Transition Mechanisms Overview

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Transition to IPv6: Some Thoughts

- We have to migrate the net to IPv6, but…
- IPv4 and IPv6 are incompatible…
  - …although they have a lot of similarities: translation between IPv4 and IPv6 will be possible in some cases
- Nothing can stop Internet:
  - No flag day migration possible
  - Interoperability between IPv6 and IPv4 systems is a must
- Internet is a heterogeneous network:
  - Thousands of organizations involved
  - Coordination but no strict authority: transition could last forever…
- Transition is a hard work:
  - Upgrade routers, hosts, applications, etc
- Transition is the key to IPv6 success:
  - IPv6 HAS BEEN DESIGNED WITH TRANSITION IN MIND

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Transition to IPv6

- Simple Internet Transition (SIT): *"is a set of protocol mechanisms implemented in hosts and routers, along with some operational guidelines for addressing and deployment, designed to make transitioning the Internet to IPv6 work with as little disruption as possible".*
- Basic objectives:
  - Interoperability between IPv6 and IPv4 systems (key)
  - Highly diffuse and incremental deployment of IPv6 (reduce interdependencies)
  - Mechanisms as easy as possible for end-users, system administrators, and network operators to understand and carry out

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Transition Requirements

- The IPv6 transition plan is aimed at meeting four basic requirements: [RFC 1752]
  - Incremental upgrade. Upgrade installed IPv4 devices to IPv6 at any time without any dependencies on any other devices.
  - Incremental deployment. New IPv6 devices can be installed at any time without any prerequisites (apart from upgrading DNS).
  - Easy Addressing. When upgrading installed IPv4 devices to IPv6, the existing addressing will continue to be used (no need to assign new addresses).
  - Low start-up costs. Little or no preparation work is needed in order to upgrade existing IPv4 systems to IPv6, or to deploy new IPv6 systems.

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Next Generation Transition (NGN)

- IETF Working Group responsible of:
  - Specifying tools and mechanisms for transition to IPv6
  - Outlining how mechanisms and tools might apply to different scenarios
  - Coordinating with 6BONE the development, testing and deployment of IPv6
  - Coordinating with other IPv6 related activities inside or outside IETF
- Approach: Create a “Transition Toolbox”
  - A growing collection of techniques which implementations and users may employ to ease the transition
  - The tools may be used as needed
  - Implementations and sites decide which techniques are appropriate to their specific needs

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Basic Transition Mechanisms

- Defined in:
  - RFC 2893. Transition Mechanisms for IPv6 Hosts and Routers. August 2000.
- Two basic mechanisms defined:
  - Dual stack: complete implementation of IPv6 and IPv4 stacks in hosts and routers
  - Tunneling: of IPv6 packets over IPv4 networks
- Objective: maintain compatibility of IPv6 hosts and routers with IPv4 hosts and routers (transition requirement)

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Dual Stack

- It is really a ”Dual IP layer” approach:
  - Only IP layer is duplicated, not the whole stack
- IPv6/IPv4 nodes (dual nodes):
  - Have both IPv6 and IPv4 addresses
  - Include resolver libraries capable of dealing with A, AAAA and A6 records
  - When asking to DNS for a dual node, the order of the answers would normally define the protocol used
- Recommendation: do not register IPv6 address in DNS till they are configured and working in systems
  - TCP timeout delays when connecting to nodes

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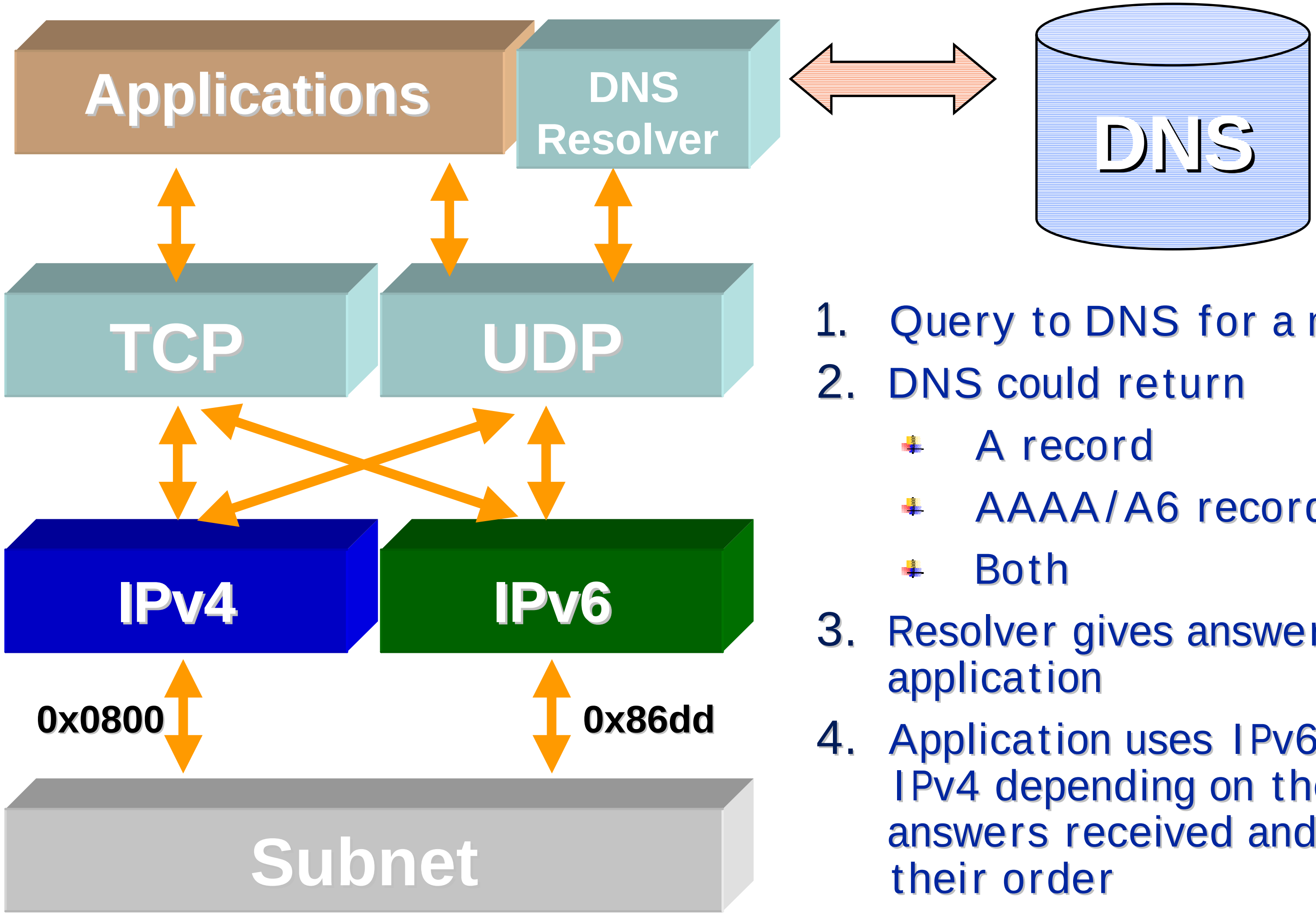
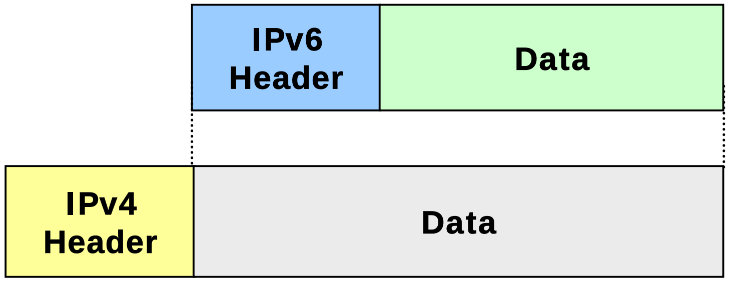
Dual Nodes Operation



1. Query to DNS for a name
2. DNS could return
   - A record
   - AAAA/A6 record
   - Both
3. Resolver gives answers to application
4. Application uses IPv6 or IPv4 depending on the answers received and their order

Tunneling

- RFC 2893 defines the basic use of tunnels as a mechanism to transport IPv6 packets over IPv4 networks
- IPv6 datagrams are encapsulated on IPv4 datagrams to traverse non IPv6 capable networks



- Same technique extensively used in today's networks
  - Ej: MBONE, multiprotocol (IPX, Appletalk, etc) over IP backbones, IP movility, etc

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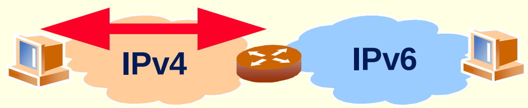
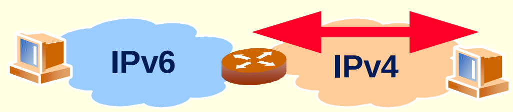
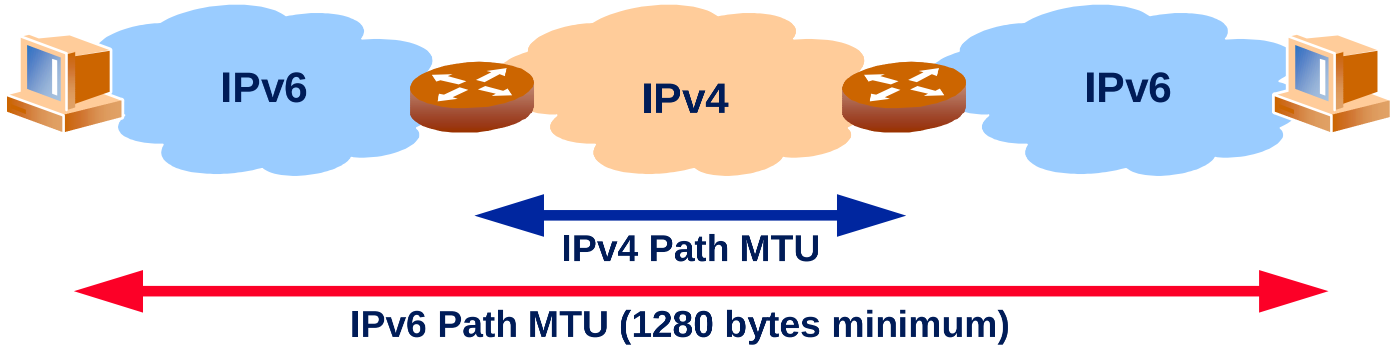
Tunnel Types

Router-to-router Connect IPv6 islands through IPv4 networks	
Host-to-Router Useful for isolated IPv6 hosts (i.e. with no local IPv6 routers)	
Host-to-Host Isolated IPv6 hosts	
Router-to-Host Destination host has no local IPv6 capable routers	

Fragmentation and Tunnels



- Avoid Fragmentation on IPv4 networks by using PATH MTU Discovery (RFC 1191)
  - Could not be completely eliminated if IPv4 Path MTU is less than 1280 bytes (minimal IPv6 MTU)
- Hop Limit:
  - IPv6-over-IPv4 tunnels are modeled as "single-hop"
  - So, IPv6 Hop limit decremented by 1

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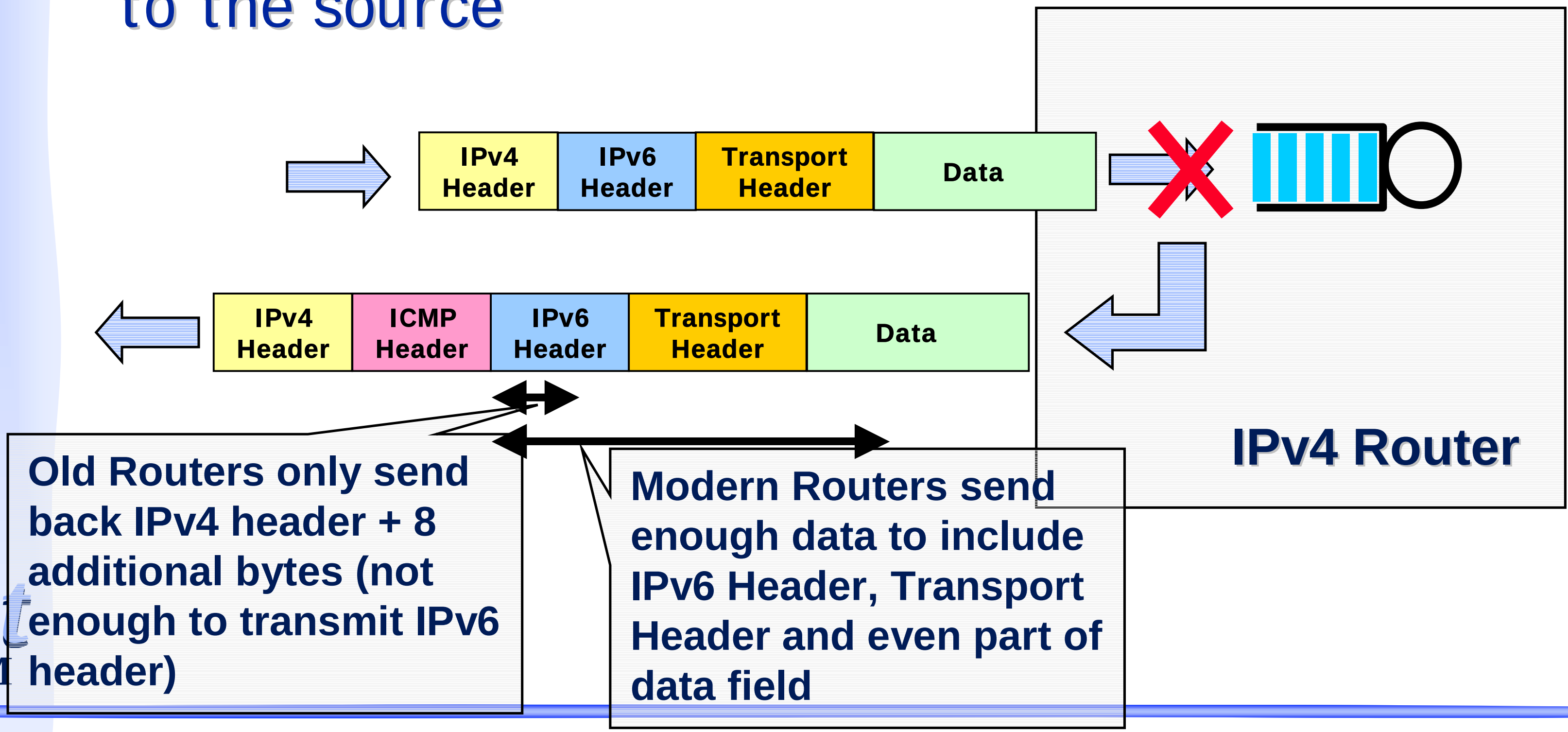
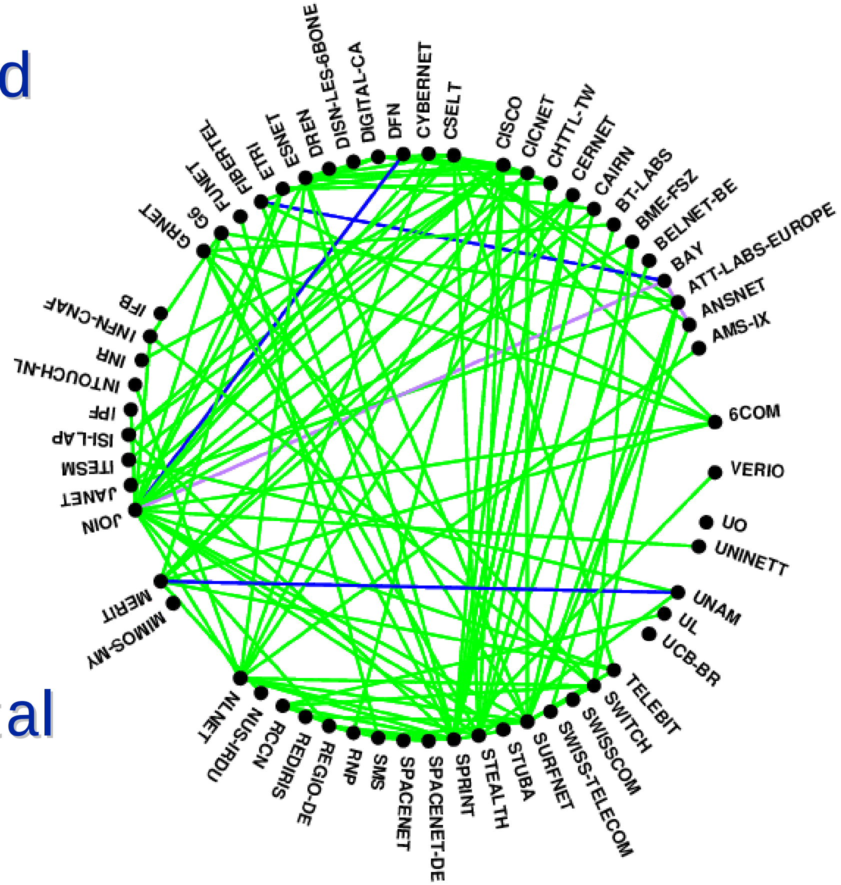
Handling ICMP Errors

- If packets are discarded in IPv4, ICMPv4 errors are sent to tunnel origin endpoint
- If enough information is included in ICMPv4 errors, an ICMPv6 packet can be propagated back to the source



6BONE

- IPv6 testbed created to assist in the evolution and deployment of IPv6
  - www.6bone.net
- Based on IPv6 over IPv4 tunnels
- RFC 2471: IPv6 Testing Address Allocation
  - Assigns 3ffe::/16 prefix for experimental use



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Tunnel Brokers

- Defined in:
  - RFC 3053: IPv6 Tunnel Broker. January 2001
- Motivation:
  - Help early IPv6 adopters to hook up on an existing IPv6 network and get stable, permanent IPv6 addresses and names
- Automates the management of IPv6 tunnels requests from users. Requests are processed by a server that automatically:
  - creates and configure the server part of the tunnel, and
  - provides to the client the information necessary to configure the client side

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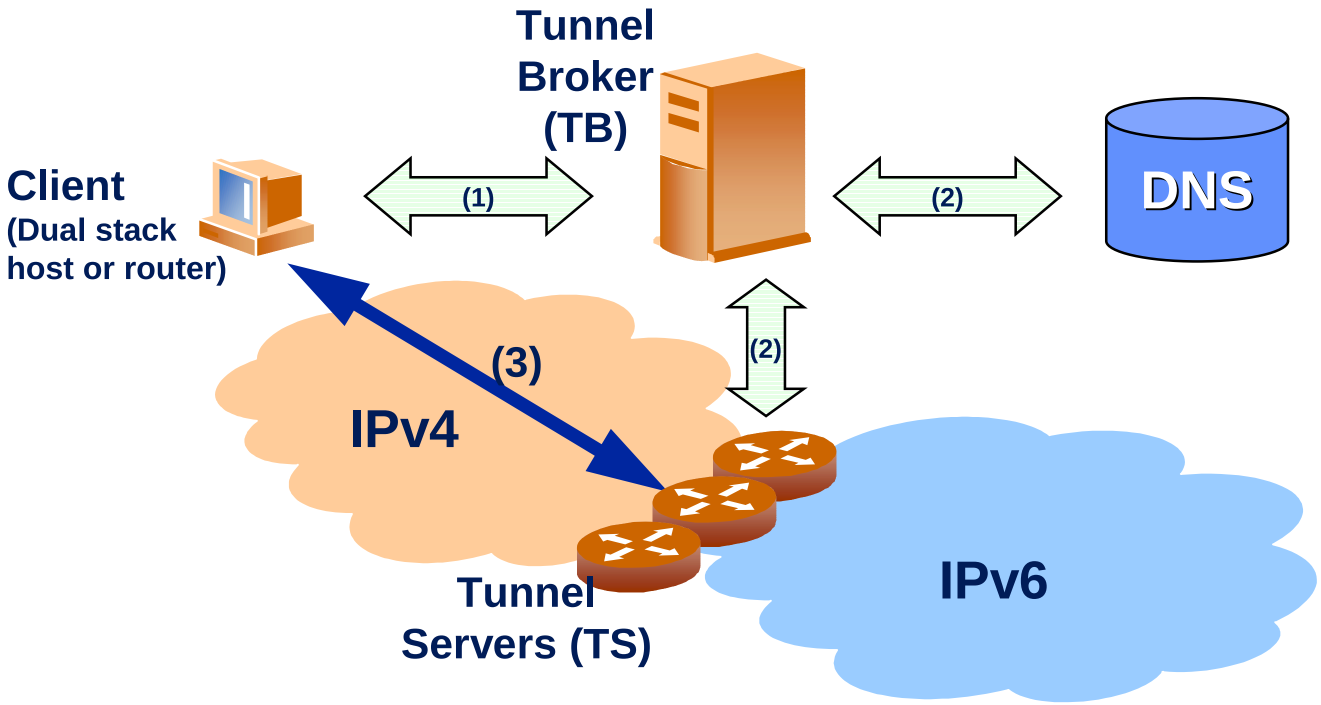
Tunnel Broker Model



1. Client registers (e.g. through https) in TB and gets IPv6 address/es
2. TB configures the server part of the tunnel in a TS and registers the addresses in DNS
3. Client configures (manually or by means of scripts provided by TB) the client side of the tunnel

Tunnel Brokers

- Several available nowadays:
  - Freenet6. http://www.freenet6.net
  - CSELT. https://carmen.cselt.it/ipv6tb
  - BT. http://tb.ipv6.bt.com/v6broker/
- See a TB list, for example, at: http://hs247.com
- Other TB proposals:
  - "MIME TYPE definition for tunnels". draft-ietf-ngtrans-tunnel-mime-type-00.txt
  - "Tunnel Setup Protocol (TSP)". draft-vg-ngtrans-tsp-00

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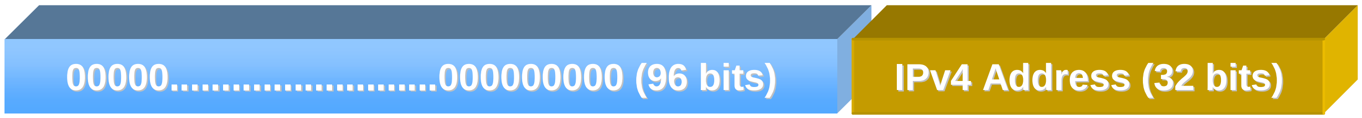
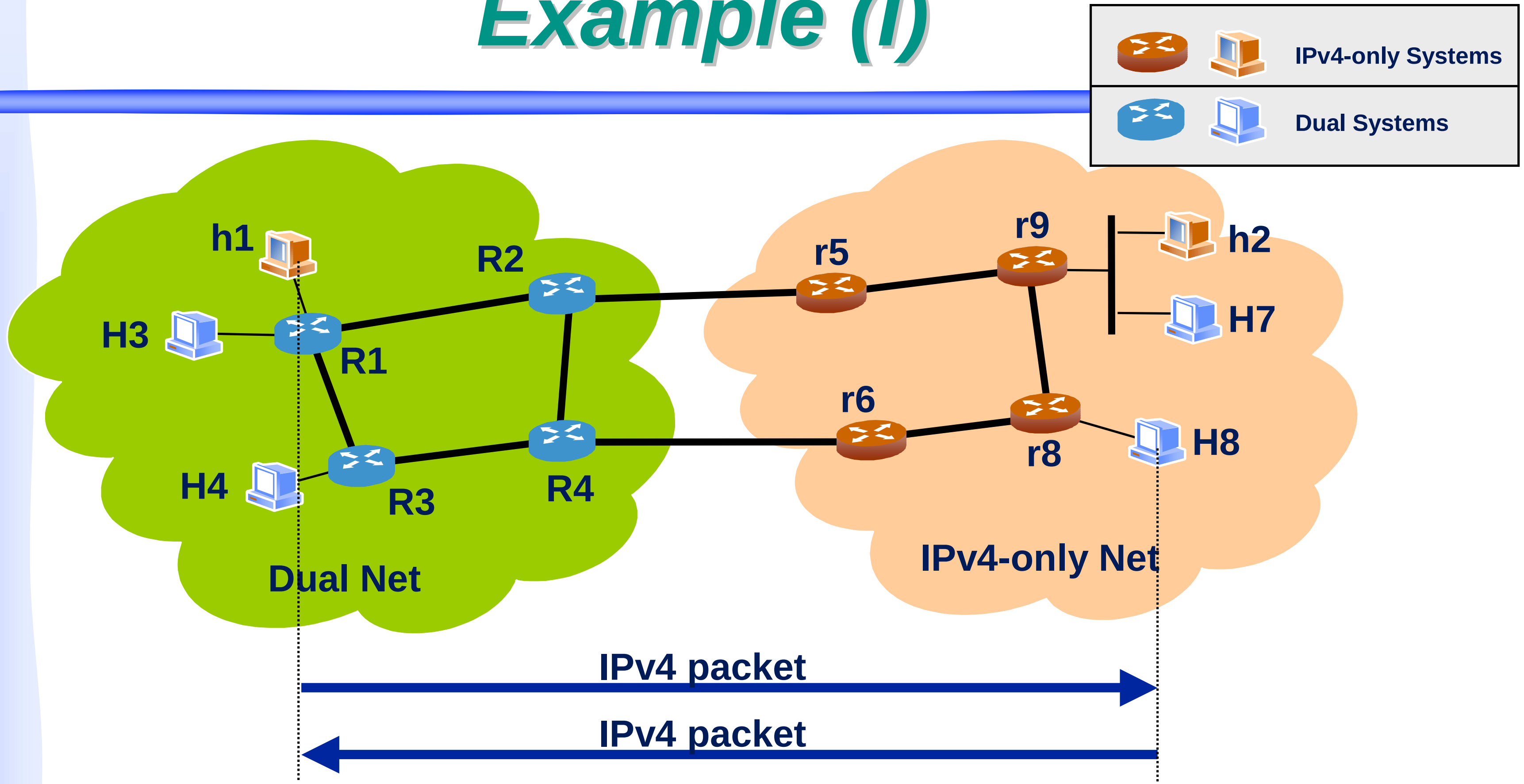
Automatic Tunnels (I)

- If the tunnel ends at the destination node (host-to-host and router-to-host types):
  - IPv6 and IPv4 destination addresses identify the same node, so
  - IPv4 addr. could be encapsulated in IPv6 addr. in order to automatically obtain tunnel endpoint address
- IPv4-Compatible Address Format:



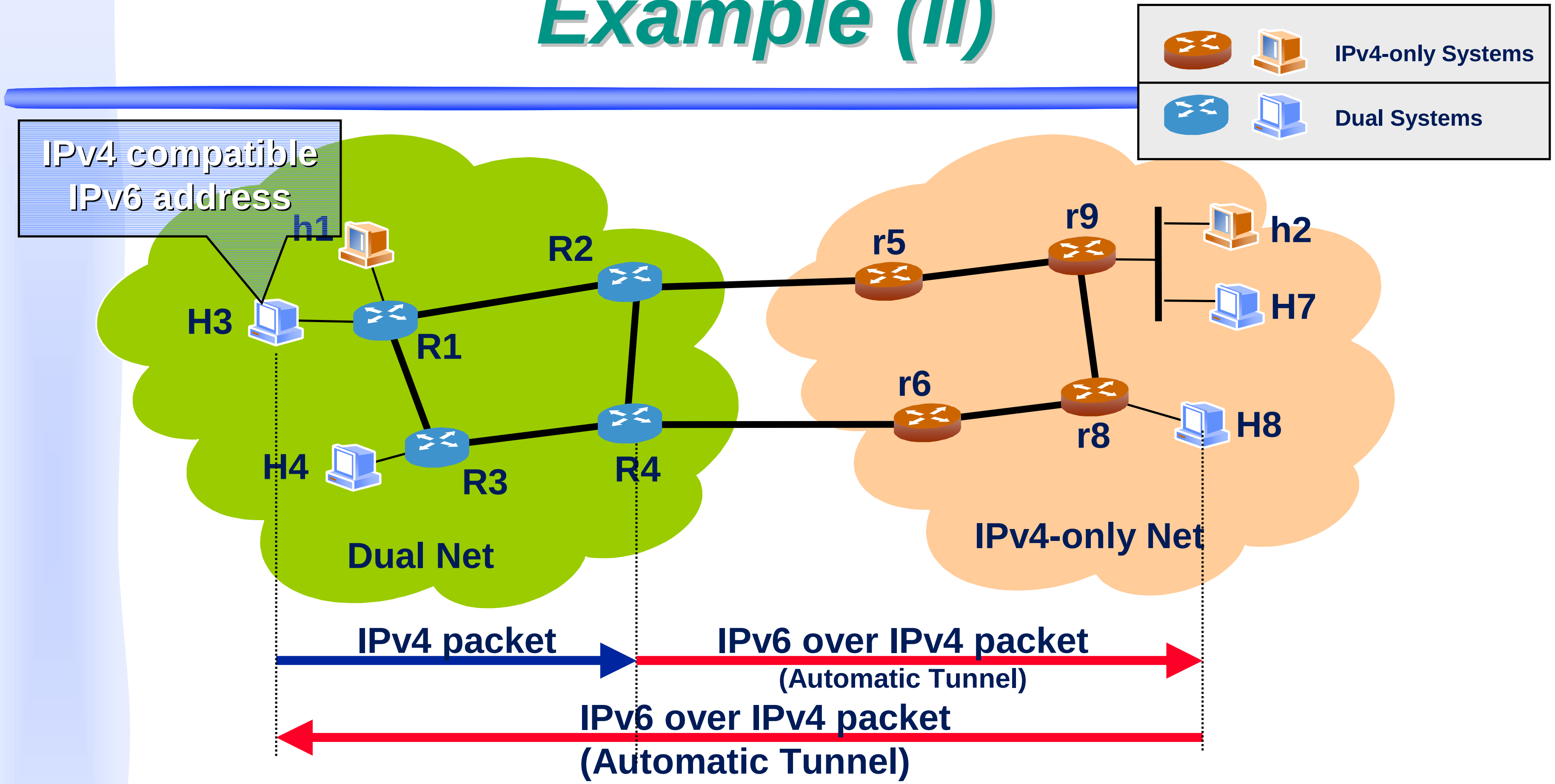
  - Example: 0:0:0:0:0:0:138.4.3.150 or ::138.4.3.150
  - IPv4-compatible addresses are assigned exclusively to nodes that support automatic tunneling

Example (I)



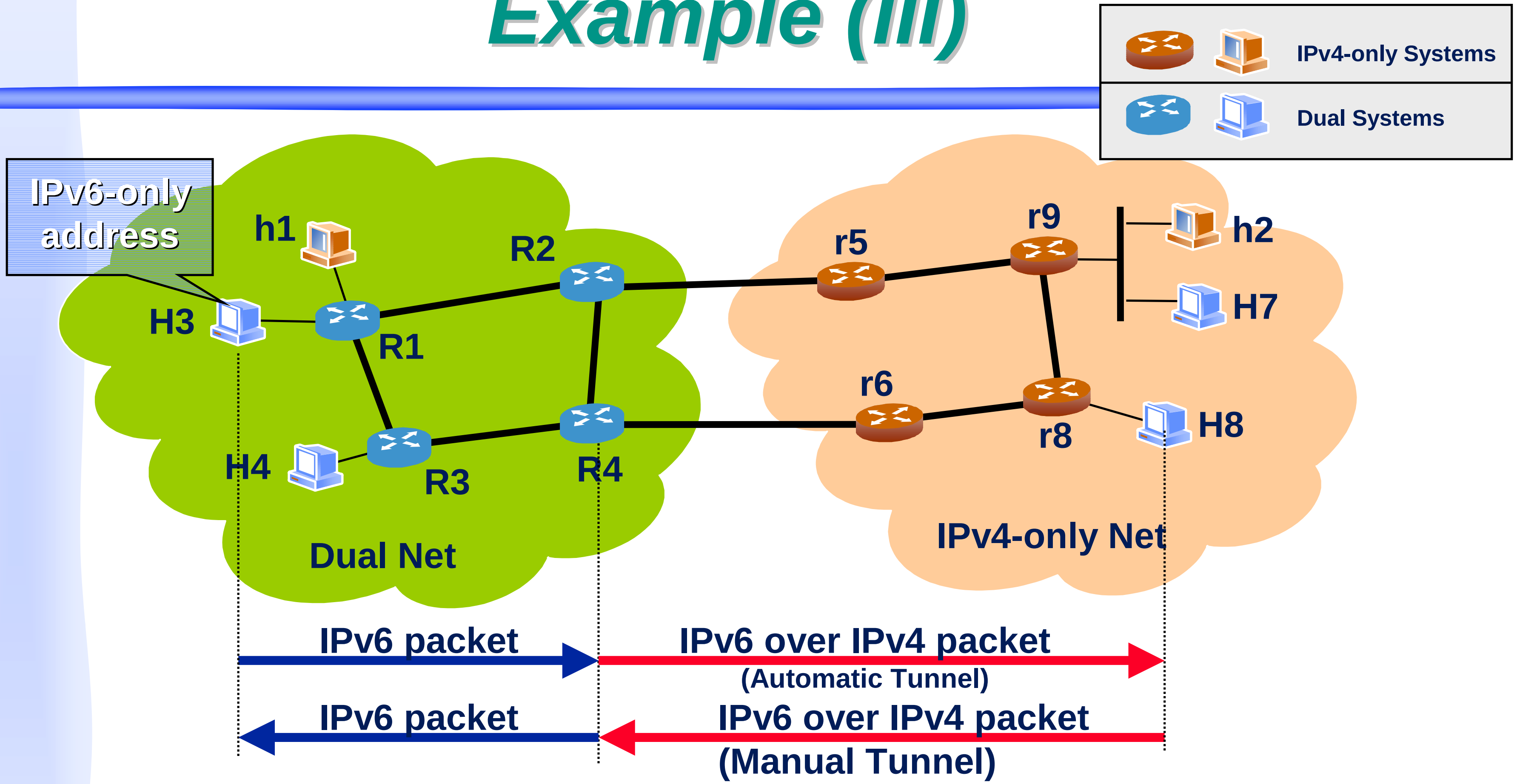
- A packet from h1 to H8:
  - As h1 is IPv4-only it will send IPv4 packets
  - H8 will also answer with IPv4 packets

Example (II)



- A packet from H3 to H8:
  - H8 uses an IPv4-compatible IPv6 addr. (it's in an IPv4-only net)
  - H3 uses also an IPv4-compatible IPv6 addr.

Example (III)



- A packet from H3 to H8:
  - H8 uses an IPv4-compatible IPv6 addr. (it's in an IPv4-only net)
  - H3 uses an IPv6-only address

Other Transition Mechanisms

- Based on Translation Techniques:
  - Stateless IP/ICMP Translation Algorithm (SIIT)
  - NAT-PT
  - SOCKS64
  - Bump in the Stack (BIS/MBIS)
  - Bump in the API (BIA)
  - Transport Relay Translator (TRT)
  - Application Level Gateways (ALG)
- Based on Tunneling Techniques:
  - 6to4
  - 6over4 (RFC 2529)
  - Dual Stack Transition Mechanism (DSTM)
  - Tunneling IPv6 over UDP through NATs (TEREDO)
  - Intra-Site Automatic Tunnel Addressing Protocol (ISATAP)
  - IPv64

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Comparison of Transition Mechanisms

- Made in terms of:
  - Implications on Applications
    - Whether they have to be modified or not
  - IPv4 address requirements
    - How many IPv4 addresses are required to implement the mechanism
  - Host/Site mechanism
    - If the mechanism is designed for isolated hosts or complete sites or both
  - Scalability
    - How the mechanism scales

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Transition Strategies

- So, the “Transition Toolbox” is full of mechanisms…
  - But… which one should I use in my case?
  - Should I combine several?
- A lot of effort being invested to define *Transition Scenarios and Strategies* for:
  - ISP: new or existing, with/out backbone, …
  - Companies: new or existing, with public or private IPv4 addressing, … etc, etc
- See, for example, results from LONG IST project and Armstrong EURESCOM project
- More about it at the end of the tutorial
  - Case Studies & Conclusions

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