ENSC 891: Directed Studies

Final Project Presentation
Fall 2009

Integration of ns-BGP with ns-2.34

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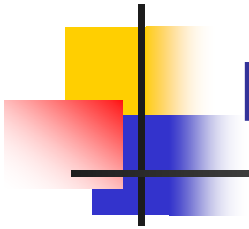
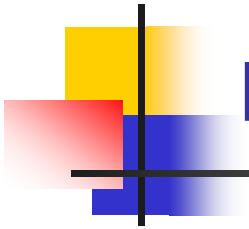


Road map

- Introduction
- Related work
- Hardware platform
- ns-BGP analysis
- Integration of ns-BGP with ns-2.34
- Validation of ns-2.34-BGP
- Conclusions and future work
- References



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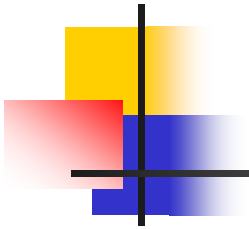
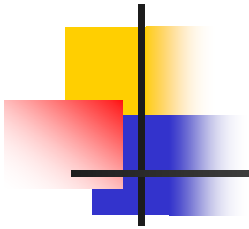


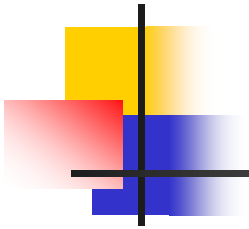
Introduction: project motivation

- BGP is the core routing protocol of the Internet
- BGP performance degradations are due to the highly dynamic nature of the Internet
- Simulation is an effective way to analyze the protocol
- ns-2 network is a widely used simulator
- Update ns-BGP to work with ns-2.34
- BGP ns-2.34 implementation will assist BGP-related research activities



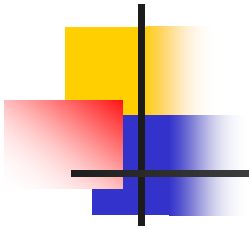
Introduction: ns-2 overview

- ns-2 network simulator broadly used in research communities
- Begun as a variant of the REAL simulator, (1989)
- Gained support from DARPA (1995): the VINT (Virtual Inter Network Testbed) project at LBNL, Xerox PARC, UCB, and USC/ISI
- Stable release 2.34: 2009-06-17
- Implemented in C++/Tcl/OTcl
- Platform: Unix, Mac OS X, Windows via Cygwin
- Website: www.isi.edu/nsnam/ns



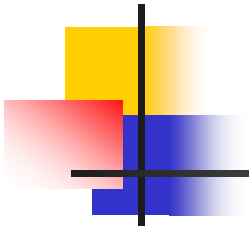
Introduction: ns-2 overview

- Wired and wireless networks
- Various routing algorithms
- Transport protocols: TCP, UDP, SCTP, ...
- Queuing disciplines: drop-tail FIFO, RED, CBQ priority and round-robin, FQ, SFQ, and DDR
- Traffic generator: CBR, exponential, Pareto, trace file
- Tracing
- Visualization: network animator (nam)



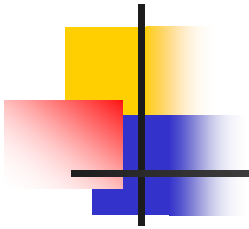
Introduction: BGP overview

- June 1989: BGP-1 published as RFC 1105 by Lougheed and Rekhter
- March 1995: BGP-4 published as RFC 1771 by Rekhter and Li
- De facto inter-autonomous systems routing protocol
- Exchange network layer reachability information (NLRI) between autonomous systems (AS)
- Uses TCP protocol (port 179)
- Message type: open, update, notification, keepAlive



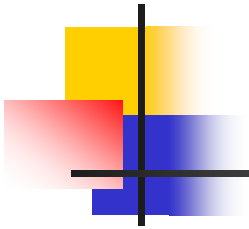
Introduction: BGP overview

- Two speakers establish connection
- Exchange message to open and confirm connection parameters (open)
- Send entire BGP routing table (update)
- Incremental updates sent later (update)
- KeepAlive periodically sent to ensure connection
- Notification sent in response to errors or a special condition then the connection closes
- Various policies control and modify the routing table



Introduction: ns-BGP overview

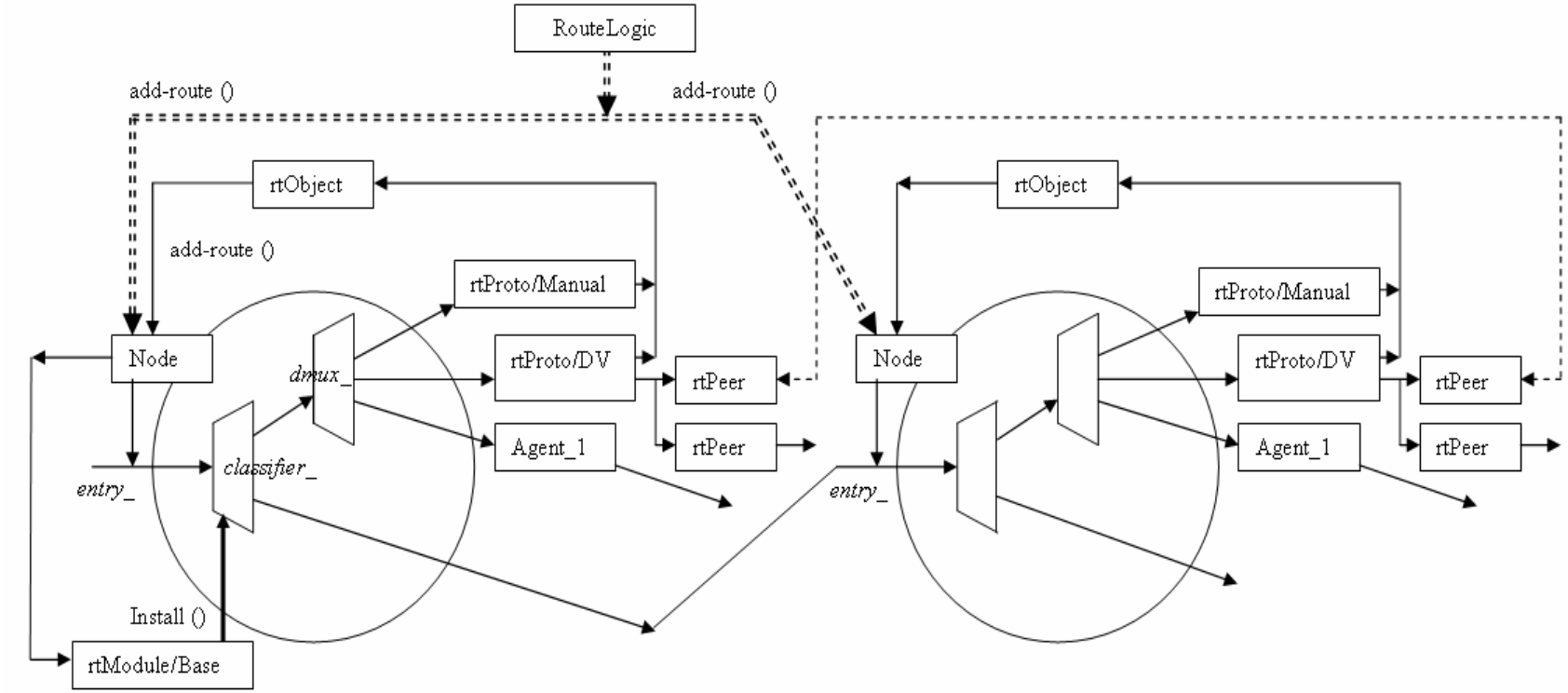
- ns-BGP integrates BGP-4 in ns-2
- BGP implementation ported from SSFNet
- IPv4 addressing, TCP sockets, packet forwarding added
- ns-BGP derived from ns-2 unicast routing structure
- Routing achieved through forwarding and control planes
- Forwarding plane classifies and forwards
- Control plane handles route computation, creation, and the maintenance of routing tables



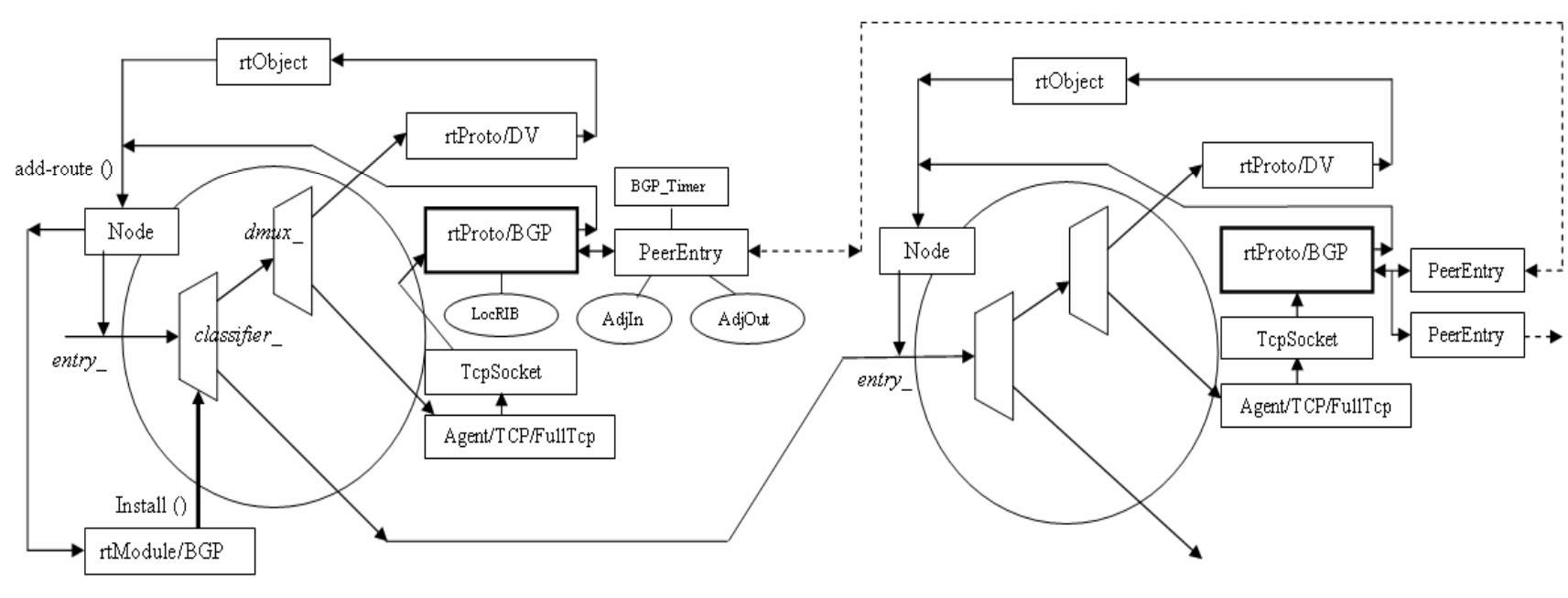
Introduction: ns-BGP overview

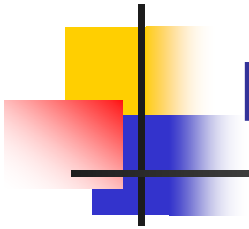
- Summary of changes made to ns-2:
  - TcpSocket: the socket layer implementation of SSFNet, ported
  - IPv4Classifier: replaced the basic address classifier to support IPv4 addressing and packet forwarding
  - FullTcpAgent: the TCP agent for TcpSocket, modified to support user data transmission
  - rtModule/BGP: replaced basic routing module rtModule/Base
  - rtProto/BGP: a new routing protocol, added for packet transmision
  - BGP_Timer: added to support the BGP timing features

Introduction:
ns-2 unicast routing structure



Introduction:
ns-BGP unicast routing structure





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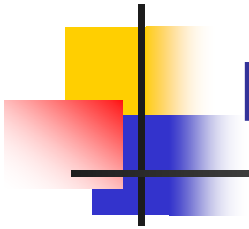
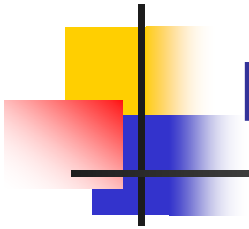


Related work

- OPNET BGP Available: http://www.opnet.com
  - a commercial network simulator
- SSFNet Available: http://www.ssfnet.org/homePage.html
  - open source Java and C++ models (not as popular as ns)
- C-BGP Available: http://cbgp.info.ucl.ac.be/wiki/index.php
  - dedicated BGP solver rather than simulator
- GNU Zebra BGP daemon Available: http://www.zebra.org/zebra/BGP.html#BGP
  - ported to ns-2 around the same time as ns-BGP and written in C
- BGP++ Available: http://www.ece.gatech.edu/research/labs/MANIACS/BGP++
  - written for ns-2 and GTNetS simulator
  - a port of Zebra BGP in C++



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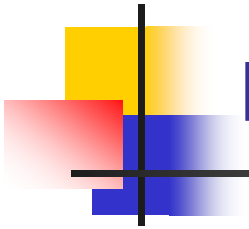
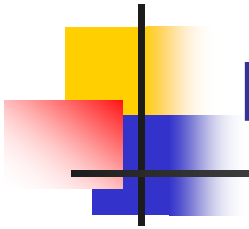


Hardware platform

- Primary hardware:
  - Toshiba Satellite
  - Intel® Pentium® 4 CPU 2.4 GHz / 1 GB RAM
  - Linux Xandros 3.0.2
- Additional hardware:
  - Dell Inspiron
  - Pentium® Dual-Core CPU T4200 2.0 GHz / 3 GB RAM
  - Linux Xubuntu 9.4



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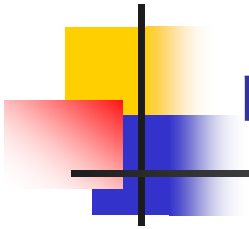
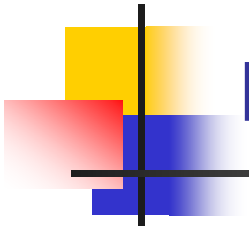


ns-2.33-BGP release details

- Software release format:
  - 110 kB compressed tar ball / 780.0 kB uncompressed
- 145 files in release:
  - 104 source files:
    - 46 C++ header files (.h)
    - 41 C++ body files (.cc)
    - 16 Tcl files (.tcl)
    - patch file (contains edit to 16 ns-2 files)
  - 9 sub-directories
  - 1 readme file (.txt)



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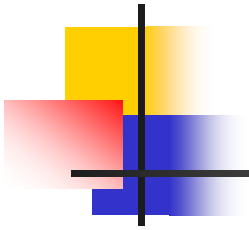
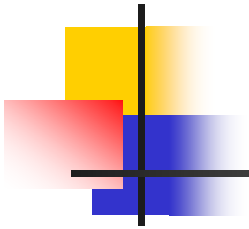


Integration of ns-BGP with ns-2.34

- Objectives:
  - Integrate ns-BGP, originally ported to ns-2.27 and then to ns-2.33, into the current release of the simulator: ns-2.34
  - Preserve all ns-2 enhancement, development, and bug fixes, that have occurred since the last ns-BGP release



Integration approach

- Code integration:
  - incorporate new ns-BGP source files into ns-2.34 directories
  - amalgamate logic changes in the patch to ns-2.34, which affects sixteen ns-2.27 and ns-2.33 core files
- Compilation modifications:
  - update the usage of the standard C++ library calls to make them compatible with the newer version of C compiler: gcc 4.3.3 (Ubuntu 4.3.3-5ubuntu4)

Summary of modified source files (cont.)

Files	Merge
ns-2.34/common/node.cc	o
ns-2.34/common/node.h	o
ns-2.34/common/packet.h	X
ns-2.34/common/simulator.cc	X
ns-2.34/Makefile.in	o
ns-2.34/routing/route.cc	o
ns-2.34/routing/rtmodule.cc	o
ns-2.34/routing/rtmodule.h	o
ns-2.34/tcl/lib/ns-default.tcl	o
ns-2.34/tcl/lib/ns-lib.tcl	o
ns-2.34/tcl/lib/ns-node.tcl	X
ns-2.34/tcp/rq.cc	o
ns-2.34/tcp/rq.h	o
ns-2.34/tcp/scoreboard-rq.cc	o
ns-2.34/tcp/tcp-full.cc	X
ns-2.34/tcp/tcp-full.h	X

The files listed in the table are ns-2.34 core files that will be modified after applying the ns-2.34-BGP patch file

O: denotes low complexity

X: denotes moderate complexity

Summary of modified source files (cont.)

Files	Compilation
ns-2.33/tcp/tcp_master.h	o
ns-2.33/tcp/tcp_socket.h	o
ns-2.33/tcp/receive_queue.cc	o
ns-2.33/tcp/send_queue.cc	X
ns-2.33/bgp/Util/ipaddress.h	o
ns-2.33/bgp/Comm/bgpmessage.h	o
ns-2.33/bgp/route.h	o
ns-2.33/bgp/Path/segment.h	o
ns-2.33/bgp/Path/aspath.h	o
ns-2.33/bgp/Timing/bgp_timer.h	o
ns-2.33/bgp/rtProtoBGP.h	o
ns-2.33/bgp/routeInfo.h	o
ns-2.33/bgp/peer-entry.h	o
ns-2.33/bgp/Timing/mraiperpeertimer.h	o

The files listed in the table required code modification to enable successful compilation

O: denotes low complexity

X: denotes moderate complexity

Summary of modified source files

Files	Compilation
ns-2.33/bgp/Path/attribute.cc	o
ns-2.33/bgp/Timing/mraitimer.cc	o
ns-2.33/bgp/Path/classifier-ipv4src.h	o
ns-2.33/bgp/Util/ipaddress.cc	o
ns-2.33/bgp/Util/stringmanip.cc	o
ns-2.33/bgp/Path/aggregator.cc	o
ns-2.33/bgp/Path/segment.h	o

The files listed in the table required code modification to enable successful compilation

O: denotes low complexity

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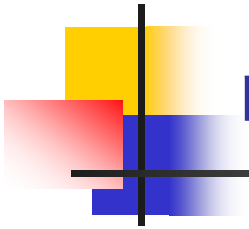
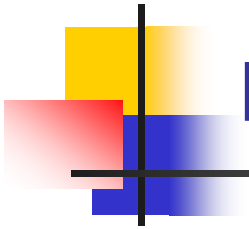


ns-2.34-BGP limitations

- Functionality is the same as the first ns-BGP implemented for ns-2.27 (and for ns-2.33-BGP)
- Any previous ns-BGP software bugs and/or computational inefficiencies still remain:
  - execution of validation script “ns reflection2.tcl” causes a core dump
- Further enhancements to ns-BGP by others not included



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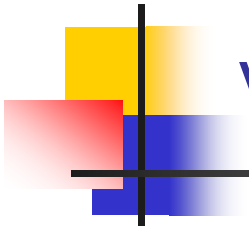
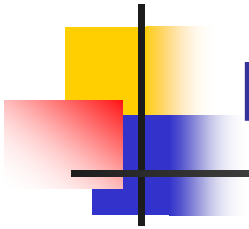


Validation of ns-2.34-BGP

- Compilation phase:
  - performed code modification to ensure successful compilation
- ns-BGP test scripts:
  - BGP-4 predefined compliant test cases (single function test)
  - performed combination of single function test cases
  - evaluated and compared each test case output and trace output (.nam) between ns-2.33-BGP and ns-2.34-BGP



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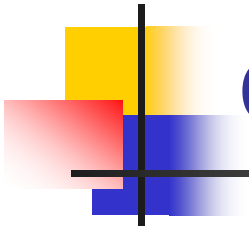
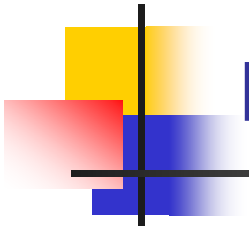


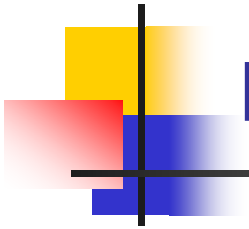
Conclusions

- Achieved the project objectives
- Overcame the ns-BGP integration challenges:
  - becoming familiar with ns-2, BGP, ns-BGP, and OTcl
  - setting environment for ns-2 to work properly
  - dealing with code incorporation, ambiguities, and complications
  - dealing with incompatibility of the code with newer C libraries
- Validation results:
  - show that ns-2.33-BGP and ns-2.34-BGP output and trace output (.nam) are identical
- Code release: stable ns-2.34-BGP



Future work

- Address the problem of core dump for the test case reflection2.tcl
- Incorporate the ns-2.34-BGP code in ns-2 distribution
- Add route flap damping
- Add adaptive minimal route advertisement interval (MRAI)
- Add policy routing
- Related area:
  - incorporate the ns-BGP code in ns-3 distribution



References

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