

The Long and Windy Road (IPv6)

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This is a brief history of Internet routing and addressing (ROAD) evolution especially the IPng (Internet Protocol Next Generation) in the early 1990s. It was somewhat a cloudy and windy dragon (LONG) thing. The IPng is currently known as IPv6.

- **David H. Crocker:** The ROAD to a new IP (<http://www.bbiw.net/articles/ROAD.article.txt>) explores the nature of the limitation and the efforts to move from the current IP version 4 to a new IP version.
- **November 1988:** Running out of IP address (<http://rms46.vlsm.org/3/0178.txt>)
Has anybody make any serious estimates of how long it will be before we run out of 32-bit IP addresses?
- **8 January 1991:** Defining The Problem (<http://rms46.vlsm.org/3/0203.txt>)
The Internet Activities Board (IAB) met with the Internet Engineering Steering Group (IESG) at USC Information Science Institute in Marina del Rey, CA, USA. See also RFC-1126: Goals and Functional Requirements for Inter-Autonomous System Routing by M. Little/ SAIC (October 1989).
- **5 August 1991:** Definition of Class E IP Addresses (<http://rms46.vlsm.org/3/0017.txt>)
Frank Solenski and Frank Kastenholz proposed an extension to the method of classifying and assigning IP network numbers. This Internet-Draft was available at the Big-Internet list.

- **10 October 1991:** ROAD: Architectural Retreat -- Results and Plans (<http://rms46.vlsm.org/3/0133.txt>)
Minutes of the meeting of the Internet Activities Board (IAB) at Fairmont Hotel during the Interop'91 conference in San Jose, CA, USA.
- **November 1991:** ROAD (Routing and Addressing)
To explore these many issues and dilemmas, the IETF formed the Routing and Addressing (ROAD) group at the November 1991 Santa Fe meeting. (Scott O. Bradner and Allison Mankin, 1996, p. 7).
The ROAD working group members were Phill Gross (co-chair), Peter Ford (co-chair), Ross Callon (DEC), Lyman Chapin, Kent England, Vince Fuller (BARRNet), Bob Hinden, Dave Oran (DEC), T. Li (Cisco), Bob Smart, K. Varadhan (OARnet), Greg Vaudreuil (IESG-Exec), Zheng Wang, and J. Yu (MERIT).
- **15 March 1992:** A Revision of IP Address Classifications (<http://rms46.vlsm.org/3/0018.txt>)
Frank Solenski and Frank Kastenholz proposed C# (C-sharp) IP addresses. This Internet-Draft was available at the Big-Internet list.
- **May 1992:** RFC-1335
A Two-Tier Address Structure for the Internet: A Solution to the Problem of Address Space Exhaustion. By Z. Wang and J. Crowcroft.
- **19 May 1992:** PIP: The "P" Internet Protocol (<http://rms46.vlsm.org/3/0019.txt>)
Paul Francis (then Tsuchiya) proposed an IP protocol that scales, encodes policy, and is high speed. This draft was available at the Big-Internet list. See also RFC-1621: Pip Near-term Architecture.
- **19 May 1992:** NSAPS (<http://rms46.vlsm.org/3/0066.txt>)
Surveys how NSAPS are being/will be/may be used with a view to deciding on the use of NSAPS within the CLNS project (by Paul Bryant).
- **June 1992:** RFC-1338
Supernetting: an Address Assignment and Aggregation Strategy. By V. Fuller, T. Li, J. Yu, and K. Varadhan.
- **June 1992:** RFC-1347
TCP and UDP with Bigger Addresses (TUBA), A Simple Proposal for Internet Addressing and Routing. By Ross Callon/DEC.
- **12 June 1992:** The Extended Internet Protocol (<http://rms46.vlsm.org/3/0091.txt>)
EIP does not propose any new addressing schemes but a framework in which any addressing schemes can be accommodated (by Zhen Wang).
- **17 June 1992:** IESG Deliberations on Routing and Addressing (<http://rms46.vlsm.org/3/0092.txt>)
A preliminary report on how the IESG will recommend various ROuting and ADdressing issues. See also RFC-1380.
- **18 June 1992:** An Introduction To NAT (<http://rms46.vlsm.org/3/0020.txt>)
Refers to a class of schemes for solving 2 of the three ROAD Internet problems (by J. Noel Chiappa).
- **25 June 1992:** IP Address Encapsulation (<http://rms46.vlsm.org/3/0094.txt>)
To define the addressing enhancements to IP so that they are carried as IP data and therefore invisible to all current IP hosts and routers (by Bob Hinden and Dave Crocker).

- **1 July 1992:** IAB proposal for CIDR and IPv7 (<http://rms46.vlsm.org/3/0001.txt>)
A summary of the IAB's proposals in response to the work of the ROAD group.

I wrote the first draft in the plane (from Kobe) and posted it to our internal distribution list the next Monday. The IAB discussed it extensively. In less than two weeks, it went through eight successive revisions. We thought that our wording was very careful, and we were prepared to discuss it and try to convince the Internet community. Then, everything accelerated... (Christian Huitema, 1996, p. 2).

After considering the IESG's recommendations, the IAB felt that additional ideas in the CLNP were also important, particularly some of the addressing ideas in the CLNP protocol. The IAB communicated its concerns, and there was immediate controversy along two dimensions. One dimension was technical: What is the best course for evolving the IP protocol? How important or useful are the ideas in the OSI protocol stack? The other dimension was political: Who makes these decisions? (Steve Crocker in RFC-1640).

After spirited discussion on this controversial proposal, the IETF decided to reject the IAB's recommendation and instead issued the call for proposals recommended by the ROAD group... The call for IPng proposals went out in July 1992 at the Boston IETF meeting, and a number of working groups were formed in response (Scott O. Bradner and Allison Mankin, 1996, p. 7).

- **22 September 1992:** SIP (<http://rms46.vlsm.org/3/0003.txt>)
The Simple Internet Protocol philosophy is that the IP model of globally-unique addresses, hierarchically-structured of efficient routing, is fundamentally sound (by Steve Deering).
- **November 1992:** The New World Order (<http://rms46.vlsm.org/3/0089.txt>)
The November 1992 IETF meeting adopted the outline of a new organizational structure for the IAB/IETF, to accommodate continued growth and new constituencies. See also RFC-1396 and IETF 25 Trip Report.
- **4 June 1993:** SIP & IPAE groups to merge and shuffle chairs (<http://rms46.vlsm.org/3/0004.txt>)

IPAE has evolved into being the SIP transition and implementation group (by Christian Huitema, Steve Deering, Bob Hinden, Dave Crocker).

- **July 1993:** IP Decide BOF minutes (<ftp://ftp.ietf.org/ietf/93jul/ipdecide-minutes-93jul.txt>)
At the July 1993 Amsterdam IETF meeting, Phill Gross, chair of the IETF and IESG, led the participants towards a consensus on these issues and set in motion the process for deciding on a new Internet protocol (Scott O. Bradner and Allison Mankin, 1996, p. 7).
This BOF was intended to help re-focus attention on the very important topic of making a decision between the candidates for IPng (minutes by Brian Carpenter).
- **7 September 1993:** A Direction for IPng (<http://rms46.vlsm.org/3/0002.txt>)
What is the basis for choosing the next generation of IP? What about CIDR? Should the IETF or the market make the final IPng decision? (by Phill Gross). See also RFC-1719.
- **14 October 1993:** IESG Handling of IPng documents (<http://rms46.vlsm.org/3/0005.txt>) The IESG has determined how documents from the IPng candidates will be treated when they are submitted to the IESG for publication as RFCs (by Phill Gross).
- **20 October 1993:** IPNG Area Report (<http://rms46.vlsm.org/3/0006.txt>)
A temporary area in the IESG charged with managing the "IP next generation" process. Co-chaired by Scott O. Bradner and Allison Mankin,
The directorate members (with their employers at the time) were: J. Allard (Microsoft), Steve Bellovin (AT&T), Jim Bound (Digital), Ross Callon (Bay Networks), Brian Carpenter (CERN), Dave Clark (MIT), John Curran (BBN Planet Corp.), Steve Deering (Xerox Corp.), Dino Farinacci (Cisco Systems), Mark Knopper (Ameritech), Greg Minshall (Novel, Inc.), Paul Mockapetris (USC/ISI), Rob Ullman (Lotus Development Corp.), Lixia Zhang (Xerox Corp.) -- (Scott O. Bradner and Allison Mankin, 1996, p. 13).
- **November 1993:** SIPP=SIP+PIP (<http://rms46.vlsm.org/3/0021.txt>)
The PIP and SIP WG have combined their efforts and the working groups will be merged in a new WG called Simple Internet Protocol Plus (SIPP). Minutes are reported by Bob Hinden
- **7 December 1993:** IPNG Area Report (<http://rms46.vlsm.org/3/0007.txt>)
The IPng area is soliciting white papers on topics related to the IPng requirements and selection criteria (by Scott O Bradner and Allison Mankin). See also the RFC-1550.
- **27 April 1994:** IPNG Update (<http://rms46.vlsm.org/3/0008.txt>)
A quick update on the status of the IETF IPng effort (by Allison Mankin).
The definition of the addressing and routing strategy for the new IP was indeed subject to many debates, some of which were very sour... (p. 63) The definition of security for IPv6 generated some heated debates... These debates were among the worst that I ever observed in the IETF (Christian Huitema, 1996, pp. 116-117)
- **May 1994:** Retreat
Each Directorate member was requested to evaluate the proposals in the preparation for a two-day retreat held near Chicago in May 1994... During the May 1994 retreat with the IPng Area Directorate and invited guests, there was considerable discussion of the strengths and weaknesses of the various IPng proposals (Scott O. Bradner and Allison Mankin, 1996, p. 197, 201).
- **26 June 1994:** IPNG ADs request (<http://rms46.vlsm.org/3/0009.txt>)
Are the transport and internetwork level names the same thing? Or, are they totally different? (by Scott O. Bradner and Allison Mankin).

- **7 July 1994:** IPng ADs Wish to Gauge Consensus on Address Length Requirements (<http://rms46.vlsm.org/3/0010.txt>)
Hi TUBA, SIPP, CATNIP, BIG-INTERNET, and IETF. We are especially interested on the address length.
- **December 1995:** RFC-1883 -- Internet Protocol, Version 6 (IPv6) Specification. -- by S. Deering and R. Hinden. This RFC was obsoleted by RFC-2460. See also the IP Next Generation Overview by R. Hinden.
- **11 April 1996:** Note of Appreciation (<http://rms46.vlsm.org/3/0090.txt>)
The IESG commended Scott O. Bradner and Allison Mankin for the outstanding job they performed as co-Area Directors of the IPng Area.
The IPng Area will pass into history in the next month or two, and we will be able to go back to our normal lives and our duties as area directors in other IETF areas. We will continue to be involved in the development and deployment of IPv6; as we both have more than a bit of pride of parenthood (Scott O. Bradner and Allison Mankin, 1996, p. 276).

References

- [BRADNERMANKIN96] Bradner, Scott O., and Mankin, Allison. 1996. IPng, Internet Protocol Next Generation. Addison-Wesley, - ed., pp. 288.
- [TK5105.875 Int.Ip CLMS SCMS, ISBN 0-2016-3395-7]
- [HUITEMA96] Huitema, Christian. 1996. IPv6 -- the new Internet Protocol. Prentice Hall, - ed., pp. 188.
- [TK5105.875 Int.Hui CLMS SCMS, ISBN 0-1324-1936-X]
- Bradnet, Scott. This is a history of the IETF IPng, <http://www.sobco.com/ipng/>
- Aggregate Archive <http://rms46.vlsm.org/3/208.txt>

Backlinks

- Introduction to IPv6 (Cisco)
- IPv6 Essentials (Philip Smith)
- RFC-4632: Classless Inter-domain Routing (CIDR): The Internet Address Assignment and Aggregation Plan V. Fuller and T. Li (August 2006)

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