IPv6
Networking for the 21st Century

IPv6 Advantages

IPV6 FORUM

I E T F
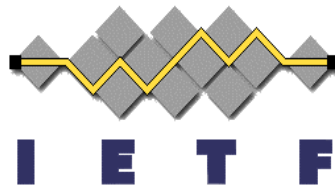
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IPv6 FORUM

- **A world-wide consortium of leading Internet vendors and Research and Education Networks**

- **The IPv6 FORUM mission**
  - To promote IPv6 in order to create a higher quality and more secure Next Generation Internet.

- **The FORUM works closely with the Internet Engineering Task Force (IETF) which is responsible for the IPv6 technical specifications**

- **66 'Founding Members'**

http://www.ipv6forum.com/

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- *" IPv6 is here and now, so take the Internet where no other network has gone before! "* **comments Dr. Vint Cerf, Chairman of the Internet Society and known as the father of the Internet.**

- *" We've known for some years that IP version 4 was heading towards its limits, and the IETF has been working on IPv6 since 1994. Now, the basic standards are agreed and implemented, and it is time to move forward,"* **adds Dr. Brian E. Carpenter, Chair of the IETF's Internet Architecture Board, and a Program Director in IBM's Internet Division.**

- *" The IPv6 FORUM's core objectives will be to promote this new technology on a world-wide basis sharing knowledge, experience and interoperability and creating common grounds for the Internet of the next millennium",* **states Latif Ladid, a Director of the IPv6 FORUM & VP, Telebit Communications.**

IPv4 - Limiting factors

IPv4 issues (1)

- **Out of Internet addresses**
  - Address Shortages
  - Limits Internet growth for existing users
  - Hinders use of the Internet for new users
  - Internet Routing today is inefficient
  - Forces users to use NAT
- **System Management Costs**
  - Managing addresses manually is costly
    - and error-prone
  - Inconsistent level of DHCP support in clients
    - Lowest common denominator wins
  - Networks are having to Renumber
    - Caused by address space shortage
    - When choosing a more competitive ISP
  - Mobile IP
    - Complicated to manage

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IPv4 issues (2)

- **Optional Security**
  - IPv4 was never designed to be secure
    - Originally designed for an isolated military network
    - Then adapted for a public educational & research network
  - IPv4 security is retrofitted and many solutions defined
    - SSL, SHTTP, IPSEC v4
    - No ONE standard
  - Security features are optional
    - CANNOT count on their availability

- **Support for 21st century applications**
  - New applications are more demanding, they will require

    Guaranteed on-time delivery ; Guaranteed availability of bandwidth; Guaranteed security

  - Difficult to add to the base IPv4 technology; adding it on is very high overhead

Will IPv4 last forever?

- **How long can we ignore these problems?**
  - IPv4 address space will run out
  - There is an engineering limit to the amount of retrofitting that can be applied to IPv4

- **A natural evolution from IPv4 is required**
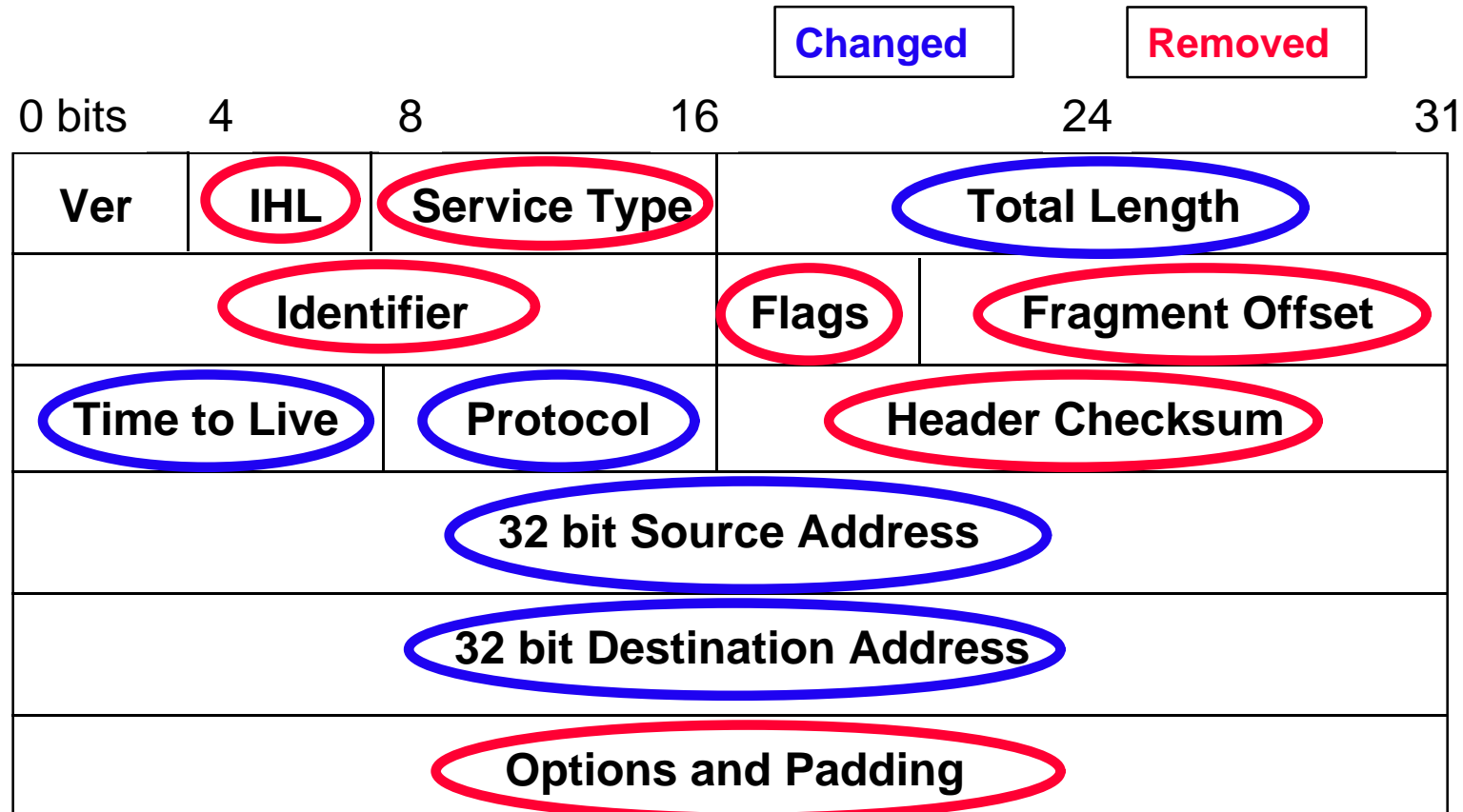 - Designed with extensibility and scalability in mind

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IPv6 Base Technology
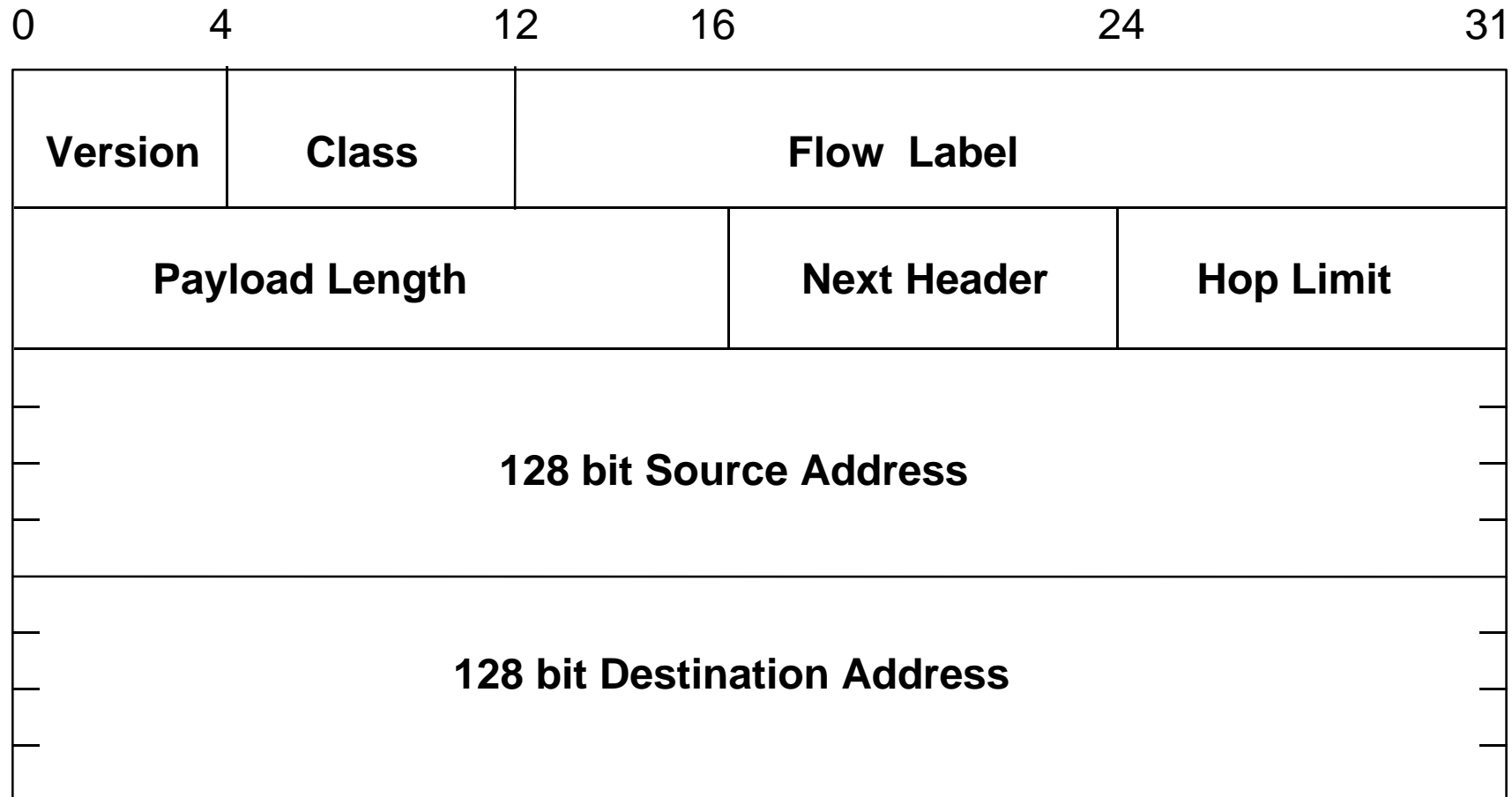
Wins

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IPv4 Header

20 octets + options : 13 fields, including 3 flag bits

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Changed	Removed

0 bits	4	8	16	24	31

Ver	**IHL**	**Service Type**	**Total Length**
Identifier		**Flags**	**Fragment Offset**
Time to Live	**Protocol**		**Header Checksum**
32 bit Source Address			
32 bit Destination Address			
Options and Padding			

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IPv6 Header
40 Octets, 8 fields

0	4	12	16	24	31

Version	Class	Flow Label		
Payload Length		Next Header		Hop Limit

128 bit Source Address

128 bit Destination Address

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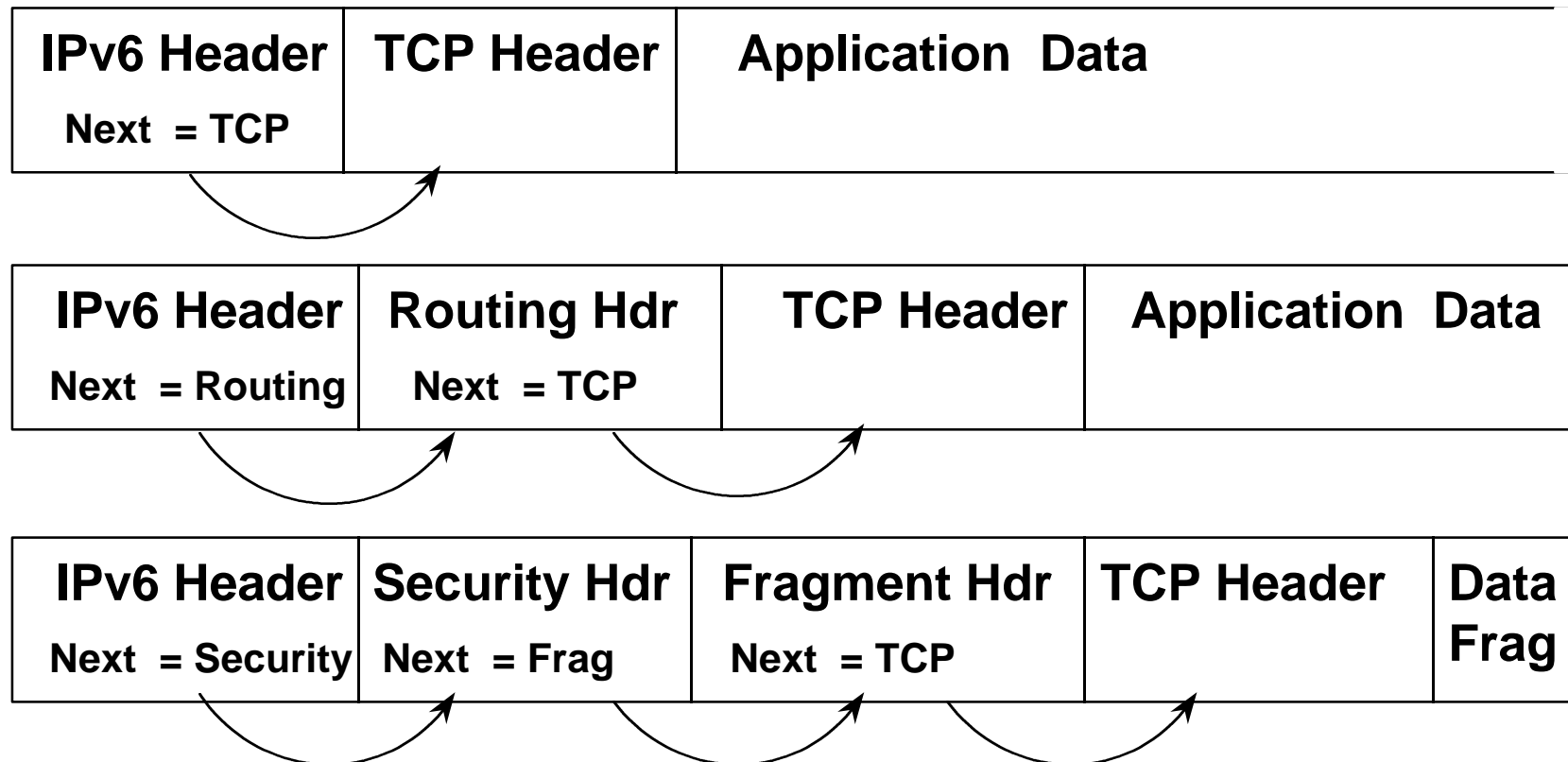
IPv6 Extension Headers

- IP options have been moved to a set of optional Extension Headers
- Extension Headers are chained together

IPv6 Header Next = TCP	TCP Header	Application Data

IPv6 Header Next = Routing	Routing Hdr Next = TCP	TCP Header	Application Data

IPv6 Header Next = Security	Security Hdr Next = Frag	Fragment Hdr Next = TCP	TCP Header	Data Frag

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Performance Wins

- **Fixed Size IPv6 Header**
  - Unlike IPv4 - Options not limited at 40 bytes
- **Fewer fields in basic header**
  - faster processing of basic packets
  - no checksum
- **64 Bit Alignment Header/Options**
- **Efficient option processing**
  - option fields processed only when the option present
  - Processing of most options limited performed only at destination
- **No Fragmentation in the network**
  - More router cycles available for forwarding packets
  - Easier to implement in Silicon

The power of IPv6 Addressing

Ease of renumbering

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IPv6 - Addressing Model

- **Addresses are assigned to interfaces**
  - No change from IPv4 Model
- **Interface can have multiple addresses**

- **Addresses have scope**
  - Link Local
  - Site Local
  - Global

- **Addresses have lifetime**
  - Valid and Preferred lifetime

Global · **Site-Local** · **Link-Local**

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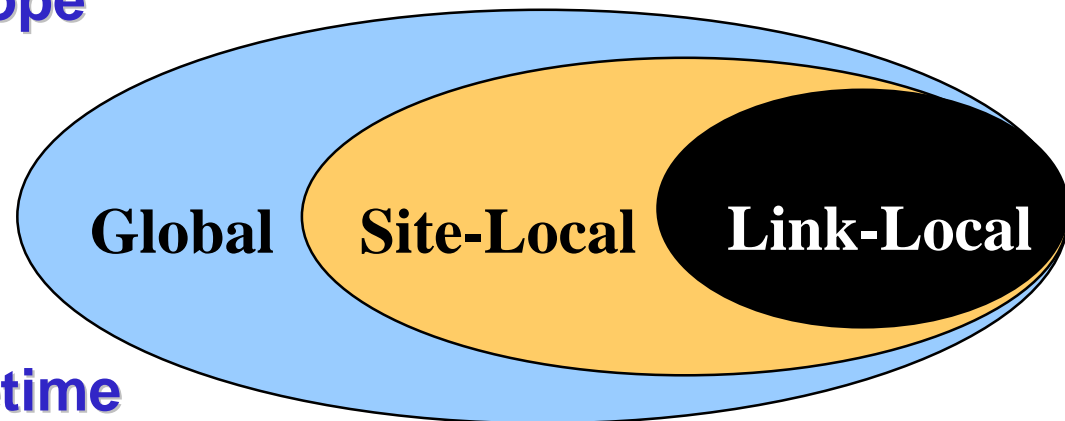
IPv6 Address Structure

- **Formed from a combination of the:**

Prefix   **Interface ID**

3FFE:0301:DEC1:: 0A00:2BFF:FE36:701E

Prefix Representation 3FFE:0301:DEC1::/64

- **Separation of "who you are" from "where you are connected to"**
  - Routing Prefix
    - Routing Topology
  - Node Identification
    - Interface Identifier

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The power of IPv6 Management

Network Management

- **Auto configuration**
  - Plug-and-Play.
  - Automate network address renumbering
  - DHCP support is mandated
    - Every host can download their network configurations from a server at startup time
  - Address changes are automated
    - Stateless ; Routers advertise prefixes that identify the subnet(s) associated with a link ; Hosts generate an "interface token" that uniquely identifies an interface on a subnet ; An address is formed by combining the two.
    - Stateful ; Clients obtain address and / or configuration from a DHCP server ; DHCP server maintains the database and has a tight control over address assignments.

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Automatic Renumbering

- **Renumbering IPv6 Hosts is easy**
  - Add a new Prefix to the Router
  - Reduce the Lifetime of the old prefix
  - As nodes depreciate the old prefix the new Prefix will start to be used for new connections
- **Renumbering in IPv6 is designed to happen!**
- **An end of ISP "lock in"!**
  - Improved competition

Putting the IT Director back in control

- **IPv6 Address Scope**
  - Some addresses are GLOBAL
  - Others are Link or Site LOCAL
  - Addressing Plan also controls network access
- **Configuration Policy Control**
  - Stateless
  - Stateful (DHCPv6)
- **Routers Dictate the Configuration Policy**
  - Router Managers are "in control" of the network
  - Routers also dictate MTU size for the Link

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Mobile IPv6

- **IPv6 Mobility is based on core features of IPv6**
  - The base IPv6 was designed to support Mobility
  - Mobility is not an "Add-on" features
    - All IPv6 Networks are IPv6-Mobile Ready
    - All IPv6 nodes are IPv6-Mobile Ready
    - All IPv6 LANs / Subnets are IPv6 Mobile Ready

- **IPv6 Neighbor Discovery and Address Autoconfiguration allow hosts to operate in any location without any special support**

- **No single point of failure (Home Agent)**

- **More Scalable : Better Performance**
  - Less traffic through Home Link
  - Less redirection / re-routing (Traffic Optimisation)

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The power of IPv6 Security

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IPv6 - Mandates Security

- **Security features are standardized and <u>mandated</u>**
  - All implementations must offer them
  - No Change to applications
- **Authentication (Packet signing)**
- **Encryption (Data Confidentiality)**
- **End-to-End security Model**
  - Protects DHCP
  - Protects DNS
  - Protects IPv6 Mobility
  - Protects End-to-End traffic over IPv4 networks

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Other IPv6 goodies

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Enables Next Generation Applications

- **IPv6 Flow Labels provide Support for Data Flows**
  - Allows Packet Prioritizing
  - Ensures that high priority traffic (voice, data, real-time manufacturing, etc.) is not interrupted by less critical data

- **IPv6 Multicast & Anycast**
  - Multicast delivers data simultaneously to all hosts that sign up to receive it
    - Makes conferencing more efficient
  - Anycast delivers data to one host in the group
    - Could be used to implement fault tolerant client/server applications more efficiently

Summary

What the future hold?

IPv6 Features and Advantages

- **Larger Address Space**
- **Efficient and Extensible IP datagram**
- **Efficient Route Computation and Aggregation**
- **Improved Host and Router Discovery**
- **Mandated New Stateless and Stateful Address Autoconfiguration**
- **Easy renumbering**
- **Mobility support**
- **Mandated Security for IP datagrams**

Is IPv6 part of the future?

- **IPv6 Solves many of the problems caused by the IPv4 success**
  - and more...

- **Will the whole Internet get upgraded any time soon?**
  - No way!

- **Will bits of IPv6 appear in production use soon?**
  - Yes

  and

  - IPv6 offer useful features for TODAY's networks

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Questions?

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