ZebOS™

Advanced Routing Suite: Testing & Interoperability

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Part No. 01600004

Introduction

IP Infusion's ZebOS™ Advanced Routing Suite (ARS) is a platform-independent software package that supports IPv4 and IPv6 based routing protocols for BGP, OSPF, and RIP. In addition, ZebOS ARS supports multiprotocol label switching (MPLS) through the label distribution protocol (LDP), which provides a crucial platform for BGP-VPN. Because this software is a critical component in routing and switching platforms, IP Infusion devotes a substantial amount of time and resources to the testing cycle of each development release, including full functional testing and extensive combinatorial testing in Multiple Instance environments and Virtual Router operation. This paper discusses IP Infusion's testing methodology and outlines in detail each phase of our test cycle.

Our aim is to provide the most complete performance, stress, interoperability, and reliability testing in the market. We welcome feedback and comments on this paper and encourage our customers to work with us to provide additional testing and performance metrics.

Please also refer to our family of Performance White Papers on BGP and OSPF, especially relating to Memory Usage and Scalability Parameters. The full Performance Test Methodology for these crucial performance issues are presented and summarized.

All the results for tests described herein and for product performance are available from IP Infusion. See your Sales Representative for instructions on how to obtain these test results.

Testing Methodology

IP Infusion has defined a testing methodology to ensure the high quality and reliability of our ZebOS Advanced Routing Suite. This testing methodology starts from the moment we begin producing each new release, until it is finally shipped to market. The five testing regimes are:

- Internal Testing
- Interoperability Lab Testing
- 6-Bone (50 country) Deployment for IPv6
- Adoption of the MPLS Forum Interoperability and Conformance Tests
- Adoption of the Network Processing Forum Testing and Benchmarking Initiatives

Our internal tests validate that the product design and functionality meet our specifications and pass a set of rigorous tests that prepare us to ship the product to private interoperability lab testing facilities. These labs make certain that each of the protocols passes a detailed list of interoperability tests. IP Infusion ensures compliance with these tests before we go into our beta test cycle.

Advanced-concepts test sites are those special worldwide configurations that certify the rapid growing advanced features of the Internet. The 6-Bone test site for IPv6 has been in-place worldwide for 16 months with many ZebOS-based operational routers. The ZebOS-MPLS will undergo rigorous testing in full compliance with the MPLS Forum and its interoperability and conformance testing. The MPLS Forum Technical Committee meets on a regular basis and posts results on its performance testing events. In addition, ZebOS will be in full compliance with the Testing and Benchmarking of the Network Processing Forum (NPF). Currently IP Infusion chairs the Software Working Group of the NPF.

ZebOS originated from the open source community, having passed hours and hours of live testing in hundreds of sites. These real-world installations have been a crucial kick-off for the platform of reliable operations upon which all ZebOS feature sets are based.

Internal Testing

Our internal test suites are designed at the same time we develop the initial product specifications for each ZebOS release. This process certifies that testing is an integral part of the design of our product. While we implement the initial design, we continually perform a set of unit tests to ensure the reliability and functionality of the software. When the unit tests are complete, we go into a set of protocol module and routing services module tests to validate the performance, functionality, and reliability of each module in ZebOS routing suite.

Of extreme importance to the testing cycle is the adoption of the Software Engineering Best Practices concepts embedded within the Rational Test RealTime testing and evaluation suites. This filtering process scans through and compiles the raw source code and scans for errors, redundancies, and in-efficiencies.

When the module tests are complete, we run a set of system tests to determine the functionality of the entire system. This includes the routing services module and the protocol modules for OSPF, BGP, and RIP (both IPv4 and IPv6) as well as our newest MPLS-LDP Switching Module, ZebOS NSM, and BGP with VPN extensions. This process validates the communication, configuration, and functionality for each of the protocol modules and the routing services module. This includes route conversion, command line interface functionality, management, logging, and event handling.

We use a variety of tools to validate the functionality and performance of ZebOS. These include:

- Rational Test RealTime
- Empirix ANVL
- Ixia performance tool

Additionally, we test the software on a variety of platforms, including: Linux, Solaris™, FreeBSD, OpenBSD, NetBSD, VxWorks®, OSE, OS-9®, and QNX.

The Rational Test RealTime software suite provides key elements to ensure Source Code integrity for IP Infusion’s Linux code and VxWorks Tornado code. The code is subjected to various levels of analysis throughout its compilation and link stages. Code under execution is scrutinized for possible memory leaks and a variety of erroneous operating conditions.

Empirix ANVL testing begins with the authoring of an array of test suites to specifically test a rich variety of router functionalities. Each release is subjected to this barrage of testing.

Given all the platforms, and the various ANVL test suites, a total of 33 full-test runs comprise every ZebOS release. Those ANVL test suites are:

RIP Testing (54 Tests)

1. Messages, 520 Updates
2. Messages, Unsolicited
3. Messages, Responses
4. Packets, 25 times
5. Valid Packets
6. Trace Packets
7. Packet Skipping
8. Packet Metrics
9. Maximum datagram
10. Checking packet format
11. *Host Route Dropping*
12. *Checking Bad Values*
13. *Subnet Restrictions*
14. *Gateways w/ addr 0.0.0.0*
15. *Ignoring 0.0.0.0 entries*
16. *Router/Garbage Timers*
17. *Garbage Collection Reset*
18. *Ignoring Version 0 datagrams*
19. *Checking "must be zero"*
20. *Responses to Valid Requests*
21. *Sending the Full Route Table*
22. *Checking Replies to Request*
23. *Split Horizon and Hiding*
24. *Ignoring responses*
25. *IP valid neighbor*
26. *Ignore own address response*
27. *Ignore unused octets not-zero*
28. Ignore or Update Metric
29. Non-existent infinite metric
30. Update routes with metric 16
31. Ignore already as good route
32. Response only sent to one
33. Trigger update on changes
34. Update Delays
35. *Horizon w/poisoned reverse*
36. *Disallow/Allow lists*
37. *Version 2 fields*
38. *Version 2 tuples*
39. *0xffff Authentications*
40. *Authentication verification*
41. *Authentication validation*
42. *Reachable Address*
43. *Next Hop Reachability*
44. *Multicast Addressing*
45. *Multicast receive capability*
46. *Multicast Receive Capability*
47. *Compatibility Switch*
48. *Receive Control Switch-1*
49. *Receive Control Switch-2*
50. *Receive Control Updates*
51. *Ignore Receive Switch*
52. *Router List Feature*
53. *Receive Version Switch*
54. *Route Table Overflow*

OSPF Testing in 62 Categories (non-extended, 307 tests)

1. OSPF Set-up, Hello, Advert.
2. OSPF Flooding
3. Routing Table Look-ups
4. Testing route table changes
5. Intra-Area SPF
6. Inter-Area SPF
7. AS Route Calculation
8. Functional Summaries
9. Routing Protocol Packets
10. Hello Protocol
11. *DataBase Synchronization*
12. *Designated Router*
13. *Backup Designated Router*
14. *Send Protocol Packets*
15. *Receive Protocol Packets*
32. LS Sequence Numbers
33. Type-3 LSAs
34. LS Sequence Numbers
35. Type-1 LSAs
36. Initial LS Sequence Number
37. Type-3 LS Sequence Num.
38. Type-4 LSAs
39. *Type-1 LSAs*
40. *Type-3 LSAs*
41. *Link State Header*
42. *LSA Checksum*
43. *LSA deletion*
44. *LSA Database*
45. *LSA Details (type-1 to 5)*
46. *Originating LSAs*

16.Send Hello Packets
17.Interfce Data Structure
18.Interface States
19.DR election
20.Send Hello packets
21.Neighbor Data Structure
22.Neighbor States (machine)
23.Receive Hello Packet
24.Receive Data Descriptors
25.Receive LS Request Packets
26.Send Data Descriptors
27.Send LS Request Packets
28.Link State Age
29.Options
30.Link State Types
31.Link State Types
47.Router LSAs
48.Network LSAs
49. Summary LSAs
50. AS-External LSAs,
51. Flooding Procedures
52. Sending Protocol Packets
53. Receiving Self-Orig. LSAs
54. Sending LSA Packets
55. Receiving LSA Packets
56.Virtual Links
57. Calculating Inter-Areas
58. Encapsulation
59. Hello Packets
60.LSA Ack. Packets
61.Router/Summary LSAs
62. Architectural Constraints

Extended OSPF Testing (46 tests)

1. OSPF NSSA Hello N-Bit
2. NSSA non-type-5 LSA
3. NSSA, Type-7s, Internal only
4. NSSA, Type 7s no external
5. NSSA Summary imports
6. N-bit On, E-bit off
7. NSSA no type 5 LSAs
8. NSSA translations
9. NSSA ABRs set the E-bit
10. NSSA Summary imports
11. *NSSA rules to skip Type-7s*
12. *NSSA Identical Type-7 paths*
13. *NSSA Type-5s and Type-7s*
14. *NSSA Type-7 AS Ext Routes*
15. *NSSA Type-5 tie-breaker*
16. *NSSA P-bit priority*
17. *NSSA High ID Translator*
18. *NSSA Type-7 Ranges*
19. *NSSA Type-5 Origination*
20. *NSSA Type 7/5 Translation*
21. *NSSA Type-5 Origination*
22. *NSSA Type-5 Origination*
23. *NSSA Type-5 Rules*
24. NSSA subsumed addresses
25. NSSA subsumed ranges
26. NSSA Highest path type
27. NSSA DoNotAdvertise
28. NSSA Type-7s not in range
29. NSSA Type-7 Advertise
30. NSSA ABR Advertise
31 NSSA ABR/Path Advertise
32 NSSA ABR/FWD Advertise
33 NSSA Ranges Advertise
34. NSSA Drop LSA w/Limits
35. Overflow State AS Accept.
36. Opaque Type-9 not flooded
37. Opaque Type-10 flooding
38. Opaque Type-10 flooding
39 Opaque Type-11 AS-transit
40. Opaque Type-11 non-stubs
41. Opaque Stub Rejection
42. Opaque Type-9 Restrictions
43. Opaque Type-10 Restriction
44. Opaque O-Bit
45. Opaque Handshakes
46. Opaque Virtual Neighbors

BGP Testing (48 tests)

1. Establish BGP-4 Session
2. Establish two Sessions
3. Router Adds Updates
4. Router Forwards Updates
5. BGP Next Hop Advertising
6. Never Install Itself
7. Next Hop Modifying
8. Next Hop Aggregation
9. State Machine Open Message
25. Internal Peer Exclusion
26. Internal Peer Exclusion
27. Internal Peer Preference
28. Internal Peer tie-breaking
29. Internal Peer ID tie-breaking
30. Internal Peer w/same NLRI
31. Internal Peer Unfeasible
32. External Peer new routes
33 Own AS updates

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10. Update Messages, Withdraw
11. Feasible and Unfeasible msg
12. Update Message Replacmnt
13. Update Decision Process
14. Update NLRI
15. Update Route Overlapping
16. Route Selection Preferences
17. Route Selection Policy
18. Route Selection, Exclusion
19. Route Selection Feasibilities
20. Route Selection Sets
21. Route Selection Removal
22. Route Selection Lowest ID
23. Route Selection Priorities
24. Route Selection, Internal
34 MinRouteAdvertiseinterval
35. Withdrawal Exclusion
36.Next Hop non- Aggregation
37. Next Hop Aggregation
38. Aggregation AS_Path
39.Aggreation Tuples
40. Aggregation AS_SET tuples
41. Aggregation X precedes Y
42 Aggregation same value
43. Update Packets Stress Test
44.BigNet Sessions
45 BigNet Updates
46. BigNet Updates, Forwarding
47. BigNet Route Flapping
48. BigNet Link Flapping

LDP Testing (58 tests)

1. Periodic LDP Hello
2. Proper LDP Version
3. Hello upstream / downstream
4. Targeted Hello upstream
5. TCP connection from TLV
6. TCP connection well known
7. LDP passive Init / Keepalive
8. Closes TCP upon error
9. Delayed Session after error
10. Hold Timer Expiration
11. (Session rejected)
12. Keepalive before expiration
13. Loop Detection, Label Req
14.Upstream to Downstream Req
15. Label Map to Upstream LSR
16. Hop Count Increment
17. Independent Control Mode
18. Unknown Hop Count Msg
19. Path Vector Downstream
20. Self Path vector
21. Ordered Control Self Path
22. Independent Control path
23. Path Vector upstream
24. Appending self to Path
25. Notification w/ F-bit
26. Notification Rejection
27. Upstream Advertisement
28. Label Request Downstream
29. Retransmit Downstream
30. Loop Detection Notification
31. No Label Resource notify
32. retransmit Label Request
33. Unmatched Prefix Response
34. Hop Count exceeded max
35. Label Request out of range
36. Label Request downstream
37. Mapping for FEC from FIB
38. Mapping DOD label adv
39. Mapping on new FEC N-Hop
40. Using Label from Neighbor
41. Upstream Label w/no map
42. Upstream Label w/Indep.
43. Upstream Label w/egress
44. Ordered control mode
45. Upstream Label w/loop det.
46. Label Map with own LSR ID
47 Upstream Label w/ord. Ctrl
48. Upstream Label w/ord. Ctrl
49.Downstream Label, new FEC
50 Label Req Abort Notification
51. Ignoring Label Abort Msg
52. Label Withdraw Messages
53. Fwd Label Withdraw Msg
54. Response to Label Release
55. Transmit Label Release Msg
56. label Release not Next Hop
57. Response, Label Withdraw
58. Interface Status

Advanced internal testing continues with several combinations of testing, including OSPF/BGP Multiple Instances, BGP/MPLS/VPN over Ethernet, IPv6, full SNMP-API, full Command Line Interface-API, and Virtual Router Operation. At this point many configurations are tested for memory usage and scalability parameters. For further details, please refer to our separate Test Methodology White Papers.

Significant Performance Evaluation statistics are gathered using the IXIA traffic generator. Some tests have exceeded 900,000 installed routes and the testing focuses on building a data base of Benchmarks, Memory Footprints, and Scalability. These tests are especially tailored to generate massive router traffic deployed with an extensive variety of parameters.

Finally, we run a set of interoperability tests to validate that the ZebOS Advanced Routing Suite (running on a variety of processors and operating systems) can interoperate with popular routers such as Cisco Systems, as well as firewalls and other Internet devices.

It is important to note that as ZebOS is ported and integrated into various customer configurations it is subjected to yet another level of rigorous testing and validation. These customer-run verifications of the product become an important ingredient to overall reliability of the ZebOS Advanced Routing Suite.

Interoperability Lab Testing

After completing our internal tests, we send the software to private entities that perform very detailed protocol functionality, reliability, stress, and interoperability testing. One of the key interoperability labs that we use is the University of New Hampshire Interoperability Laboratory (UNH IOL). The UNH IOL tests all of the protocols (OSPF, BGP, and RIP), and tests IPv6 for RIP. The UNH IOL tests perform multiple sets of tests for each protocol. The UNH IOL has a large list of consortium members that use their various testing services

The service that UNH IOL provides to IP Infusion and to our customers is invaluable. They test each protocol in detail and provide well-documented feedback indicating when a protocol has not met a specification. We then return to our internal development and test cycles until we feel we have substantially addressed each one of the issues in the UNH IOL test results.

The UNH IOL tests are extensive. The sections below outline the specific tests run for each of the protocols that we support: RIP, OSPF, and BGP, as well as IPv6.

RIP Testing

The UNH IOL RIP testing for RIP v1 and v2 is a complete set of RIP protocol tests that include: Processing Tests, Validation Tests, and Forwarding Tests. The lists below show the specific tests run in each of the categories. Each of the tests in a specific category can include multiple subtests.

Processing Tests

Basic Response	Next Hop
Subnet Mask	Default Route
Metric Processing	Host Route
Version Number	Family Identifier
Route Tags	Triggered Response

Route Timeout	Number of Entries
v1 Compatibility	Full Table Request
Simple Authentication	

Validation Tests

Subnet Mask	Network Validation
Metric Validation	Must Be Zero Fields
Command Number	Number of Entries
Source Address	Next Hop

Forwarding Tests

Basic Forwarding	Priority Forwarding

OSPF Testing

The OSPF tests that the UNH IOL performs are extremely detailed. They are broken into five main test categories: Hello Protocol tests, Flooding & Adjacency tests, Link State Advertisement tests, Route Calculation tests, and Configuration & Formatting tests. In each category multiple tests validate that the protocol is functioning as required by the IETF RFC's and in an interoperable fashion.

Hello Protocol

Hello Addressing	Hello Waiting
Event Backup	No Waiting
Accept Existing	Dr Collision
Bdr Become Dr	Dr Other Become
Hello Mismatch	Remote Hello
Hello E Bit	

Flooding & Adjacency

Multi-Access Adj.	Database Desc mtu set
Database Desc mtu match	Master Negotiation
Self Orig LSA Rcpt	Old LSA Rcpt
NBR State Too Low	DD Retransmit
Event Seq. Num Mismatch	Flooding
Flooding ASE	LS Ack
LSA Retransmission	LSA Flood guarantee
LSA Multicast Flood	LSA Retransmit Unicast
LSA Request Retransmit	Event Bad LS Req
LSA Maxage Flood	LSA Refresh Flood
Remove LSA from retrans	Remove LSA from retran

Link State Advertisements

Router LSA transit	Router LSA DR change
Router LSA stub	Net LSA DR Change
Net LSA Attached Router	Summary Asbr LSA Intra Area
Sum Net LSA Intra Area	Inter Area Become Inter Area
Sum Area Range RFC 1583	Sum Area Range RFC 2328
Sum Area Range Common	Sum Area Range No Transit
Virtual Link LSA	ASE static
ASE RIP	Remove Redundant
Default Summary Origination	Default Summary Use
Host Bits ASE	LE Sequence

Route Calculation

Prefer Intra Area Route	Inter Area Through Transit
ASE Forwarding Addr	Asbr Intra Area Route
Prefer Internal Route	ASE Type 1 and 2
Multiple Asbr Intra enabled	Multiple Asbr Intra disabled
Multiple Asbr Inter enabled	Multiple Asbr Inter disabled

Configuration & Formatting

Area Parameters Config	Interface Parameters
Router LSA Bits	Precedence TOS IP Header
No Virtual Link In Stub	Authentication RFC 1583
Authentication RFC 2328	Authentication MD5
Checksum	Number Advertisements
Packet Length Field	LSA Header Length
Router LSA #Links	Router LSA #TOS
Bad LSA Age	

BGP Testing

As with OSPF and RIP, the BGP protocol test suite is broken into the following categories: Basic Processing, BGP Finite State Machine, Error Handling, and Extensions. The specific tests in each category are listed below:

Basic Processing

TCP port connection direct	TCP port connection remote
Routing table matching	Hold Time Negotiation
Keep Alive	Close
Internal Update	External Update
Attribute Order	Origin Attribute
AS Path Attribute	Next Hop Attribute
Multi Exit Disc Attribute	Local Pref Attribute
Atomic Aggregate Attribute	Aggregation Path Attributes
Optional Attributes	Route Selection

BGP Finite State Machine

Idle FSM	Connect FSM
Active FSM	Opensent FSM
Openconfirm FSM	Established FSM

Error Handling

Header Error	Open Error
Update Error	Hold Timer
Connection Collision Detect	

Extensions

Confederations Propagate	Confederations Orig
Confederations Changes	Route Reflector
Route Reflector To Nonclient	Communities
Capabilities Negotiation	Multiprotocol
Label Info	

Internet Protocol Version 6 (IPv6)

To fully evaluate the ZebOS Advanced Routing Suite, the interoperability tests begin with the full base of TCP/IP testing for IPv6 in conformance with RFC 2460 (Basic IPv6 Packet Operation) and RFC 2461 (IPv6 Neighbor Discovery). Once the base is tested, the UNH IOL lab proceeds with Router Testing. The UNH IOL suite includes the following fundamental IPv6 operations:

Basic IPv6 Packet Operation

Unknown Header Error Recovery	Packet Reassembly Error Recovery
Valid Zero Payload Length	Fragment Flag Error Recovery
Zero Next Header Error Recovery	Proper response to oversized packet
Proper Header Processing	Proper Offset Zero Fragment Handling
Unknown Options Processing	Two Fragments More Error Recovery
Options, Order of Occurrence	Proper Fragment Reassembly
Routing Header Processing	Next Header Value 59 Handling
Routing Header Error Recovery	
Packet Fragment Parsing	

IPv6 Neighbor Discovery

Destination on-link	Reachable State Handling
Packet Queuing	ICMP Redirect Message
Router Solicitation Processing	Non Neighbor ICMP rejection
Neighbor Cache Updating	Redirect Message Limitations
Neighbor Solicitation Handling	Redirect Message Handling

Neighbor Solicitation Actions	Packet-Too-Big Handling
Neighbor Solicitation to Cache	Packet-Too-Big Generation
Neighbor Advertisement Discarding	Reduction in Path MTU Handling
Incomplete State Handling	Lower PMTU handling
Stale State Handling	PMTU low value Handling
Delay State Handling	PMTU greater than Estimate Handling
Probe State Handling	

RIPng Testing

The UNH IOL RIPng testing for IPv6 Operation is a complete set of RIP protocol tests that ensure complete compliance with RFC 2080.

Basic RIPng, IPv6 Packet Operation

Add Routes from valid RIPng response	Route Entry Validations
RIPng Zero-Message Handling	Multiple Next Hop Handling
Handling of Must-Be-Zero in Next hop	Off-Link Global Address Handling
Default Route Handling	Ignoring self Route Updates
Multiple Route Selections	Next Hop Half-Spent Handling
Route Expiration and Garbage collection	Triggered Responses Waiting
Empty Request Message Handling	Triggered Response Contents
Full Table Request Handling	Multiple Response Generation
Invalid UDP port Handling	New Version Packet Processing
Hop Count non-255 handling	

As can be seen from the above test suites for RIP, OSPF, and BGP, the UNH IOL tests are very detailed test suites. IP Infusion feels that by successfully completing these tests, we have achieved a significant level of functionality, quality, reliability, and performance with our software. IP Infusion will continue to use the UNH IOL as an external protocol test center.

6-Bone (50 country) Deployment for IPv6

The 6-bone test bed deployment of IPv6 is a massive site representing over 50 countries engaged in the IPv6 phase-in. It is an outgrowth of the IETF Ipng project that created the IPv6 protocols. It is operated with oversight from the "NGtrans" (IPv6 Transition) Working Group of the IETF. The test bed started as a virtual network (using IPv6 over IPv4 tunneling/encapsulation) operating over the IPv4-based Internet to support IPv6 transport, and is slowly migrating to native links for IPv6 transport.

ZebOS IPv6 features are well represented by several countries, and especially in Japan by DML Networks and its affiliates. The world transition to IPv6 is proceeding quickly and ZebOS is tested for the following IPv6 functions:

- Expanded Addressing
- Simplified Header Format
- Improved Extension and Option Support
- Flow Labeling

- Improved Authentication and Privacy
- Tunneling

A member of the University of New Hampshire Interoperability Lab, IP Infusion, is committed to the growth of IPv6 protocols. ZebOS™ is one of the most widely deployed testing software used on the 6Bone (IPv6 test bed). The management of IP Infusion is also active in a number of international organizations such as the IETF (Internet Engineering Task Force), JANOG (Japan Network Operators Group) and the Global IPv6 Summit[1]. IP Infusion will continue its participation in the standards bodies while fully supporting the latest developments in IPv6 protocol and its testing.

The 6bone operates under the IPv6 Testing Address Allocation (see RFC 2471).

Adoption of MPLS Interoperability and Conformance Tests

The MPLS Forum is engaged in the rapid definition and deployment of the crucial performance feature set grouped as MPLS.

The performance demand for MPLS has never been greater, and IP Infusion tests its MPLS and Traffic Engineering solutions to the fullest level possible. With the introduction of MPLS, IP Infusion offers its first Data Plane product called the MPLS Forwarder; the product undergoes significant testing for Packet Performance and Reliability for Ethernet data link layers.

Partnering with DML Networks in Japan, MPLS has passed several stages of functionality and interoperability testing. The LDP module with its Ethernet Forwarder is in full compliance with interoperability with Cisco and other competitive routers that have deployed MPLS.

The ZebOS-MPLS will undergo rigorous testing in full compliance with the MPLS Forum and its Interoperability and Conformance testing. The MPLS Forum Technical Committee meets on a regular basis and ensures the full interoperability of the MPLS functionality across all vendors.

Adoption of NPF Testing and Benchmarking Initiatives

The Network Processing Forum (NPF) is devoted to the advanced definition of the Data Plane and Control Plane operations that ensure high-speed hardware solutions on the Internet. Their goal is to focus on Standards, Testing, Benchmarking, and Education, so that effective high-performance hardware solutions are properly defined.

IP Infusion is working with its strategic partners in helping to define, standardize, and test the NPF Software API. The ZebOS High Level API (Classification, IPv4) uses both a Unicast ARP and Unicast Forwarding interface to the High Level API of the Forwarding Plane (data plane). The Low Level API provides interconnect to cPCI, Switch Fabric, Ethernet, etc.

[1] Please see http://www.jp.ipv6forum.com/slides/J3-3.ppt for a presentation given at the last Global IPv6 Summit by Kunihiro Ishiguro, C.T.O. of IP Infusion.

As we demo products in 2001 and early 2002, the NPF components are tested under worldwide partnership agreements and commonly viewed in operation at several worldwide conferences and seminars.

Conclusions & Futures

By using in house tools & processes, external testing organizations, advanced-concepts test-sites, and the open source community, IP Infusion offers a complete testing program that focuses on the delivery of high-quality, reliable, high-performance routing software to the router/switch, network processor, wireless, and embedded device community. Our mission is to become the industry standard, platform-independent, routing protocol vendor. IP Infusion's focus on next generation Internet standards such as IPv6, MPLS, the Network Processor, our rich feature set, and our complete testing program positions us well to achieve our mission.

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