IP Next Generation (IPng)

IETF

July 1994

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History

July 1993

ipdecide BOF & IESG plenary result in IETF taking on responsibil
for IPng (not let the market decide)

August 1993

temporary IETF area formed to consolidate IPng activity

area directors from other areas

on temporary assignment in addition to regular duties

existing IPng working groups moved into area

area given charge by the IETF chair

Charge From the IETF Chair

establish directorate

keep process public

understand the available timeframe
  recommend policy changes if warranted

make a recommendation regarding the scope of IPng
  'just' fix addresses or do more

develop a clear and concise set of technical requirements

develop a recommendation on which, if any, of the
  current proposals should be the next IP

Time Line, Recommendation

July 1994 - IPng recommendation

August 1994 - recommendation released as Internet Draft

August 1994 - IETF chair issues 'last call' on recommendation

September 1994 - IESG approves recommendation

Directorate

J. Allard - Microsoft	<jallard@microsoft.com>
Steve Bellovin - AT&T	<smb@research.att.com>
Jim Bound - Digital	<bound@zk3.dec.com>
Ross Callon - Wellfleet	<rcallon@wellfleet.com>
Brian Carpenter - CERN	<brian.carpenter@cern.ch>
Dave Clark - MIT	<ddc@lcs.mit.edu >
John Curran - NEARNET	<curran@nic.near.net>
Steve Deering - Xerox	<deering@parc.xerox.com>
Dino Farinacci - Cisco	<dino@cisco.com>
Paul Francis - NTT	<francis@slab.ntt.jp>
Eric Fleischmann - Boeing	<ericf@atc.boeing.com>
Mark Knopper - Ameritech	<mak@aads.com>
Greg Minshall - Novell	<minshall@wc.novell.com>
Rob Ullmann - Lotus	<ariel@world.std.com>
Lixia Zhang - Xerox	<lixia@parc.xerox.com>

Open Public Process

big-internet mailing list used (or abused)
(big-internet-request@munnari.oz.au)

internal directorate mailing list archive made public

public reports at IETF & other conferences

open directorate meetings

archive site
hsdndev.harvard.edu
anonymous ftp & gopher

as always, open working group meetings and mailing lists

IPng Proposal Working Groups

multiple working groups

open meetings and mailing lists

different approaches to solve addressing and routing problems

different views on problems

optimize different aspects of problems

not right or wrong

learned from all efforts

CATNIP

Common Architecture for Next-generation Internet Protocol

chair: Vladimir Sukonnik

developed from TP/IX working group

The objective is to provide common ground between the Internet, OSI, and the Novell protocols, as well as to advance the Internet technology to the scale and performance of the next generation of internetwork technology.

document authors:
Michael McGovern, Robert Ullmann

SIPP

Simple Internet Protocol Plus

chairs: Robert Hinden, Steve Deering, Paul Francis

developed from merger of IPIP into IPAE which then merged with SIP then finally with PIP
past WG chairs: D. Crocker, C. Huitema

SIPP is a new version of IP which is designed to be an evolutionary step from IPv4. It is a natural increment to IPv4. SIPP is designed to run well on high performance networks (e.g., ATM) and at the same time is still efficient for low bandwidth networks (e.g., wireless). In addition, it provides a platform for new internet functionality that will be required in the near future.

document authors:
R. Atkinson, J. Bound, D. Crocker, S. Deering, P. Francis,
P. Ford, R. E. Gilligan, R. Govindan, R. Hinden, C. Huitema,

T. Li, E. Nordmark, Y. Rekhter, W. A. Simpson, S. Thomson

TUBA

TCP/UDP Over CLNP-Addressed Networks

chairs: Mark Knopper, Peter Ford

The TUBA effort will expand the ability to route Internet packets by using addresses which support more hierarchy than the current Internet Protocol (IP) address space. TUBA specifies the continued use of Internet transport protocols, in particular TCP and UDP, but specifies their encapsulation in ISO 8473 (CLNP) packets. TUBA seeks to upgrade the current system by a transition from the use of IPv4 to ISO/IEC 8473 (CLNP) and the corresponding large Network Service Access Point address space.

document authors:
R. Callon, P. Ford, K. R. Glenn, D. Katz, M. Knopper, D. Marlow, D. Piscitello, Y. Rekhter, J. West (and a fleet of ISO docs)

Available Timeframe

Address Lifetime Expectations (ALE) working group
  Frank Solensky, FTP Software <solensky@ftp.com>
  Tony Li, Cisco Systems <tli@cisco.com>
  <ipv4-ale-request@ftp.com>

made prediction at Seattle IETF meeting
  2005 - 2011 (new projection shorter ~2000)

assumes no paradigm shifts
    mixed view of confidence level

routing tables are still going to be a problem

ADs endorse current address assignment policies

ADs do not currently recommend address reclamation efforts
  may be warranted only if very large address request(s) received
  and sub-Class A nets can be assigned

Scope of IPng

development, testing & deployment will take time

still we seem to have adequate time in IPv4 address space
but not excessive (excluding paradigm shifts)

can do more than 'just' fix addresses

use requirements process to determine actual scope

IPng Technical Requirements

IPng requirements process (ngreq)
- Frank Kastenholz, FTP Software <kasten@ftp.com>
- Jon Crowcroft, UCL <J.Crowcroft@cs.ucl.ac.uk>
- used big-internet mailing list

RFC1550 white papers

BOF in Seattle

requirements document
- based on Kastenholz/Partridge draft
- (draft-kastenholz-ipng-criteria-02.txt)
- criteria, discussion & time frame
- Informational RFC very soon

White Papers

draft-adamson-ipng-radio-req-00.txt
draft-bellovin-ipng-addr-per-host-00.txt
draft-bellovin-ipng-sec-concerns-00.txt
draft-bound-ipng-bsdhost-implement-00.txt
draft-brazdziunas-ipng-atm-00.txt
draft-britton-ipng-req-corp-netwrk-00.txt
draft-brownlee-ipng-acct-req-00.txt
draft-carpenter-ipng-whitepaper-00.txt
draft-chiappa-ipng-nimrod-arch-00.txt
draft-clark-ipng-multipro-interop-00.txt
draft-curran-ipng-viability-00.txt
draft-estrin-ipng-unified-routing-00.txt
draft-fleischman-ipng-corp-view-00.txt
draft-ghiselli-ipng-whitepaper-req-00.txt
draft-green-ipng-navy-hpn-00.txt
draft-heagerty-ipng-input-00.txt
draft-simpson-ipng-mobility-00.txt
draft-skelton-ipng-epri-00.txt
draft-symington-ipng-model-00.txt
draft-taylor-ipng-cdpd-viewpt-00.txt
draft-vecchi-ipng-tvcable-viewpt-00.txt

to become Informational RFCs

Proposal Whitepapers

catnip
    draft-mcgovern-ipng-catnip-wpaper-00.txt

sipp
    draft-ietf-sipp-whitepaper-00.txt

tuba
    draft-ford-ipng-tuba-whitepaper-00.txt

to become Informational RFCs

IPng Criteria

at least 10^9 networks, 10^{12} end-systems
- safer goal 10^{12} nets, 10^{15} end-systems

conservative routing schemes
topologically flexible
high performance
straightforward transition plan from IPv4
robust service
media independent
datagram service
autoconfiguration
secure operation
globally unique names
access to standards
support multicasting
extensible
support service classes
support mobility
include control protocol (ping etc.)
support for private networks (tunneling)

Nostradamus mode

predicting the future is hard

from "A Proposal for a Next Generation Internet Protocol"
Ross Callon - December, 1987

Internet doubling every year (720 assigned nets in '87)

- requirements as seen for 1997
  - change should last for at least 10-15 years
  - very high speed nets (microsecond forwarding time)
  - plan for at least 100,000 nets, 10,000 ASs
  - administrative diversity - addressing complexity
  - effective general congestion control
  - efficient source routing

Assumptions

we see consensus on the following points:

specific recommendation required now

basic requirements agreed to

it has to work

proceed with single IPng effort

Reviews of IPng Proposals

directorate did continuous reviews of proposals during its teleconferences and on its mailing list

aspects of proposals discussed on big-internet mailing list

directorate asked to do formal reviews of the IPng proposals before the retreat on May 19 & 20

reviews received will be reformatted and released as informational rfcs

following are summaries of these reviews

Reviews of IPng Proposals

summarized against protocol requirements

	catnip	sipp	tuba	IPng
complete spec	no	yes	mostly	mostly
simplicity	no	no	no	mostly
scale	yes	yes	yes	yes
topological flex	yes	yes	yes	yes
performance	mixed	mixed	mixed	yes
robust service	mixed	mixed	yes	yes
transition	mixed	no	mixed	yes
media indepdnt	yes	yes	yes	yes
datagram	yes	yes	yes	yes
config. ease	unknown	mixed	mixed	mostly
security	unknown	mixed	mixed	yes
unique names	mixed	mixed	mixed	mixed
access to stds	yes	yes	mixed	yes
multicast	unknown	yes	mixed	yes
extensibility	unknown	mixed	mixed	yes
service classes	unknown	yes	yes	yes
mobility	unknown	mixed	yes	mixed
control proto	unknown	yes	mixed	yes
tunneling	unknown	yes	mixed	yes

CATNIP

common feeling in the Directorate that catnip proposal is incomplete

'best vision but rather complex'
'limited scope, not a full proposal'
'lack of maturity, lack of widespread support'
'straightforward bidirectional translation'
'you may as well just be running the native protocol[s]'

SIPP

common view in and out of the Directorate that IPAE has severe operational flaws
general approval of clean, simple SIPP header design
extended addressing is too complex to explain easily
64 bit address assignment is inadequate

'I am very unhappy...with the support SIPP gives to autoconfiguratior
'SIPP source route reversal is a security problem'
'The IPAE proposal is a very large solution to an ill-specified problem
'SIPP has left it to others to solve important problems, such as a scalable addressing structure'
'SIPP has not dealt with the issue of mobility'
'SIPP addresses are inadequately hierarchical'

TUBA

deeply divided views on whether IETF could fix CLNP
the CLNP bugs are significant, e.g. source route bugs
mixed views on value of using NSAP address space

'TUBA is good because of CLNP. If not CLNP, it is a new proposal'
'If TUBA becomes the IPng, then the IETF must own TUBA'
'Using CLNP error responses is a transition problem'
'Variable length addresses increase the cost of development and worsen performance on the host'
'TUBA dual stack only transition is problematic, both dual stack and translation are needed'
'CLNP multicast is complex'
'Addresses are not 8-byte aligned'

Result of Reviews

significant flaws seen in all proposals

revised proposal components offered since retreat
- answer most of the perceived problems
  - routing and addressing
  - transition
  - autoconfiguration
- some still unresolved issues
  - source routing support
  - mobility

synthesis of multiple efforts

basis of IPng recommendation

Kudos

huge amount of work has gone into the IPng effort over the last few years

multiple working groups, mailing list participants (thanks kre)

IPng directorate, white paper authors, IESG, IAB ...

(cast of thousands)

remarkable degree of cooperation between efforts

the IETF way!

Recommendations

form new IPng working group

all base documents to be ready for proposed standard
consideration by December 1994

minimal required IPng functionality must include
address autoconfiguration & support for authentication

IPng description

expanded from IPv4 addressing capability

simple header

support for extension headers and options

support for authentication and privacy

support for autoconfiguration

support for source routes

simple and flexible transition from IPv4

flow ID

Header Format

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Version|                   Flow Label                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|         Payload Length        |  Next Header  |   Hop Limit   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
+                                                               +
|                                                               |
+                         Source Address                        +
|                                                               |
+                                                               +
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
+                                                               +
|                                                               |
+                      Destination Address                      +
|                                                               |
+                                                               +
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Extension Headers

```
+---------------+------------------------
|  IPng header  | TCP header + data
|               |
| Next Header = |
|          TCP  |
+---------------+------------------------

+---------------+----------------+------------------------
|  IPng header  | Routing header | TCP header + data
|               |                |
| Next Header = | Next Header =  |
|      Routing  |           TCP  |
+---------------+----------------+------------------------

+---------------+----------------+-----------------+-----------------
|  IPng header  | Routing header | Fragment header | fragment of TCP
|               |                |                 |  header + data
| Next Header = | Next Header =  |  Next Header =  |
|      Routing  |     Fragment   |            TCP  |
+---------------+----------------+-----------------+-----------------
```

Extension Header Types

Hop-by-Hop Options

End-to-End Options

Routing

Fragment

Authentication

Privacy

IPng Addresses

16 byte fixed length Internet address

address formats determined by IPng working group

assignment coordinated by the IANA

IPng Addresses, contd.

propose mapping algorithms from and to other environments

where addresses are globally unique and assigned with regard to network topology

IETF should work with other organizations for development of such mappings

permits unified management of address space among multiple protocol families

common addresses facilitate transition to IPng

goal to provide a 1:1 mapping between address types

e.g. IPX, NSAP, E164

IPng Working Group, charter outline

chairs: Ross Callon, Steve Deering

document editor: Bob Hinden

Goal is to resolve any remaining issues (source route, payload size, etc),complete unfinished work (security, ICMP, IGMP, DNS, etc),develop/finalize addressing/routing plans and move IPng to proposed standard. Cooperate with work in other areas impacted by IPng, routing for example.

IPng BOF meeting in Toronto

short-term milestones for the proposed standards for IPng
- revise existing IDs to produce IPng base documents in August
- IDs submitted as proposed standards in December

IPng Working Group, starting documents

S. Deering - Simple Internet Protocol Plus (SIPP) Spec. (128 bit ver)
P.Francis et all - SIPP Addressing Archecture
Y. Rekhter - An Archecture for SIPP-16 Address Allocation
R. Gilligan - Simple SIPP Transition (SST) Overview
R. Atkinson - SIPP Security Architecture
R. Atkinson - SIPP Authentication Header
R. Atkinson - SIPP Encapsulating Security Payload
...

Existing IPng Proposal Working Groups

at start of process we said that the existing working groups would not be required to shutdown when the IPng recommendation was made

after this week current IPng proposal working groups will be returned to the Internet area

they can continue to work, but the work will not be on IPng or be expected to have influence on IPng

must revise charter if they wish to continue

IPng Area

IPng area will conclude after documents enter standards track

working groups will then move to logical IETF areas

directorate maintained while area active

Autoconfiguration

address autoconfiguration a required feature of IPng

an IPng autoconfiguration working group to be formed

short lived working group
focus on documents for server-less & server-full modes of
  autoconfiguration
coordinate with other IETF activities affected by autoconfiguration
  such as DNS (for autoregistration) and CAT (for authentication)

starting document
  from Sue Thomson & Dave Katz

Transition

two IPng transition efforts

short term

refine IPng-specific documents for proposed standard

long term

transition, coexistence & testing

work together

Transition, Short Term - ngtrans

chairs: TBA

short lived working group

focus on IPv4 to IPng transition and coexistence
- work with TACIT WG

finalize IPng transition overview

develop documents relating directly to the IPv4 to IPng transition
- define each transition function in detail
- guidance for network designers
- guidance for operators

Sep. 1994
- documents published as Internet Drafts

Dec. 1994
- documents submitted as proposed standards

Transition, long term

Transition and Coexistence Including Testing (tacit) WG
  Atul Bansal, Digital <bansal@lkg.dec.com>
  Geoff Huston, AARNet <G.Huston@aarnet.edu.au>

facets of issue

- transition from the currently deployed protocol
  to a new protocol

- heterogeneity and decentralization will need to
  be accommodated

- long period of coexistence between a new
  protocol and the existing protocol

- the Internet must now be considered a utility
  rigorous architectural and interoperability testing
  needed as part of predeployment phase

- not just IPv4 to IPng

TACIT WG, contd.

goals
- learn from other transition and deployment efforts
- detail problem areas in transition and coexistence
- facilitate transition plans from other network technologies
  - e.g. IPX, CLNP
- recommendation of specific testing procedures
- recommendation of coexistence operations procedures with IPv4
- recommendations for the smoothing of decentralized
  transition planning

Nov. 1994
- documents published as Internet Drafts

Dec. 1994
- documents submitted to standards track

IPng Reviewer

appoint an IPng reviewer to be specifically responsible
  for ensuring that a consistent view of IPng is
  maintained across the related working groups

needed since IPng related work will be going on in
  a number of IETF areas

job description
- time scale - long term
- offering the broadest perspective,
- question
- connect all the points
- spotting gaps
- but not making architectural decisions
  - that is the work of the working groups and the IETF

Dave Clark

Security

there is a recognition that the Internet needs strong security

IPng and other protocols are evolving toward incorporation of capabilities for authentication, integrity and confidentiality

the goal is to provide strong protection as a matter of course throughout the Internet

It is likely that the different communities on the Internet will need different suites of algorithms

one common mandatory set of algorithms, others optional

the use of multiple suites of algorithms will pose some interoperability issues; they will be dealt with over time.

Security, contd.

separate use of encryption from use of authentication

support of authentication header is required in IPng

support of encrypted payload is encouraged
- use and export restrictions can limit ability to support function

a key management infrastructure is required but
- outside of IPng effort

inclusion of cryptography for authentication and/or privacy may add t
- the cost and impact the performance of an implementation, but it is worth the cost

IETF work underway to embed signed keys in DNS

each IPng node should have a key

need framework for firewalls under IPng

EIDs

there has been much discussion with little resolution
- EIDs appear to be too much a research topic at this time

ADs sanctioned EID BOF in Toronto

any follow-on WG likely will not be in IPng area
- transport possible

Other Needed Work

changing the size of the internetwork layer address and other IPng changes affects many IETF standards

new working groups must be formed in many IETF areas to examine and resolve changes required, some work can be done by IPng WG

TCP, UDP, ICMP ...
FTP, SNMP, DNS, BOOTP, DHCP ...
IDRP, ISIS, OSPF, RIPv2 ...

host & router requirements

APIs - may or may not be IETF issue but needs to be addressed (Informational RFC?)

Time Line

July 1994 - IPng announcement

August 1994 - 1st test implementations

September 1994 - documents as Internet-Drafts

December 1994 - documents submitted as proposed standards

July 1995 - 1st beta versions of release software

December 1995 - initial scaling tests complete

December 1995 - 1st production software releases

IPng Schedule This Week

Mon	1330	Open Directorate Meeting
	1600	Endpoint EID BOF
		Transition, Coexistence & Testing
Tue	0930	IPng BOF
	1330	TCP/UDP over CLNP-Addressed nets
Wed	0930	TCP/UDP over CLNP-Addressed nets
	1330	Common Architecture for Next-Generation IP
	1600	Simple Internet Protocol Plus
	1930	Address Lifetime Expectations
Thu	0930	Simple Internet Protocol Plus
	1330	Transition, Coexistence & Testing

In Closing

In anything at all, perfection is finally attained not when there is no longer anything to add, but when there is no longer anything to take away.

Antoine de Saint-Exupery

Everything should be made as simple as possible, but not simpler.

A. Einstein