



Ideas and Challenges on testing a routing protocol

Experiences testing Quagga

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May 26, 2016



Open Source Routing

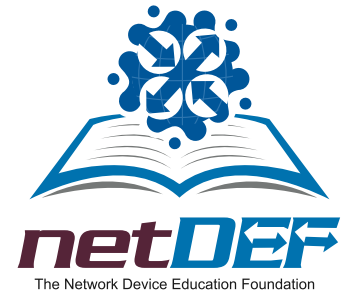
Who is OpenSourceRouting ?



Open Source Routing

▶ Who is Open Source Routing ?

- www.opensourcerouting.org
- Project by NetDEF (Network Device Education Foundation)
 - www.netdef.org
 - Non-Profit Company based in California
- Working on Quagga Routing



▶ Who is Martin Winter ?

- Co-Founder of NetDEF
- Focusing on Testing Quagga
- Previously worked for Equipment Vendor & large ISP

Building Tools

Tools used for “building”



Compiler VMs

- ▶ **Build in VMs: Simple Reset**
- ▶ **Build on specific distro and version**
 - Different versions of libraries used
- ▶ **Different CPU Architectures**



Static Analysis: Clang-Analyzer

quagga-1.0.20160315 (master @ 20160315.231717 UTC)

Source Git:	https://git.netdef.org/scm/quagga/quagga-savannah-official.git
Git Commit:	86c5d2ee68f7b9c00ae4aeb5c8b3c5d82c5ebffc
Configure command:	scan-build-3.8 ./configure --enable-vtysh --enable-isisd --enable-watchquagga \\\n--enable-ospf-te --enable-opaque-lsa --enable-ospfclient=yes \\\n--enable-ospfapi=yes --enable-multipath=0 --enable-rtadv \\\n--enable-gcc-rdynamic --enable-user=root \\\n--enable-tcp-zebra --enable-fpm --enable-pimd \\\n--prefix=`pwd`/usr_local
Make command:	scan-build-3.8 -maxloop 16 make
Clang Version:	clang version 3.8.0-svn262614-1~exp1 (branches/release_38)
Date:	Sat Apr 23 01:57:36 2016

Bug Summary

Bug Type	Quantity	Display?
All Bugs	73	<input checked="" type="checkbox"/>
Dead store		
Dead assignment	27	<input checked="" type="checkbox"/>
Dead increment	2	<input checked="" type="checkbox"/>
Dead initialization	10	<input checked="" type="checkbox"/>
Logic error		
Assigned value is garbage or undefined	1	<input checked="" type="checkbox"/>
Called function pointer is null (null dereference)	1	<input checked="" type="checkbox"/>
Dereference of null pointer	31	<input checked="" type="checkbox"/>
Result of operation is garbage or undefined	1	<input checked="" type="checkbox"/>

Reports

Bug Group	Bug Type	File	Function/Method	Line	Path Length	
Logic error	Assigned value is garbage or undefined	pimd/pim_sock.c	pim_socket_recvfromto	278	7	View Report
Logic error	Called function pointer is null (null dereference)	ospf6d/ospf6_lsa.c	ospf6_lsa_show	534	2	View Report
Dead store	Dead assignment	isisd/isis_spf.c	remove_excess_adj	83	1	View Report
Dead store	Dead assignment	bgpd/bgp_btoa.c	main	240	1	View Report

Static Analysis: Clang-Analyzer

BUT: Expect a lot of bad warnings...

```
74 while ((lif = LIST_FIRST(&l2vpn->if_list)) != NULL) {  
    1 Loop condition is true. Entering loop body →  
    3 ← Loop condition is true. Entering loop body →  
75     LIST_REMOVE(lif, entry);  
    4 ← Within the expansion of the macro 'LIST_REMOVE':  
    a Use of memory after it is freed  
76     free(lif);  
    2 ← Memory is released →  
77 }
```

Static Analysis: Coverity Scan

opensourcerouting/quagga

Overview Project Settings Analysis Settings Members Invite

coverity **passed**

Analysis Metrics

Version: 1.0.20160315

Apr 22, 2016 Last Analyzed	259,257 Lines of Code Analyzed	0.84 Defect Density
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Defects by status for current build

219 Total defects	219 Outstanding	0 Dismissed	0 Fixed
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See how defect density for 'opensourcerouting/quagga' compares with defect density for other open source projects. [Learn more](#)

Note: Defect density is measured by the number of defects per 1,000 lines of code.

Analysis Metrics per Components

Component Name	Pattern	Ignore	Line of Code	Defect density
bgpd	./bgpd/.*	No	52,760	0.91
isisd	./isisd/.*	No	20,487	0.88
ospfd	./ospfd/.*	No	34,003	1.03

Static Analysis: Coverity Scan

Nice: Finds some Copy & Paste errors!

```
985     }
986 }
original: circuit->ipv6_link looks like the original copy.
987     if (circuit->ipv6_link && listcount(circuit->ipv6_link) > 0)
988     {
989         vty_out(vty, "    IPv6 Link-Locals:%s", VTY_NEWLINE);
990         for (ALL_LIST_ELEMENTS_RO(circuit->ipv6_link, node, ip_addr))
991         {
992             prefix2str(ip_addr, (char*)buf, BUFSIZ),
993             vty_out(vty, "    %s%s", buf, VTY_NEWLINE);
994         }
995     }
```

❖ CID 94082 (#1 of 1): Copy-paste error (COPY_PASTE_ERROR)
copy_paste_error: ipv6_link in circuit->ipv6_link looks like a copy-paste error.

💡 Should it say `ipv6_non_link` instead?

```
996     if (circuit->ipv6_link && listcount(circuit->ipv6_non_link) > 0)
997     {
998         vty_out(vty, "    IPv6 Prefixes:%s", VTY_NEWLINE);
```

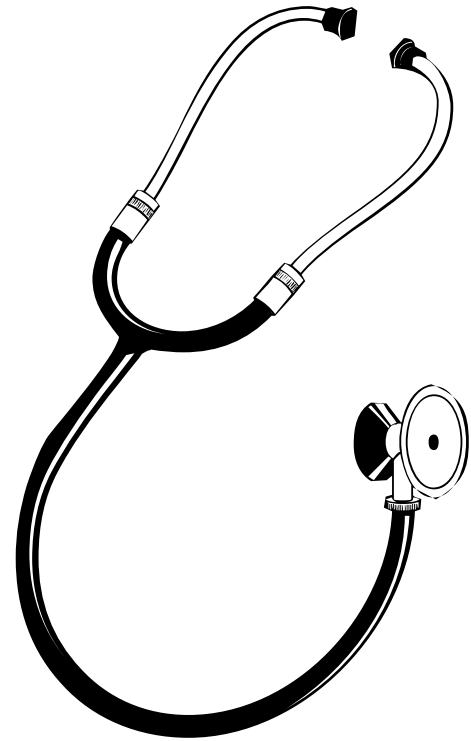

Code Coverage



[this slide is left blank – we don't do this yet]

Testing Tools

Tools used for Testing

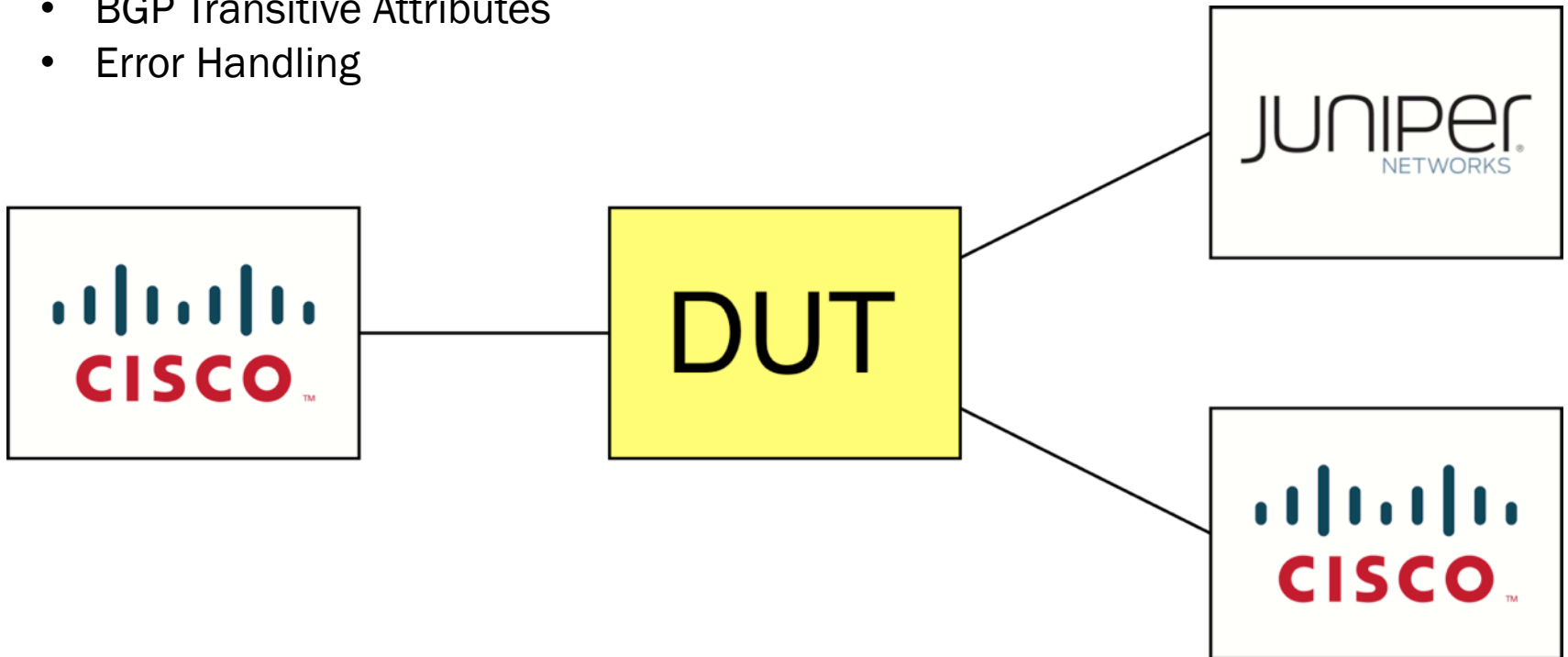


RFC Compliance Tests

Interoperability with Cisco/Juniper \neq RFC Compliance Test

Hint:

- BGP Transitive Attributes
- Error Handling



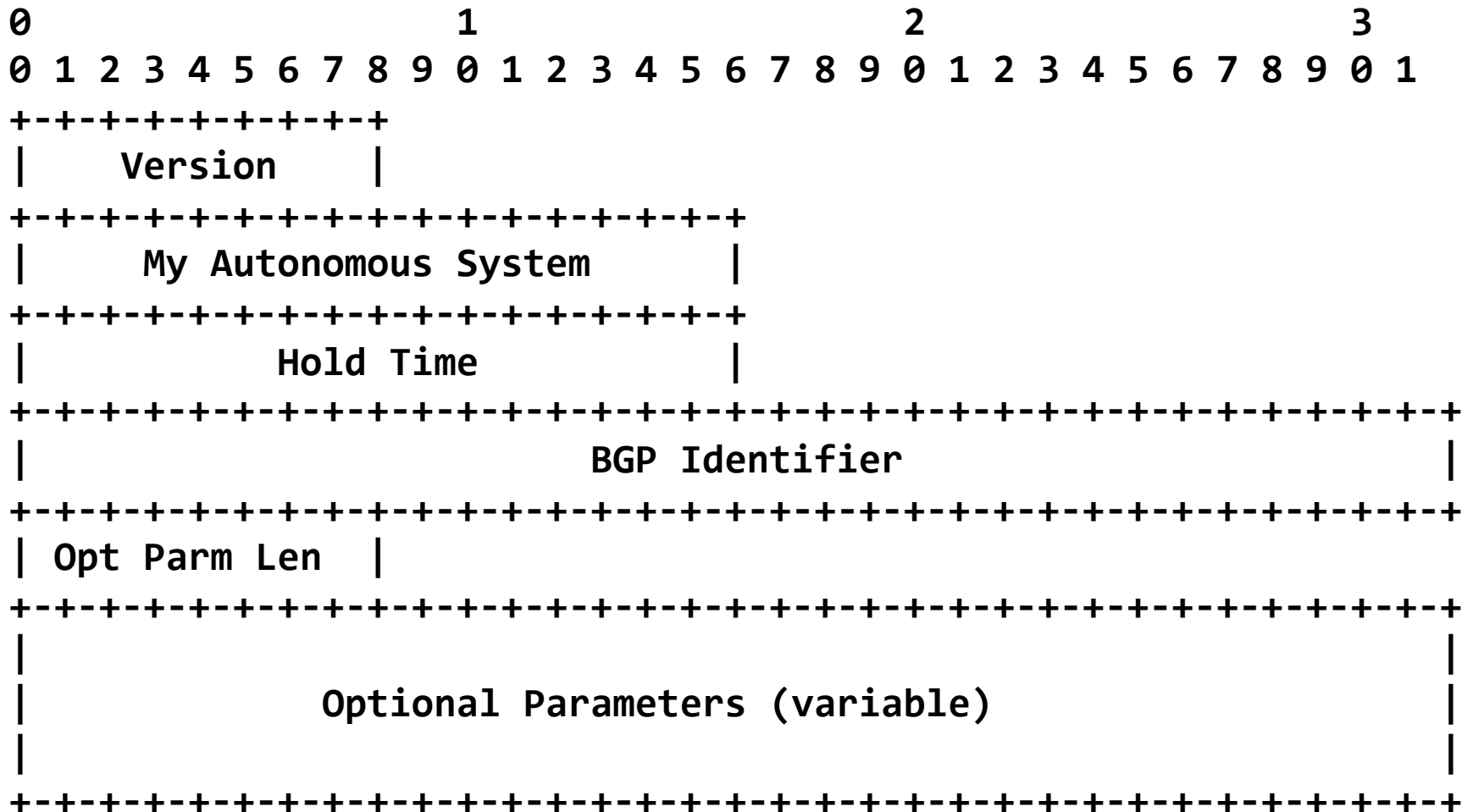
RFC Compliance Test: Ixia ANVL

RFC Compliance Test Report BGP4 Results

	Quagga 0.99.21	Quagga 0.99.22	Quagga 0.99.22.1	Quagga 0.99.22.4	Quagga 0.99.23	Quagga 0.99.23.1	Quagga 0.99.24	Quagga 0.99.24.1 plus BSD fix	Quagga 1.0.20160315	Quagga 1.0.20160315
Type	QUAGGA	QUAGGA	QUAGGA	QUAGGA	QUAGGA	QUAGGA	QUAGGA	QUAGGA	QUAGGA	QUAGGA
OS	Ubuntu 14.04	Ubuntu 14.04	Ubuntu 14.04	Ubuntu 14.04	Ubuntu 14.04	Ubuntu 14.04	Ubuntu 14.04	FreeBSD 10.2	Ubuntu 14.04	FreeBSD 10.2
Commit ID	828f235	66b63aa	747d6e7	15fe4b7	a4b5665	8e7e875	f191f1e	3e07588	5e57b5f	5e57b5f
Commit Date	2012-05-01	2013-02-10	2013-04-11	2013-09-02	2014-06-23	2014-08-25	2015-03-02	2015-03-24	2016-03-11	2016-03-11
ANVL-BGP4-1.1	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass
MUST	ANVL, setup verification									
	ANVL, Setup Verification DUT Listens on TCP port 179 for BGP4 Connection									
ANVL-BGP4-2.1	pass	pass	pass	unpredict	pass	pass	pass	pass	pass	pass
MUST	RFC4271, Sect. 4, p 11, Message Formats									
	Message Formats The maximum message size is 4096 octets. All implementations are required to support this maximum message size.									
ANVL-BGP4-3.1	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL
MUST	RFC4271, Sect.4.2, page 13, OPEN message format									
	OPEN Message Format After a TCP connection is established, the first message sent by each side is an OPEN message.									
ANVL-BGP4-3.2	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL
MUST	RFC4271, Sect.4.2, page 13,									

Protocol Fuzzer

BGP OPEN Message Format (RFC 4271)



Protocol Fuzzer: Spirent SPS-8000

Executive Summary Report: Quagga SrcDest ISIS Fuzzer Results

Mu System User	Martin Winter
Start Date/Time	9/19/15 3:27:13 PM
Duration	9 hours 30 minutes 27 seconds 961 milliseconds




Product	Mu Test Suite (6.5.2.r48322)
Mu System IP	192.168.2.31
Mu System Serial #	0203-0711-0000-008C

Traffic Variation Results (Protocols)

Grade
A+
100%
> Five 9's

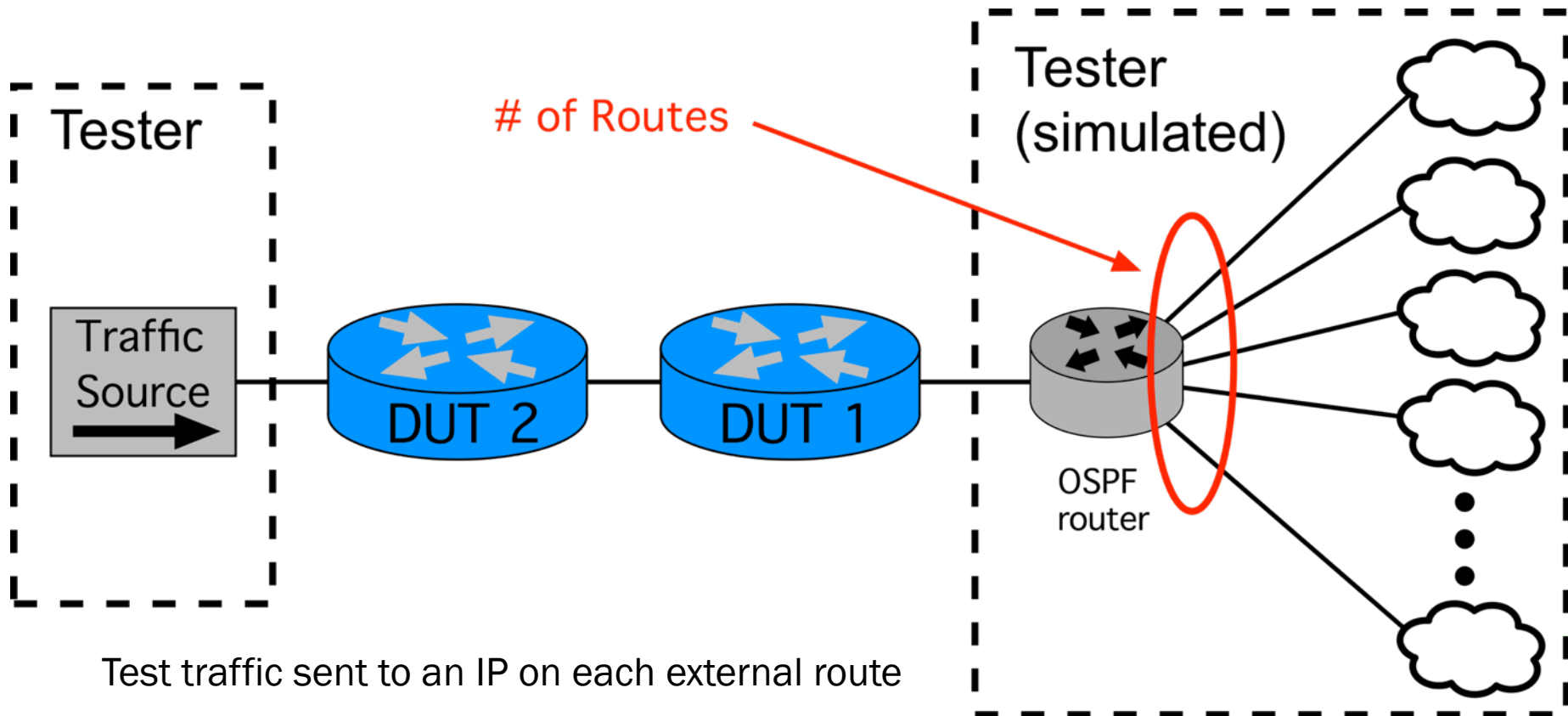
The target was analyzed using **33,015 variations** (generated from 2,490 test cases in 1 suite). The target was **available for 9 hours 30 minutes 8 seconds 509 milliseconds** during the attacks and was **unavailable for 0 milliseconds**.

Total Tests Run	2,490 test cases were run
Passed	2,490 test cases passed
Failed	0 test cases failed

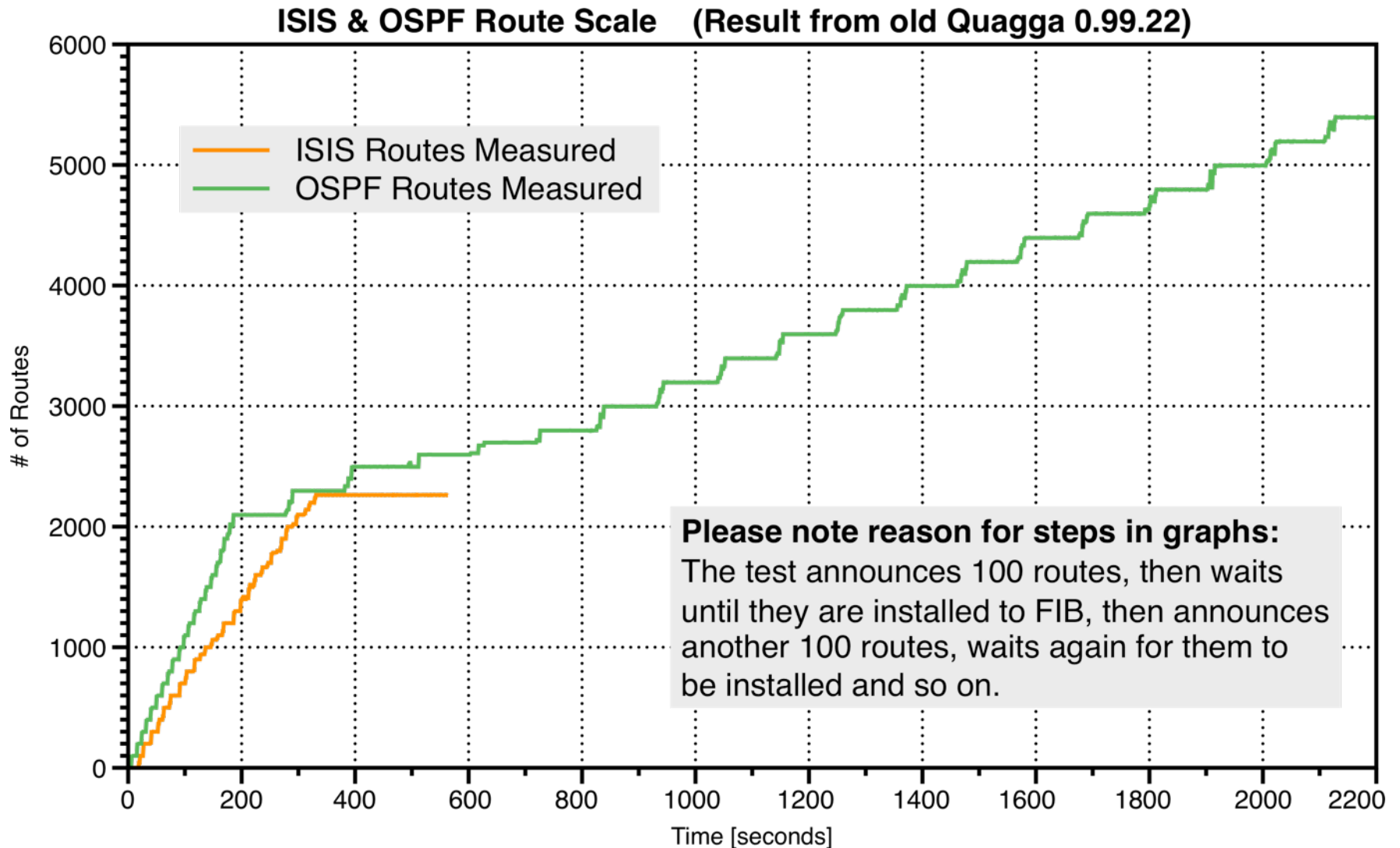
Test	Statistics										
IS-IS	<table border="1"><tr><td>Protocol Scenario</td><td>IS-IS (6.5.2.r48336)</td></tr><tr><td>Availability</td><td> 100.000%</td></tr><tr><td>Faults</td><td>✔ No faults were found</td></tr><tr><td>Variations</td><td>33015</td></tr><tr><td>Coverage</td><td></td></tr></table>	Protocol Scenario	IS-IS (6.5.2.r48336)	Availability	 100.000%	Faults	✔ No faults were found	Variations	33015	Coverage	
Protocol Scenario	IS-IS (6.5.2.r48336)										
Availability	 100.000%										
Faults	✔ No faults were found										
Variations	33015										
Coverage											

Protocol Performance & Scale

Example – Scale using external routes in OSPF

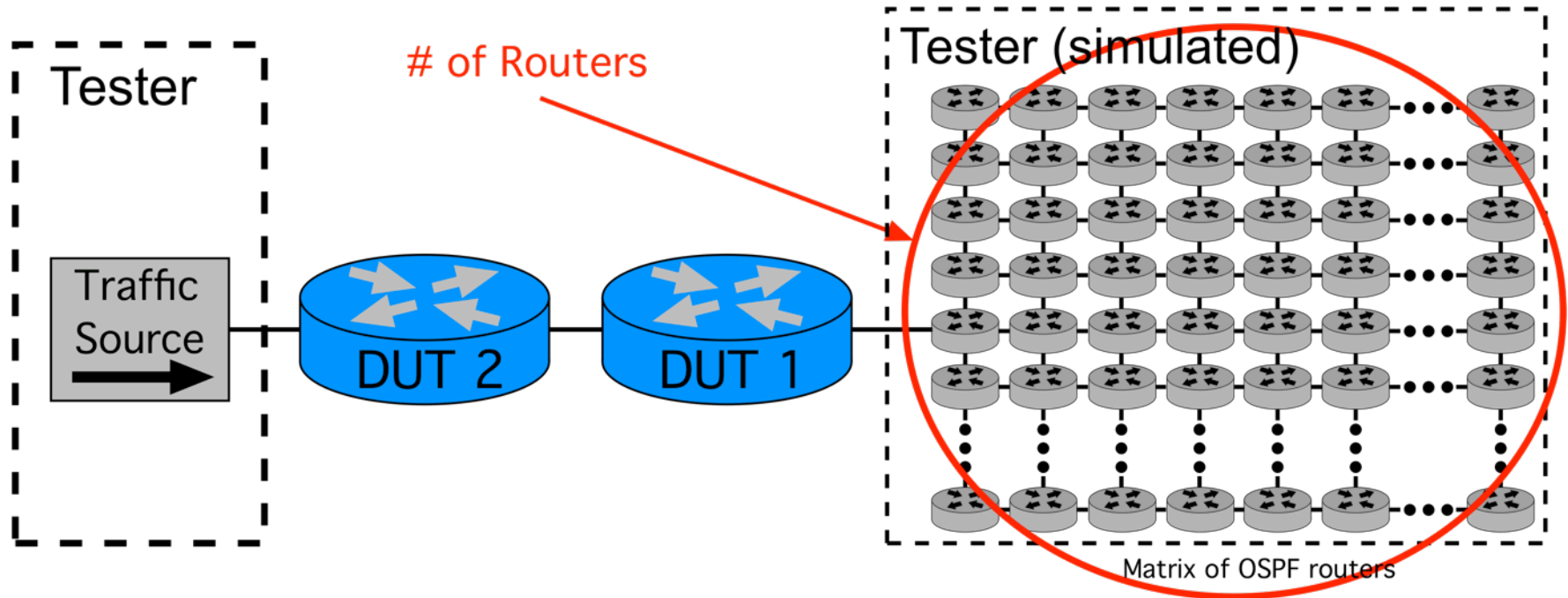


Protocol Performance & Scale



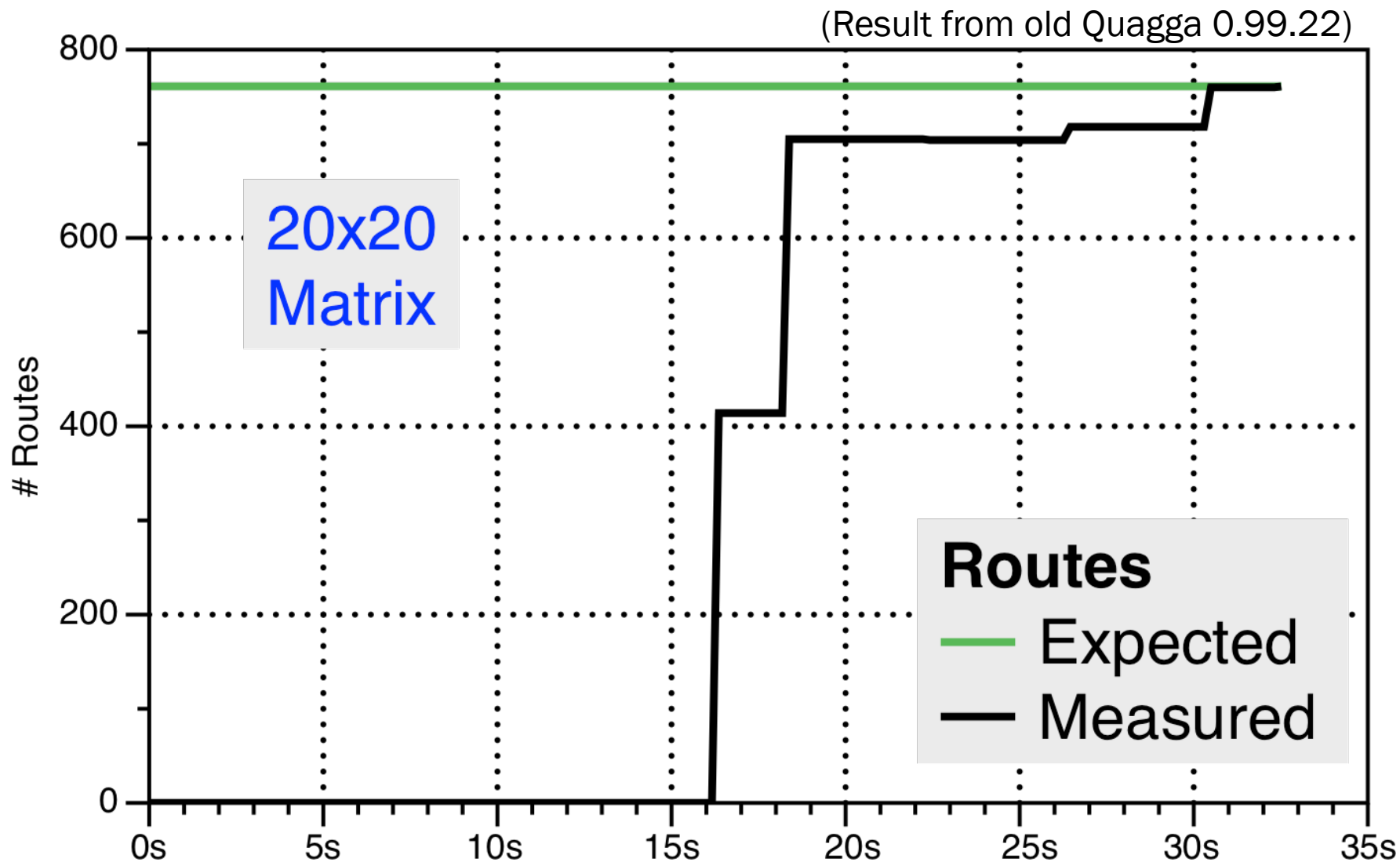
Protocol Performance & Scale

Example – Scale using internal routes in OSPF



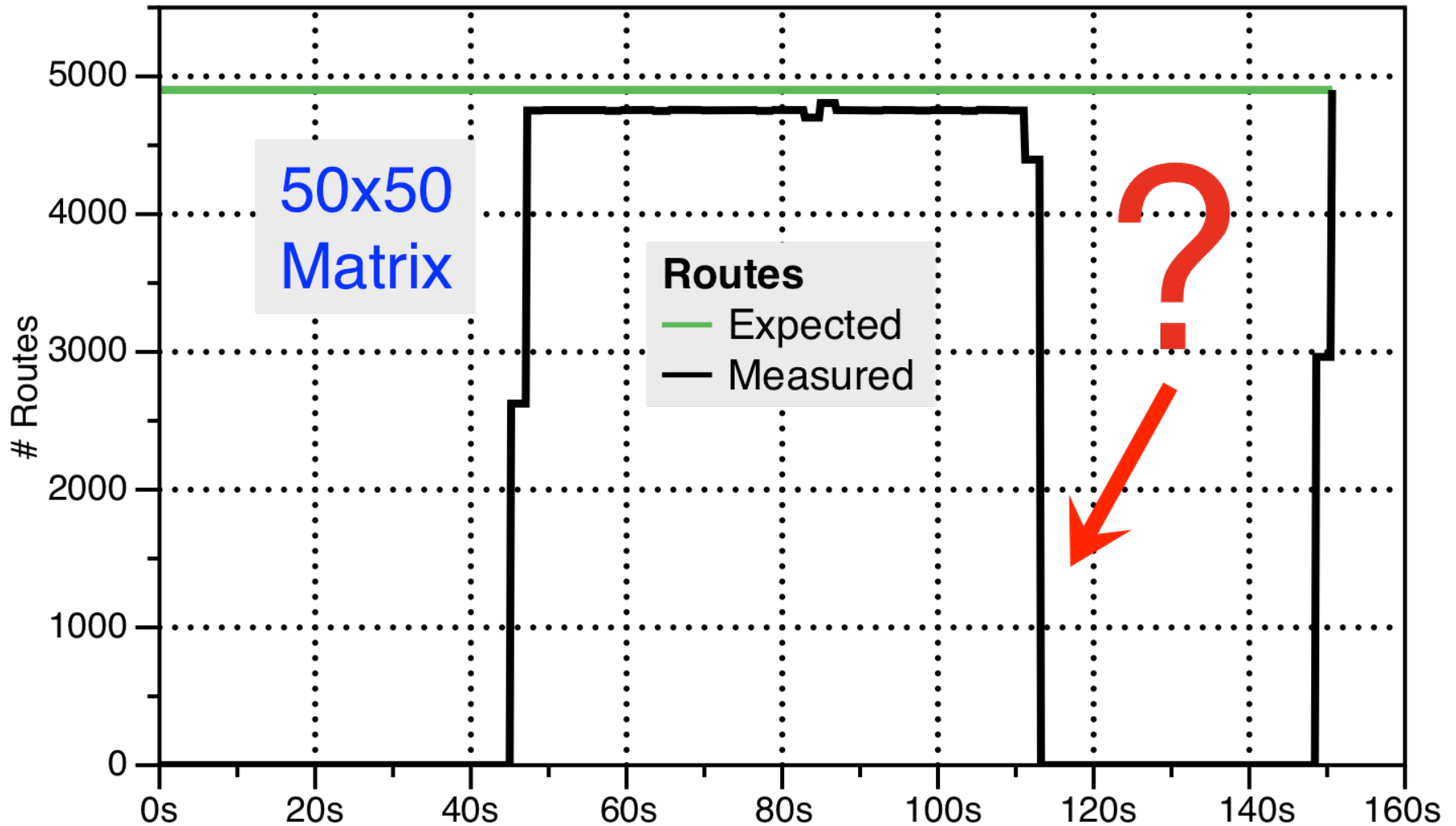
Test traffic sent to an IP on each link in matrix

Protocol Performance & Scale



Protocol Performance & Scale

(Result from old Quagga 0.99.22)



Protocol Performance & Scale

- ▶ **How to summarize result? (Pass/Fail)**
- ▶ **Testing in VM or physical machine?**
- ▶ **Tools for testing?**
 - ExaBGP for BGP
 - no tools for OSPF/ISIS/RIP/PIM/....

Automate (incl Result Parsing!)

Bamboo Build ▾ Deploy ▾ Reports ▾

Build projects / QUAGGA / MASTER
Build #90 master ▾
Quagga Master Build

✔ #90 was successful – Rebuilt by [Martin Winter](#)

Stages & jobs

- Get Sourcecode
 - ✔ Checkout Code
- Building Stage
 - ✔ ci001_ubuntu1404_amd64 build
 - ✔ ci002_ubuntu1204_amd64 build
 - ✔ ci003_freebsd10_amd64 build
 - ✔ ci004_freebsd9_amd64 build
 - ✔ ci005_centos7_amd64 build
 - ✔ ci006_centos6_amd64 build
 - ✔ ci007_netbsd6_amd64 build
 - ✔ ci008_debian8_amd64 build
 - ✔ ci009_freebsd8_amd64 build
 - ✔ ci010_omnios_amd64 build
 - ✔ ci011_openbsd58_amd64 build
 - ✔ ci012_netbsd7_amd64 build
 - ✔ ci014_ubuntu1404_amd64 build

Summary Tests Commits Artifacts Logs Metadata

Build result summary

Details

Completed 22 Apr 2016, 11:29:57 PM – 1 month ago

Duration 48 minutes

Flags **REBUILD**

Labels `version=quagga-1_0_20160315`
`git=https://git_netdef_org/scm/quagga/quagga-savannah-official_git`
`buildurl=https://ci_netdef_org/browse/quagga-qmaster-90`
`branch=master`

Revision `86c5d2ee...`

Total tests 2544

Successful since #87 (1 month before)

Number of retries 2

0	0	0	12
New failures	Existing failures	Fixed	Quarantined / skipped

Shared artifacts

Artifact

Links

- NetDEF CI System

<https://ci.netdef.org>

- Quagga RFC Compliance Reports

<https://www.opensourcerouting.org/compliance-test-results/>

- More details on our testing:

<https://www.opensourcerouting.org/2016/05/whitepaper-how-opensourcerouting-tests-quagga>

Questions ?



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Network Device Education Foundation
(NetDEF)

www.netdef.org /
www.opensourcerouting.org

