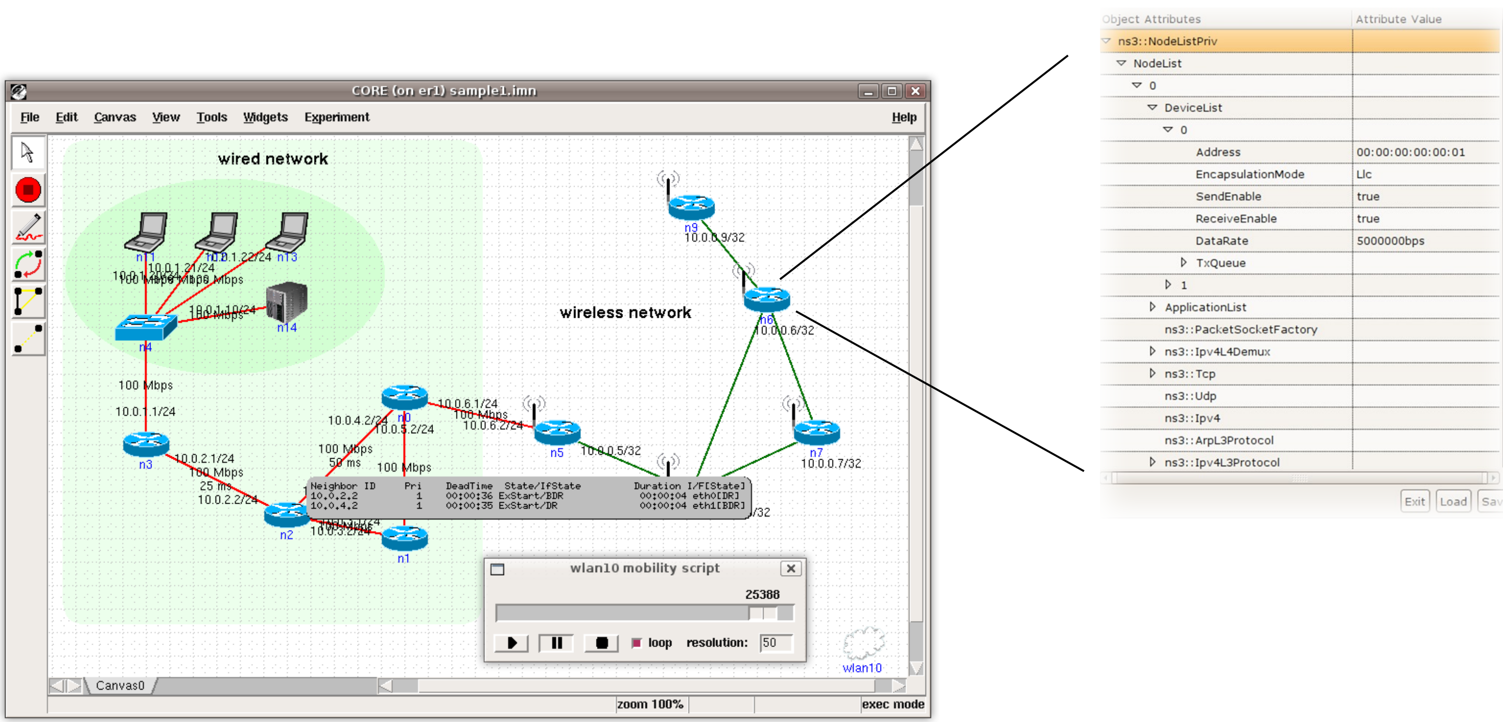
- Web site and code repository hosted by NRL ITD



- Open source licensed
  - –modified BSD license
- Source code at NRL SVN
  - –https://pf.itd.nrl.navy.mil/sf/sfmain/do/
- Wiki/Bug tracker:
  - –http://code.google.com/p/coreemu/
- Mailing lists at NRL:
  - –core-users
  - –core-dev

Future work: Integrating ns-3 and GUIs

- Example CORE and ns-3
  - CORE could glue virtual machines to ns-3 networks



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Other recent related work

CORE is the Common Open Research Emulator that controls lightweight virtual machines and a network emulation subsystem (more on this later)

NEPI/NEF: Using Independent Simulators, Emulators, and Testbeds for Easy Experimentation

- Lacage, Ferrari, Hansen, Turletti (Roads 2009 workshop)

EMANE is an Extendable Mobile Ad-hoc Network Emulator that allows heterogeneous network emulation using a pluggable MAC and PHY layer architecture.

- http://labs.cengen.com/emane
- being integrated with CORE

Scaling time in virtualized environments

- Synchronized Network Emulation - RWTH Aachen University
  - Modified Xen
- VAN Testbed – Telcordia/CERDEC
  - Modified Xen
- Linux Time namespace - Jeff Dike (UML creator)
  - Add a time namespace to the Linux kernel, allowing for gettimeofday() offsets

NEPI

Resources

Web site:

http://www.nsnam.org

Mailing list:

http://mailman.isi.edu/mailman/listinfo/ns-developers

IRC: #ns-3 at freenode.net

Tutorial:

http://www.nsnam.org/docs/tutorial/tutorial.html

Code server:

http://code.nsnam.org

Wiki:

http://www.nsnam.org/wiki/index.php/Main_Page