"From IPv4 to eternity": the HEPiX IPv6 working group

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On behalf of the co-authors

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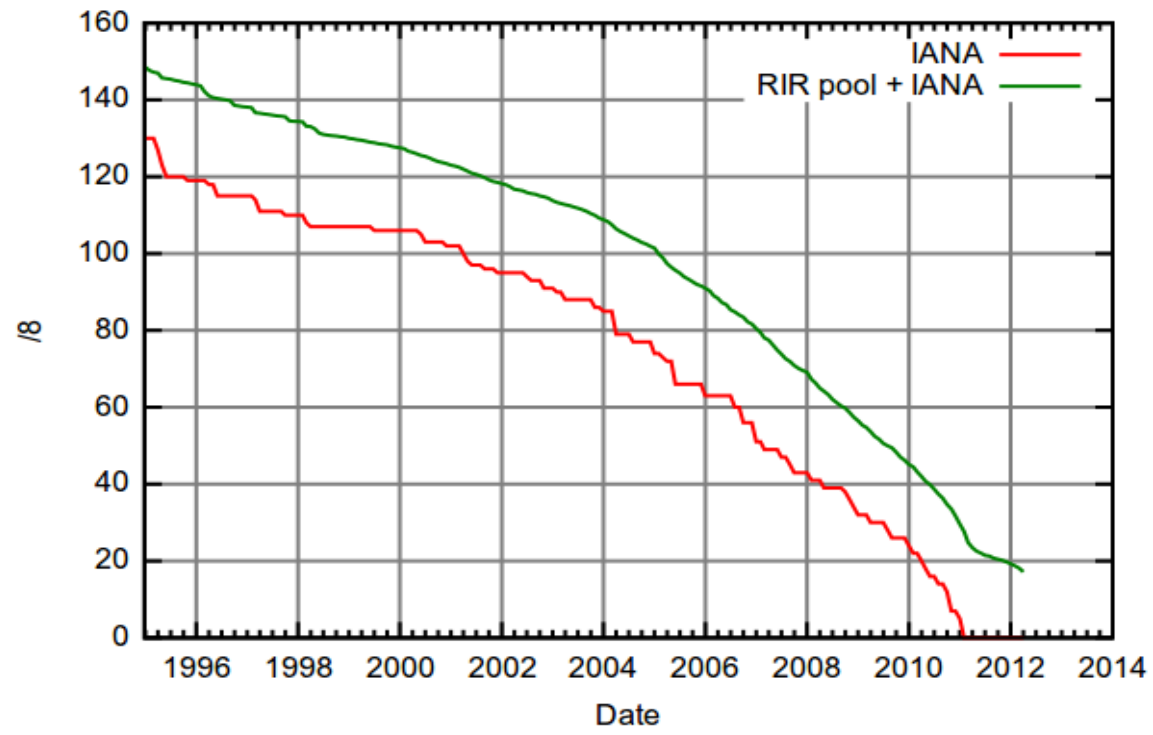And several others who have participated in the past

Outline

- Background – why move to IPv6?

- The HEPiX IPv6 working group

- HEPiX IPv6 Testbed

- Recommendations and future plans

Why Move to IPv6?

IPv4 address space depletion

Remaining IPv4 Free Addresses (/8 blocks):

Source: http://en.wikipedia.org/wiki/File:Ipv4-exhaust.svg

IPv4 Addresses exhaustion dates

- IANA Unallocated Address Pool (Global)
  Exhaustion happened: **03-Feb-2011**

- Projected Regional (RIR) Address Pool Exhaustion Dates:
  - APNIC: **19-Apr-2011** (Asia Pacific - happened)
  - RIPENCC: **14-Aug-2012** (Europe)
  - ARIN: **20-Jun-2013** (North America)
  - LACNIC: **29-Jan-2014** (South America)
  - AFRINIC: **05-Nov-2014** (Africa)

(source: http://www.potaroo.net/tools/ipv4/index.html   )

World IPv6 Launch Day

- http://www.worldipv6launch.org/

- 6 June 2012 "The Future is Forever"

- ISPs, home routing equipment vendors, web companies all coming together

- Permanently enable IPv6 by 6th June 2012

Ready to go?

- IPv6 *is* coming to stay!
- And it will bring a lot of new opportunities
- The IPv4 software legacy will keep us busy for a while.
- Are the HEP and WLCG communities ready?

Hepix IPv6 Working Group

WG membership

- Chaired by Dave Kelsey (RAL)
- Active members:
  - CERN, DESY, FNAL, FZU, GARR, Glasgow, INFN, KIT, Manchester, RAL, SLAC, USLHCnet (Caltech)
  - CMS, ALICE and LHCb (ATLAS to come)
- Nearly 50 on the mail list
- Regular video and face-to-face meetings

HEPiX IPv6 WG

Created in April 2011 with aims:

- Consider how IPv6 should be deployed in HEP and especially in WLCG

- Readiness and Gap analysis

- HEP applications, Middleware, Security issues, System management and monitoring tools, End to end network monitoring tools

- Run a distributed HEP testbed to verify compliance in reality

- Share experiences

IPv6 and WLCG

Currently it's not known when WLCG will need to deploy IPv6-capable services.

But:

- up rise of VMs and Cloud services may be impaired by the IPv4 shortage

- some sites in the Far East already prefers IPv6

IPv6 and WLCG

To get there takes time and effort!

- It's not only a network deployment challenge
- software and tools must be able to use IPv6.
- Need operational monitoring, security and tools
- IPv6 performance must be as good as IPv4

WG activity:
Implementation check list

List of steps to take and recommendations to design and implement a dual stack network

Based on the real experience of the members

WG activity:
Software & Tools IPv6 Survey

- An "Asset" survey is now underway
  - A spreadsheet to be completed by all sites and the LHC experiments
  - Includes **all** applications, middleware and tools
  - Tickets to be entered for all problems found
- If IPv6-readiness is known, can be recorded
- Otherwise we will need to investigate further
  - Ask developer and/or supplier
  - Scan source code or look for network calls while running
  - Test the running application under dual stack conditions

WG activity:
Distributed Dual Stack Testbed

A place where to gain real experience

Implemented on real networks, in a distributed environment as close as possible to production

Open to anyone in WLCG

To test applications over IPv6 but also in the dual-stack cohabitation

Software with IPv6 problems

- Need to check many things
  - Break when installed on a dual-stack node?
  - Does it bind to both stacks?
  - Is IPv6 preferred?
  - Can it be configured to prefer V4 or V6?
- Already found a few problems

WG activity:
Attention to Security

New protocol => many new weaknesses to exploit

Everything to be verified again

Share recommendations and best practices

Working with others

- Use tools developed by EGEE
- EGI recently started IPv6 activities
  - Work together
  - Avoid duplication
- EMI testing nightly builds for IPv6 compliance
  - Will work together
  - Allow EMI developers access to our testbed

EGEE IPv6 tools

- Source code checker
  - A bash script looking for non compliant function calls and address data structures

- Dynamic Code Checker (IPV6 CARE tool)
  - A tool based on the LD_PRELOAD mechanism to intercept calls to non compliant functions in the dynamically linked libraries

- Analysis of all gLite code was performed
  - And code was modified to fix problems
- *https://twiki.cern.ch/twiki/bin/view/EGEE/IPv6FollowUp*

HEPiX IPv6 Testbed Experiences

The IPv6 Testbed

- Deployed a distributed testbed: CERN, DESY, FZU, GARR, INFN, KIT and USLHCnet

- All installations have uniform architecture (x86_64) and uniform OS (Scientific Linux 5) for full support of `WLCG' applications and middleware.

- Each node with at least 1 Gbps network connection.

- All running at least one GRIDFTP server, giving access only to the ipv6.hepix.org VO.

- https://w3.hepix.org/ipv6-bis/doku.php?id=ipv6:testb

GridFTP tests

- Successfully installed and tested GridFTP clients and servers on all nodes

- Virtual organization ipv6.hepix.org

- Full mesh of data transfers (globus_url_copy): Tested and works

- CMS now performing continuous data transfers between pairs of nodes

The CMS file transfer tests

- Reliability test - not a stress/performance test
- Single 2000 MB file from IPv6 VM at CERN transfered to 4 systems
- globus_url_copy and uberftp to confirm file arrived then delete
- Tests have been running continuously since February 2012
- Statistics since April 20th:

Site	#_of_transfers	Failed_transf.	Average_duration	Duration_range
DESY	390	13 (3.3 %)	66s (~30 MB/s)	41 - 425s
Gridka	780	29 (3.7 %)	130s (~15 MB/s)	110 - 439s
INFN	1299	43 (3.3 %)	66s (~30 MB/s)	34 - 549s
Uslhcnet	1299	28 (2.2 %)	81s (~25 MB/s)	38 - 549s

Can still conclude: no show-stoppers. CMS PhEDEx should work.

FTS

- gSOAP supports IPv6
  - on TCP since version 2.5 (2005)
  - on UDP since version 2.7.2 (still 2005)
- BUT compiled without the "WITH_IPv6" flag.
- Oracle IPv6-enabled from version 11g rel 2, but FTS transfer agent libraries in EMI-1 still carry a hard dependency on Oracle V10
- Transfer agents (Tomcat/Axis servlets) can be invoked on dual stack hosts and from dual stack clients
- but 'urlcopy' agent still uses IPv4 for file transfer
- As in the globus-url-copy command, IPv6 resolution in the Globus FTP client needs to be *explicitly* enabled

UberFTP

- UberFTP is an interactive GridFTP client tool

- No IPv6 support

- Francesco Prezl has written an IPv6 patch and sent it to the author for integration

Testbed results so far

- Time consuming

- Several fake "IPv6 ready" exposed

- Necessary to develop and test IPv6 patches

More results and Future plans

Managing IPv6 at large sites

- Best practices are still far from clear!
- Large sites (e.g. CERN and DESY) wish to manage the allocation of addresses
  - Do not like autoconfiguration (SLAAC)
- Wish to filter out Router Advertisements
- DHCPv6 very attractive
  - BUT IETF still discussing
  - Will the 'route' options be there or not?

IPv6 security

- Are operational security teams ready for IPv6?   No!
- Challenges include
  - Address format has multiple forms, many addresses per host and addresses difficult to remember
  - IPv6 standards contain many suggestions - implementation optional
  - Required security features, like RAGuard and SEND, are a long way from full deployment
  - Incomplete and immature implementations
  - Many vulnerabilities expected
  - Log parsing tools must all change
  - Dual stack and tunnels cause problems – e.g. packet inspection
- Must test that things which are supposed to be blocked really are.

Future plans

* Aim to implement Dual Stack on all WLCG services
  - Avoid complications of tunnels, proxies, gateways etc.
- Perform full asset survey (Spring 2012)
  - Identify show-stoppers & quantify effort and resources required to fix
- Expand testbed gradually during 2012
  - work with EGI and EMI
  - Considering merging of EGI and HEPiX testbeds later this year
  - All WLCG services
  - Perform more extensive functionality and performance tests
- Must consider operational impact
  - including security and monitoring

Future plans (2)

- Review status at end of 2012

- Produce implementation plans for 2013 and/or later

- Need to perform tests on the production infrastructure

  – involve WLCG Tier 1 centres

- Plan several HEP IPv6 "Days" (for 2013?)

  – turn on dual stack for 24 hours on production infrastructure and test/observe

Conclusion

Conclusions

- The HEPiX IPv6 working group is functioning well

- *MUCH* work still to be done during the next year or two & effort is difficult to find (new volunteers are welcome to join)

- IPv6 won't be easy to exploit in the beginning, but then it will bring new functionalities and opportunities

Further info

- HEPiX IPv6 wiki

https://w3.hepix.org/ipv6-bis/

- Working group meetings

http://indico.cern.ch/categoryDisplay.py?categId=3538