UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

JUNIPER NETWORKS, INC.,
Petitioner,

v.

MONARCH NETWORKING SOLUTIONS LLC,
Patent Owner.

U.S. Patent No. 8,451,844

"Method of Receiving a Data Packet Coming from an IPv4 Domain in an IPv6 Domain, an Associated Device, and Associated Access Equipment"

IPR2024-00485

DECLARATION OF DR. SAMRAT BHATTACHARJEE IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 8,451,844

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LIST OF CHALLENGED CLAIMS

Claim	Limitation
1[pre]	A method of receiving a data packet from an IPv4 domain in an IPv6 domain, said data packet comprising an IPv4 destination address and a destination port number, said method comprising the following steps:
1[a]	constructing an IPv6 destination address by concatenating an operator prefix, said IPv4 destination address, and the destination port number;
1[b]	generating an IPv6 data packet from the IPv6 constructed destination address and the received IPv4 packet; and
1[c]	routing the generated IPv6 data packet in the IPv6 domain using the IPv6 constructed destination address, said constructed address belonging to a range of IPv6 addresses routable to an interconnection equipment of the IPv6 domain with the IPv4 destination address.
2	A non-transitory computer program product that is at least one of downloadable from a communications network and stored on a computer-readable medium and executable by a microprocessor, comprising program code instructions for executing the method according to claim 1 of receiving in an IPv6 domain a data packet from an IPv4 domain.
3[pre]	A method of sending a data packet from an IPv6 domain to a destination address of an IPv4 domain, said packet comprising an IPv6 destination address of the packet constructed by concatenating an operator prefix, the IPv4 destination address, and a destination port number, said method executing the following steps on reception of the data packet:
3[a]	extracting the IPv4 destination address and the destination port number from the IPv6 destination address;
3[b]	generating an IPv4 data packet from the IPv6 data packet, said packet including said IPv4 destination address and said destination port number; and
3[c]	routing the IPv4 data packet to its IPv4 destination.

Claim	Limitation
4	A non-transitory computer program product that is at least one of downloadable from a communications network and/or stored on a computer-readable medium and/or executable by a microprocessor, comprising program code instructions for executing the method according to claim 3 of sending a data packet from an IPv6 domain to a destination address of an IPv4 domain.
5[pre]	A device for receiving a data packet from an IPv4 domain in an IPv6 domain, said data packet comprising an IPv4 destination address and an IPv4 destination port number, said device comprising:
5[a]	means for constructing an IPv6 destination address by concatenating an operator prefix, said IPv4 destination address, and the destination port number;
5[b]	means for generating an IPv6 data packet from the IPv6 constructed destination address and the received IPv4 packet; and
5[c]	means for routing the generated IPv6 data packet in the IPv6 domain using the IPv6 constructed destination address, said constructed address belonging to a range of IPv6 addresses routable to an interconnection equipment of the IPv6 domain with the IPv4 destination address.
6[pre]	Access equipment to an IPv6 domain comprising an interface with at least one IPv4 domain, further comprising:
6[a]	a device according to claim 5 for receiving a data packet coming from an IPv4 domain in the IPv6 domain; and
6[b]	a device for sending a data packet from an IPv6 domain to an IPv4 domain, said packet comprising an IPv6 destination address of the packet constructed by concatenating an operator prefix, the IPv4 destination address, and a destination port number, said device, on reception of the data packet, making use of:
6[c]	means for extracting the IPv4 destination address and the destination port number from the IPv6 destination address;

Claim	Limitation
6[d]	means for generating an IPv4 data packet from the IPv6 data packet, said packet including said IPv4 destination address and said destination port number; and
6[e]	means for routing the IPv4 data packet to its IPv4 destination.
7	IPv6 domain access equipment according to claim 6, wherein the IPv4 is a public network, said equipment comprising first means for advertising to the IPv4 domain IPv4 addresses of network equipments connected to the IPv6 domain and second means for advertising in the IPv6 domain IPv6 addresses constructed from IPv4 addresses of the IPv4 domain.
8	IPv6 domain access equipment according to claim 6, wherein the IPv4 domain is a private network, the access equipment is a home gateway adapted to connect user terminals of the private network to the IPv6 domain.
9	IPv6 domain access equipment according to claim 8, comprising means for obtaining an IPv4 address, a range of port numbers, and a range of authorized IPv6 addresses, said range of IPv6 addresses being constructed by concatenating an operator prefix, said IPv4 address, and the range of authorized IPv4 port numbers.
10[pre]	A device for sending a data packet from an IPv6 domain to an IPv4 domain, said packet comprising an IPv6 destination address of the packet constructed by concatenating an operator prefix, the IPv4 destination address, and a destination port number, said device, on reception of the data packet, making use of:
10[a]	means for extracting the IPv4 destination address and the destination port number from the IPv6 destination address;
10[b]	means for generating an IPv4 data packet from the IPv6 data packet, said packet including said IPv4 destination address and said destination port number; and
10[c]	means for routing the IPv4 data packet to its IPv4 destination.

I. INTRODUCTION

1. I have been retained by Quinn Emanuel Urquhart & Sullivan, LLP on behalf of Juniper Networks, Inc. ("Juniper" or "Petitioner") as an independent expert in this *inter partes* review before the Patent Trial and Appeal Board of the United States Patent and Trademark Office to review claims 1-10 ("Challenged Claims") of U.S. Patent No. 8,451,844 ("the '844 patent"). I have been asked by Petitioner to assist in evaluating the claims and the disclosure of the '844 patent.

2. I understand that the '844 patent is currently asserted in a litigation by Monarch Networking Solutions LLC ("Monarch" or "Patent Owner") against Petitioner in *Monarch Networking Solutions LLC v. Juniper Networks, Inc.*, Case No. 3:23-cv-05076-RFL (N.D. Cal.).

A. Qualifications

3. I provide below an overview of my background and qualifications.

4. I earned a Ph.D. in Computer Science from Georgia Institute of Technology in 1999. Before that, I earned Bachelor of Science degrees in Mathematics and Computer Science from Georgia College and State University in 1994. I was a Teaching Assistant at the Georgia Institute of Technology from 1994 to 1995 and an Instructor in 1998.

5. From 1999 through 2005, I was an Assistant Professor at the University of Maryland, College Park, in the Department of Computer Science, and then an

Associate Professor with tenure from 2005 through 2009. In 2006, I was a Visiting Professor at Max Planck Institüt für Software Systems in Saarbrücken, Germany. In 2007, I was a Visiting Researcher at AT&T Labs in Florham Park, New Jersey.

6. Since 2009, I have been a tenured Professor at the University of Maryland. My teaching and research have focused on computer networking and other aspects of the technologies pertaining to the '844 patent. As part of my Ph.D. research, I worked on implementing various network protocols in both IPv4 and IPv6. In fact, my IPv6 implementation of Active Networking was one of the first to use the (then yet incomplete) IPv6 implementation in the Linux kernel. I was familiar with the details of IPv4 and IPv6 as part of my dissertation research, and have continuously taught both IPv4 and IPv6 as part of undergraduate and graduate networking courses since 1999, and done research involving both IPv4 and IPv6 since the mid-1990s.

7. I served as a reviewer for ACM/IEEE Transactions on Networking, IEEE Journal on Selected Areas in Communications, Computer Communications Journal (Special Issue on Network Security), ACM Transactions on Computer Systems, Performance Evaluation Journal, Computer Communications Review, European Transactions on Telecommunications, IEEE Transactions on Parallel and Distributed Systems, and ACM Transactions on Internet Technology.

8. I am the author of numerous publications in the field of networking, including journal articles, book chapters, publications in proceedings, technical reports, and invited papers.

9. I have been active in a number of professional organizations and conferences. I have served with the National Science Foundation (NSF) Workshop on Network Testbeds, the NSF Networking Research Panel, the Department of Education High Performance Networking Panel, and as an Evaluator for the Intel Science Talent Search.

10. I have received several honors and awards. These include the Alfred P. Sloan Jr. Fellowship; the Best Paper Award, 14th Annual IEEE International Conference on High Performance Computing (HiPC) (with Vijay Gopalakrishnan, Ruggero Morselli, Peter Keleher, and Aravind Srinivasan); the Best Paper Award, 7th IEEE/ACM Conference on Grid Computing (with Jiksoo Kim, Byomsuk Nam, Peter Keleher, Michael Marsh, and Alan Sussman); and the NSF CAREER Award. I also received Teaching Excellence Awards in 2004, 2008, and 2012.

11. In 2017, along with colleagues from Cornell University and the Max Planck Society in Germany, I started an annual school for introducing undergraduate students from across the world to research. This school is partially supported by the NSF and had student participants from 29 countries.

12. I am also the co-director of a new joint Ph.D program in computer science between the University of Maryland and the Max Planck Society in Germany.

13. Additional details of my education and employment history, professional service, patents, publications, and other testimony are set forth in my current curriculum vitae, which is attached as Petitioner's Exhibit 1004.

B. Materials Considered

14. In forming my opinions, I have considered the '844 patent specification, including the Abstract, the figures, and the claim language itself, as would have been understood by a person having ordinary skill in the art. I have also reviewed the file history of the '844 patent, the exhibits listed within the petition, and any other material cited in the petition and this declaration.

15. In forming my opinions, I have relied on my personal knowledge and professional experience in designing, developing, deploying, or using software related to computer networks, IPv4, IPv6, and related technologies, and on the documents and information referenced in this declaration.

16. I am being compensated for my time spent on this matter at a rate of $700 per hour, and my compensation is in no way contingent upon the outcome of this matter or on the opinions I offer.

II. LEGAL UNDERSTANDINGS

17. In this section, I describe my understanding of certain legal standards that I have relied upon in forming my opinions set forth in this declaration. I am not an attorney. I have been informed of these legal standards by Petitioner's attorneys.

18. I understand that the claims define the invention. I also understand that an unpatentability analysis is a two-step process. First, the claims of the patent are construed to determine their meaning and scope. Second, after the claims are construed, the content of the prior art is compared to the construed claims.

19. I understand that a claimed invention is only patentable when it is new, useful, and non-obvious in light of the "prior art." That is, the invention, as defined by the claims of the patent, must not be anticipated by or rendered obvious by the prior art.

A. Claim Construction

20. I understand that the United States Patent and Trademark Office interprets claim terms in an *inter partes* review proceeding under the "*Philips*" claim construction standard. I understand that under this standard, the meaning of claim terms is considered from the viewpoint of one of ordinary skill in the art at the time of the alleged invention. For this declaration, I have been asked to apply June 30, 2008 as the priority date for the '844 patent, which is the date I have used for claim

interpretation purposes. However, the interpretations that I provide below would have also been correct if the date of alleged invention was a year earlier or later.

21. I understand that, through the use of "means-plus-function" limitations, patentees may claim functions without reciting structures for performing those functions in the claims. Such limitations are construed to cover the corresponding structure described in the specification. This process requires first determining the function of the means-plus-function limitation, and then determining the corresponding structure disclosed in the specification. A structure is corresponding if the specification or file history clearly links or associates it to the function recited in the claim. I understand that if a term is a "means-plus-function" term, then it must be construed by first identifying the function as set forth in the claims and then identifying the corresponding structure in the specification that performs the recited function.

22. I have been informed that, for the purposes of my analysis in this IPR proceeding, the terms appearing in the claims of the '844 patent should be interpreted according to how a POSITA would have understood the claim terms at the time of the earliest priority date, in light of the patent specification, the prosecution history, and any other relevant intrinsic and extrinsic evidence.

B. Anticipation

23. I understand that a patent claim is anticipated when a single piece of prior art describes every element of the claimed invention, either expressly or inherently, arranged in the same way as in the claim. For inherent anticipation to be found, it is required that the missing descriptive material is necessarily present in the prior art. I understand that, for the purpose of an *inter partes* review, prior art that anticipates a claim can include both patents and printed publications from anywhere in the world.

C. Obviousness

24. I understand that a patent may not be valid even though the invention is not identically disclosed or described in the prior art if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious to a person having ordinary skill in the art in the relevant subject matter at the time the invention was made.

25. I understand that the following factors are evaluated to determine whether the claimed subject matter is obvious: (1) the scope and content of the prior art; (2) the difference or differences, if any, between each claim of the patent and the prior art; and (3) the level of ordinary skill in the art at the time the patent was filed. Unlike anticipation, which allows consideration of only one prior art reference, I

understand that obviousness may be shown by considering more than one prior art reference.

26. I understand that the following rationales may be used to determine whether a piece of prior art can be combined with other prior art or with other information within the knowledge of one of ordinary skill in the art:

- Combining prior art elements according to known methods to yield predictable results;
- Simple substitution of one known element for another to obtain predictable results;
- Use of known techniques to improve similar devices (methods, or products) in the same way;
- Applying a known technique to a known device (method, or product) ready for improvement to yield predictable results;
- "Obvious to try" - choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success;
- Known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations would have been predictable to one of ordinary skill in the art; or

- Some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

27. Moreover, I understand that certain secondary considerations may be considered in evaluating obviousness in order to prevent hindsight bias. These secondary considerations may include : (1) commercial success; (2) long-felt but unresolved needs; (3) copying of the invention by others in the field; (4) initial expressions of disbelief by experts in the field; (5) failure of others to solve the problem that the inventor solved; and (6) unexpected results. I also understand that evidence of objective indicia of non-obviousness must be commensurate in scope with the claimed subject matter.

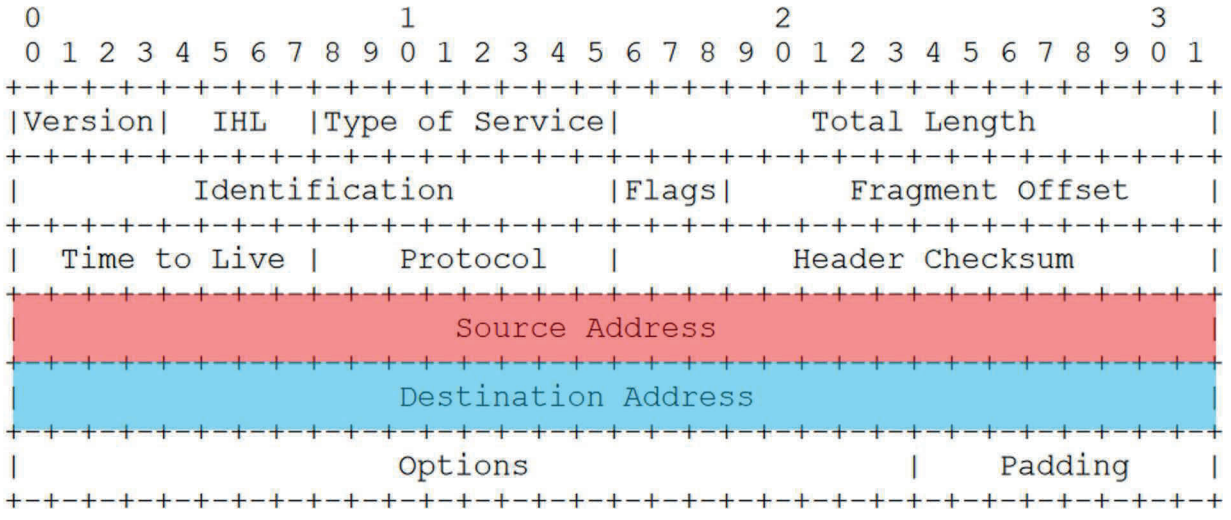
28. Finally, I understand that independently made, simultaneous inventions, made within a comparatively short space of time, are persuasive evidence that the claimed apparatus was the product only of ordinary mechanical or engineering skill. I understand that simultaneous invention can occur as late as one year after the patent's priority date.

III. TECHNOLOGY BACKGROUND

A. Internet Protocol Version 4

29. Internet Protocol Version 4 ("IPv4") is described in RFC 791 (September 1981). EX1011. When a source computer sends an IPv4 packet to a

destination computer, the packet includes an IPv4 header. *Id.*, 17.[1] The format of an IPv4 header is shown below and includes a source address (red) and a destination address (blue) for routing the packet from the source computer to the destination computer. *Id.*, 20. IPv4 addresses are 32 bits long:



Example Internet Datagram Header

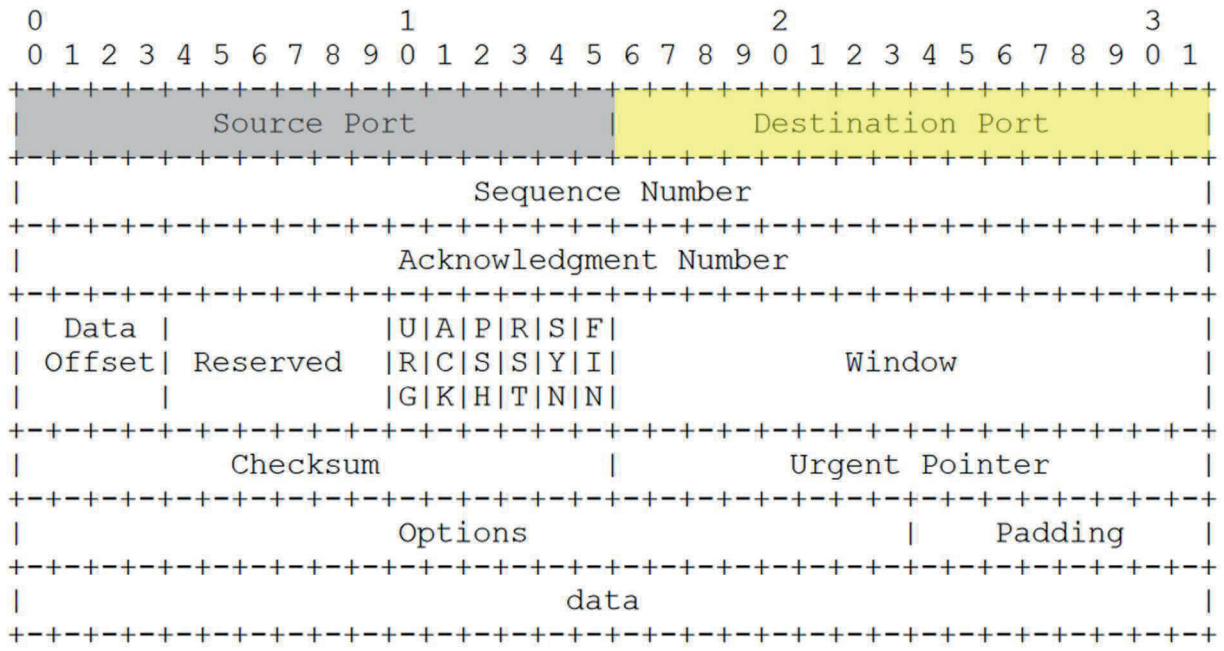
Figure 4.

Id., 17. An IPv4 address is typically written in dotted-quad notation, formatted as four decimal numbers (eight bits each) that are separated by periods, for example: **172.16.254.1**. This representation is for readability purposes; translating a decimal

[1] Exhibit citations—excluding exhibits, like patents, that designate their own paragraph or line numbers—refer to the page stamped on the bottom right of each exhibit, following the words "Juniper Exhibit."

number to a different format—for example, hexadecimal—does not change the underlying binary number.

30. An IPv4 packet sent across the Internet typically encapsulates a TCP or a UDP header which contains a 16-bit source port number and a 16-bit destination port number. A TCP header is shown below with a source port number (grey) and destination port number (yellow):



TCP Header Format

Note that one tick mark represents one bit position.

Figure 3.

EX1012, 21. The source port number identifies the specific process that sends the data, while the destination port number identifies the process that is to receive it. Email, for instance, might use Simple Mail Transfer Protocol ("SMTP") on port 25,

while a web server might use Hypertext Transfer Protocol ("HTTP") on port 80 or HTTP Secure ("HTTPS") on port 443.

31. The fact that an IPv4 address consists of 32 bits means that there are only ~4 billion available IPv4 addresses. By the time of the '844 patent, it was well-understood that available IPv4 addresses would soon run out. EX1001, 1:61-62 ("It is commonly accepted in the IP service provider community that IPv4 public addresses are going to run out."). Indeed, "[t]he Internet engineering community ha[d] long recognized the impending exhaustion of IPv4." EX1013, 1, 8-9. And this problem had only grown over time "as the number of devices connecting to the Internet continue[d] to increase." EX1014, ¶1. A new standard—Internet Protocol version 6 ("IPv6")—was therefore developed to address this issue of IPv4 address exhaustion.

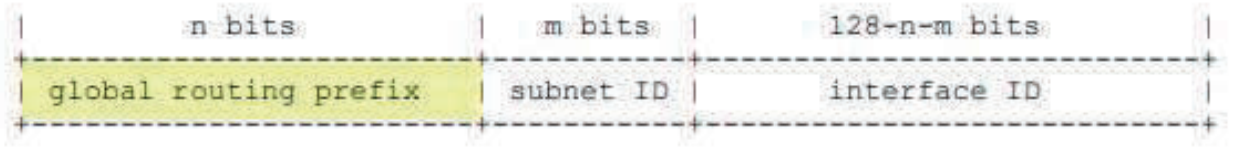
B. Internet Protocol Version 6

32. IPv6 is described in RFC 2460 (December 1998) and is an evolution of IPv4. EX1015. The IPv6 header is shown below and also includes a source address (red) and a destination address (blue):

Id., 4.

33. An IPv6 address is 128 bits long and is conventionally written using hexadecimal digits within eight groups, each of which is 16 bits. *Id.*, 5. Each group is expressed as four hexadecimal digits and the groups are separated by colons, for example: **FE80:CD00:0000:0CDE:1257:0000:211E:729C**. Further, the example address can be shortened, as the addressing scheme allows the omission of consecutive zeros, designated by two colons "::". For example, FE80:CD21:0000:0000:0000:0000:211E:729C can be shortened to FE80:CD21::211E:729C. EX1016, 4-5.

34. An IPv6 address begins with a "prefix" (yellow) that is "n bits" long—meaning the prefix is variable in length:



EX1017, 2; EX1018, 176. The prefix can be allocated to individuals, companies, service providers, and any other entity requesting an IPv6 network address space. EX1018, 176.

C. IPv4/IPv6 Transition Mechanisms

35. The most striking difference in the evolution from IPv4 to IPv6 is the tremendous expansion of the size of the IP address field. Whereas IPv4 uses a 32-bit IP address field, IPv6 uses 128 bits. A 32-bit address field provides a maximum of 2^{32} addresses (~4.2 billion addresses), whereas a 128-bit field provides 2^{128} addresses (~340 trillion trillion trillion addresses). The large number of possible IPv6 addresses helps prevent the problem of Internet addresses running out.

36. IPv6, however, is not inherently compatible with IPv4 and this incompatibility drove the need for transition mechanisms that permitted IPv6 to be deployed alongside IPv4. By the priority date of the ’844 patent, myriad transition mechanisms had been proposed and developed.

1. Converting IPv4 Addresses into IPv6 Addresses to Allow IPv4 Hosts to Communicate with IPv6 Hosts

37. One of the most common methods of communicating between IPv4 devices and IPv6 devices involved using an intermediary device to convert an IPv4 address into an IPv6 address.

38. For example, U.S. Patent No. 7,391,768 ("Samprathi"), filed in May 2003, describes a network device **112** that sits between an IPv4 FTP client **118** and an IPv6 FTP server **108**:

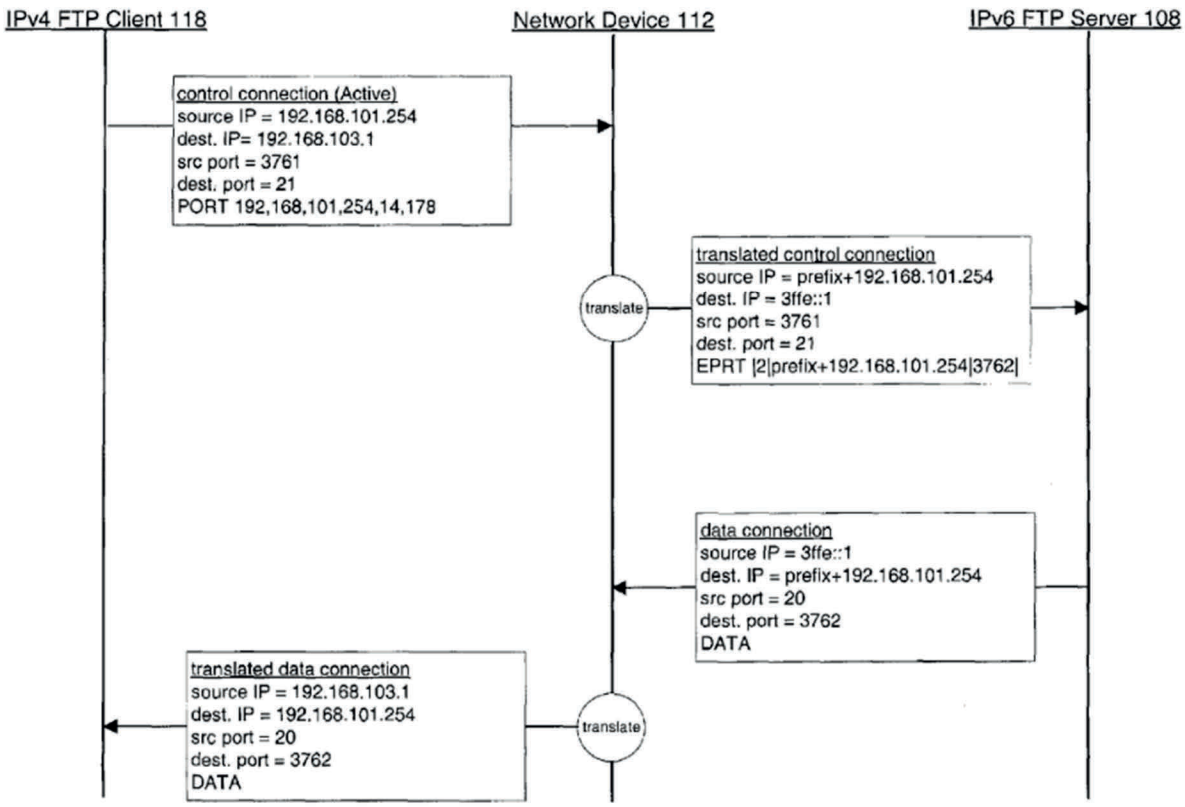


Figure 2A

EX1019, Fig. 2A. When the IPv4 client **118** sends data to the IPv6 server **108**, that data is intercepted by network device **112**. Network device **112** converts the IPv4

source address into an IPv6 source address by concatenating an IPv6 prefix with the IPv4 source address. *Id.*, 6:35-7:9.

39. Similarly, Tim Rooney published "IPv4-to-IPv6 Transition Strategies" in February 2007. EX1020. This document detailed "an IPv6-over-IPv4 tunneling technique" called "6to4," which constructs an IPv6 address by concatenating a "6to4 prefix" with a "globally unique IPv4 address":

Figure 8: 6to4 Address Prefix Derivation

Id., 11. The same can be done with a protocol called "6over4." *Id.*, 15.

2. Using Port Information to Prevent IPv4 Exhaustion

40. Although converting IPv4 addresses into IPv6 addresses solves the compatibility issue—*i.e.*, it allows IPv4 hosts to communicate with IPv6 hosts—it does not solve the IPv4 address exhaustion issue—*i.e.*, IPv4 hosts still need to occupy one of the finite public IPv4 addresses to participate in the network, and eventually the finite number of public IPv4 addresses will run out. This need for both IPv4-and-IPv6 compatibility and IPv4-exhaustion prevention led some persons of ordinary skill in the art ("POSITAs") to take advantage of the ~65,000 port numbers that hosts can use to access services.

41. As mentioned above, an IPv4 packet that encapsulates a TCP or UDP header includes 16-bit port numbers that identify the specific process or application on the computer sending or receiving the packet. *See* §III.A. The 16-bit port field provides a maximum of 2^{16} (65,536) unique port numbers. By the priority date of the '844 patent, POSITAs understood that computers typically utilized only a small portion of these port numbers. EX1021, 4 ("Now, we introduce a new technique to re-use address space by transparent port-address translation. We note that there are a lot of ports in a node and only a small portion of them are used at any time."). Thus, POSITAs proposed solutions that extended the IPv4 address space by combining the 32-bit address with bits from the port number field. *Id.* In this way, multiple devices could share the same 32-bit address with port information distinguishing them. *Id.*; EX1022, 9 ("As such, if you consider a host to be the <IP address, port> pair, then because there are approximately 65,000 possible ports, it is possible to multiplex many hosts on one IP address. This has become quite popular in the marketplace, from large organizations all the way down to small home installations."); EX1023, 2 ("Intuitively, a host only use[s] a small part of port numbers to connect with others. Therefore, if we limit the port that one host can use, then multiple hosts in an IPv6 network can share a same IPv4 address.").

42. For example, U.S. Patent No. 8,032,639 ("King"), filed May 23, 2006 and granted October 4, 2011, teaches assigning ranges of port numbers to internal

hosts so that the internal hosts can share an IPv4 address while still allowing external devices to identify hosts based on the port numbers assigned to each host. EX1024, 1:15-4:2.

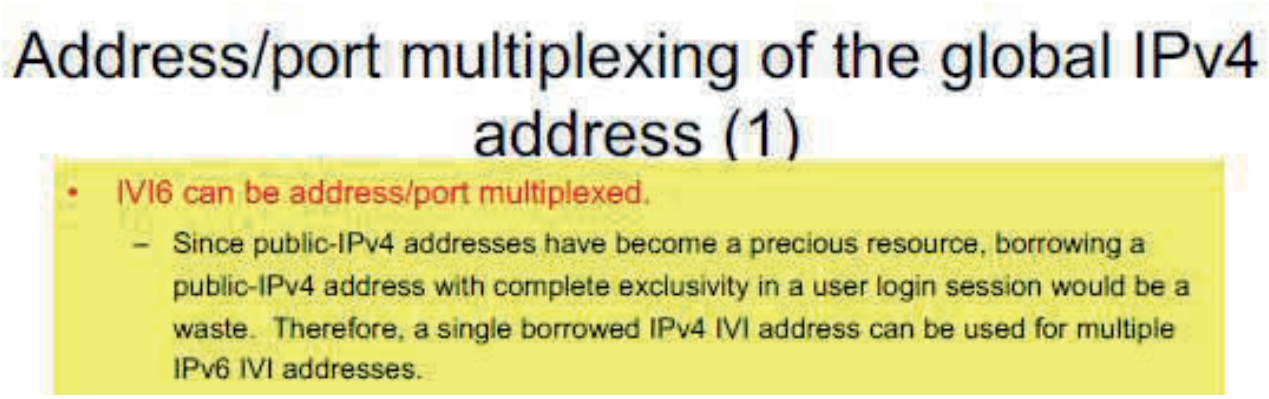
43. Similarly, U.S. Patent No. 8,019,889 ("Biswas"), filed May 31, 2002 and granted September 13, 2011, also teaches assigning port numbers to internal hosts so that the internal hosts can share an IPv4 address. EX1025, 2:16-4:9.

3. Combining the Above Two Ideas

44. Several prior art references, including those discussed in the invalidity grounds below, disclose combining these two ideas: (1) converting IPv4 addresses into IPv6 addresses to make IPv4 devices interoperable with IPv6 devices and (2) incorporating port numbers into constructed IPv6 addresses to prevent IPv4 address exhaustion.

45. For example, an IPv4-IPv6 coexistence mechanism called "IVI"—a merger of the roman numerals four (IV) and six (VI)—was deployed by the China Education and Research Network (CERNET) in 2006. EX1038, 17 ("The IVI gateway based on the Linux implementation has been deployed between CERNET (IPv4 and partially dual-stack) [CERNET] and CNGI-CERNET2 (pure IPv6) [CERNET2] since March 2006."). IVI forms an IPv6 address by concatenating an IPv6 prefix with an IPv4 address. *Id.*, 6. And by June 21, 2008, authors had prepared an Internet Draft specification titled "Bi-Directional Address Borrowing (IVI)"

(EX1038) and presentation (EX1026) that extended IVI by further concatenating a port number with the IPv4 address and prefix:



EX1026, 24; EX1038, 14.

46. No later than July 6, 2008, one week after the '844 patent's priority date, those same authors submitted an updated draft to the IETF titled "Prefix-Specific and Stateless Address Mapping (IVI) for IPv4/IPv6 Coexistence and Transition" ("IVI Memo") that continued to propose including a port number when forming the IPv6 address. EX1027, 18-19; *see also* EX1028, 20-22 (July 29, 2008). Various other publications from around the time of the '844 patent similarly proposed extending the IPv4 address space by combining an IPv4 address and port number, and further disclosed using this extended IPv4 address to construct an IPv6 address. EX1029, 2 ("[W]e propose to extend the IPv4 address space by assigning to each customer a single IPv4 address which is extended by 'stealing' bits from the port number…"); *see also* §VII.B.1 (discussing simultaneous invention of the '844 patent's disclosures).

47. Further, U.S. Patent Application No. 10/401,083 ("Huitema"), filed on March 27, 2003 and later granted on July 17, 2007 as U.S. Patent No. 7,245,622 also recognizes both of these co-existence and address-depletion problems. EX1030. Huitema explains that "[i]n order for one computing system to communicate with another computing system over a particular network, it is important that each computing system be uniquely identified on that network." *Id.*, ¶5. Huitema further explains that "IPv4 addresses have become scarcer" and that "the problem associated with a limited number of unique addresses under IPv4 may be addressed by reconfiguring the Internet to operate exclusively under IPv6 instead," which "is sufficient to provide unique addresses for well into the anticipated future." *Id.*, ¶¶6-8. But "such a reconfiguration is not practical for the time being," so "it is commonly accepted that the Internet needs to concurrently work with both IPv6 and IPv4, at least for the near future." *Id.*, ¶8. Huitema describes the following network configuration:

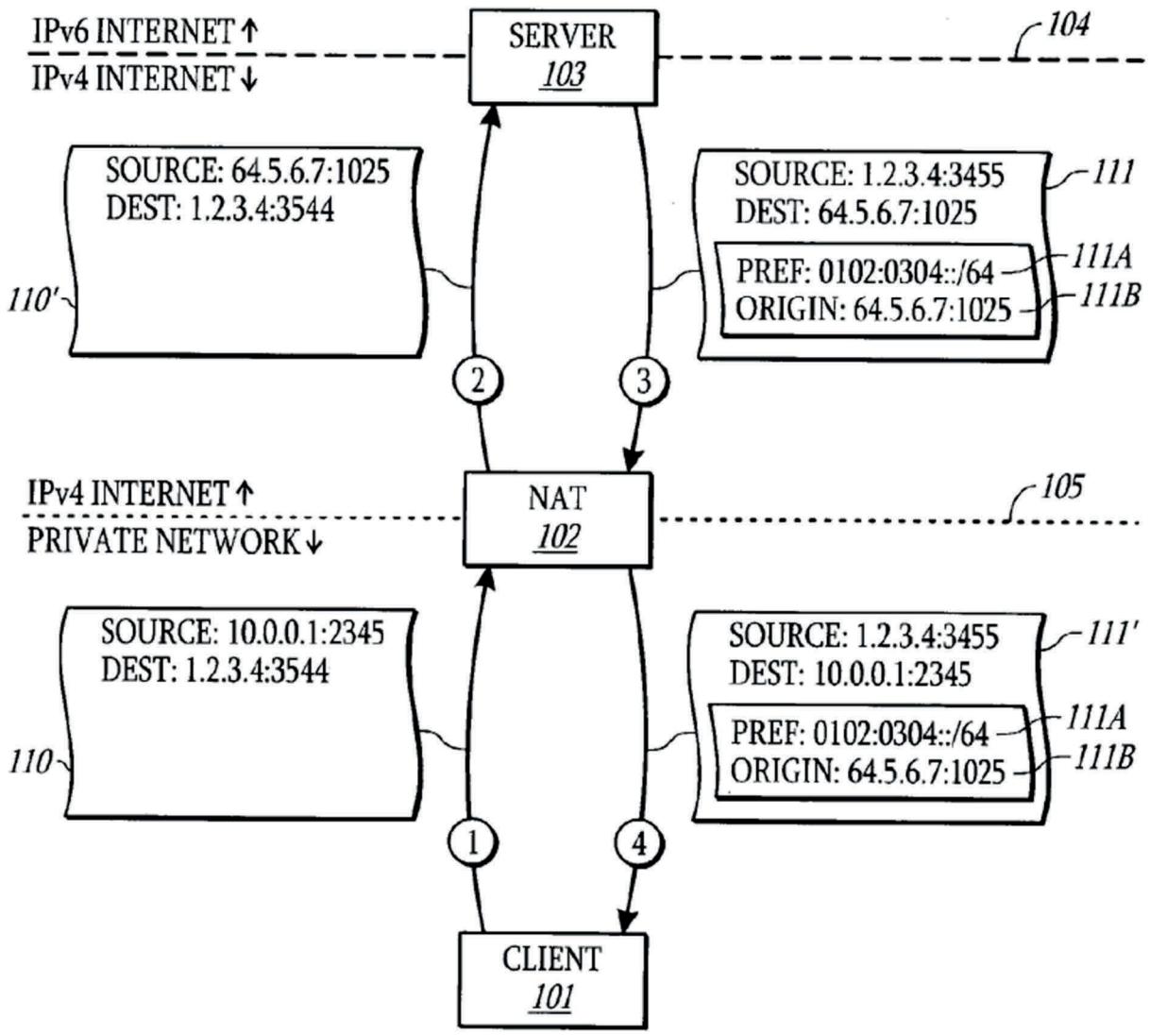


FIG. 1

Id., Fig. 1. In this embodiment, client **101** sits in a private network and needs an IPv6 address "[i]n order to participate in communications with IPv6 computing systems." *Id.*, ¶49. Client **101** thus requests and receives several pieces of information, (*id.*, ¶¶49-54), in order to construct the following IPv6 address:

PREF:102:304::FBFE:BFFA:F9F8

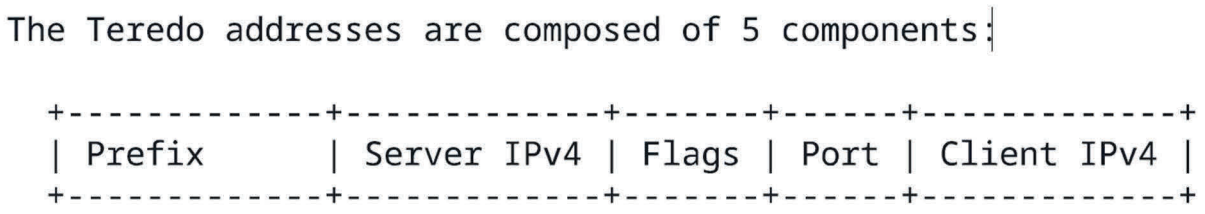
Id., ¶55. The first portion, "**PREF:102:304**" is an IPv6 prefix that client **101** receives from server **103**. *Id.* The second portion, "**FBFE**" is a port number that client **101** obtains from NAT **102**—port number 1025—converted to hexadecimal and XORed[2] with hexadecimal number "FFFF." *Id.* The third portion, "**BFFA:F9F8**" is an IPv4 address that client **101** obtains from NAT **102**—64.5.6.7—converted to hexadecimal and XORed with hexadecimal number "FFFF:FFFF." *Id.* Accordingly, client **101** constructs an IPv6 address that comprises an IPv6 prefix, a port number, and an IPv4 address. *Id.* In this manner, Huitema is able to address both IPv4-and-IPv6 interoperability and IPv4 address exhaustion.

48. Similarly, U.S. Patent No. 7,149,225 ("Thubert"), filed July 11, 2003 and granted December 12, 2006, teaches using a Teredo address to solve the

[2] XOR is a binary operation, like an OR operation or an AND operation, that outputs a 1 only if the two input bits are different:

Input Bit #1	Input Bit #2	Output Bit
0	0	**0**
0	1	**1**
1	0	**1**
1	1	**0**

problems of IPv4-and-IPv6 compatibility and IPv4 address exhaustion. EX1031, 2:30-3:42. Teredo addresses are constructed IPv6 addresses that comprise five components: (1) **an IPv6 prefix**, (2) a server IPv4 address, (3) a flag that designates the type of NAT used, (4) **a port number**, and (5) **the client IPv4 address**:



EX1032, 9.

IV. OVERVIEW OF THE '844 PATENT

A. Priority

49. I am informed that because the prior art cited in this petition pre-dates the earliest possible priority date of the '844 patent (June 30, 2008), each cited reference herein qualifies as prior art under at least one of pre-AIA 35 U.S.C. §§ 102(a), (b), and/or (e).

B. Specification

50. The '844 patent is directed to an Internet Protocol telecommunications network for transmitting data packets from a source terminal identified by a source address to a destination terminal identified by a destination address. EX1001, 1:17-

21. At the time, there were two incompatible versions of Internet Protocol: IPv4[3] with 32-bit addresses and IPv6[4] with 128-bit addresses. *Id.*, 6:21-24.

51. The '844 patent describes "routing an IPv4 data packet coming from an IPv4 [domain] in an IPv6 domain," where "said data packet includes an IPv4 destination address and a destination port number." *Id.*, 2:61-3:11. "The general principle of the invention relies on constructing an IPv6 address from an IPv4 address, a predetermined operator prefix, and a port number." *Id.*, 6:13-15. The '844 patent depicts the following network configuration that implements its teachings:

[3] The IPv4 protocol was standardized by the Internet Engineering Task Force (IETF) in RFC791 in September 1981. EX1011.

[4] The IPv6 protocol was standardized by the IETF December 1995 and revised in later years. EX1015.

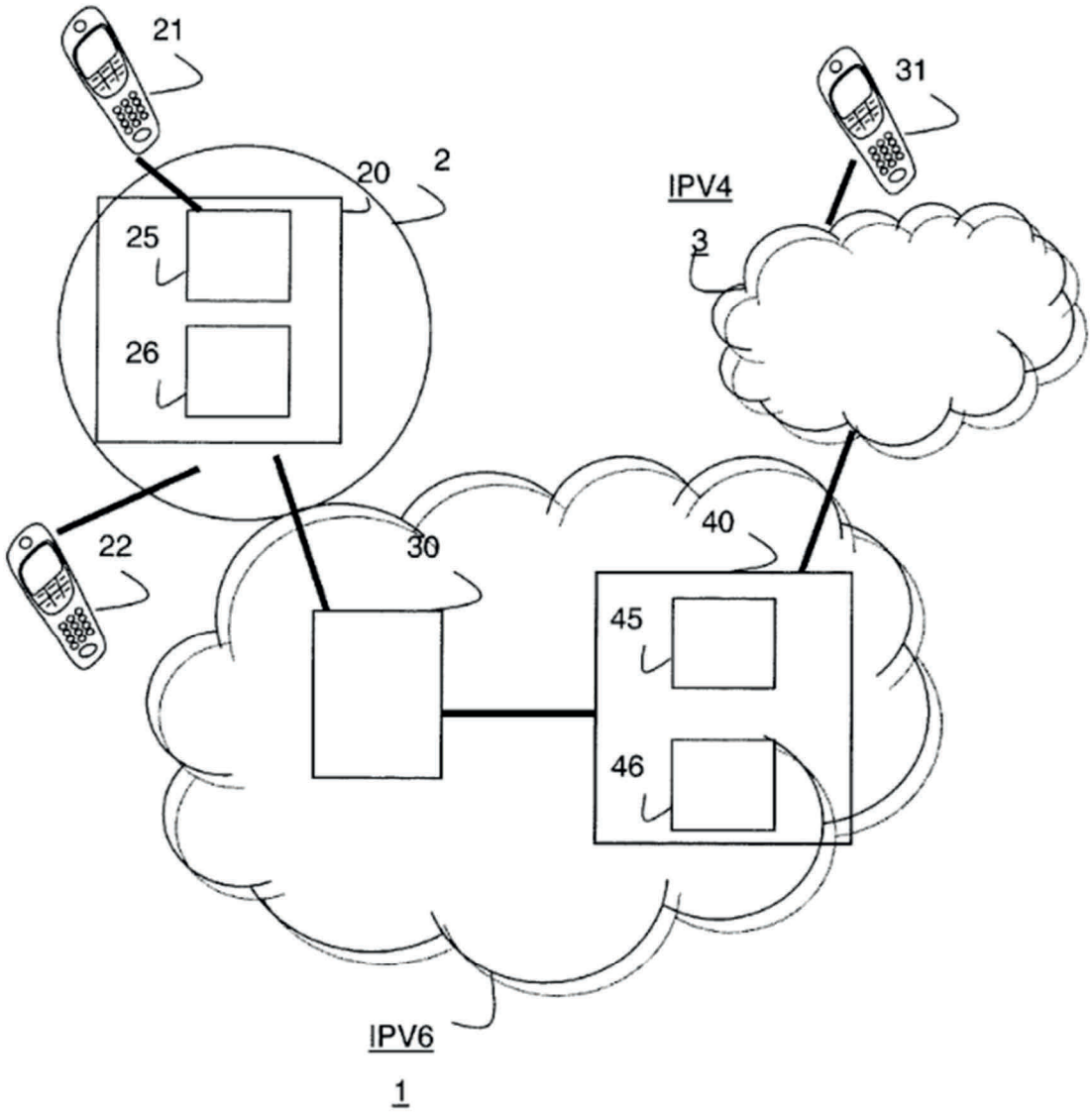


FIG. 1

Id., Fig. 1. Figure 1 depicts an IPv6 domain **1** that includes an access node **40** that can communicate between both IPv4 and IPv6 networks. *Id.*, 7:4-10. The access node **40**, coupled with an access router **30**, routes "data packets going to and from a home gateway **20**." *Id.* The home gateway **20** services user terminals **21** and **22**,

which have either (1) both IPv4 and IPv6 capability or (2) just IPv6 capability. *Id.*, 7:4-20. At the other end of the network sits a user terminal **31** in an IPv4-only domain **3**. *Id.*, 7:16-28.

52. When user terminal **31**, which has only IPv4 capabilities, transmits data packets to user terminals **21** or **22**, it first sends the data packet to access node **40**. *See id.*, 10:4-25, 14:1-16. Access node **40** receives the IPv4 data packet and constructs an IPv6 address by concatenating an IPv6 prefix, the received IPv4 address, and the received port number. *Id.*, 6:13-15, 10:4-48, 14:1-16, 14:29-42. Access node **40** can then route the data packet to the correct user terminal in the IPv6 domain. *Id.* 10:59-63, 14:1-16. An example of the constructed IPv6 address is depicted in Figure 4:

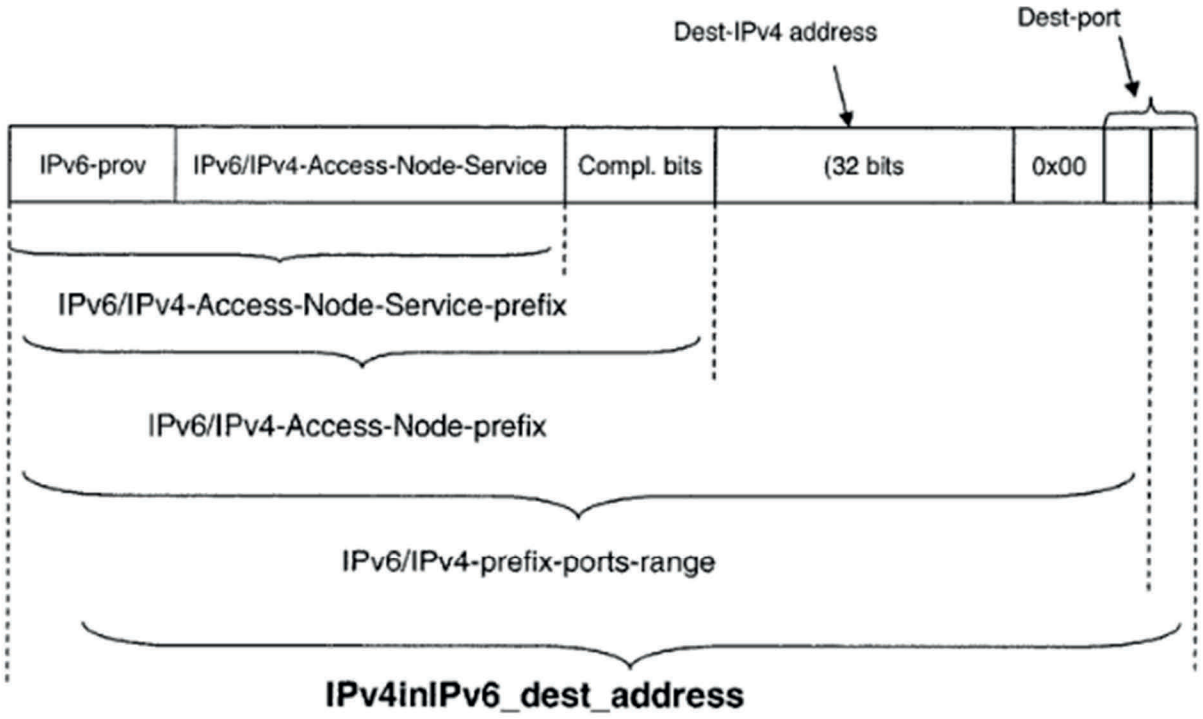


FIG. 4

Id., Fig. 4. In particular, the IPv6 prefix is designated by IPv6/IPv4-Access-Node-prefix, the received IPv4 address is designated by Dest-IPv4 address, and the received port number is designated by Dest-port. *Id.*, 10:9-37. The '844 patent further discloses doing the same process in reverse—receiving an IPv6 packet and extracting an IPv4 address and port number from the IPv6 address. *Id.*, 11:16-41.

V. LEVEL OF ORDINARY SKILL IN THE ART

53. I understand that a person of ordinary skill in the art ("POSITA") is a hypothetical person who is presumed to be aware of all pertinent art, thinks along conventional wisdom in the art, and is a person of ordinary creativity—not an automaton. In deciding the level of ordinary skill, I understand that the following

factors may be considered: the levels of education and experience of persons working in the field, the types of problems encountered in the field, and the sophistication of the technology.

54. I understand that the asserted patents must be evaluated from the perspective of a POSITA. In my opinion, the relevant art for this patent relates to the field of computer networks and routing packets in a computer network. I understand that the relevant point in time for determining the qualifications of a POSITA is the time of the alleged invention, which I assume to be the earliest filing date for the patent. Here, I understand that the earliest invention date contended by Patent Owner is June 30, 2008.

55. In my opinion, a POSITA at the time of the invention (*i.e.*, in June 2008) would have had a Bachelor of Science degree in electrical engineering, computer engineering, computer science, or a related subject, and three years of work experience in computer networking, including experience with the IPv4 and IPv6 protocols, or a related field. Lack of professional experience can be remedied by additional education, and vice versa. I meet these criteria and have applied it in my analysis.

VI. CLAIM CONSTRUCTION

56. I have been informed that, in a prior district court litigation brought by Patent Owner, the district court construed the ’844 patent’s terms. EX1036. These

constructions are identified below, and I have been instructed to apply them in my analysis for the purposes of this proceeding. I have also applied Monarch's proposed constructions in my analysis below, to the extent they are different.

Claim(s)	**Term**	**Construction**
1, 3, 5-6, 10	"IPv4 destination address"	"address formatted according to Internet Protocol version 4 indicating a destination"
1, 3, 5-6, 9-10	"concatenating"	"appending one item to the end of another so as to form a single unit in a contiguous pattern"
8	"home gateway"	"any equipment for interconnecting a private network and a network operated by a service provider, the private network being either a home network or a business network"
1, 3, 5-6, 10	"destination port number"	"number indicating a logical point of connection with a destination device."
1, 3, 5-6, 9-10	"operator prefix"	"a prefix assigned to an Internet Service Provider by its Regional Internet Registry"
1, 5	"an interconnection equipment of the IPv6 domain" / "with the IPv4 destination address"	"a router of the IPv6 domain" / "with the IPv6 constructed destination address including the IPv4 destination address"
5	"means for constructing"	Function: "constructing an IPv6 destination address by concatenating an operator prefix, said IPv4 destination address, and the destination port number" Structure: "access node 40 with a device 25 that includes a processor programmed to perform the step of constructing an IPv6

		destination address by concatenating an operator prefix, said IPv4 destination address, and the destination port number as illustrated in Figures 2 and 4"
5	"means for generating"	Function: "generating an IPv6 data packet from the IPv6 constructed destination address and the received IPv4 packet" Structure: "access node 40 with a device 25 that includes a processor programmed to perform the step of encapsulating the received IPv4 packet in an IPv6 packet or translating the received IPv4 packet IPv4-in-pt into an IPv6 packet"
5	"means for routing"	Function: "routing the generated IPv6 data packet in the IPv6 domain using the IPv6 constructed destination address" Structure: "access node 40 with a device 25 that includes a processor programmed to perform the step of routing the IPv6 data packet using the IPv6 routing core of the access node"
6, 10	"means for extracting"	Function: "extracting the IPv4 destination address and the destination port number from the IPv6 destination address" Structure: "home gateway 20 with a device 26 that includes a processor programmed to perform the step of determining whether the IPv6 data packet is a standard IPv6 packet or an IPv6 packet encapsulating an IPv4 packet using the header of the received packet"
6, 10	"means for generating"	Function: "generating an IPv4 data packet from the IPv6 data packet, said packet

		including said IPv4 destination address and said destination port number" Structure: "home gateway 20 with a device 26 that includes a processor programmed to perform the step of de-encapsulating the IPv4 packet contained in the packet IPv6 data packet to yield the IPv4 destination address and the destination port number"
6, 10	"means for routing"	Function: "routing the IPv4 data packet to its IPv4 destination" Structure: "home gateway 20 with a device 26 that includes a processor programmed to perform the step of routing the IPv4 data packet to its IPv4 destination by processing the IPv4 data packet with the internal address translation table (NAT table) of the home gateway"
7	"first means for advertising"	Function: "advertising to the IPv4 domain IPv4 addresses of network equipment connected to the IPv6 domain" Structure: "a dual-stack router that includes a processor programmed to perform the step of advertising to an IPv4 domain, IPv4 addresses of network equipment connected to the IPv6 domain"
7	"second means for advertising"	Function: "advertising in the IPv6 domain IPv6 addresses constructed from IPv4 addresses of the IPv4 domain" Structure: "a dual-stack router that includes a processor programmed to perform the step of advertising in the IPv6 domain, IPv6 addresses constructed from IPv4 addresses of the IPv4 domain"

9	"means for obtaining"	Function: "obtaining an IPv4 address, a range of port numbers, and a range of authorized IPv6 addresses" Structure: "the home gateway 20 or access router 30 serving home gateway 20 that includes a processor programmed to perform the step of obtaining an IPv4 address, a range of port numbers, and a range of authorized IPv6 addresses"

VII. IDENTIFICATION OF HOW THE CHALLENGED CLAIMS ARE UNPATENTABLE

A. Ground 1: Claims 1-10 Would Have Been Obvious in View of Li and Li-2

1. Li (EX1037)

57. Li (EX1037) is a paper entitled "Forwarding IPv4 Traffics in Pure IPv6 Backbone with Stateless Address Mapping" by Xing Li *et al.* that was published by the Institute of Electrical and Electronics Engineers ("IEEE") in April 2006, in connection with a conference that occurred on April 3-7, 2006 in Vancouver, Canada. EX10370.

(a) Public Accessibility of Li

58. The IEEE is a well-known, reputable organization and its website is known by POSITAs and routinely used by POSITAs to access technical publications and papers. In my experience, the copyright date that is disclosed on the face of an

IEEE paper—in this case, 2006—is the year that the paper was made publicly available.

59. In my opinion, interested persons would have been able to locate Li exercising reasonable diligence. Based on my experience with the standard IEEE practices, Li would have been available to the public no later than the last day of the conference, *i.e.*, April 7, 2006. Because of the IEEE's eminence in the industry as a source for standards and innovative technical publications, a POSITA would have been a member of the IEEE or, at the very least, would have followed its publications and therefore would have been able to locate Li exercising reasonable diligence.

(b) Overview of Li

60. Li concerns the transition between IPv4 and IPv6. EX1037, 1. According to Li, "[t]ransition is one of the most significant problems in deploying an emerging network technology." *Id.* "[M]igrating networks from IPv4 to IPv6 is very difficult and complicated," and current solutions "do not terminate all the obstacles of transition." *Id.* Li therefore proposes "a new technique of forwarding IPv4 traffics in pure IPv6 backbone" by mapping IPv4 packets into IPv6 packets (or vice versa) "automatically at the edge of the IPv6 backbone." *Id.*

61. Li depicts the following network configuration as one embodiment that implements its invention:

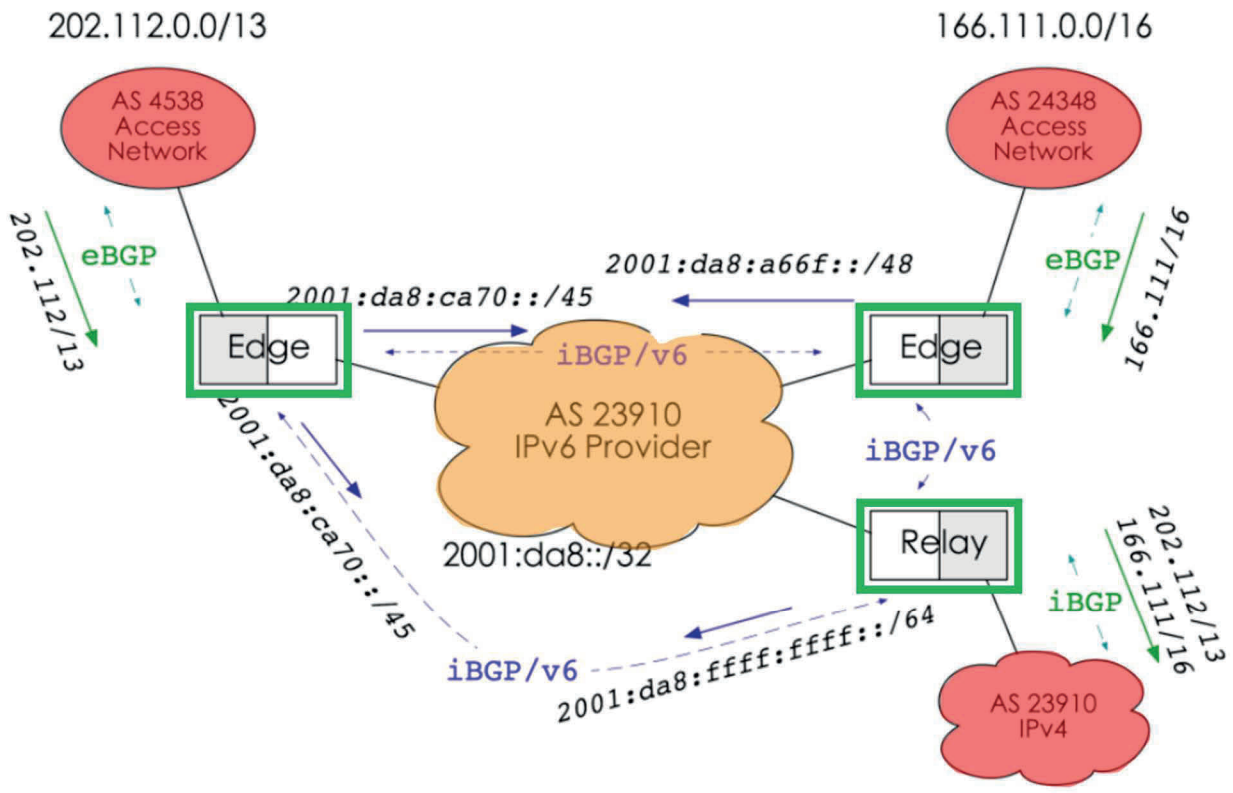


Figure 7. IPv4-over-IPv6 transition for access networks

Id., 7 (highlighted). At the center of the network is an IPv6 domain (orange) that routes incoming data packets. *Id.*, 3, 6-7. Surrounding the IPv6 domain are several IPv4 domains (red), called access networks. *Id.* Edge routers and edge relays (surrounded by green borders) straddle the IPv6 domain and the IPv4 domains. *Id.* These "IPv4-IPv6 edge routers" implement the disclosed invention and convert IPv4 data packets into IPv6 data packets and vice versa. *Id.*, 2-4.

62. The grounds in this petition walk through an example of sending a data packet from an IPv4 host in the top-left IPv4 domain, through the IPv6 domain, to an IPv4 host in the top-right IPv4 domain:

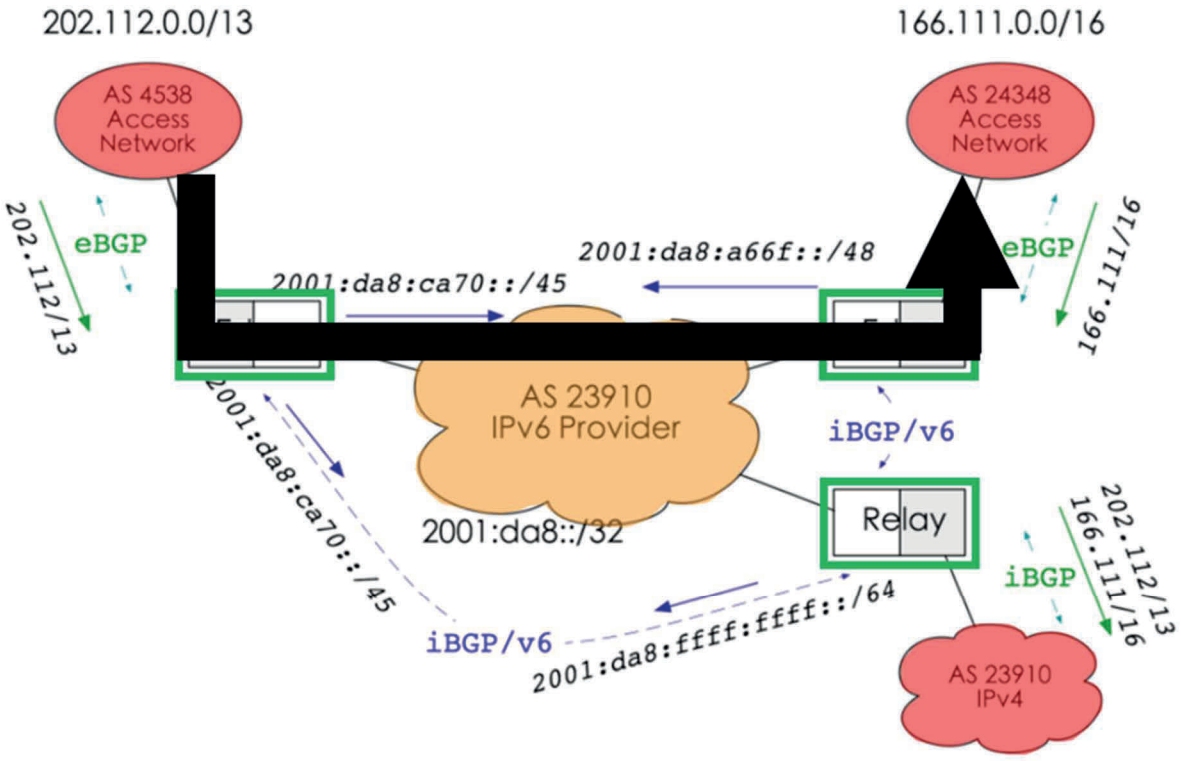
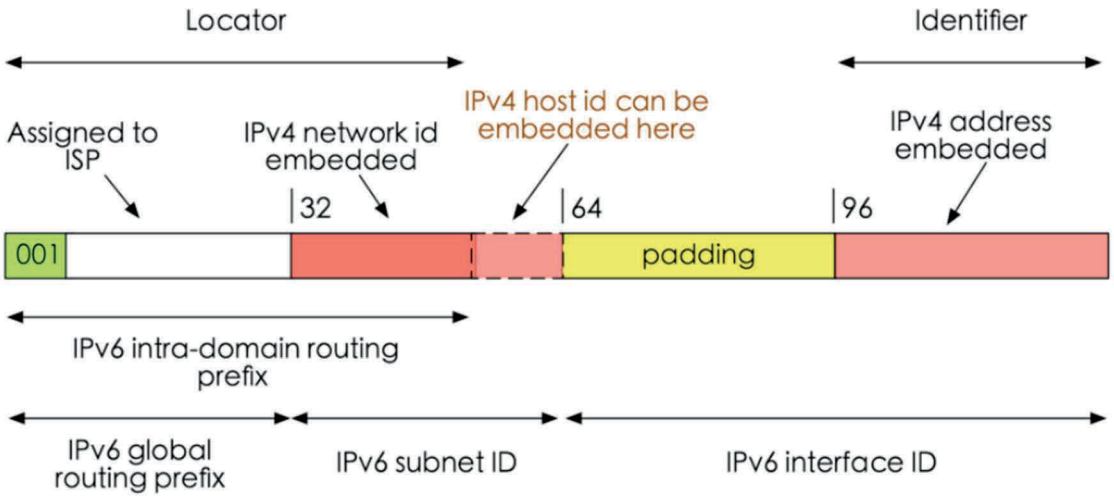


Figure 7. IPv4-over-IPv6 transition for access networks

Id., 7 (highlighted and annotated).

63. To convert the IPv4 data packets into IPv6 data packets during this routing process, the edge routers and edge relays implement a process called "address mapping." *Id.*, 3. According to Li, "[i]t is simple to map an IPv4 prefix into an IPv6 one." *Id.* Li provides an example of one such mapping:



Id. This mapping includes a variety of components. Particularly relevant to this IPR, it includes an "IPv6 global routing prefix," an "IPv4 address," and 32 bits of "padding" *Id.*

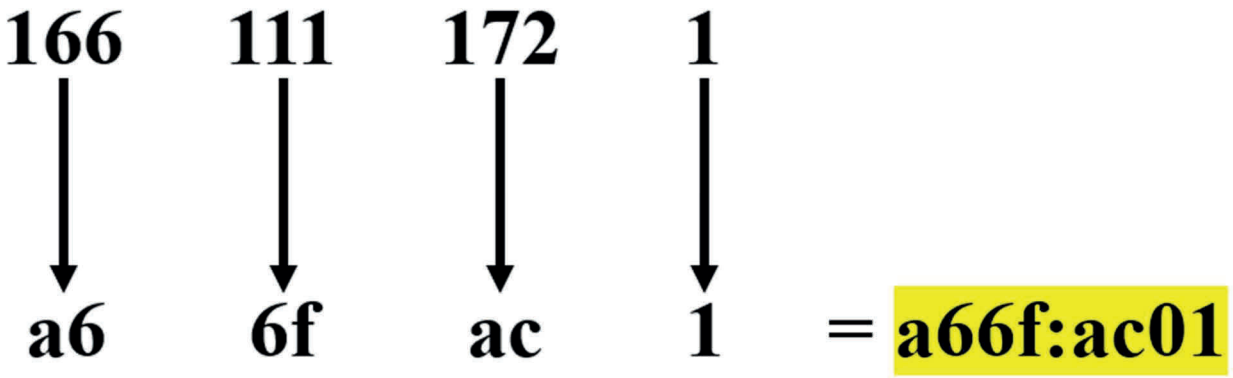
64. Li provides examples of address mapping in Table 1:

TABLE I. SOME ADDRESS MAPPING EXAMPLES

IPv4 prefix/address	IPv6 prefix/address
202.112.0.0/13	2001:da8:ca70::/45
166.111.0.0/16	2001:da8:a66f::/48
166.111.172.1	2001:da8:a66f:ac01::a66f:ac01

Id. (highlighted). In this mapping, Li constructs an IPv6 address in the right column by appending an IPv6 prefix (2001:da8) to the IPv4 address or address range in the left column. *Id.* It is critical to note that IPv4 addresses are typically represented in

dotted-quad notation, whereas IPv6 addresses are represented in hexadecimal notation, so while the IPv4 address on the left side appears different from the right side, they are actually the same. For example, the third row in Table 1 contains the IPv4 address 166.111.172.1. *Id.* Translating this address from dotted-quad notation to hexadecimal yields the following result:



The translation is merely aesthetic, for readability. The translation does not alter the IPv4 address itself—the IPv4 address on the left is the exact same 32-bit address as the one on the right. Thus, the resulting IPv6 address is 2001:da8:a66f:ac01::a66f:ac01,[5] where "2001:da8" is the IPv6 prefix (blue),

[5] In this example, the IPv4 address is repeated twice in the constructed IPv6 address. Li explains that issues arise with defining prefixes that cover both networks inside and outside of the autonomous system. Li therefore reserves the last 32 bits of the IPv6 address for the original IPv4 address in order to define a "common convention" and solve this problem. EX1037, 3. Thus, the IPv4 address "a66f:ac01" is repeated

"a66f:ac01" is the IPv4 address in hexadecimal notation (red), and the notation "::" represents zero-bit padding (yellow), in which bits 64 to 96 are zeros.

65. Thus, Li teaches constructing an IPv6 destination address by concatenating an IPv6 prefix, an IPv4 destination address, and zero padding. Li acknowledges that its invention "is just a small step" and "is an extensible foundation" that could be modified further to address the problem of IPv4 address exhaustion. *Id.*, 2.

2. Li-2 (EX1038)

66. On June 21, 2008, the authors of Li did just that—they extended the foundation provided by Li in an Internet Draft published with the IETF. EX1038 ("Li-2").

(a) Public Accessibility of Li-2

67. The IETF is an "Internet Engineering Task Force" that was founded in 1986 to "make[] voluntary standards that are often adopted by Internet users, network operators, and equipment vendors." *Introduction to the IETF*, IETF, available at https://www.ietf.org/about/introduction/ (last accessed Dec. 13, 2023). The IETF is a well-known, reputable organization and its website is routinely used

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at the end of the constructed IPv6 address (*i.e.*, the last 32 bits) to adhere to this convention. *Id.*

and known by POSITAs to access technical documents, like Internet Drafts, that are publicly published on the IETF website.

68. The IETF has a "commitment to making [its] documents, [its] Working Group mailing lists, [its] attendance lists, and [its] meeting minutes publicly available on the Internet." *Introduction to the IETF*, IETF, available at https://www.ietf.org/about/introduction/ (last accessed Dec. 13, 2023). One type of document that the IETF makes publicly available are Internet Drafts, which are "working documents of the IETF, its Areas, and its Working Groups." *Internet-Drafts*, IETF, available at https://www.ietf.org/how/ids/ (last accessed Dec. 13, 2023). The IETF makes Internet Drafts publicly available on its website and provides a way to search Internet Drafts by using the IETF Datatracker. *Id.*

69. As disclosed on the face of the document, Li-2 was submitted on June 21, 2008. EX1038, 1. In my experience, the date that is disclosed on the face of an Internet Draft is the date that the Internet Draft was made publicly available.

(b) Overview of Li-2

70. Li-2 recognizes that "IPv6 deployment in the past 10 years strongly indicate that for a successful transition, the IPv6 hosts need to communicate with the global IPv4 networks." EX1038, 4. However, current transition methods, like dual-stack hosts do not solve the "IPv4 address depletion problem." *Id.* And other options, like Network Address Translation "lost the scalability and end-to-end

address transparency." *Id.* Li-2 therefore describes a scheme that converts IPv4 addresses into IPv6 addresses to address these issues. *Id.* Li-2 explains that "[b]ased on this scheme, special IPv6 address blocks are defined, which can communicate with the global IPv6 network directly and with the global IPv4 networks via stateless (or almost stateless) gateways." *Id.*, 1-2. This addressing scheme confers several benefits, including "end-to-end address transparency, being globally routable, incremental deployable, having multi-homing support and being able to use the global IPv4 addresses effectively." *Id.*, 2.

71. Like the 2006 Li paper above, (EX1037), Li-2 describes an address mapping in which an IPv6 address is constructed by concatenating a 32-bit IPv6 prefix, a 32-bit IPv4 address, and 55 bits of zero padding:

IVI Address Mapping

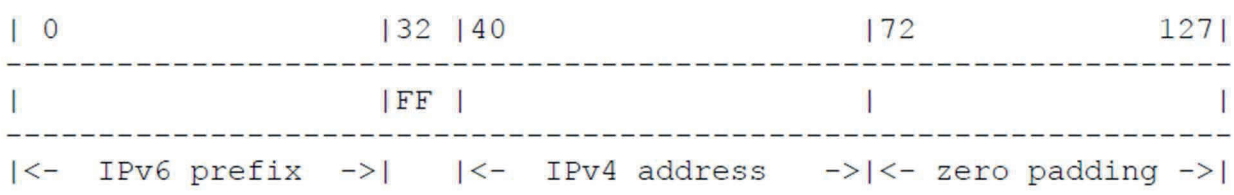


Figure 1

EX1038, 6.

72. However, Li-2 recognizes that this addressing scheme does not solve the problem of IPv4 address depletion. "Since public-IPv4 address is a scarce resource, the effective use of the IPv4 address is important for IVI scheme." *Id.*, 14.

Li-2 therefore expands upon the 2006 paper by introducing an idea of "multiplexing," specifically "port multiplexing," to mitigate IPv4 address depletion. *Id.*

73. Port multiplexing works by further replacing the "least significant bits" of the constructed IPv6 address—currently occupied by unused zero padding—with a port number. *Id.* (emphasis added). The relevant embodiment is "1-to-1 mapping," which means the mapping process "is stateless." *Id.* Li-2 explains that port multiplexing "increase[s] the utilization ratio of the public IPv4 address" by allowing a "single borrowed IPv4 address" to "be used for multiple IVI6(i) addresses." *Id.*

74. In fact, just one month later, the authors of Li and Li-2 provided examples of this stateless mapping algorithm in a presentation that they gave in Dublin for an IETF conference. EX1028; EX1007, ¶11 (confirming public accessibility); EX1005, ¶53-57 (same). These examples, which I explain below, further confirm that Li-2 teaches concatenating the destination port number to the IPv6 address by replacing unused zero padding. For example, the authors provided the following examples:

```
202.38.108.2#81 --> IVI61=2001:250:ffca:266c:0200::81#81
202.38.108.2#82 --> IVI61=2001:250:ffca:266c:0200::82#82
202.38.108.2#83 --> IVI61=2001:250:ffca:266c:0200::83#83
202.38.108.2#84 --> IVI61=2001:250:ffca:266c:0200::84#84
```

EX1028, 22 (highlighting added). The IPv6 prefix is the first box, highlighted in blue. EX1038, 6 ("[B]it 0 to bit 31 are the prefix of ISP(i)'s /32."). The second box, highlighted in red, is a flag that specifies that the IPv6 address has been constructed according to IVI. *Id.* ("[B]it 32 to bit 39 are all one's as the identifier of IVI."). The third box, which highlights the next 32 bits in purple, is the IPv4 address from the left side, translated from decimal to hexadecimal. *Id.* ("[B]it 40 to bit 71 are the global IPv4 space (IPG4) presented in hexadecimal format."). The fourth box, highlighted in yellow, is zero padding. *Id.* (Fig. 1). And the fifth box, highlighted in gray, is the port number that has been taken from the left side of the translation and concatenated to the end of the constructed IPv6 address, replacing unused zero padding as appropriate. *Id.*, 14.

75. I note that the authors did not translate, perhaps for the sake of convenience, the port number from decimal (*i.e.*, "81") to hexadecimal (*i.e.*, "51"). However, a POSITA would have understood that the port number extracted from the IPv4 data packet on the left-hand side of the equation is the exact same 16-bit number that is concatenated to form the IPv6 address on the right-hand side of the equation.

76. Finally, as discussed, the double-colon notation—"::"—indicates a string of zeros from the bit preceding the double-colon notation to the bit following the double-colon notation. *See* §III.B. If there is no number following the double-colon notation, then that indicates the zero padding continues to the end of the IPv6

address. Thus, by adding the destination port number to the end of the IPv6 address, that destination port number replaces unused zero padding.

3. The Li-Li-2 Combination

77. In the Li-Li-2 combination, Li teaches the general network structure and the steps of receiving a data packet from an IPv4 domain in an IPv6 domain. Li further teaches constructing an IPv6 address by concatenating an IPv6 prefix, an IPv4 address, and 32-bits of zero padding (and extracting the IPv4 information from the constructed IPv6 address and routing the IPv4 information). Li-2 supplements Li's disclosures by teaching concatenating a destination port number to the end of the constructed IPv6 address (replacing any unused zero padding as necessary) in order to uniquely identify IPv4 hosts and mitigate IPv4 address exhaustion. Thus, in the Li-Li-2 combination, Li would operate in its disclosed manner but would further implement Li-2's teaching of including port numbers in constructed IPv6 addresses.

4. Motivations to Combine Li and Li-2

78. A POSITA would have been motivated to combine the teachings of Li and Li-2 and would have had a reasonable expectation of success of doing so.

79. **First**, the prior art includes express teachings that would have led a POSITA to combine Li and Li-2. As discussed above, several prior art documents expressed a need to not only make IPv4 domains interoperable with IPv6 domains

in order to smooth the transition from IPv4 to IPv6, but also a need to slow IPv4 address exhaustion by sharing a single public IPv4 address among multiple hosts. *See* §III.C. Based on the information in the prior art, a POSITA would have known that (1) IPv4 addresses could be converted into IPv6 addresses to allow for IPv4-IPv6 interoperability, (*see* §III.C.1); and (2) port numbers could be used to extend the IPv4 address space by allowing multiple hosts to share a single public IPv4 address, (*see* §III.C.2). Indeed, Li-2 expressly discloses these teachings and explains that they are the underlying motivation for Li-2's port multiplexing extension of the original Li paper. EX1038, 4, 14. A POSITA would have had a reasonable expectation of success in combining Li and Li-2, especially because a POSITA did succeed in combining these references, since Li-2 is an extension of Li authored by the same inventors of the original Li paper. Indeed, the combination merely involves the straightforward application of replacing unused padding in Li's constructed IPv6 address with the destination port number, as taught by Li-2.

80. **Second**, this combination would have involved applying a known technique to a known device ready for improvement to yield predictable results. The '844 patent can be seen as an obvious improvement of Li. Although Li solves the issue of IPv4-IPv6 interoperability, it does not solve the issue of IPv4 address exhaustion. Similarly, the '844 patent explains that "[i]t is commonly accepted in the IP service provider community that IPv4 public addresses are going to run out"

and proposes a method of constructing IPv6 addresses that not only renders IPv4 domains interoperable with IPv6 domains but also maps one IPv4 address into multiple IPv6 addresses, slowing IPv4 address exhaustion. EX1001, 1:25-2:55. Thus, the purported "improvement" of the '844 patent is using destination port numbers to extend the IPv4 address space and slow IPv4 address depletion.

81. Li-2 describes the same improvement articulated by the '844 patent to Li's base device. For example, Li-2 similarly explains that concatenating destination port numbers to construct an IPv6 destination address further "increase[s] the utilization ratio of the public IPv4 address," allowing "a single borrowed IPv4 address" to "be used for multiple IVI6(i) addresses." EX1038, 14. Li-2 explains that this extension, called "port multiplexing," is important because "public-IPv4 address is a scarce resource" and "the effective use of the IPv4 address is important" for its addressing scheme. *Id.* Li-2 also explains that its disclosures carry several other advantages, like "end-to-end transparency, being globally routable, incremental deployable, having multi-homing support and being able to use the global IPv4 addresses effectively." *Id.*, 4. A POSITA not only could have applied the known improvement technique from Li-2 to Li, but a POSITA did apply this technique, and the results would therefore not only have been predictable to a POSITA but are explicitly described in Li-2. *Id.*, 14.

82. **Third**, this combination would have involved simple substitution of one known element for another to obtain predictable results. The only arguable difference between Li and the '844 patent is that Li does not explicitly disclose concatenating a destination port number to construct an IPv6 destination address. In other words, the prior art differs from the '844 patent's claimed device by the substitution of Li's zero padding with a destination port number. However, Li-2 shows that this substitution and its function was known in the art. As described above, Li-2 similarly replaces Li's unused zero padding with a port number in order to prevent IPv4 address exhaustion. *See* §VII.A.2. Li-2 describes the function of this substitution. EX1038, 14. Not only could a POSITA have substituted the known element of Li's zero padding for the other known element of Li-2's port multiplexing, but a POSITA did make this substitution, as described in Li-2. *See id.* And the results would have been predictable, as Li-2 describes the results of the substitution. *Id.*, 14.

83. **Fourth**, this combination would have involved combining prior art elements according to known methods to yield predictable results. Li and Li-2 recite all elements of the '844 claims, as described in the claim-by-claim analysis below. A POSITA could have combined the elements as claimed by known methods, which are described in Li-2. In fact, Li-2 is an extension of the ideas described in the original Li reference and was published by the same authors that published the

original Li paper in 2006. So not only could a POSITA have combined the elements of Li and Li-2, but a POSITA did combine these elements, resulting in Li-2. Moreover, a POSITA would have recognized that the results of the combination were predictable, especially because Li-2 describes the exact results of implementing port multiplexing. EX1038, 14.

84. **Finally**, Li, Li-2, and the '844 patent are analogous art because the references are in the same field of endeavor as each other, *i.e.*, computer networking and routing data packets. For example, the '844 patent explains that "[t]he field of the invention is that of telecommunications networks, in particular IP telecommunications networks transporting data packets." EX1001, 1:17-21. Li similarly explains that it is directed to "a new technique of forwarding IPv4 traffics in IPv6-only backbone" and includes "routing" as one if its "keywords." EX1037, 1. And Li-2 is also directed to a system that allows "IPv6 hosts… to communicate with the global IPv4 networks." EX1038, 4.

85. Additionally, all references are concerned with the interoperability of IPv4 networks and IPv6 networks. The '844 patent explains that "[t]he invention improves upon the [previously discussed] situation by means of a method of receiving a data packet coming from an IPv4 domain in an IPv6 domain" and is specifically directed to "a period of transition during which IPv6 domains will have to interconnect with IPv4 domains." EX1001, 2:46-64. Li similarly explains that

"at this stage, interoperability of applications in a dual-protocol environment has, replacing connectivity, become the sharpest issue of the IPv4-IPv6 transition." EX1037, 1. And Li-2 describes itself as "present[ing] the concept and practice of the bi-directional address borrowing scheme (IVI) for smooth and transparent transition from IPv4 to IPv6." EX1038, 4.

5. Claim 1

(a) 1[pre]: A method of receiving a data packet from an IPv4 domain in an IPv6 domain, said data packet comprising an IPv4 destination address and a destination port number, said method comprising the following steps:

86. To the extent the preamble is limiting, Li discloses limitation 1[pre]: "a method of receiving a data packet [*e.g.*, **IPv4 traffics received by the top-left edge router in Figure 7 that are destined for a host in the top-right IPv4 access network**] from an IPv4 domain [*e.g.*, **top-left IPv4 access network in Figure 7**] in an IPv6 domain [*e.g.*, **IPv6 domain in Figure 7**], said data packet comprising an IPv4 destination address [*e.g.*, **received IPv4 destination address that corresponds to a host in the top-right IPv4 access network**] and a destination port number [*e.g.*, **received destination port number**], said method comprising the following steps." I break down the elements of this limitation below.

87. ***A method of receiving a data packet from an IPv4 domain in an IPv6 domain***: Figure 7 depicts an embodiment of a network that facilitates communications between hosts:

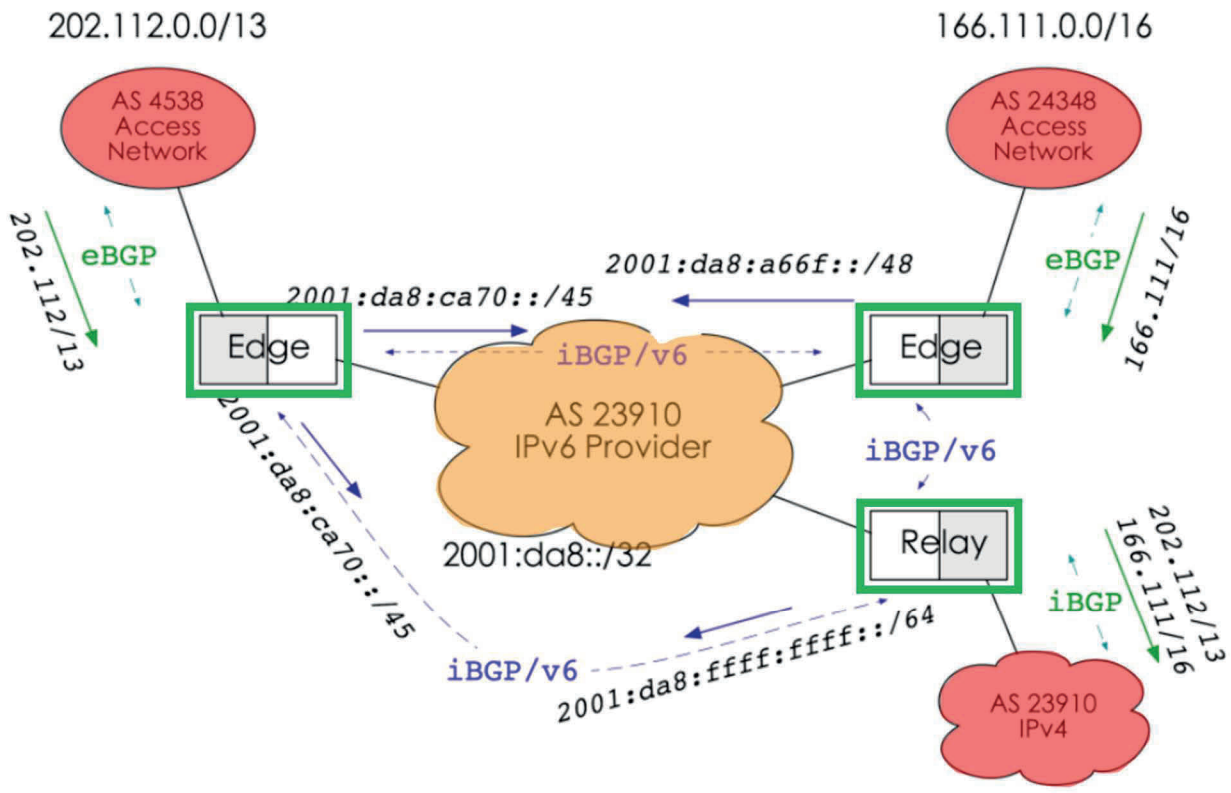


Figure 7. IPv4-over-IPv6 transition for access networks

EX1037, 7 (highlighted). The grounds in this report walk through an example in which an IPv4 host in the top-left IPv4 access network sends a data packet to an IPv4 host in the top-right IPv4 access network, as depicted by the large black arrow below:

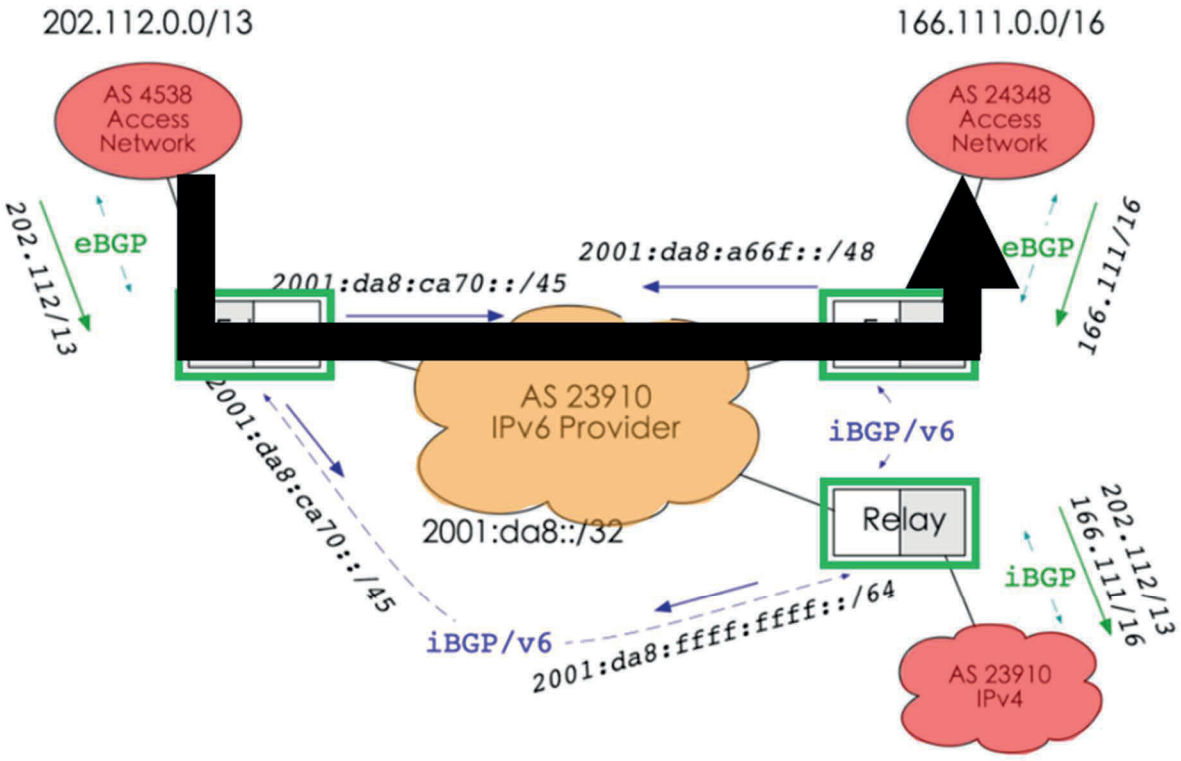


Figure 7. IPv4-over-IPv6 transition for access networks

Id., 7 (highlighted and annotated). At the center of the network is an IPv6 domain (orange) that routes communications between the surrounding IPv4 domains (red). *Id.* Edge routers (surrounded in a green box) straddle the IPv6 domain and the IPv4 domains with which they are associated. *Id.* 4, 7.

88. Li discloses that the edge routers (*e.g.*, the edge router in the top left corner) receive data packets from an IPv4 domain, namely the IPv4 access networks (*e.g.*, the AS 4538 Access Network in the top left corner). EX1037, 4-5. Indeed, Li explains that "IPv4 packets are mapped into IPv6 (or vice versa) automatically at the edge of the IPv6 backbone." *Id.*, 1. Li further explains that edge routers route data

packets by "perform[ing] proper routing and header processing" (*id.*, 3) and that the edge routers, which are dual-stack nodes, "forward[] IPv4 traffics in pure IPv6 backbone" (*id.*, 1, 4).

89. The edge routers (*e.g.*, the edge router in the top left corner) are in an IPv6 domain. For instance, Li describes the edge routers as "backbone border gateways," indicating that the edge routers belong to the IPv6 backbone. *Id.*, 6. Li further explains that edge routers need to perform a check to see if an incoming data packet originated from an access network, further indicating that the edge routers belong at least to the IPv6 domain. *Id.*, 7. Additionally, Li discloses that "[a]n edge router is a dual-stack node" (*id*., 4) and illustrates the edge router having an interface to the IPv6 network (*id*., Fig. 7). Similarly, the '844 patent explains that the access node **40** that receives the data packet in the IPv6 domain is a "Dual-Stack (IPv4 and IPv6) router" that interfaces with the IPv4 and IPv6 domains. EX1001, 9:48-56. Based on these disclosures, the edge routers are located in the IPv6 domain (*e.g.*, the IPv6 domain in the center of Figure 7) and that these edge routers receive data packets from IPv4 domains (*e.g.*, IPv4 access networks), as disclosed in the '844 patent.

90. I have been informed that Patent Owner did not seek a construction of the term "domain" in the prior litigation it brought against Cisco in the Eastern District of Texas and the court did not construe the term. EX1036. I have been

further informed, however, that Patent Owner has previously argued in an IPR that the "domain" should be construed to mean "a network or subnetwork and its address space that are under common control." EX1034, 20-21. Patent Owner further argued that two networks that are controlled by the same entity cannot be separate domains under the '844 patent's use of the term. *Id.*, 27-29. Patent Owner's construction and arguments regarding the term "domain" are incorrect. The '844 patent defines "domain" at the very beginning of its specification, explaining that "[a] telecommunications network administered by an operator is also referred to as a domain." EX1001, 1:30-31. The '844 patent never requires the IPv4 domains and the IPv6 domain to each be controlled by distinct entities, organizations, or providers. In fact, the '844 patent does not at all indicate that networks controlled by the same entities do not qualify as "domains" in the '844 patent. *See generally id.* A first IPv4 network, a second IPv4 network, and an IPv6 network are a first IPv4 domain, a second IPv4 domain, and an IPv6 domain respectively even if they are administered by the same operator because, under the '844 patent's definition of "domain" they are each "telecommunications network[s] administered by an operator."

91. In any event, Li discloses and renders obvious an IPv4 and an IPv6 "domain" under Patent Owner's construction. Li states that its teachings can "fit the requirements of forwarding IPv4 traffic in an inter-domain environment."

EX1037, 3, 6; *see also id.*, 1 ("This makes the technique suitable for large-scale deployment in an inter-domain networking environment."). Li further teaches that the inter-domain environment can include "customer IPv4" domains and an "IPv6 provider" domain, and that Figure 7 discloses an example of an "inter-domain environment." *Id*., 6-7. A POSITA would therefore have understood Li's IPv4 customer network and IPv6 provider network to disclose IPv4 and IPv6 domains because the domains in Li are a separate networks controlled by different entities.

92. ***said data packet comprising an IPv4 destination address and a destination port number, said method comprising the following steps***: Li discloses that edge routers receive and process "IPv4 packets." EX1037, 1, 3. An IPv4 packet includes a destination address field and may further encapsulate a TCP or UDP header that includes a port number. *See* §III.A. Indeed, Li explains that both the "IPv4 source and destination addresses in a packet can be translated into their IPv6 version" using the disclosed algorithm. EX1037, 3; *see also* EX1037, 5 (confirming that the mapping is applied to the destination address because "either the IPv4 source ***or the destination address*** is sometimes copied twice at the translation." (emphasis added)). And Li's experimentation section explains that the IPv4 packets include destination addresses and further discusses using "UDP-based protocols" and "TCP-based applications," which both include port numbers. *Id.*, 5-6.

93. In fact, as part of the packet translation process that will be discussed in further detail below, Li teaches transforming the IPv4 address in the received data packet into an IPv6 address. EX1037, 2. Li explains that it transforms "IPv4 source and destination address in a packet." *Id.*, 3. In Table 1, Li provides examples of IPv4 destination addresses that can be mapped to IPv6 addresses:

TABLE I. SOME ADDRESS MAPPING EXAMPLES

IPv4 prefix/address	IPv6 prefix/address
202.112.0.0/13	2001:da8:ca70::/45
166.111.0.0/16	2001:da8:a66f::/48
166.111.172.1	2001:da8:a66f:ac01::a66f:ac01

Id. One example of an IPv4 address is "166.111.172.1." *Id.* As shown in Figure 7, this IP address would belong to the top-right IPv4 access network. *Id.* Thus, in the mapping discussed above—in which a host in the top-left IPv4 access network sends data to a host in the top-right IPv4 access network—the "166.111.172.1" address is the IPv4 destination address—in the data packet received by the top-left edge router—that belongs to a host in the top-right IPv4 access network. The IPv4 destination address in Li is an "address formatted according to Internet Protocol

version 4 indicating a destination" as construed by the Eastern District of Texas court.[6] EX1036, 18.

94. Li further discloses that the received IPv4 packet encapsulates and therefore includes a destination port number. Indeed, in Li's experimentation section, it discusses using "UDP-based protocols" and "TCP-based applications," and a POSITA would have known that both protocols include port numbers. EX1037, 5-6. Additionally, Li-2 discloses data packets that contain port numbers. EX1038, 11, 14, 18. A POSITA would have known that this destination port number is a "number indicating a logical point of connection with a destination device" as construed by the Eastern District of Texas court. *See* §III.A.[7]

[6] I have been informed that Monarch requested the Eastern District of Texas court construe "IPv4 destination address" according to its "plain and ordinary meaning." EX1036, 13. The IPv4 destination address in Li satisfies this proposed construction because Li uses standardized IPv4 destination addresses, which the '844 patent also uses. *Compare* EX1037, 3 *with* EX1001, 1:17-21 (explaining that the patent is directed to "IP telecommunications networks" in which "destination equipment [is] identified by a destination address").

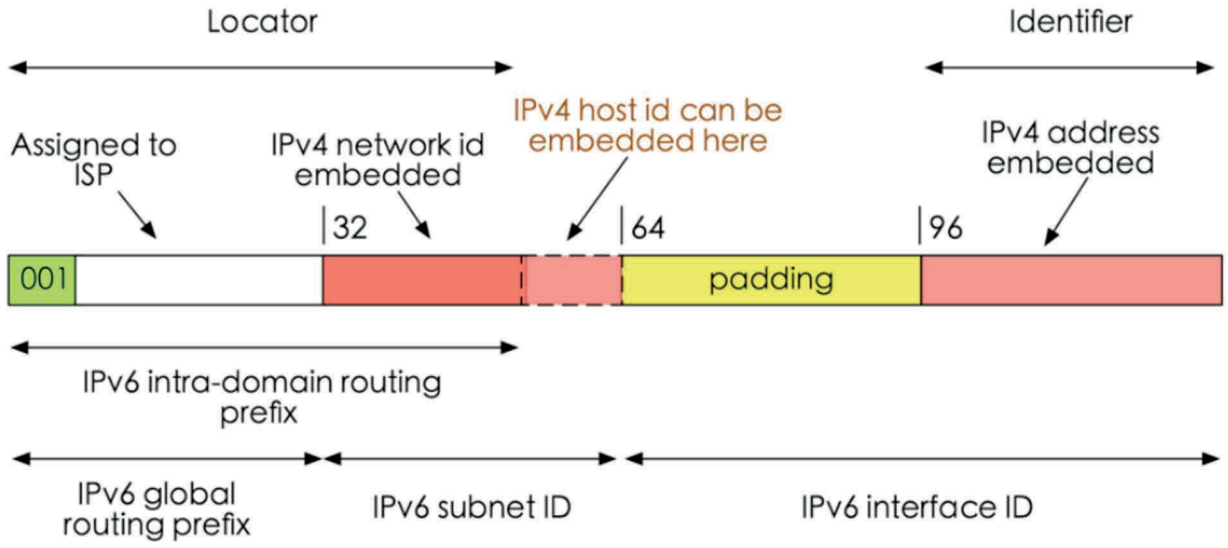
[7] I have been informed that Monarch requested the Eastern District of Texas court construe "destination port number" according to its "plain and ordinary meaning" or

(b) 1[a]: constructing an IPv6 destination address by concatenating an operator prefix, said IPv4 destination address, and the destination port number;

95. Li and Li-2 render obvious limitation 1[a]: "constructing an IPv6 destination address [*e.g.*, **Li's translated IPv6 address that corresponds to a host in the top-right IPv4 access network**] by concatenating an operator prefix [*e.g.*, **Li's IPv6 global routing prefix**], said IPv4 destination address [*e.g.*, **Li's received IPv4 destination address that corresponds to a host in the top-right IPv4 access network**], and the destination port number [*e.g.*, **Li's received destination port number in light of Li-2's teachings**]."

96. Li teaches "address mapping" in which "IPv4 source ***and destination addresses*** in a packet can be translated into their IPv6 version." EX1037, 3 (emphasis added). Figure 2 of Li discloses an IPv6 address constructed with Li's address mapping:

in the alternative to mean "a port designation for destination devices." EX1036, 18. The destination port number in Li and Li-2 satisfies these proposed constructions because it designates a port on a destination device.



Id.

97. The first 32 bits of the constructed IPv6 address are an IPv6 global routing prefix that is assigned to the IPv6 domain. *Id.* Li's IPv6 global routing prefix corresponds to the '844 patent's "operator prefix." I have been informed that the Eastern District of Texas court construed "operator prefix" to mean "a prefix assigned to an Internet Service Provider by its Regional Internet Registry."[8] EX1036, 25. Li's IPv6 global routing prefix satisfies the court's construction: Li explains that "[t]hrough out this paper, it is assumed that an Internet service provider

[8] I have been informed that Monarch requested the Eastern District of Texas court construe "operator prefix" according to its "plain and ordinary meaning." EX1036, 12. The IPv6 prefix in Li satisfies this proposed construction for the same reasons discussed above. *See* EX1001, 9:9-10.

who would like to apply this approach holds at leas[t] one IPv6 prefix not smaller than /32." EX1037, 2. And Li further discloses that "IPv6 prefixes [are] allocated by the provider." *Id.*, 7. In fact, Figure 2 expressly states that the "IPv6 global routing prefix" is "Assigned to ISP [Internet Service Provider]." *Id*., 3.

98. The next 32 bits (up to bit 64)[9] of the constructed IPv6 address is the received IPv4 destination address. *Id.*; *see also id.*, 3 ("IPv4 source ***and destination addresses*** in a packet can be translated into their IPv6 version." (emphasis added)); §VII.A.1.b.

99. The 32 bits after that (up to bit 96) is "padding," in which empty space is filled with 0s. EX1037, 3 And the last 32 bits are optional and allow for the "IPv4 host id" to be "embedded as well." *Id.*

100. Thus, Li's "address mapping" involves concatenating—which Patent Owner and Cisco agreed to define as "appending one item to the end of another so as to form a single unit in a contiguous pattern"—these pieces of information. EX1036, 13. As shown in the examples below and in Figure 2 discussed above, Li explicitly teaches appending these pieces of information to the end of one another to form a single unit in a contiguous pattern.

[9] Or, alternatively, the last 32 bits, for reasons discussed above in footnote 5. EX1037, 3.

101. Li provides examples of such address mapping in Table 1:

TABLE I. SOME ADDRESS MAPPING EXAMPLES

IPv4 prefix/address	IPv6 prefix/address
202.112.0.0/13	2001:da8:ca70::/45
166.111.0.0/16	2001:da8:a66f::/48
166.111.172.1	2001:da8:a66f:ac01::a66f:ac01

EX1037, 3. The left column contains IPv4 addresses or address ranges, represented in dotted-quad notation. The right column contains IPv6 addresses or address ranges, represented in hexadecimal notation. This mapping can apply to both source and destination addresses. EX1037, 3 ("IPv4 source ***and destination addresses*** in a packet can be translated into their IPv6 version." (emphasis added))

102. In this example, the IPv6 domain is assigned an IPv6 prefix of 2001:da8. *Id.* When an edge router receives a data packet, it concatenates the IPv6 prefix with the IPv4 address shown in the left column. *Id.* For instance, as Table 1 shows, the third row maps IPv4 address 166.111.172.1, which corresponds to a host in the top-right IPv4 access network, to IPv6 address 2001:da8:a66f:ac01::a66f:ac01. *Id.* The double-colon notation—"::"—represents a string of zeros from the number preceding the double colon to the number following

the double colon; thus, the IPv6 address 2001:da8:a66f:ac01::a66f:ac01 is equivalent to 2001:da8:a66f:ac01:0:0:a6f:ac01. *See* §III.B.

103. The first two groups of this IPv6 address—2001:da8:—are an IPv6 prefix. EX1037, 3. The third and fourth groups of the IPv6 address, "a66f:ac01," are the IPv4 destination address. EX1037, 3.[10] And the fifth and sixth groups, "0:0," are the padding shown in Figure 2. *Id.*

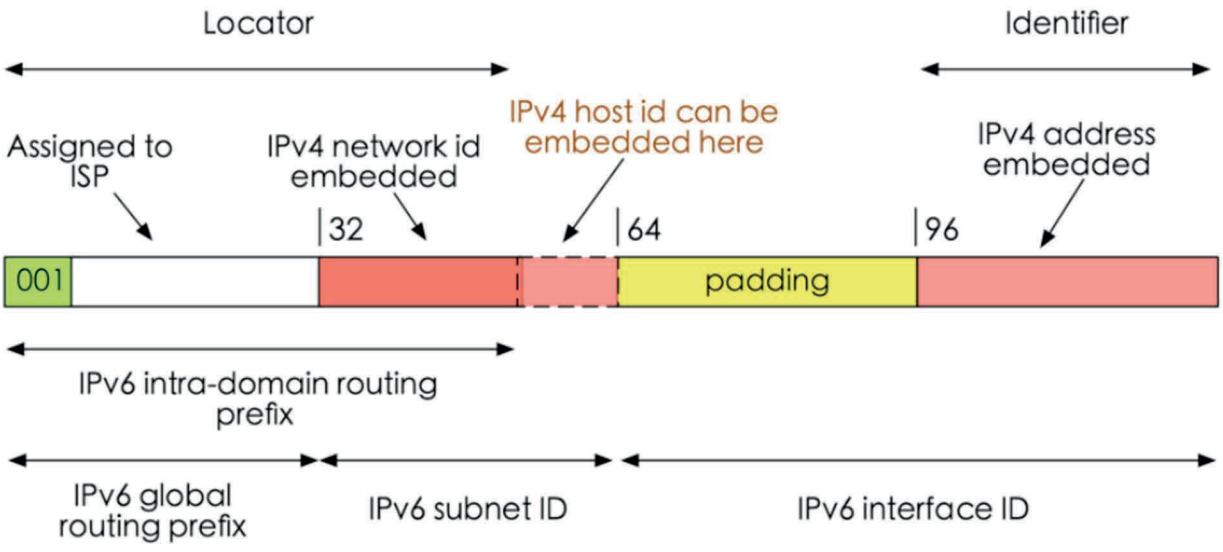
104. In sum, Li teaches "constructing an IPv6 destination address by concatenating an operator prefix [*e.g.*, **IPv6 global routing prefix**], said IPv4 destination address [*e.g.*, **received IPv4 destination address that corresponds to a host in the top-right IPv4 access network**]." Although Li does not expressly

[10] Converting the first portion of the IPv4 address—166—from decimal to hexadecimal results in the hexadecimal number a6, converting the second portion of the IPv4 address—111—results in hexadecimal number 6f, converting the third changes 172 to ac, and converting the fourth keeps 1 as 1. *See* §VII.A.1. Thus, converting "166.111.172.1" from dotted-quad notation to hexadecimal would have resulted in the third and fourth groups of the IPv6 address, "a66f:ac01" (which are also repeated in the seventh and eighth groups, for reasons discussed above in footnote 5). EX1037, 262.

disclose further concatenating "the destination port number," it would have been obvious to do so in view of Li-2.

105. Li-2 teaches that a constructed IPv6 address may be formed by concatenating the received destination port number. Specifically, Li-2 describes "port multiplexing"—an extension of Li that constructs an IPv6 address by not only concatenating an IPv6 prefix and IPv4 address but further concatenating a port number. EX1038, 14.

106. Li already teaches that its IPv6 address concatenates 32-bits of zero padding (bits 64-96) following the operator prefix and IPv4 address:



EX1037, 3. Li-2 also teaches this:

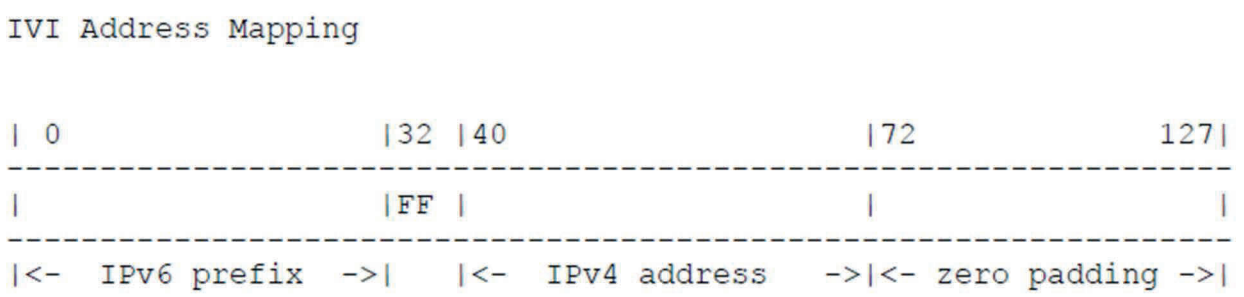


Figure 1

EX1038, 6. Thus, a POSITA would have recognized that there is more than sufficient space to further include a 16-bit destination port number in Li's constructed IPv6 destination address by replacing 16 bits of the zero padding with the destination port number. Indeed, that's exactly what Li-2 teaches: "The mapping scheme is to use the least significant bits in the IVI6(i) to define the multiple mapping and combine the tran[s]port-layer port number to uniquely perform the mapping from IVI4(i) to IVI6(i)." *Id.*, 14. In other words, in the combined Li-Li-2 combination Li's edge router would construct an IPv6 destination address by concatenating an operator prefix, said IPv4 destination address, and the destination port number.

(c) 1[b]: generating an IPv6 data packet from the IPv6 constructed destination address and the received IPv4 packet; and

107. Li teaches limitation 1[b]: "generating an IPv6 data packet from the IPv6 constructed destination address and the received IPv4 packet."

108. Li explains that its "edge router is a dual-stack node, extended with the ability of translating routing messages and ***modifying packet IP versions between IPv6 and IPv4***." EX1037, 4 (emphasis added). As discussed, Li and Li-2 render obvious constructing the '844 patent's IPv6 destination address. *See* §VII.A.5.b. Li further teaches generating an IPv6 packet based on that constructed IPv6 address and the received IPv4 packet. For example, Li teaches mapping the data packet's header from IPv4 to IPv6. EX1037, 4. As described in Li's experimentation section, the inventors implemented a server that performs Li's disclosed invention, and the inventors noted that, in the constructed system, "[a] 1480-byte IPv4 packet will become a 1500-byte IPv6 packet after the translation." *Id.*, 6. The generated IPv6 packet includes the constructed IPv6 destination address in the combined system. *Id.*, 3-4; *see also id.*, Fig. 4.

(d) 1[c]: routing the generated IPv6 data packet in the IPv6 domain using the IPv6 constructed destination address, said constructed address belonging to a range of IPv6 addresses routable to an interconnection equipment of the IPv6 domain with the IPv4 destination address.

109. Li teaches limitation 1[c]: "routing the generated IPv6 data packet in the IPv6 domain using the IPv6 constructed destination address, said constructed address [*e.g.*, **constructed IPv6 address**] belonging to a range of IPv6 addresses [*e.g.*, **range of IPv6 addresses corresponding to devices in the top-right IPv4 access network in Figure 7**] routable to an interconnection equipment [*e.g.*, **top-**

right edge router that services the IPv4 access network in Figure 7] of the IPv6 domain [*e.g.*, **IPv6 domain in the center of Figure 7**] with the IPv4 destination address." I break down the elements of this limitation below:

110. ***routing the generated IPv6 data packet in the IPv6 domain using the IPv6 constructed destination address***. Li explains that it describes "a new technique of forwarding IPv4 traffics ***in pure IPv6 backbone***." EX1037, 1 (emphasis added). Li routes packets in the IPv6 domain by mapping IPv4 packets into IPv6 packets (*i.e.*, by generating an IPv6 data packet as discussed above) "(or vice versa) automatically at the edge of the IPv6 backbone." *Id.* A POSITA would have understood that the generated IPv6 data packet is routed through the IPv6 domain according to the constructed IPv6 destination address.

111. ***said constructed address belonging to a range of IPv6 addresses routable to an interconnection equipment of the IPv6 domain with the IPv4 destination address***. The '844 patent suggests that an "interconnection equipment" is equipment that sits between an IPv4 and IPv6 domain and can route data packets between those domains. EX1001, 7:16-21, 14:1-26. And I have been informed that the Eastern District of Texas court construed "an interconnection equipment of the IPv6 domain" to mean "a router of the IPv6 domain." EX1036, 29. Patent Owner had also requested to construe the term as "a routing or switching device in the IPv6 domain." EX1036, 25. Li's edge routers and edge relays correspond to the

"interconnection equipment" because they similarly interconnect the IPv4 and IPv6 domains and route data packets between those domains. EX1037, 1-3; *see* §VII.A.5.a.

112. Li discloses that its interconnection equipment (*e.g.*, its edge routers or edge relays) serve a range of IPv6 addresses that correspond to IPv4 addresses within their associated domain. For example, Li explains that its edge routers and edge relays service IPv4 access networks. EX1037, 3-4. The access networks contain multiple devices. The notation used in Figure 7 and Table 1 of Li indicates that each edge router serves a range of IPv4 addresses. *Id.*, 3, 7. For example, the notation "202.112.0.0/13" means that the edge router in the top-left of Figure 7 serves IP addresses that start with "202.112" and include a range of 2^{19} (~500,000) addresses (where 19 is derived from 32 bits minus 13 bits, where 32 is the maximum amount of bits and 13 is designated by the "/13" at the end of the notation above).

113. The range of IPv6 addresses constructed from this range of IPv4 addresses are "routable to" the edge relays and edge routers serving those addresses. I have been informed that the Eastern District of Texas court construed "with the IPv4 destination address" to mean "with the IPv6 constructed destination address including the IPv4 destination address." EX1036, 29. As discussed in the analysis corresponding to limitation 1[a], Li's IPv6 constructed destination address includes the IPv4 destination address. *See* §VII.A.5.b.

6. Claim 2: A non-transitory computer program product that is at least one of downloadable from a communications network and stored on a computer-readable medium and executable by a microprocessor, comprising program code instructions for executing the method according to claim 1 of receiving in an IPv6 domain a data packet from an IPv4 domain.

114. Li further discloses the additional limitation of claim 2. Li describes "in-lab experiments" that its inventors performed to verify Li's invention. EX1037, 5. Specifically, the inventors set up "5 computers" that were "connected by one over 100Mbps direct Ethernet links." *Id.* A POSITA would have known that these computers comprise memory and a processor, which they use to perform the programmed functions. A POSITA would have further known that the programmed functions are executed by processing program code instructions to perform the steps discussed for claim 1 above.

7. Claim 3

(a) 3[pre]: A method of sending a data packet from an IPv6 domain to a destination address of an IPv4 domain, said packet comprising an IPv6 destination address of the packet constructed by concatenating an operator prefix, the IPv4 destination address, and a destination port number, said method executing the following steps on reception of the data packet:

115. To the extent the preamble is limiting, Li and Li-2 render obvious limitation 3[pre]: "a method of sending a data packet [*e.g.*, **Li's IPv6 data packet that is constructed by the top-left edge router of Figure 7**] from an IPv6 domain [*e.g.*, **Li's IPv6 domain in the center of Figure 7**] to a destination address of an

IPv4 domain [*e.g.*, **Li's IPv4 destination address in the top-right IPv4 access network in Figure 7**], said packet comprising an IPv6 destination address of the packet constructed by concatenating an operator prefix [*e.g.*, **Li's IPv6 global routing prefix**], the IPv4 destination address [*e.g.*, **Li's received IPv4 destination address that corresponds to a host in the top-right IPv4 access network**], and a destination port number [*e.g.*, **Li's received destination port number in light of Li-2's teachings**], said method executing the following steps on reception of the data packet."

116. Li describes a network that facilitates communications between hosts. Figure 7 depicts an embodiment of the network:

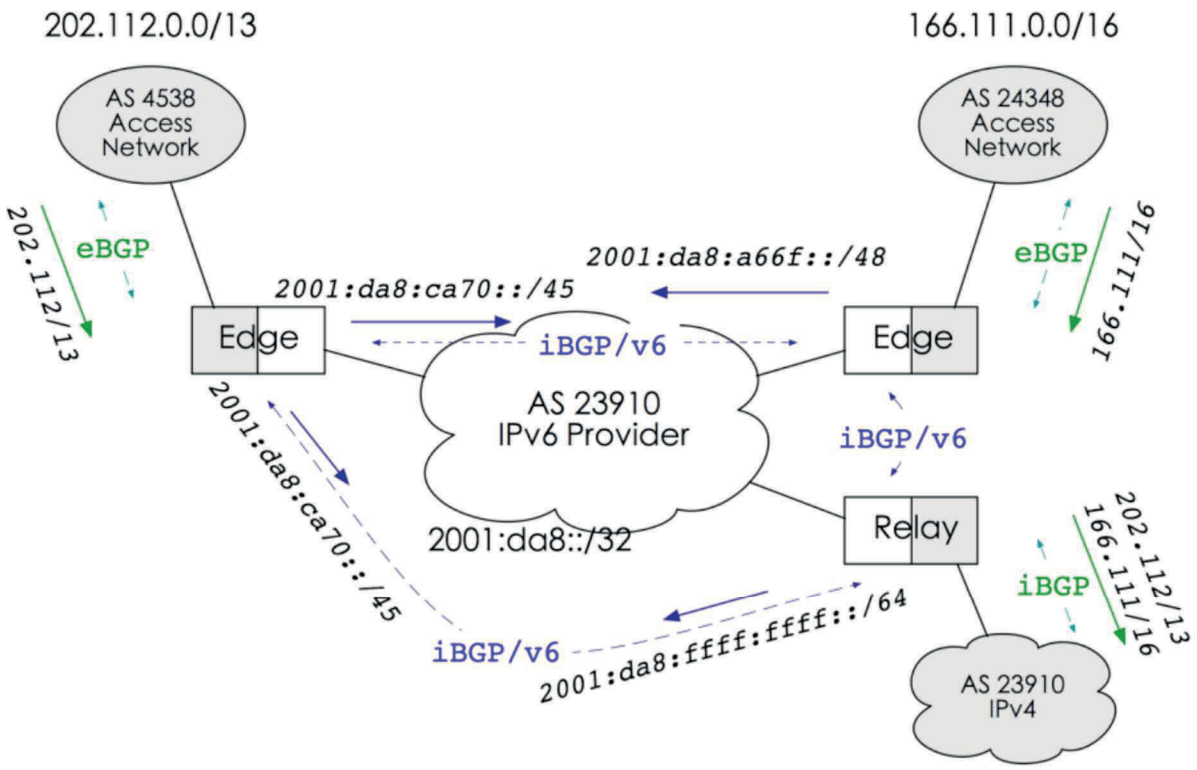


Figure 7. IPv4-over-IPv6 transition for access networks

EX1037, 7. As discussed, Li discloses edge routers that straddle an IPv4 domain and an IPv6 domain. *See* §VII.A.5. These edge routers, like the edge router in the top-left of Figure 7, construct IPv6 data packets and route them through an IPv6 domain to other edge routers, like the edge router in the top-right or the edge relay in the bottom-right of Figure 7. *Id.* These data packets are intended for IPv4 hosts in an IPv4 domain and ultimately get routed to the host associated with the corresponding IPv4 address. *Id.*

117. As discussed above, Li in combination with Li-2 renders obvious an IPv6 data packet that has an IPv6 destination address constructed by concatenating

an operator prefix (*e.g.*, **Li's IPv6 global routing prefix**), the IPv4 destination address (*e.g.*, **Li's received IPv4 destination address that corresponds to a host in the top-right IPv4 access network**), and a destination port number (*e.g.*, **Li's received destination port number in light of Li-2's teachings**). *See* §VII.A.5.b.

(b) 3[a]: extracting the IPv4 destination address and the destination port number from the IPv6 destination address;

118. Li and Li-2 render obvious limitation 3[a]: "extracting the IPv4 destination address [*e.g.*, **Li's top-right edge router in Figure 7, extracting the received IPv4 destination address**] and the destination port number [*e.g.*, **Li's destination port number in light of Li-2's teachings**] from the IPv6 destination address [*e.g.*, **Li's constructed IPv6 address that is received by the top-right edge router in Figure 7**]."

119. Li explains that it not only teaches mapping an IPv4 address to an IPv6 address but also the reverse, mapping an IPv6 address back into an IPv4 address. EX1037, 1 ("IPv4 packets are mapped into IPv6 (or vice versa)…"). For example, the top-left edge router in Li's Figure 7 can transform IPv4 addresses into IPv6 addresses and then route the corresponding data packets to the top-right edge router. *Id.*, 3. The top-right edge router can then extract the IPv4 destination addresses from the received IPv6 data packets and then route the resulting IPv4 data packets to the correct IPv4 hosts. *Id.* A POSITA would have understood that for the edge router

to route the data packet to its IPv4 destination, it would extract the IPv4 destination address from the received IPv6 destination address. In fact, Li's experimentation section explains that the end result of its invention is "a real IPv4 packet captured on the host" that is the intended recipient of the data packet. *Id.*, 6.

120. A POSITA would have found it obvious to apply the teachings of Li-2 to Li such that Li's edge router would extract both the IPv4 destination address and the destination port number from the IPv6 destination address. In other words, upon receipt of the data packet, Li's edge router would convert the IPv6 data packet into an IPv4 data packet and use the information in the IPv6 data packet, including the IPv4 destination address and the destination port number, to route the resulting IPv4 data packet to the correct IPv4 host.

(c) 3[b]: generating an IPv4 data packet from the IPv6 data packet, said packet including said IPv4 destination address and said destination port number; and

121. Li and Li-2 render obvious limitation 3[b]: "generating an IPv4 data packet [*e.g.*, **Li's top-right edge router in Figure 7, generating an IPv4 data packet**] from the IPv6 data packet [*e.g.*, **Li's IPv6 data packet that is received by the top-right edge router in Figure 7**], said packet including said IPv4 destination address [*e.g.*, **Li's IPv4 destination address that corresponds to a host in the top-right IPv4 access network in Figure 7**] and said destination port number [*e.g.*, **Li's destination port number in light of Li-2's teachings**]."

122. As discussed, Li teaches generating an IPv6 data packet from an IPv4 data packet. *See* §VII.A.5.c. Li further teaches that it can do the reverse and generate IPv4 data packets from IPv6 data packets. EX1037, 1 ("IPv4 packets are mapped into IPv6 (or vice versa)…"). A POSITA would have understood that the IPv4-to-IPv6 process disclosed in Li could be reversed to teach an IPv6-to-IPv4 process. For example, Li teaches and depicts the process of mapping an IPv4 header into an IPv6 header. *Id.*, 4. To do the opposite, a POSITA would merely have to perform the reverse process—extract information from the IPv6 header and place that information in the appropriate location of the IPv4 header. And a POSITA would merely have to perform the reverse calculations to generate IPv4 information from the IPv6 address; for example, to generate an IPv4 destination address from the IPv6 destination address, a POSITA would simply have to convert the second and third groupings of the IPv6 destination address from hexadecimal into decimal. Further, a POSITA would have known that TCP requires two-way communications in order to set up the network (for instance, to perform the "handshake" process that enables hosts send data over the network), in which case the reverse mapping is required in order to enable these two-way communications. Thus, Li teaches generating an IPv4 data packet from the IPv6 data packet, said packet including said IPv4 destination address.

123. A POSITA would have found it obvious to further use the extracted destination port number, as discussed in the combination above, to generate the IPv4 data packet. A POSITA would have understood that to maintain end-to-end communications, Li's edge router would need to extract the destination port number from the constructed IPv6 destination address, and then use that destination port number to identify the destination IPv4 host and route the data packet accordingly.

(d) 3[c]: routing the IPv4 data packet to its IPv4 destination.

124. Li teaches limitation 3[c]: "routing the IPv4 data packet [*e.g.*, **the top-right edge router in Figure 7 routing the constructed IPv4 data packet**] to its IPv4 destination [*e.g.*, **an IPv4 host in the top-right IPv4 access network in Figure 7**]." Li explains that its invention "deliver[s] IPv4 traffics" via edge routers that "can perform proper routing." EX1037, 1, 3. Similarly, Li's experimentation section describes an experiment in which the disclosed edge routers deliver IPv4 data packets to IPv4 hosts. *Id.*, 5-6.

8. Claim 4: A non-transitory computer program product that is at least one of downloadable from a communications network and/or stored on a computer-readable medium and/or executable by a microprocessor, comprising program code instructions for executing the method according to claim 3 of sending a data packet from an IPv6 domain to a destination address of an IPv4 domain.

125. Li further discloses the additional limitation of claim 4. Li teaches a "non-transitory computer program product that is at least one of downloadable from

a communications network and/or stored on a computer-readable medium and/or executable by a microprocessor, comprising program code instructions for executing" claim 3's methods. *See* §§VII.A.6-7.

9. Claim 5

(a) 5[pre]: A device for receiving a data packet from an IPv4 domain in an IPv6 domain, said data packet comprising an IPv4 destination address and an IPv4 destination port number, said device comprising:

126. To the extent the preamble is limiting, Li teaches limitation 5[pre]: "a device [*e.g.*, **edge router**]" that performs the claimed steps. *See* §VII.A.5.a. The '844 patent explains that its disclosed device "includes the hardware elements conventionally found in a standard computer or a dedicated router," like a processor and memory. EX1001, 12:38-46. Li's edge router corresponds to such a device.

(b) 5[a]: means for constructing an IPv6 destination address by concatenating an operator prefix, said IPv4 destination address, and the destination port number;

127. Li and Li-2 render obvious the claimed steps, performed on an edge router. *See* §VII.A.5.b. I have been informed that the Eastern District of Texas court construed the structure of "means for constructing" as "access node **40** with a device **25** that includes a processor programmed to perform the" limitation. EX1036, 59. I have been further informed that Patent Owner had requested the broader construction of "a device" that includes "hardware elements conventionally found in a standard computer or a dedicated router." *Id.*, 49. Li's edge router satisfies both

constructions. The '844 patent explains that access node **40** is a dual-stack router that is used to communicate between the IPv6 domain and the IPv4 domain. EX1001, 7:4-10, 9:48-56, Fig. 1. Li's edge routers correspond to access node **40**. Indeed, Li explains that "[a]n edge router is a dual-stack node, extended with the ability of translating routing messages and modifying packet IP versions between IPv6 and IPv4." EX1037, 4. Additionally, "the routers at the edge between IPv4 subnet and IPv6 backbone can perform proper routing and header processing." *Id.*, 3. A POSITA would have further known that edge routers use a processor to perform the claimed steps. And a POSITA would have known that the edge router contains conventional computer and router hardware elements.

128. I have been informed that Patent Owner requested—and the Eastern District of Texas court agreed—the function should be construed as "constructing an IPv6 destination address by concatenating an operator prefix, said IPv4 destination address, and the destination port number." EX1036, 49, 59. As discussed, Li and Li-2 render obvious this function, performed on an edge router. *See* §VII.A.5.b.

(c) 5[b]: means for generating an IPv6 data packet from the IPv6 constructed destination address and the received IPv4 packet; and

129. Li teaches the claimed steps, performed on an edge router. *See* §VII.A.5.c. I have been informed that the Eastern District of Texas court construed

the structure of "means for generating" as "access node **40** with a device **25** that includes a processor programmed to perform the step of encapsulating the received IPv4 packet in an IPv6 packet or translating the received IPv4 packet IPv4-in-pt into an IPv6 packet." EX1036, 59. I have been further informed that Patent Owner had requested the broader construction of "a device" that includes "hardware elements conventionally found in a standard computer or a dedicated router." *Id.*, 49. Li's edge routers correspond to access node **40** and Patent Owner's broader "device" construction, and the edge routers use a processor to perform the claimed steps. *See* §VII.A.9.b. In line with this construction, Li explains that "[a]n edge router manipulates the IP headers for the packets passing through it from IPv6 to IPv4 or vice versa. There are two possible ways of header manipulation: encapsulation and translation." EX1037, 4. I have been informed that Patent Owner requested—and the Eastern District of Texas court agreed—the function should be construed as "generating an IPv6 data packet from the IPv6 constructed destination address and the received IPv4 packet." EX1036, 49, 59. As discussed, Li teaches this function, performed on an edge router. *See* §VII.A.5.c.

(d) 5[c]: means for routing the generated IPv6 data packet in the IPv6 domain using the IPv6 constructed destination address, said constructed address belonging to a range of IPv6 addresses routable to an interconnection equipment of the IPv6 domain with the IPv4 destination address.

130. Li teaches the claimed steps, performed on an edge router. *See* §VII.A.5.d. I have been informed that the Eastern District of Texas court construed the structure of "means for routing" as "access node **40** with a device **25** that includes a processor programmed to perform the" limitation. EX1036, 60. I have been further informed that Patent Owner had requested the broader construction of "a device" that includes "hardware elements conventionally found in a standard computer or a dedicated router." *Id.*, 50. Li's edge routers correspond to access node **40** and Patent Owner's broader "device" construction, and the edge routers use a processor to perform the claimed steps. *See* VII.A.9.b. I have been informed that Patent Owner requested—and the Eastern District of Texas court agreed—the function should be construed as "routing the generated IPv6 data packet in the IPv6 domain using the IPv6 constructed destination address." EX1036, 50, 60. As discussed, Li teaches this function, performed on an edge router. *See* §VII.A.5.d.

10. Claim 6

(a) 6[pre]: Access equipment to an IPv6 domain comprising an interface with at least one IPv4 domain, further comprising:

131. To the extent the preamble is limiting, Li teaches limitation 6[pre]. The '844 patent explains that "access equipment" connects "to an IPv6 domain" and includes "an interface with at least one IPv4 domain." EX1001, 4:31-32. "This kind of access equipment therefore interconnects the IPv6 domain to which it belongs and

to a neighboring IPv4 domain." *Id.*, 4:39-47. The '844 patent discloses that "this access equipment may be a network equipment of any type, provided that it has a network interface between an IPv6 and an IPv4 domain." *Id.* Similarly, Li teaches edge routers and edge relays that interface with both an IPv6 domain and an IPv4 domain:

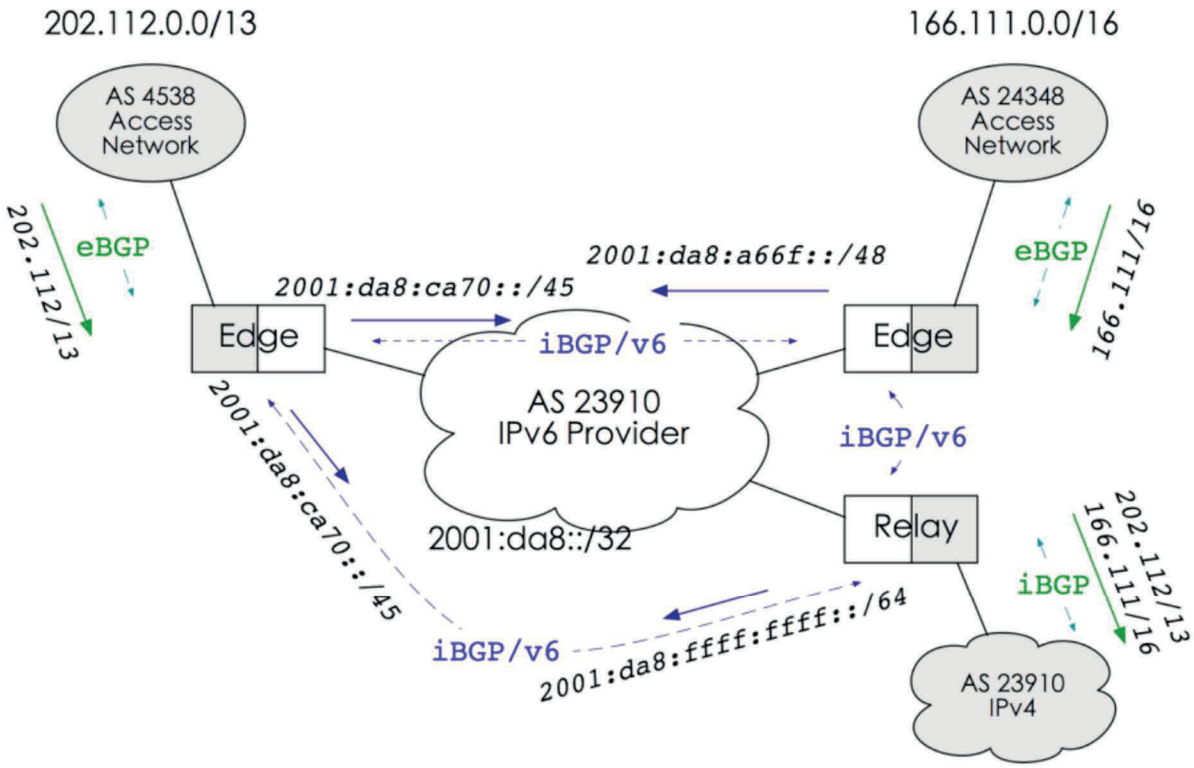


Figure 7. IPv4-over-IPv6 transition for access networks

EX1037, 7; *see also* §§VII.A.5.a, VII.A.5.d.

(b) 6[a]: a device according to claim 5 for receiving a data packet coming from an IPv4 domain in the IPv6 domain; and

132. Li teaches a device, an edge router, that performs the steps in claim 5. *See* §VII.A.9.

(c) 6[b]: a device for sending a data packet from an IPv6 domain to an IPv4 domain, said packet comprising an IPv6 destination address of the packet constructed by concatenating an operator prefix, the IPv4 destination address, and a destination port number, said device, on reception of the data packet, making use of:

133. Li teaches the claimed steps, performed on an edge router. *See* §VII.A.7.a. The '844 patent discloses "a device **26** that is described below with reference to Fig. 6b for sending a leaving packet. It includes the hardware elements conventionally found in a standard computer or a dedicated router, namely a processor $\mathbf{26}_1$, a random-access memory (RAM) $\mathbf{26}_2$, a read-only memory (ROM) $\mathbf{26}_3$, and telecommunications means $\mathbf{26}_4$ for communicating with the network **1**." EX1001, 12:58-65. A POSITA would have known that Li's edge routers and edge relays include the hardware elements described in the '844 patent; for example, a processor, RAM, ROM, and telecommunications means. *See* §VII.A.9.b.

(d) 6[c]: means for extracting the IPv4 destination address and the destination port number from the IPv6 destination address;

134. Li and Li-2 render obvious the claimed steps, performed on an edge router. *See* §VII.A.7.b. I have been informed that the Eastern District of Texas court construed the structure of "means for extracting" as "home gateway **20** with a device **26** that includes a processor programmed to perform the step of determining whether

the IPv6 data packet is a standard IPv6 packet or an IPv6 packet encapsulating an IPv4 packet using the header of the received packet." EX1036, 70. I have been further informed that Patent Owner had requested the broader construction of "a home gateway or access node with a device" that includes "hardware elements conventionally found in a standard computer or dedicated router." *Id.*, 60. I have also been informed that Patent Owner and Cisco had agreed to construe "home gateway" to mean "any equipment for interconnecting a private network and a network operated by a service provider, the private network being either a home network or a business network." *Id.*, 13.

135. Li's edge router corresponds to the Eastern District of Texas court's "home gateway" construction and Patent Owner's "device" construction, and the edge router uses a processor to perform the claimed steps. *See* §VII.A.9.b. In particular, the edge router interconnects a private network—*i.e.*, the IPv4 access network that it services—and a network operated by a service provider—*i.e.*, the IPv6 domain. Indeed, Li explains that the IPv4 access networks are "customer networks." EX1037, 6. A POSITA would have understood that these customer networks would typically be home or business networks. Li further explains that an "Internet service provider" is "apply[ing] this approach" on its IPv6 domain, which is a separate autonomous system from the IPv4 access networks. *Id.*, 2-3, 6-7. And a POSITA would have understood that as part of the extraction process, the edge

router would need to first determine whether the incoming data packet is a standard IPv6 packet—in which case, the edge router would not be able to extract an IPv4 address or port number because the standard IPv6 address would not contain that information—or an IPv6 packet encapsulating an IPv4 packet using the header of the received packet. Indeed, Li teaches that the edge routers can perform "header manipulation" via "encapsulation" and that the invention can work with "native IPv6 applications" (*i.e.*, standard IPv6 data packets). *Id.*, 4, 9-10.

136. I have been informed that Patent Owner requested—and the Eastern District of Texas court agreed—the function should be construed as "extracting the IPv4 destination address and the destination port number from the IPv6 destination address." EX1036, 60, 70. As discussed, Li and Li-2 render obvious this function, performed on an edge router. *See* §VII.A.7.b.

(e) 6[d]: means for generating an IPv4 data packet from the IPv6 data packet, said packet including said IPv4 destination address and said destination port number; and

137. Li and Li-2 render obvious the claimed steps, performed on an edge router. *See* §VII.A.7.c. I have been informed that the Eastern District of Texas court construed the structure of "means for generating" as "home gateway **20** with a device **26** that includes a processor programmed to perform the step of de-encapsulating the IPv4 packet contained in the packet IPv6 data packet to yield the IPv4 destination address and the destination port number." EX1036, 71. I have been further informed

that Patent Owner had requested the broader construction of "a device" that includes "hardware elements conventionally found in a standard computer or dedicated router." *Id.*, 61. Li's edge router corresponds to home gateway **20** and Patent Owner's broader "device" construction, and it uses a processor to perform the claimed steps. *See* §VII.A.9.b. In particular, Li explains that its edge routers can convert IPv4 packets into IPv6 packets and vice versa via encapsulation. EX1037, 4.

138. I have been informed that Patent Owner proposed construing the function as "generating an IPv4 data packet from the IPv6 data packet." EX1036, 61. I have also been informed that the Eastern District of Texas court agreed but further required "said packet including said IPv4 destination address and said destination port number." *Id.*, 71. As discussed, Li and Li-2 render obvious this function, performed on an edge router. *See* §VII.A.7.c.

(f) 6[e] means for routing the IPv4 data packet to its IPv4 destination.

139. Li teaches the claimed steps, performed on an edge router. *See* §VII.A.7.d. I have been informed that the Eastern District of Texas court construed the structure of "means for routing" as "home gateway **20** with a device **26** that includes a processor programmed to perform the step of routing the IPv4 data packet to its IPv4 destination by processing the IPv4 data packet with the internal address translation table (NAT table) of the home gateway." EX1036, 71. I have been

further informed that Patent Owner had requested the broader construction of "a device" that includes "hardware elements conventionally found in a standard computer or dedicated router." *Id.*, 61. Li's edge router corresponds to home gateway **20** and Patent Owner's broader "device" construction, and it uses a processor to perform the claimed steps. *See* §VII.A.9.b. Indeed, Li explains that the edge router can encapsulate data packets "similar to what a NAT-PT gateway does." EX1037, 4. Li explains how the edge router can map IPv6 entries into a "route table." *Id.*

140. I have been informed that Patent Owner requested—and the Eastern District of Texas court agreed—the function should be construed as "routing the IPv4 data packet to its IPv4 destination." EX1036, 61, 71. As discussed, Li teaches this function, performed on an edge router. *See* §VII.A.7.d.

11. Claim 7: IPv6 domain access equipment according to claim 6, wherein the IPv4 is a public network, said equipment comprising first means for advertising to the IPv4 domain IPv4 addresses of network equipments connected to the IPv6 domain and second means for advertising in the IPv6 domain IPv6 addresses constructed from IPv4 addresses of the IPv4 domain

141. Li further teaches the additional limitation of claim 7: "IPv6 domain access equipment according to claim 6 [*e.g.*, **an edge relay**], wherein the IPv4 is a public network [*e.g.*, **the IPv4 Internet**], said equipment comprising first means for advertising to the IPv4 domain IPv4 addresses of network equipments connected to

the IPv6 domain [*e.g.*, **edge relay advertising IPv4 addresses of network equipment connected to the IPv6 domain to the IPv4 domain via IBGP**] and second means for advertising in the IPv6 domain IPv6 addresses constructed from IPv4 addresses of the IPv4 domain [*e.g.*, **edge relay advertising addresses in the IPv4 Internet to the IPv6 domain via IBPG/v6**]." I break down the elements of this claim below:

142. ***IPv6 domain access equipment according to claim 6***. As discussed, Li teaches IPv6 domain access equipment, which for this claim is an edge relay. *See* §VII.A.10.a; EX1037, 4 ("A relay is a special edge router.")

143. ***wherein the IPv4 is a public network***. Li explains that its invention works with the IPv4 Internet. EX1037, 3, 8. A POSITA would have known that the Internet is a public network.

144. ***said equipment comprising first means for advertising to the IPv4 domain IPv4 addresses of network equipments connected to the IPv6 domain***. I have been informed that Patent Owner requested—and the Eastern District of Texas court agreed—the function of "first means for advertising" to be construed as "advertising to the IPv4 domain IPv4 addresses of network equipment connected to the IPv6 domain." EX1036, 72, 77. The '844 patent specifically describes advertising routes via IGP and BGP. EX1001, 14:1-4, 14:24-25, 8:39-44, Fig. 1. Li

also describes using EBGP peers and IBGP to advertise IP addresses throughout the network, as shown in Figures 7 and 8:

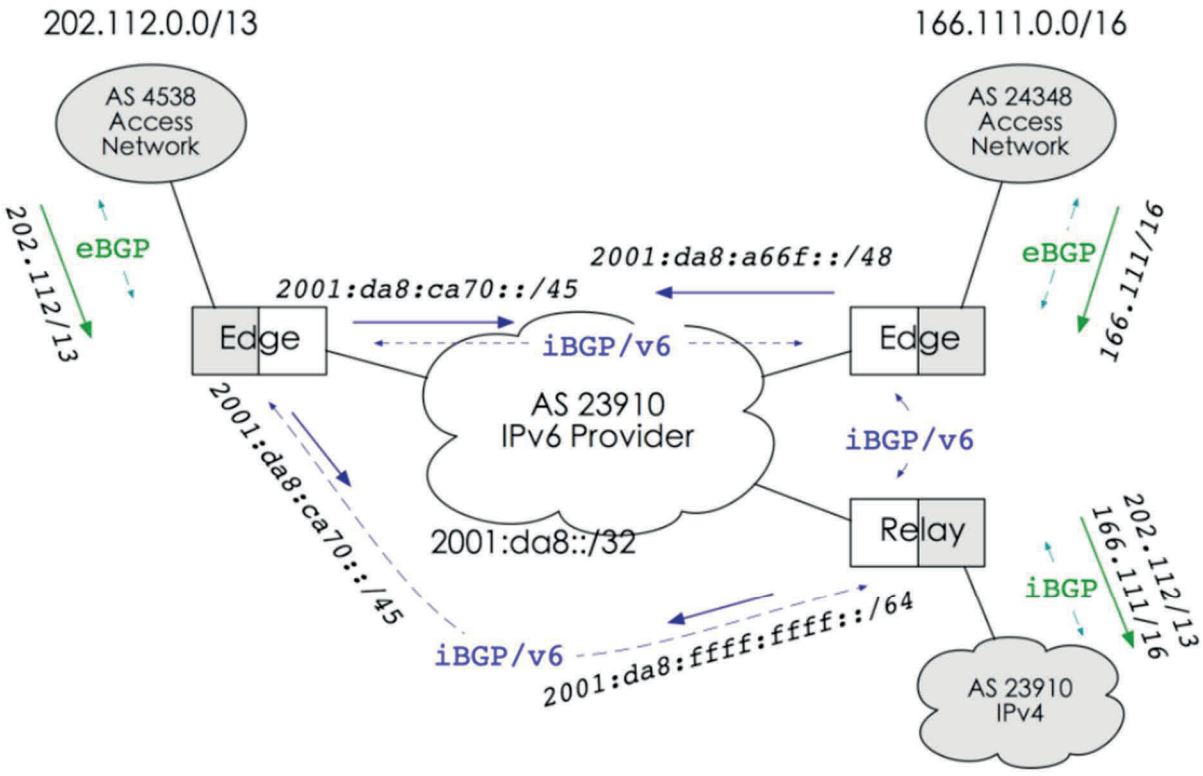


Figure 7. IPv4-over-IPv6 transition for access networks

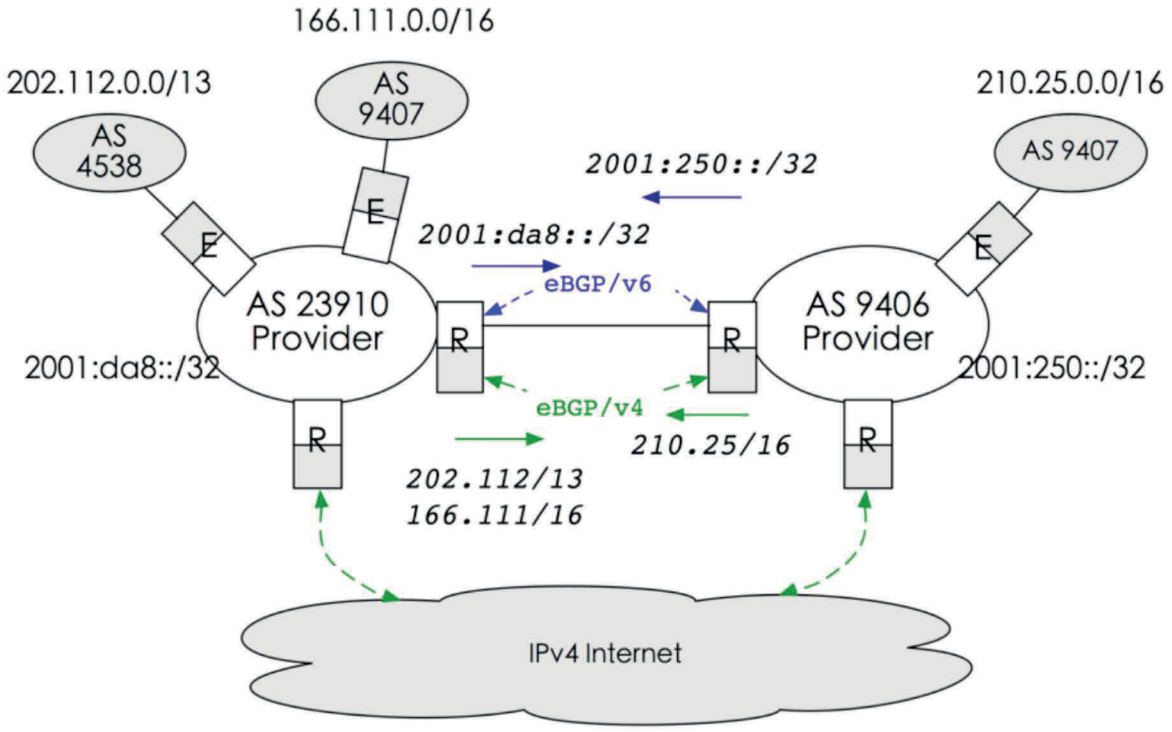


Figure 8. Transition in inter-domain environment

EX1037, 6-8. In particular, "EBGP peers are established between edge routers and their customers' BGP routers, while IBGP peers are utilized between relay routers and their counterparts in IPv4 Internet." *Id.*, 6. Li explains that the edge relay "translates the learned IPv6 prefixes" from the IPv6 domain "that originate from the mapped network identifiers of the customers, back into its original IPv4 version, and advertises them to the IPv4 backbone." *Id.*, 7. Indeed, a POSITA would have known that in order for hosts in the IPv4 Internet to communicate with Li's edge routers, the edge relay would need to advertise to the hosts in the IPv4 Internet the IPv4 addresses of the edge routers.

145. I have been informed that the Eastern District of Texas construed the structure of "first means for advertising" as "a dual-stack router that includes a processor programmed to perform the" limitation. EX1036, 77. I have been further informed that Patent Owner had requested the broader construction of "a device" that includes "hardware elements conventionally found in a standard computer or a dedicated router." *Id.*, 72. As discussed, Li's edge routers and edge relays are dual-stack routers that satisfy the Eastern District of Texas court's construction and Patent Owner's more general "device" construction, and they use processors to perform the claimed steps; *see* §VII.A.9.b.

146. ***and second means for advertising in the IPv6 domain IPv6 addresses constructed from IPv4 addresses of the IPv4 domain***. I have been informed that Patent Owner requested—and the Eastern District of Texas court agreed—the function of "second means for advertising" to be construed as "advertising in the IPv6 domain IPv6 addresses constructed from IPv4 addresses of the IPv4 domain." EX1036, 72, 77-78. Like the '844 patent, Li also describes using EBGP peers and IBGP to advertise IP addresses throughout the network, as shown in Figures 7 and 8. EX1037, 6-8. Li explains that the edge relays can "advertise[] [a] special prefix with '0xFFFFFFFF' for all the IPv4 networks outside the scope of the provider's administration." *Id.*, 7. Li explains that the "special prefix" is applied to public IPv4 networks; *i.e.*, "all the IPv4 networks outside the [autonomous system] should be

mapped to a special prefix." *Id.*, 4. Indeed, a POSITA would have known that in order for Li's edge routers to communicate with hosts in the IPv4 Internet, the edge relay would need to advertise the constructed IPv6 addresses for the hosts in the IPv4 Internet to the edge routers.

147. I have been informed that The Eastern District of Texas construed the structure of "second means for advertising" as "a dual-stack router that includes a processor programmed to perform the" limitation. EX1036, 77-78. Patent Owner had requested the broader construction of "a device" that includes "hardware elements conventionally found in a standard computer or a dedicated router." *Id.*, 72. As discussed, Li's edge routers and edge relays are dual-stack routers that satisfy the Eastern District of Texas court's construction and Patent Owner's more general "device" construction, and they use processors to perform the claimed steps. *See* §VII.A.9.b.

12. Claim 8: IPv6 domain access equipment according to claim 6, wherein the IPv4 domain is a private network, the access equipment is a home gateway adapted to connect user terminals of the private network to the IPv6 domain

148. Li further teaches the additional limitation of claim 8: "IPv6 domain access equipment according to claim 6 [*e.g.*, **edge router**], wherein the IPv4 domain is a private network [*e.g.*, **IPv4 access network**], the access equipment is a home gateway [*e.g.*, **edge router**] adapted to connect user terminals [*e.g.*, **IPv4 hosts**] of

the private network to the IPv6 domain [*e.g.*, **the IPv6 domain in the center of Figure 7**]." I break down the elements of this claim below:

149. ***IPv6 domain access equipment according to claim 6***. As discussed, Li teaches IPv6 domain access equipment, which for this claim is an edge router. *See* §VII.A.10.a.

150. ***wherein the IPv4 domain is a private network***. Li explains that its invention works with IPv4 access networks. EX1037, 3, 7. A POSITA would have known that the IPv4 access network in Li is a private network.

151. ***the access equipment is a home gateway adapted to connect user terminals of the private network to the IPv6 domain***. I have been informed that Patent Owner and Cisco had agreed to construe "home gateway" to mean "any equipment for interconnecting a private network and a network operated by a service provider, the private network being either a home network or a business network." EX1036, 13. As discussed, the IPv4 access network is a private network, and a POSITA would have known that the private network is typically either a home network or a business network, especially in light of Li's explicit disclosures that the IPv4 access networks are "customer networks" that are distinct autonomous systems from the "Internet service provider's" IPv6 domain. EX1037, 2-3, 6-7; *see* §VII.A.10.d.

152. As shown in Li's Figure 7, the edge routers connect user terminals of the IPv4 access networks to the IPv6 domain:

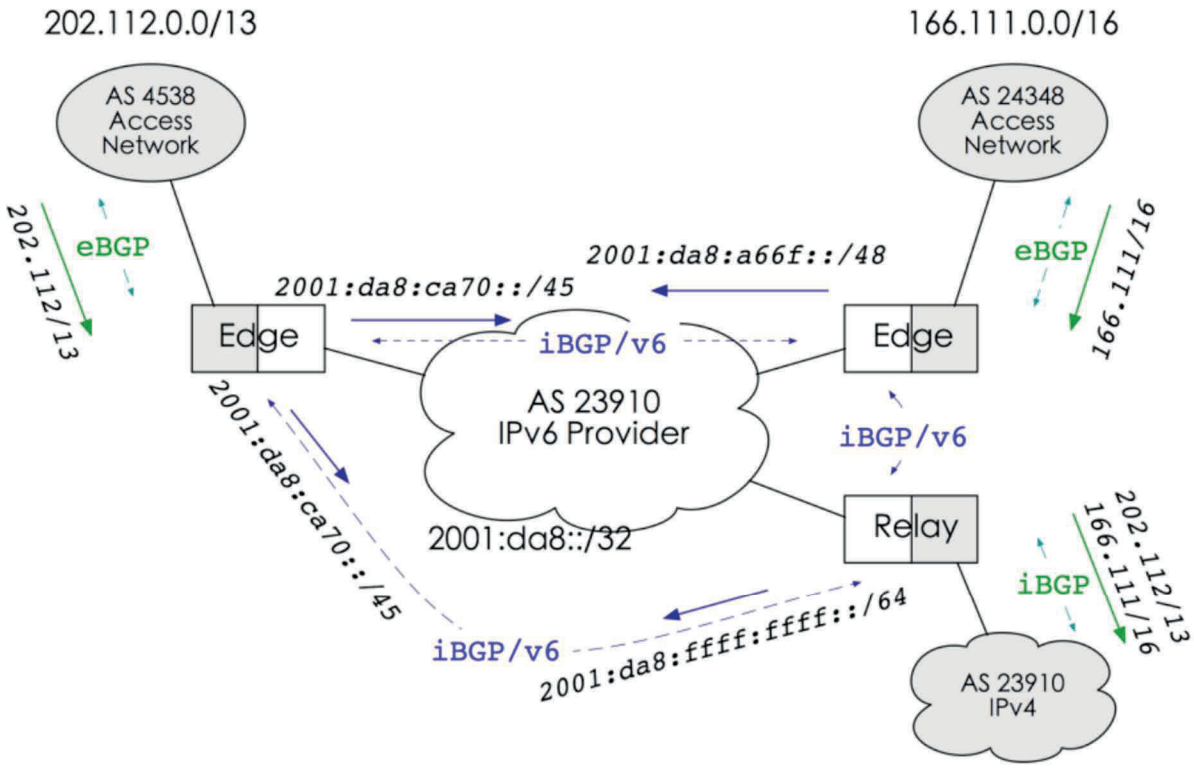


Figure 7. IPv4-over-IPv6 transition for access networks

EX1037, 7. For example, the IPv4 access network includes IPv4 hosts that send messages through the edge router to other hosts. *See id.*, 3, 6.

13. Claim 9: IPv6 domain access equipment according to claim 8, comprising means for obtaining an IPv4 address, a range of port numbers, and a range of authorized IPv6 addresses, said range of IPv6 addresses being constructed by concatenating an operator prefix, said IPv4 address, and the range of authorized IPv4 port numbers

153. Li and Li-2 further render obvious the additional limitation of claim 9. As discussed, Li and Li-2 render obvious an IPv6 domain access equipment (*e.g.*,

an edge router) that obtains an IPv4 address, a port number, and then uses that information to construct an IPv6 address. *See* §VII.A.5. Li and Li-2 further render obvious constructing IPv6 addresses by concatenating an operator prefix, an IPv4 address, and port numbers. *See* §VII.A.5.b.

154. I have been informed that Patent Owner requested—and the Eastern District of Texas court agreed—to construe the function of "means for obtaining" as "obtaining an IPv4 address, a range of port numbers, and a range of authorized IPv6 addresses." EX1036, 78, 80. Li discloses that the edge routers can obtain IP addresses and other information using Border Gateway Protocol ("BGP"). EX1037, 6. Li explains that BGP "provides useful information" to the edge routers, including network prefixes. *Id.* The BGP Routing Information Base ("RIB") "provides a way of automatically distributing the list" of addresses and other information provided by BGP. *Id.*, 7. And that list can be cached "in order to accelerate the processing speed." *Id.* Figure 7 of Li depicts edge routers sending and receiving ranges of constructed IPv6 addresses via BGP:

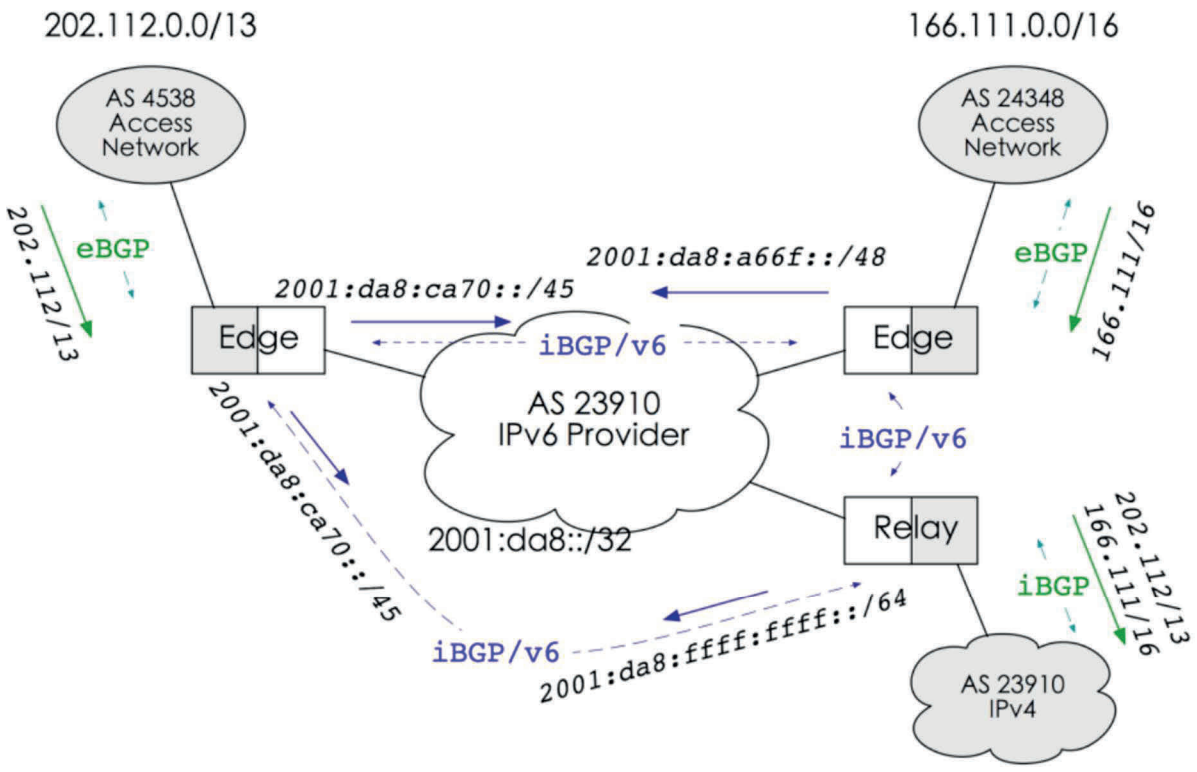


Figure 7. IPv4-over-IPv6 transition for access networks

Id., 7. For example, "2001:da8:ca70::/45"—advertised away from the top-left edge router and obtained by the top-right edge router—is a constructed IPv6 address range comprising an IPv6 prefix and a range of IPv4 addresses. A POSITA would have found it obvious for the edge routers to further advertise and obtain the range of port numbers used so that other edge routers would be able to identify IPv4 hosts that are assigned port numbers. Further, Li-2 also explains that its routes "can be learned/inserted by dynamic routing protocols in the IVI gateway neighboring (IGP) or peering (BGP)." EX1038, 7-8. A POSITA would have therefore understood that

these protocols could be used to advertise the constructed IPv6 addresses that comprise destination port numbers, as disclosed in Li-2. *Id.*, 14.

155. I have been informed that the Eastern District of Texas court construed the structure of "means for obtaining" as "the home gateway **20** or access router **30** serving home gateway **20** that includes a processor programmed to perform the" limitation. EX1036, 80. I have been further informed that Patent Owner had requested the broader construction of "a device" that includes "hardware elements conventionally found in a standard computer or a dedicated router." *Id.*, 78. Li's edge routers correspond to the '844 patent's home gateway and Patent Owner's more general "device" construction, and they use a processor to perform the claimed steps. *See* §VII.A.9.b.

14. Claim 10

(a) 10[pre]: A device for sending a data packet from an IPv6 domain to an IPv4 domain, said packet comprising an IPv6 destination address of the packet constructed by concatenating an operator prefix, the IPv4 destination address, and a destination port number, said device, on reception of the data packet, making use of:

156. To the extent the preamble is limiting, Li teaches limitation 10[pre]: "a device [*e.g.*, **edge router**]" that performs the claimed steps. *See* §VII.A.7.a. The '844 patent explains that its disclosed device "includes the hardware elements conventionally found in a standard computer or a dedicated router," like a processor and memory. EX1001, 12:38-46. Li's edge router corresponds to such a device.

(b) 10[a]: means for extracting the IPv4 destination address and the destination port number from the IPv6 destination address;

157. Li and Li-2 render obvious the claimed steps, performed on an edge router. *See* §VII.A.7.b. I have been informed that the Eastern District of Texas court construed the structure of "means for extracting" as "home gateway **20** with a device **26** that includes a processor programmed to perform the" limitation. EX1036, 70. I have been further informed that Patent Owner had requested the broader construction of "a home gateway or access node with a device" that includes "hardware elements conventionally found in a standard computer or a dedicated router." *Id.*, 60. Li's edge router corresponds to the home gateway and Patent Owner's more general "device" construction, and it uses a processor to perform the claimed step. *See* §VII.A.10.d.

158. I have also been informed that Patent Owner requested—and the Eastern District of Texas court agreed—the function should be construed as "extracting the IPv4 destination address and the destination port number from the IPv6 destination address." EX1036, 60, 70. As discussed, Li and Li-2 render obvious this function, performed on an edge router. *See* §VII.A.7.b.

(c) 10[b]: means for generating an IPv4 data packet from the IPv6 data packet, said packet including said IPv4 destination address and said destination port number; and

159. Li and Li-2 render obvious the claimed steps, performed on an edge router. *See* §VII.A.7.c. I have been informed that the Eastern District of Texas court construed the structure of "means for generating" as "home gateway 20 with a device 26 that includes a processor programmed to perform the step of de-encapsulating the IPv4 packet contained in the packet IPv6 data packet to yield the IPv4 destination address and the destination port number." EX1036, 71. I have been further informed that Patent Owner had requested the broader construction of "a device" that includes "hardware elements conventionally found in a standard computer or a dedicated router." *Id.*, 61. Li's edge router corresponds to home gateway **20** and Patent Owner's broader "device" construction, and it uses a processor to perform the claimed steps. *See* §VII.A.10.e.

160. I have been informed that Patent Owner proposed construing the function as "generating an IPv4 data packet from the IPv6 data packet." EX1036, 61. I have also been informed that the Eastern District of Texas court agreed but further required "said packet including said IPv4 destination address and said destination port number." *Id.*, 71. As discussed, Li and Li-2 render obvious this function, performed on an edge router. *See* §VII.A.7.c.

(d) <u>10[c]: means for routing the IPv4 data packet to its IPv4 destination.</u>

161. Li teaches the claimed steps, performed on an edge router. *See* §VII.A.7.d. I have been informed that the Eastern District of Texas court construed

the structure of "means for routing" as "home gateway **20** with a device **26** that includes a processor programmed to perform the step of routing the IPv4 data packet to its IPv4 destination by processing the IPv4 data packet with the internal address translation table (NAT table) of the home gateway." EX1036, 71. I have been further informed that Patent Owner had requested the broader construction of "a device" that includes "hardware elements conventionally found in a standard computer or a dedicated router." *Id.*, 61. Li's edge router corresponds to home gateway **20** and Patent Owner's broader "device" construction, and it uses a processor to perform the claimed steps. *See* §VII.A.10.f. Indeed, Li explains that "[a]n edge router is a dual-stack node, extended with the ability of translating routing messages and modifying packet IP versions between IPv6 and IPv4." EX1037, 4. Additionally, "the routers at the edge between IPv4 subnet and IPv6 backbone can perform proper routing and header processing." *Id.*, 3.

162. I have been informed that Patent Owner requested—and the Eastern District of Texas court agreed—the function should be construed as "routing the IPv4 data packet to its IPv4 destination." EX1036, 61, 71. As discussed, Li teaches this function, performed on an edge router. *See* §VII.A.7.d.

B. Ground 2: Claims 1-10 Would Have Been Obvious in View of Li

163. The Challenged Claims are also obvious based on Li alone in view of the common knowledge in the art.

1. Evidence of Simultaneous Invention Demonstrates the Obviousness of Combining Li and Li-2

164. Evidence of simultaneous invention indicates that a POSITA would have been motivated to modify Li to form an IPv6 address that includes the destination port number.

165. Li-2 is at minimum evidence of simultaneous invention. As discussed in Ground 1, Li-2 discloses a port multiplexing technique which is used to construct an IPv6 address containing an operator prefix, the destination IPv4 address, and the destination port number.

166. Similarly, on July 6, 2008, one week after the '844 patent's priority date, the authors of Li and Li-2 submitted another IETF publication to the Network Working Group titled "Prefix-Specific and Stateless Address Mapping (IVI) for IPv4/IPv6 Coexistence and Transition" ("IVI Memo"). EX1027; EX1005, ¶¶49-52, 57; EX1007, ¶10. The IVI Memo also discloses using "port multiplexing" to construct an IPv6 address with a destination port number. EX1027, 7-8, 18-20.

167. And then less than one month after that, on July 29, 2008, the authors of Li and Li-2 provided examples of this stateless mapping algorithm in a presentation that they gave in Dublin for an IETF conference. EX1028; EX1007, ¶11 (confirming public accessibility); EX1005, ¶¶53-57 (same). These examples further confirm that Li-2 teaches concatenating the destination port number to the

IPv6 address by replacing unused zero padding. For example, the authors provided the following examples:

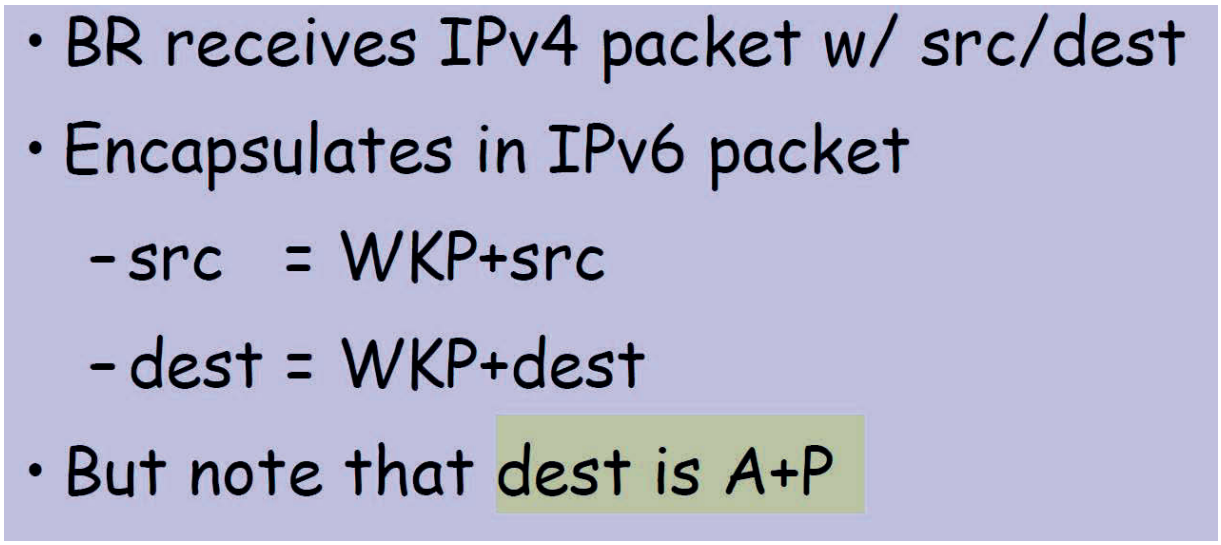
```
202.38.108.2#81 --> IVI61=2001:250:ffca:266c:0200::81#81
202.38.108.2#82 --> IVI61=2001:250:ffca:266c:0200::82#82
202.38.108.2#83 --> IVI61=2001:250:ffca:266c:0200::83#83
202.38.108.2#84 --> IVI61=2001:250:ffca:266c:0200::84#84
```

EX1028, 22 (highlighting added). The IPv6 prefix is the first box, highlighted in blue. EX1038, 6 ("[B]it 0 to bit 31 are the prefix of ISP(i)'s /32."). The second box, highlighted in red, is a flag that specifies that the address has been constructed according to IVI. *Id.*, ("[B]it 32 to bit 39 are all one's as the identifier of IVI."). The third box, which highlights the next 32 bits in purple, is the IPv4 address from the left side of the translation, converted from decimal to hexadecimal. *Id.* ("[B]it 40 to bit 71 are the global IPv4 space (IPG4) presented in hexadecimal format."). The third box, highlighted in yellow, is zero padding. *Id.* (Fig. 1). And the fifth box, highlighted in gray, is the port number that has been taken from the left side of the translation and concatenated to the end of the constructed IPv6 address, replacing unused zero padding as appropriate. *Id.*, 14.

168. I note that the authors did not translate, perhaps for the sake of convenience, the port number from decimal (*i.e.*, "81") to hexadecimal (*i.e.*, "51"). However, a POSITA would have understood that the port number should be converted to hexadecimal before concatenating it to form the IPv6 address.

169. Accordingly, the later disclosures by the authors of Li and Li-2 further confirm that it was obvious to construct a destination IPv6 address by concatenating (1) an IPv6 prefix, (2) a destination IPv4 address, and (3) a destination port number, as described in the '844 patent and in the proposed combination.

170. Other groups also disclosed the idea of forming an IPv6 address using an operator prefix, destination IPv4 address, and destination port number. *See* §III.C.3. For instance, in September 2008, Randy Bush *et al*., published a paper describing an approach called "Address + Port." EX1029. Bush explained that an IPv4 address could be combined with a port number to form a "A+P pseudo address within an IPv6 address using a well-known IPv6 prefix." *Id.*, 1-3. In other words, Bush similarly proposed forming an IPv6 address by concatenating an IPv6 prefix, IPv4 address, and port number. In fact, even at the time, Bush's disclosures were generally known; Bush identified and discussed several related works in the same field, explaining that "[t]here is a long history of treating port numbers as part of the network address." *Id.*, 4. Similarly, an October 2008 presentation from Mr. Bush acknowledges that A+P is "like" other, past techniques for extending the address space. EX1041, 16-17; *see also* EX1041, 21 (explaining that IPv6 "dest[ination]" address is formed by combining a well-known prefix ("WKP") with a "dest[ination]" IPv4 address, wherein the destination IPv4 address is an Address + Port).



EX1041, 21 (highlighted).

2. Motivations to Modify Li

171. A POSITA would have been motivated to modify the teachings of Li and would have had a reasonable expectation of success of doing so, for much of the same reasons described in ground 1. *See* §VII.A.4.

172. **First**, teachings in the art, as well as common knowledge in the art, would have encouraged a POSITA to further concatenate a destination port number to construct an IPv6 destination address in order to prevent IPv4 address exhaustion. By the time of the '844 patent, it was well-understood that IPv4 addresses would soon run out. EX1001, 1:61-62 ("It is commonly accepted in the IP service provider community that IPv4 public addresses are going to run out."); EX1013, 1, 8-9 ("The Internet engineering community has long recognized the impending exhaustion of IPv4."); EX1014, ¶1 ("The unique IPv4 addresses are becoming scarce as the number of devices connecting to the Internet continues to increase."). POSITAs

would have therefore been motivated to improve Li's system by applying known techniques for extending the IPv4 address space, thereby slowing IPv4 address depletion. Specifically, a POSITA would have recognized that port numbers could be used to uniquely identify hosts and allow them to share a single IPv4 address. *See* §III.C.2-3 (discussing EXS1021-1032, which disclose using port numbers to extend the IPv4 address space and to construct an IPv6 address). Accordingly, a POSITA would have been motivated to modify Li by replacing 16 bits of the unused padding in the constructed IPv6 destination address with a destination port number.

173. A POSITA would have had a reasonable expectation of success in modifying Li and there would have been no unexpected results because the modification merely involves the straightforward application of replacing unused padding in Li's constructed IPv6 address with the destination port number. In fact, the simultaneous invention discussed above further confirms that a POSITA would have had a reasonable expectation of success of modifying Li. *See* §§VII.B.1; VII.A.4.

174. **Second**, for the same reasons articulated above, the modification would have been of a known technique (*i.e.*, using port numbers to share an IPv4 address and prevent IPv4 address exhaustion) to a known device (*i.e.*, Li's edge router that already constructs IPv6 addresses by concatenating information, including 32 bits of unused padding) to yield a predictable result (*i.e.*, an edge router that can construct

an IPv6 address that includes a destination port number in place of 16 bits of the unused padding). *See* §VII.A.4.

175. **Third**, this modification would have been obvious because it is a simple substitution of one known element for another to obtain predictable results. Modifying Li would involve merely substituting 16 bits of unused padding in Li's constructed IPv6 address with a 16-bit destination port number to yield a predictable result—a constructed IPv6 address that contains a destination port number. As shown, using port numbers to extend the IPv4 address space, and even to construct an IPv6 address, was known in the art. *See* §III.C.2-3. And based on this state of the art, a POSITA could have substituted the unused padding for the destination port number, and the results of the substitution would have been predictable.

176. **Finally**, Li and the '844 patent are analogous art because the references are in the same field of endeavor as each other, *i.e.*, computer networking and routing data packets. For example, the '844 patent explains that "[t]he field of the invention is that of telecommunications networks, in particular IP telecommunications networks transporting data packets." EX1001, 1:17-21. Li similarly explains that it is directed to "a new technique of forwarding IPv4 traffics in IPv6-only backbone" and includes "routing" as one if its "keywords." EX1037, 1.

177. Additionally, Li and the '844 patent are concerned with the interoperability of IPv4 networks and IPv6 networks. The '844 patent explains that

"[t]he invention improves upon the [previously discussed] situation by means of a method of receiving a data packet coming from an IPv4 domain in an IPv6 domain" and is specifically directed to "a period of transition during which IPv6 domains will have to interconnect with IPv4 domains." EX1001, 2:46-64. Li similarly explains that "at this stage, interoperability of applications in a dual-protocol environment has, replacing connectivity, become the sharpest issue of the IPv4-IPv6 transition." EX1037, 1.

3. Claim 1

(a) 1[pre]: A method of receiving a data packet from an IPv4 domain in an IPv6 domain, said data packet comprising an IPv4 destination address and a destination port number, said method comprising the following steps:

178. To the extent the preamble is limiting, Li teaches limitation 1[pre]. *See* §VII.A.5.a.

(b) 1[a]: constructing an IPv6 destination address by concatenating an operator prefix, said IPv4 destination address, and the destination port number;

179. Li teaches limitation 1[a] except for concatenating a destination port number. *See* §VII.A.5.b. A POSITA would have found it obvious to modify Li to replace 16 bits of its unused padding with a destination port number in order to share a single IPv4 address among multiple hosts, thereby slowing IPv4 address exhaustion. *See* §VII.B.2. Evidence of simultaneous invention shows that not only would a POSITA have been motivated to make this modification and would have

been successful in doing so, but POSITAs at that time were actively modifying Li in such a manner. *See* §VII.B.1.

(c) 1[b]: generating an IPv6 data packet from the IPv6 constructed destination address and the received IPv4 packet; and

180. Li teaches limitation 1[b]. *See* §VII.A.5.c.

(d) 1[c]: routing the generated IPv6 data packet in the IPv6 domain using the IPv6 constructed destination address, said constructed address belonging to a range of IPv6 addresses routable to an interconnection equipment of the IPv6 domain with the IPv4 destination address.

181. Li teaches limitation 1[c]. *See* §VII.A.5.d.

4. Claim 2: A non-transitory computer program product that is at least one of downloadable from a communications network and stored on a computer-readable medium and executable by a microprocessor, comprising program code instructions for executing the method according to claim 1 of receiving in an IPv6 domain a data packet from an IPv4 domain.

182. Li teaches claim 2. *See* §VII.A.6.

5. Claim 3

(a) 3[pre]: A method of sending a data packet from an IPv6 domain to a destination address of an IPv4 domain, said packet comprising an IPv6 destination address of the packet constructed by concatenating an operator prefix, the IPv4 destination address, and a destination port number, said method executing the following steps on reception of the data packet:

183. To the extent the preamble is limiting, Li teaches limitation 3[pre] except for concatenating a destination port number to construct the IPv6 destination

address. *See* §VII.A.7.a. A POSITA would have found it obvious to modify Li to replace 16 bits of its unused padding with a destination port number in order to share a single IPv4 address among multiple hosts, thereby slowing IPv4 address exhaustion. *See* §VII.B.2. Evidence of simultaneous invention shows that not only would a POSITA have been motivated to make this modification and would have been successful in doing so, but POSITAs at that time were actively modifying Li in such a manner. *See* §§VII.B.1-2.

(b) 3[a]: extracting the IPv4 destination address and the destination port number from the IPv6 destination address;

184. Li teaches limitation 3[a] except for extracting the destination port number from the IPv6 address. *See* §VII.A.7.b. A POSITA would have found it obvious to modify Li to also extract the destination port number in the IPv6 address in order to identify the intended recipient of the data packet. *See* §VII.B.2. In a network that shares a global IPv4 address among multiple hosts to prevent IPv4 address exhaustion, the IPv4 address itself is not enough to uniquely identify the recipient host. Rather, the combination of IPv4 address and port number are used to uniquely identify hosts, thereby extending the IPv4 address space. *See* §III.C.2-3. Evidence of simultaneous invention shows that not only would a POSITA have been motivated to make this modification and would have been successful in doing so,

but POSITAs at that time were actively modifying Li in such a manner. *See* §VII.B.1.

(c) 3[b]: generating an IPv4 data packet from the IPv6 data packet, said packet including said IPv4 destination address and said destination port number; and

185. Li teaches limitation 3[b] except for including the destination port number in the generated IPv4 data packet. *See* §VII.A.7.c. A POSITA would have found it obvious to modify Li to include the extracted destination port number in the generated IPv4 data packet. *See* §VII.B.2. In particular, a POSITA would have understood that (1) in this network configuration, the destination port number is used to uniquely identify the recipient host and (2) the destination port number indicates the process of the recipient host that should receive the data packet. Evidence of simultaneous invention shows that not only would a POSITA have been motivated to make this modification and would have been successful in doing so, but POSITAs at that time were actively modifying Li in such a manner. *See* §VII.B.1.

(d) 3[c]: routing the IPv4 data packet to its IPv4 destination.

186. Li teaches limitation 3[c]. *See* §VII.A.7.d.

6. Claim 4: A non-transitory computer program product that is at least one of downloadable from a communications network and/or stored on a computer-readable medium and/or executable by a microprocessor, comprising program code instructions for executing the method according to claim 3 of sending a data packet from an IPv6 domain to a destination address of an IPv4 domain.

187. Li teaches claim 4. *See* §VII.A.8.

7. Claim 5

(a) 5[pre]: A device for receiving a data packet from an IPv4 domain in an IPv6 domain, said data packet comprising an IPv4 destination address and an IPv4 destination port number, said device comprising:

188. To the extent the preamble is limiting, Li teaches limitation 5[pre]. *See* §VII.A.9.a.

(b) 5[a]: means for constructing an IPv6 destination address by concatenating an operator prefix, said IPv4 destination address, and the destination port number;

189. Li teaches limitation 5[a] except for concatenating the destination port number. *See* §VII.A.9.b. A POSITA would have found it obvious to modify Li to concatenate the destination port number. *See* §VII.B.3.b.

(c) 5[b]: means for generating an IPv6 data packet from the IPv6 constructed destination address and the received IPv4 packet; and

190. Li teaches limitation 5[b]. *See* §VII.A.9.c.

(d) 5[c]: means for routing the generated IPv6 data packet in the IPv6 domain using the IPv6 constructed destination address, said constructed address belonging to a range of IPv6 addresses routable to an interconnection equipment of the IPv6 domain with the IPv4 destination address.

191. Li teaches limitation 5[c]. *See* §VII.A.9.d.

8. Claim 6

(a) 6[pre]: Access equipment to an IPv6 domain comprising an interface with at least one IPv4 domain, further comprising:

192. To the extent the preamble is limiting, Li teaches limitation 6[pre]. *See* §VII.A.10.a.

(b) 6[a]: a device according to claim 5 for receiving a data packet coming from an IPv4 domain in the IPv6 domain; and

193. Li teaches limitation 6[a]. *See* §VII.A.10.b.

(c) 6[b]: a device for sending a data packet from an IPv6 domain to an IPv4 domain, said packet comprising an IPv6 destination address of the packet constructed by concatenating an operator prefix, the IPv4 destination address, and a destination port number, said device, on reception of the data packet, making use of:

194. Li teaches limitation 6[b]. *See* §VII.A.10.c.

(d) 6[c]: means for extracting the IPv4 destination address and the destination port number from the IPv6 destination address;

195. Li teaches limitation 6[c] except for extracting the destination port number. *See* §VII.A.10.d. A POSITA would have found it obvious to modify Li to extract the destination port number. *See* §VII.B.5.b.

(e) 6[d]: means for generating an IPv4 data packet from the IPv6 data packet, said packet including said IPv4 destination address and said destination port number; and

196. Li teaches limitation 6[d] except for including the extracted destination port number in the generated IPv4 data packet. *See* §VII.A.10.e. A POSITA would have found it obvious to modify Li to include the extracted destination port number in the generated IPv4 data packet. *See* §VII.B.5.c.

(f) 6[e] means for routing the IPv4 data packet to its IPv4 destination.

197. Li teaches limitation 6[e]. *See* §VII.A.10.f.

9. Claim 7: IPv6 domain access equipment according to claim 6, wherein the IPv4 is a public network, said equipment comprising first means for advertising to the IPv4 domain IPv4 addresses of network equipments connected to the IPv6 domain and second means for advertising in the IPv6 domain IPv6 addresses constructed from IPv4 addresses of the IPv4 domain

198. Li teaches claim 7. *See* §VII.A.11.

10. Claim 8: IPv6 domain access equipment according to claim 6, wherein the IPv4 domain is a private network, the access equipment is a home gateway adapted to connect user terminals of the private network to the IPv6 domain

199. Li teaches claim 8. *See* §VII.A.12.

11. Claim 9: IPv6 domain access equipment according to claim 8, comprising means for obtaining an IPv4 address, a range of port numbers, and a range of authorized IPv6 addresses, said range of IPv6 addresses being constructed by concatenating an operator prefix, said IPv4 address, and the range of authorized IPv4 port numbers

200. A POSITA would have found it obvious to modify Li to meet claim 9 for the same reasons articulated above. *See* §VII.A.13. In particular, a POSITA would have found it obvious for the edge routers to further advertise and obtain the range of port numbers used so that other edge routers would be able to identify IPv4 hosts that are assigned port numbers. *Id.*

12. Claim 10

(a) 10[pre]: A device for sending a data packet from an IPv6 domain to an IPv4 domain, said packet comprising an IPv6 destination address of the packet constructed by concatenating an operator prefix, the IPv4 destination address, and a destination port number, said device, on reception of the data packet, making use of:

201. To the extent the preamble is limiting, Li teaches limitation 10[pre]. *See* §VII.A.14.a.

(b) 10[a]: means for extracting the IPv4 destination address and the destination port number from the IPv6 destination address;

202. Li teaches limitation 10[a] except for extracting the destination port number. *See* §VII.A.14.b. A POSITA would have found it obvious to modify Li to extract the destination port number. *See* §VII.B.5.b.

(c) 10[b]: means for generating an IPv4 data packet from the IPv6 data packet, said packet including said IPv4 destination address and said destination port number; and

203. Li teaches limitation 10[b] except for including the extracted destination port number in the generated IPv4 data packet. *See* §VII.A.14.c. A POSITA would have found it obvious to modify Li to include the extracted destination port number in the generated IPv4 data packet. *See* §VII.B.5.c.

(d) 10[c]: means for routing the IPv4 data packet to its IPv4 destination.

204. Li teaches limitation 10[c]. *See* §VII.A.14.d.

C. Ground 3: Claims 1-10 Would Have Been Obvious in View of Li and Wu

1. Wu (EX1039)

205. Wu teaches a "new tunnel technology in the transition period from IPv4 Internet to IPv6 Internet." EX1039, 2. Wu describes a Network Address Translation ("NAT") technology that receives a data packet from an internal network and translates a private address of the data packet into a public address, also called an "external address." *Id.*, 9. The NAT further translates a source port number into an external port number. *Id.* However, "the present NAT basically doesn't allow IPv6-in-IPv4 data packets… to pass." *Id.*, 10.

206. Wu therefore proposes a "method for automatic tunnel which can traverse NAT" that "aims to solve the mutual communication problem between the IPv6 node and other IPv6 nodes… within NAT field." *Id.* Specifically, a "Silkroad client"—a dual-stack client that has both IPv4 and IPv6 capabilities—constructs an IPv6 address by concatenating different pieces of information, as shown in Figure 1:

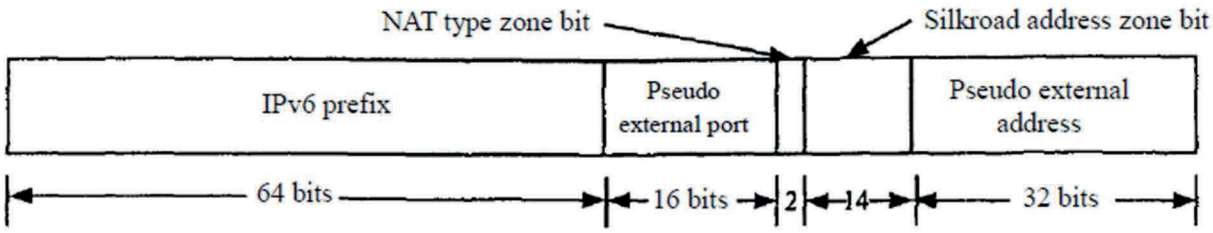


Fig. 1

Id., Fig. 1. The first 64 bits of the constructed IPv6 address correspond to an IPv6 prefix. *Id.*, 11. The next 16 bits correspond to the external port number, which can be obfuscated by using a bit-wise operation. *Id.* The next 2 bits indicate the type of NAT used in the network. *Id.* The next 14 bits are padded with 0s, reserved for a "Silkroad address." *Id.* And the final 32 bits correspond to the external address, which can be obfuscated by using a bit-wise operation. *Id.*, 12. Accordingly, the client can construct an IPv6 address by concatenating an IPv6 prefix, a port number, and an IPv4 address, along with other information. *Id.*, 13.

2. The Li-Wu Combination

207. In the Li-Wu combination, Li teaches the general network structure and the steps of receiving a data packet from an IPv4 domain in an IPv6 domain. Li further teaches constructing an IPv6 address by concatenating an IPv6 prefix, an IPv4 address, and 32-bits of zero padding (and extracting the IPv4 information from the constructed IPv6 address and routing the IPv4 information). Wu supplements Li's disclosures by teaching replacing 16 bits of the 32-bit zero padding with a destination port number in order to uniquely identify hosts and mitigate IPv4 address exhaustion. Thus, in the Li-Wu combination, Li would operate in its disclosed manner but would further implement Wu's teaching of including port numbers in constructed IPv6 addresses in order to uniquely identify hosts and prevent IPv4 address exhaustion.

3. Motivations to Combine Li and Wu

208. A POSITA would have been motivated to combine the teachings of Li and Wu and would have had a reasonable expectation of success in doing so.

209. **First**, the prior art includes express teachings that would have motivated a POSITA to combine the references. By the time of the '844 patent, it was well-understood that IPv4 addresses would soon run out. EX1001, 1:61-62 ("It is commonly accepted in the IP service provider community that IPv4 public addresses are going to run out."); EX1013, 1, 8-9 ("The Internet engineering community has long recognized the impending exhaustion of IPv4."); EX1014, ¶1 ("The unique IPv4 addresses are becoming scarce as the number of devices connecting to the Internet continues to increase."). POSITAs would have therefore been motivated to improve Li's system by applying known techniques for extending the IPv4 address space, thereby slowing IPv4 address depletion. Specifically, a POSITA would have recognized that port numbers could be used to uniquely identify hosts and allow them to share a single IPv4 address. *See* §III.C.2-3 (discussing EXS1021-1032, which disclose using port numbers to extend the IPv4 address space). Accordingly, a POSITA would have been motivated to modify Li by replacing 16 bits of the unused padding in the constructed IPv6 destination address with a destination port number, as taught by Wu.

210. A POSITA would have had a reasonable expectation of success in combining Li and Wu and there would have been no unexpected results because the combination merely involves the straightforward application of replacing unused padding in Li's constructed IPv6 address with the destination port number, as taught by Wu. In fact, the simultaneous invention discussed above further confirms that a POSITA would have had a reasonable expectation of success in combining Li and Wu. *See* §VII.B.1.

211. **Second**, a POSITA would have been particularly motivated to apply Wu to Li because the combination would have been of a known technique (*i.e.*, Wu's teaching of constructing an IPv6 address by concatenating a port number) to a known device (*i.e.*, Li's edge router that already constructs IPv6 addresses by concatenating information, including 32 bits of unused padding) to yield a predictable result (*i.e.*, an edge router that can construct an IPv6 address that includes a destination port number in place of 16 bits of the unused padding). As discussed, by the time of the '844 patent, POSITAs recognized the need to extend the IPv4 address space and a well-known technique for doing so was to form an IPv6 address by concatenating IPv4 address and port number. *See* §III.C.2-3 (discussing EXS1021-1032). The proposed combination thus applies this well-known technique, as disclosed by Wu, to Li's known device, an edge router.

212. **Third**, this combination would have been obvious because it is a simple substitution of one known element for another to obtain predictable results. Combining Li and Wu would involve merely substituting 16 bits of unused padding in Li's constructed IPv6 address with a 16-bit destination port number, as taught by Wu, to yield a predictable result—a constructed IPv6 address that contains a destination port number. As Wu shows, the substituted component—the destination port number—and its function were known in the art. And based on the state of the art, as described above and in the technology background section, a POSITA could have substituted the unused padding for the destination port number, and the results of the substitution would have been predictable. *See* §III.C.2-3.

213. **Finally**, Li, Wu, and the '844 patent are analogous art because the references are in the same field of endeavor as each other, *i.e.*, computer networking and routing data packets. For example, the '844 patent explains that "[t]he field of the invention is that of telecommunications networks, in particular IP telecommunications networks transporting data packets." EX1001, 1:17-21. Li similarly explains that it is directed to "a new technique of forwarding IPv4 traffics in IPv6-only backbone" and includes "routing" as one if its "keywords." EX1037, 1. And Wu is also directed to changes in "the existing IPv4 networking routing system." EX1039, 9.

214. Additionally, all references are concerned with the interoperability of IPv4 networks and IPv6 networks. The '844 patent explains that "[t]he invention improves upon the [previously discussed] situation by means of a method of receiving a data packet coming from an IPv4 domain in an IPv6 domain" and is specifically directed to "a period of transition during which IPv6 domains will have to interconnect with IPv4 domains." EX1001, 2:46-64. Li similarly explains that "at this stage, interoperability of applications in a dual-protocol environment has, replacing connectivity, become the sharpest issue of the IPv4-IPv6 transition." EX1037, 1. And Wu describes itself as "a tunnel technology in the transition period from IPv4 to IPv6, so as to realize the transition from IPv4 to IPv6." EX1039, 9.

4. Evidence of Simultaneous Invention Demonstrates The Obviousness Of Combining Li And Wu

215. As discussed above, there are multiple examples of POSITAs simultaneously inventing the '844 claims. *See* §VII.B.1.

5. Claim 1

(a) 1[pre]: A method of receiving a data packet from an IPv4 domain in an IPv6 domain, said data packet comprising an IPv4 destination address and a destination port number, said method comprising the following steps:

216. To the extent the preamble is limiting, Li teaches limitation 1[pre]. *See* §VII.A.5.a.

(b) 1[a]: constructing an IPv6 destination address by concatenating an operator prefix, said IPv4 destination address, and the destination port number;

217. Li teaches limitation 1[a] except for concatenating a destination port number. *See* §VII.A.5.b. Wu teaches that a constructed IPv6 address may be formed by concatenating the received destination port number. Specifically, Wu teaches a "Silkroad client"—which, like the Edge Router in Li, is a dual-stack client that has both IPv4 and IPv6 capabilities (EX1039, 11)—that constructs an IPv6 address by concatenating different pieces of information that are received from an IPv4 data packet, as shown in Figure 1:

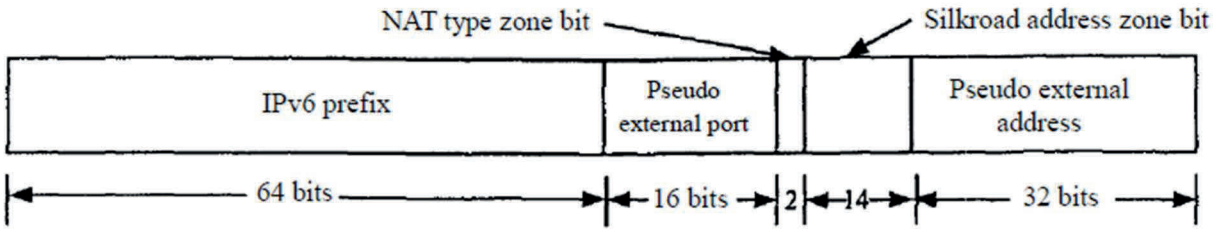
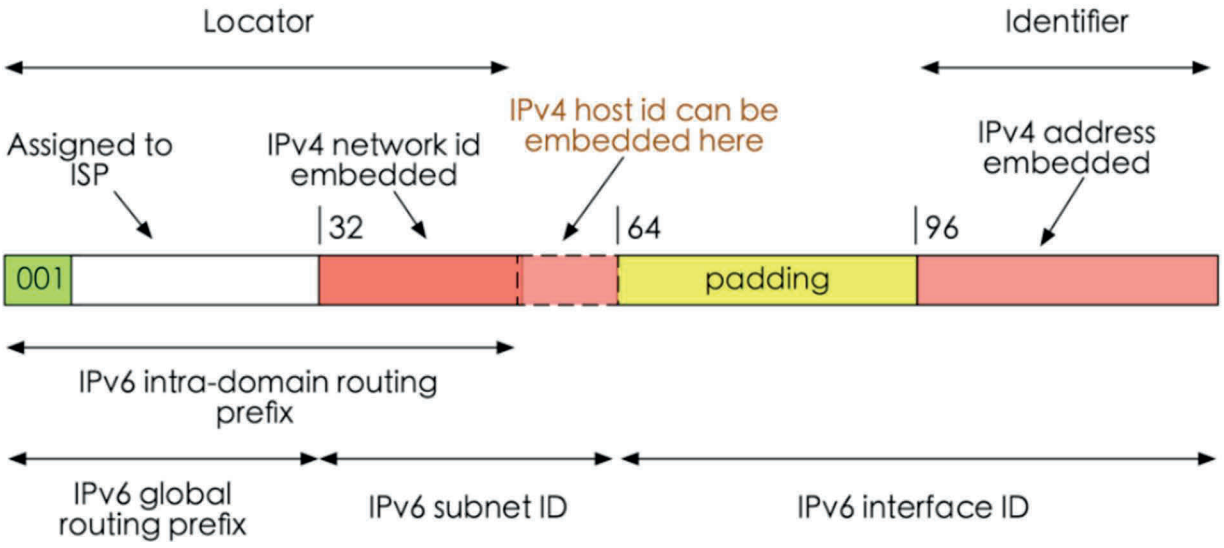


Fig. 1

EX1039, Fig. 1. Wu's constructed IPv6 address comprises an IPv6 prefix and an IPv4 address (Wu calls the IPv4 address an "external address" or "pseudo external address"), like the constructed IPv6 address described in Li. *Id.*, 9-12. Wu additionally teaches that the constructed IPv6 address may include a port number, called a "pseudo external port number." *Id.*, 11.

218. Li already teaches that its IPv6 address concatenates 32-bits of zero padding (bits 64-96) following the operator prefix and IPv4 address:



EX1037, 3. Thus, a POSITA would have recognized that there is more than sufficient space to further include a 16 bit destination port number in Li's address by replacing 16 bits of the unused padding. As such, a POSITA would have been motivated to combine Li and Wu. *See* §VII.C.3. Evidence of simultaneous invention shows that not only would a POSITA have been motivated to combine Li and Wu would have been successful in doing so, but POSITAs at that time were actively modifying Li in such a manner. *See* §VII.C.4.

(c) 1[b]: generating an IPv6 data packet from the IPv6 constructed destination address and the received IPv4 packet; and

219. Li teaches limitation 1[b]. *See* §VII.A.5.c.

(d) 1[c]: routing the generated IPv6 data packet in the IPv6 domain using the IPv6 constructed destination address, said constructed address belonging to a range of IPv6 addresses routable to an interconnection equipment of the IPv6 domain with the IPv4 destination address.

220. Li teaches limitation 1[c]. *See* §VII.A.5.d.

6. Claim 2: A non-transitory computer program product that is at least one of downloadable from a communications network and stored on a computer-readable medium and executable by a microprocessor, comprising program code instructions for executing the method according to claim 1 of receiving in an IPv6 domain a data packet from an IPv4 domain.

221. Li teaches claim 2. *See* §VII.A.6.

7. Claim 3

(a) 3[pre]: A method of sending a data packet from an IPv6 domain to a destination address of an IPv4 domain, said packet comprising an IPv6 destination address of the packet constructed by concatenating an operator prefix, the IPv4 destination address, and a destination port number, said method executing the following steps on reception of the data packet:

222. To the extent the preamble is limiting, Li teaches limitation 3[pre] except for concatenating a destination port number to construct the IPv6 destination address. *See* §VII.A.7.a. As discussed above, Li in combination with Wu renders obvious an IPv6 data packet that has an IPv6 destination address constructed by concatenating an operator prefix (*e.g.*, **Li's IPv6 global routing prefix**), the IPv4 destination address (*e.g.*, **Li's received IPv4 destination address that corresponds to a host in the top-right IPv4 access network**), and a destination port number (*e.g.*, **Li's received destination port number in light of Wu's teachings**). *See* §VII.C.5. And a POSITA would have been motivated to combine Li and Wu. *See* §§VII.C.3-4.

(b) 3[a]: extracting the IPv4 destination address and the destination port number from the IPv6 destination address;

223. Li teaches limitation 3[a] except for extracting the destination port number from the IPv6 address. *See* §VII.A.7.b. Wu discloses a server that receives an IPv6 data packet and then "extracts the external address and external port from the destination IPv6 address." EX1039, 14. A POSITA would have found it obvious to apply the teachings of Wu to Li such that Li's edge router would extract both the IPv4 destination address and the destination port number from the IPv6 destination address. In other words, upon receipt of the data packet, Li's edge router would convert the IPv6 data packet into an IPv4 data packet and use the information in the IPv6 data packet, including the IPv4 destination address and the destination port number, to route the IPv4 data packet to the correct IPv4 host. A POSITA would have been motivated to combine Li and Wu. *See* §§VII.C.3-4.

(c) 3[b]: generating an IPv4 data packet from the IPv6 data packet, said packet including said IPv4 destination address and said destination port number; and

224. Li teaches limitation 3[b] except for including the destination port number in the generated IPv4 data packet. *See* §VII.A.7.c. A POSITA would have found it obvious, in light of Wu's teachings, to further use the extracted destination port number, as discussed in the combination above, to generate the IPv4 data packet. *See* §VII.C.3. In particular, a POSITA would have understood that (1) in

this network configuration, the destination port number is used to uniquely identify the recipient host and (2) the destination port number indicates the process of the recipient host that should receive the data packet. Evidence of simultaneous invention shows that not only would a POSITA have been motivated to make this modification and would have been successful in doing so, but POSITAs at that time were actively modifying Li in such a manner. *See* §VII.C.4.

(d) 3[c]: routing the IPv4 data packet to its IPv4 destination.

225. Li teaches limitation 3[c]. *See* §VII.A.7.d.

8. Claim 4: A non-transitory computer program product that is at least one of downloadable from a communications network and/or stored on a computer-readable medium and/or executable by a microprocessor, comprising program code instructions for executing the method according to claim 3 of sending a data packet from an IPv6 domain to a destination address of an IPv4 domain.

226. Li teaches claim 4. *See* §VII.A.8.

9. Claim 5

(a) 5[pre]: A device for receiving a data packet from an IPv4 domain in an IPv6 domain, said data packet comprising an IPv4 destination address and an IPv4 destination port number, said device comprising:

227. To the extent the preamble is limiting, Li teaches limitation 5[pre]. *See* §VII.A.9.a.

(b) 5[a]: means for constructing an IPv6 destination address by concatenating an operator prefix, said IPv4 destination address, and the destination port number;

228. Li and Wu render obvious the claimed steps, performed on an edge router. *See* §§VII.A.9.b, VII.C.5.b.

(c) 5[b]: means for generating an IPv6 data packet from the IPv6 constructed destination address and the received IPv4 packet; and

229. Li teaches limitation 5[b]. *See* §VII.A.9.c.

(d) 5[c]: means for routing the generated IPv6 data packet in the IPv6 domain using the IPv6 constructed destination address, said constructed address belonging to a range of IPv6 addresses routable to an interconnection equipment of the IPv6 domain with the IPv4 destination address.

230. Li teaches limitation 5[c]. *See* §VII.A.9.d.

10. Claim 6

(a) 6[pre]: Access equipment to an IPv6 domain comprising an interface with at least one IPv4 domain, further comprising:

231. To the extent the preamble is limiting, Li teaches limitation 6[pre]. *See* §VII.A.10.a.

(b) 6[a]: a device according to claim 5 for receiving a data packet coming from an IPv4 domain in the IPv6 domain; and

232. Li teaches limitation 6[a]. *See* §VII.A.10.b.

(c) 6[b]: a device for sending a data packet from an IPv6 domain to an IPv4 domain, said packet comprising an IPv6 destination address of the packet constructed by concatenating an operator prefix, the IPv4 destination address, and a destination port number, said device, on reception of the data packet, making use of:

233. Li teaches limitation 6[b]. *See* §VII.A.10.c.

(d) 6[c]: means for extracting the IPv4 destination address and the destination port number from the IPv6 destination address;

234. Li and Wu render obvious the claimed steps, performed on an edge router. *See* §§VII.A.10.d, VII.C.7.b.

(e) 6[d]: means for generating an IPv4 data packet from the IPv6 data packet, said packet including said IPv4 destination address and said destination port number; and

235. Li and Wu render obvious the claimed steps, performed on an edge router. *See* §§VII.A.10.e, VII.C.7.c.

(f) 6[e] means for routing the IPv4 data packet to its IPv4 destination.

236. Li teaches limitation 6[e]. *See* §VII.A.10.f.

11. Claim 7: IPv6 domain access equipment according to claim 6, wherein the IPv4 is a public network, said equipment comprising first means for advertising to the IPv4 domain IPv4 addresses of network equipments connected to the IPv6 domain and second means for advertising in the IPv6 domain IPv6 addresses constructed from IPv4 addresses of the IPv4 domain

237. Li teaches claim 7. *See* §VII.A.11.

12. Claim 8: IPv6 domain access equipment according to claim 6, wherein the IPv4 domain is a private network, the access equipment is a home gateway adapted to connect user terminals of the private network to the IPv6 domain

238. Li teaches claim 8. *See* §VII.A.12.

13. Claim 9: IPv6 domain access equipment according to claim 8, comprising means for obtaining an IPv4 address, a range of port numbers, and a range of authorized IPv6 addresses, said range of IPv6 addresses being constructed by concatenating an operator prefix, said IPv4 address, and the range of authorized IPv4 port numbers

239. A POSITA would have found it obvious to modify the combination of Li and Wu to meet claim 9. *See* §VII.A.13.

14. Claim 10

(a) 10[pre]: A device for sending a data packet from an IPv6 domain to an IPv4 domain, said packet comprising an IPv6 destination address of the packet constructed by concatenating an operator prefix, the IPv4 destination address, and a destination port number, said device, on reception of the data packet, making use of:

240. To the extent the preamble is limiting, Li teaches limitation 10[pre]. *See* §VII.A.14.a.

(b) 10[a]: means for extracting the IPv4 destination address and the destination port number from the IPv6 destination address;

241. Li and Wu render obvious the claimed steps, performed on an edge router. *See* §§VII.A.14.b, VII.C.7.b.

(c) 10[b]: means for generating an IPv4 data packet from the IPv6 data packet, said packet including said IPv4 destination address and said destination port number; and

242. Li and Wu render obvious the claimed steps, performed on an edge router. *See* §§VII.A.14.c; VII.C.7.c.

(d) 10[c]: means for routing the IPv4 data packet to its IPv4 destination.

243. Li teaches limitation 10[c]. *See* §VII.A.14.d.

VIII. CONCLUSION

244. For the reasons stated above, it is my opinion that the Challenged Claims would have been obvious at the time of the invention.

245. In signing this declaration, I recognize that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to cross-examination in the case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

* * *

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true. I further declare that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001.

Respectfully submitted,

Date: January 23, 2024

/s/ Samrat Bhattacharjee
Samrat Bhattacharjee, Ph.D