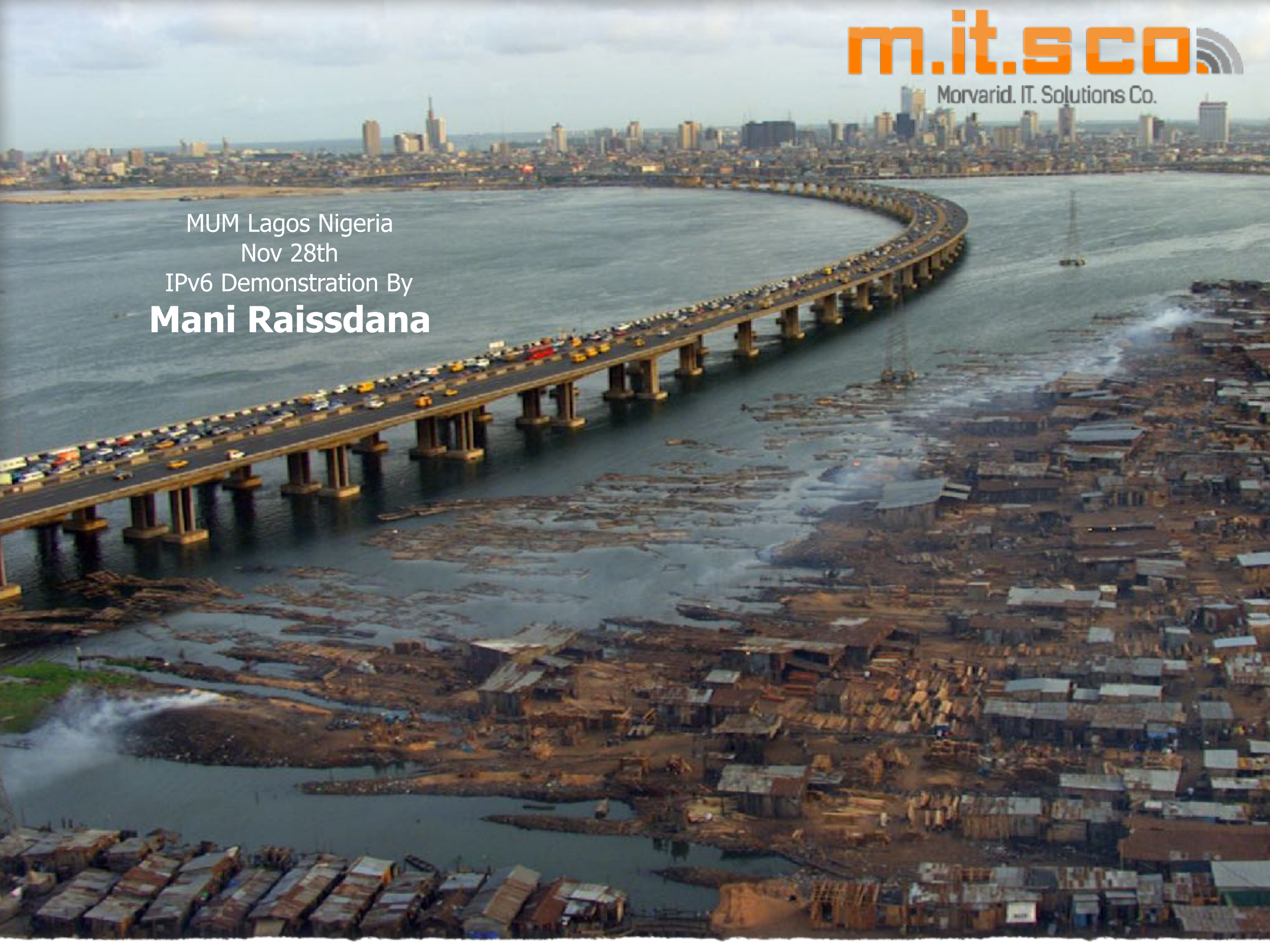
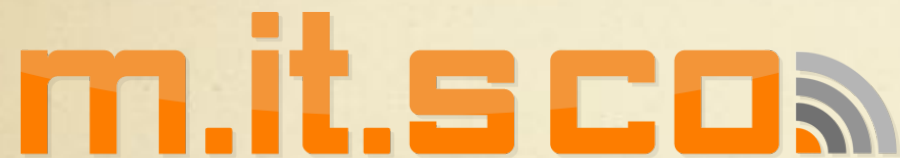


MUM Lagos Nigeria
Nov 28th
IPv6 Demonstration By
Mani Raissdana



Mani Raissdana

MikroTik Certified Trainer
CTO & Co-Founder of



Morvarid. IT. Solutions Co.



Being in IT technology business roughly around 14 years

Support & instruct Engineers more than 8 years all over the globe



Wireless, Routing, QoS, Firewall, The Dude

Mani Raissdana

- MikroTik Certified Trainers

<http://www.mikrotik.com/training/partners/europe/turkey>

- MikroTik Certified Consultants

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<http://www.mikrotik.com/certificateSearch> Check Mani Raissdana

<http://www.mits-co.com/content/certificates>

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<http://www.elastix.com/en/instructores/> Check Turkey

- elastiX Official Resellers

<http://www.elastix.com/en/resellers-elastix/> Check Europe

- Mani Raissdana Resume

www.mits-co.com/sites/default/files/Mani%20Raissdana%20Resume.pdf



Upcoming Lagos Trainings

December 01-02 Nigeria, Lagos, M.IT.S Co. - Mani Raissdana (MTCNA), English

December 03-03 Nigeria, Lagos, M.IT.S Co. - Mani Raissdana (MTCRE), English

December 04-05 Nigeria, Lagos, M.IT.S Co. - Mani Raissdana (MTCINE), English

December 06-06 Nigeria, Lagos, M.IT.S Co. - Mani Raissdana (MTCTCE), English

December 07-07 Nigeria, Lagos, M.IT.S Co. - Mani Raissdana (MTCUME), English

December 08-09 Nigeria, Lagos, M.IT.S Co. - Mani Raissdana (MTCIPv6), English

Table of contents

- 1-What is IPV6
- 2-Why IPV6
- 3-Why MikroTik
- 4-Assignment and Distribution
- 5-Security
- 6-Transition Mechanisms





What is IPv6



What is IPv6

- Internet Protocol version 6
- Designed as the alternate to IPv4
- Development started in 1996
- First IPv6 specification in 1998 (RFC 2460)

What is IPv6

- IPv6 is the most recent version of the (IP), the Communication Protocol that provides an identification and location system for computers on networks and routes traffic across the Internet
- IPv6 provides other technical benefits
- larger addressing space
- it permits hierarchical address allocation methods that facilitate Route Aggregation
- limit the expansion of the Routing Table
- The use of multicast addressing is expanded and simplified,
- provides additional optimization for the delivery of services Device mobility
- security, and configuration aspects have been considered in the design of the protocol.

Why IPv6



Why MikroTik



Why MikroTik for IPv6

- Because MikroTik is simply the best, the Easiest and the Cheapest platform to deploy, migrate and support IPv6
- Because MikroTik gives you awesome ways to
 - Monitor
 - Troubleshoot
 - or manage assignments and distribution

Assignment and distribution

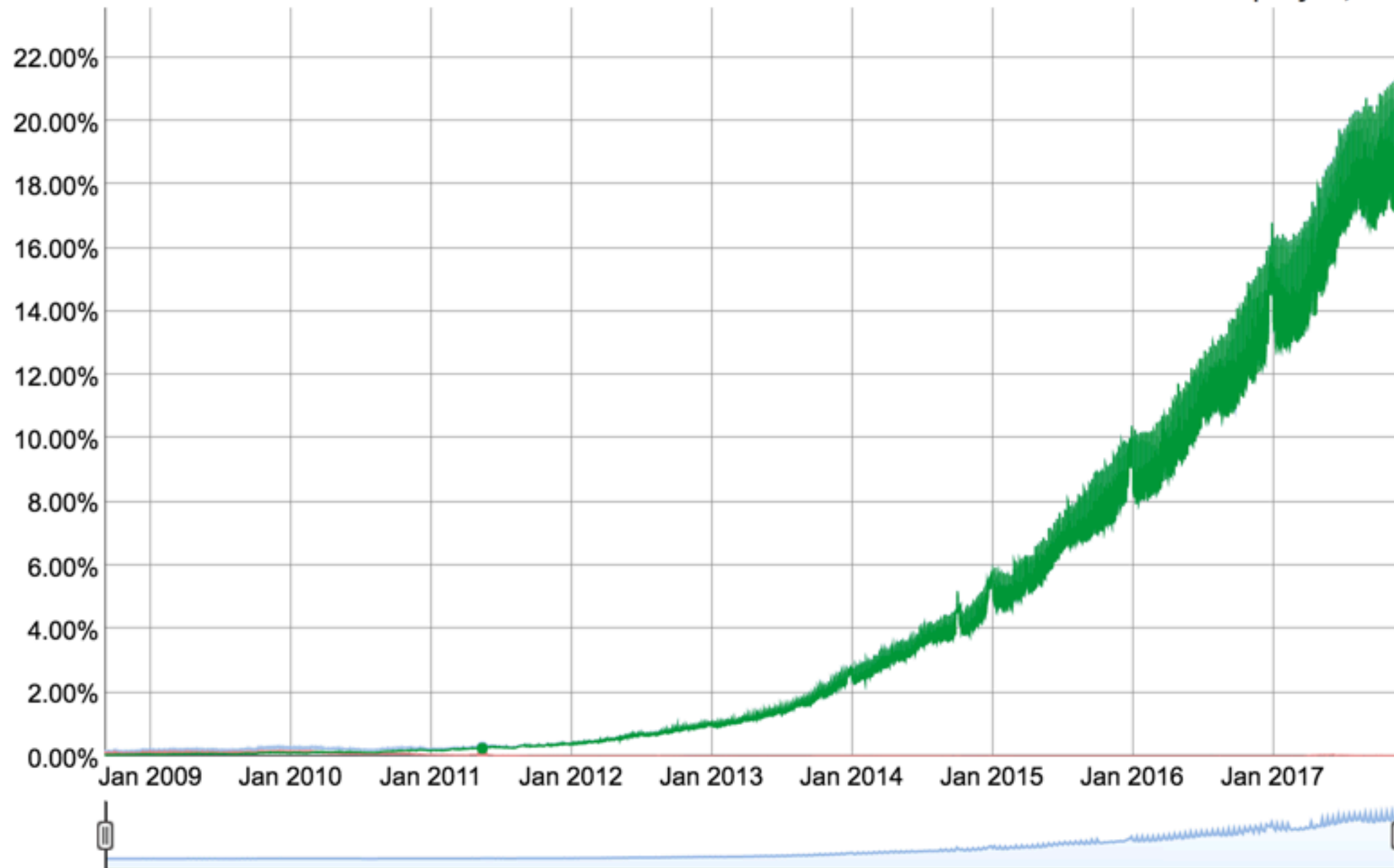


IPv6 Adoption

IPv6 Adoption

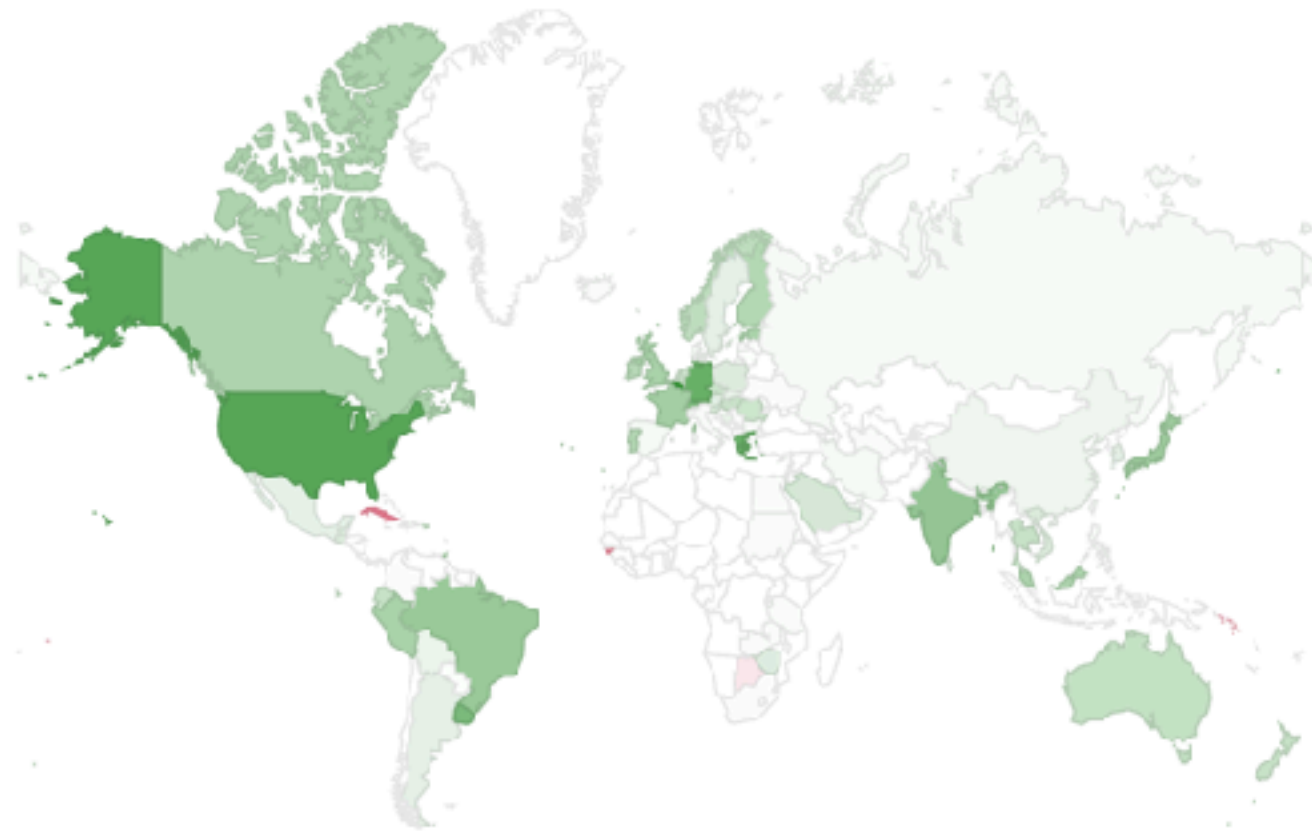
We are continuously measuring the availability of IPv6 connectivity among Google users. The graph shows the percentage of users that access Google over IPv6.

Native: 0.25% 6to4/Teredo: 0.04% Total IPv6: 0.30% | May 16, 2011



IPv6 per country Adoption

Per-Country IPv6 adoption



[World](#) | [Africa](#) | [Asia](#) | [Europe](#) | [Oceania](#) | [North America](#) | [Central America](#) | [Caribbean](#) | [South America](#)

The chart above shows the availability of IPv6 connectivity around the world.

-  Regions where IPv6 is more widely deployed (the darker the green, the greater the deployment) and users experience infrequent issues connecting to IPv6-enabled websites.
-  Regions where IPv6 is more widely deployed but users still experience significant reliability or latency issues connecting to IPv6-enabled websites.
-  Regions where IPv6 is not widely deployed and users experience significant reliability or latency issues connecting to IPv6-enabled websites.

HURRICANE ELECTRIC INTERNET SERVICES

Remaining v4 IPs by RIR

10.7%

12.965.461



0.7%

5.811.460



0.0%

0



1.5%

2.943.508



1.3%

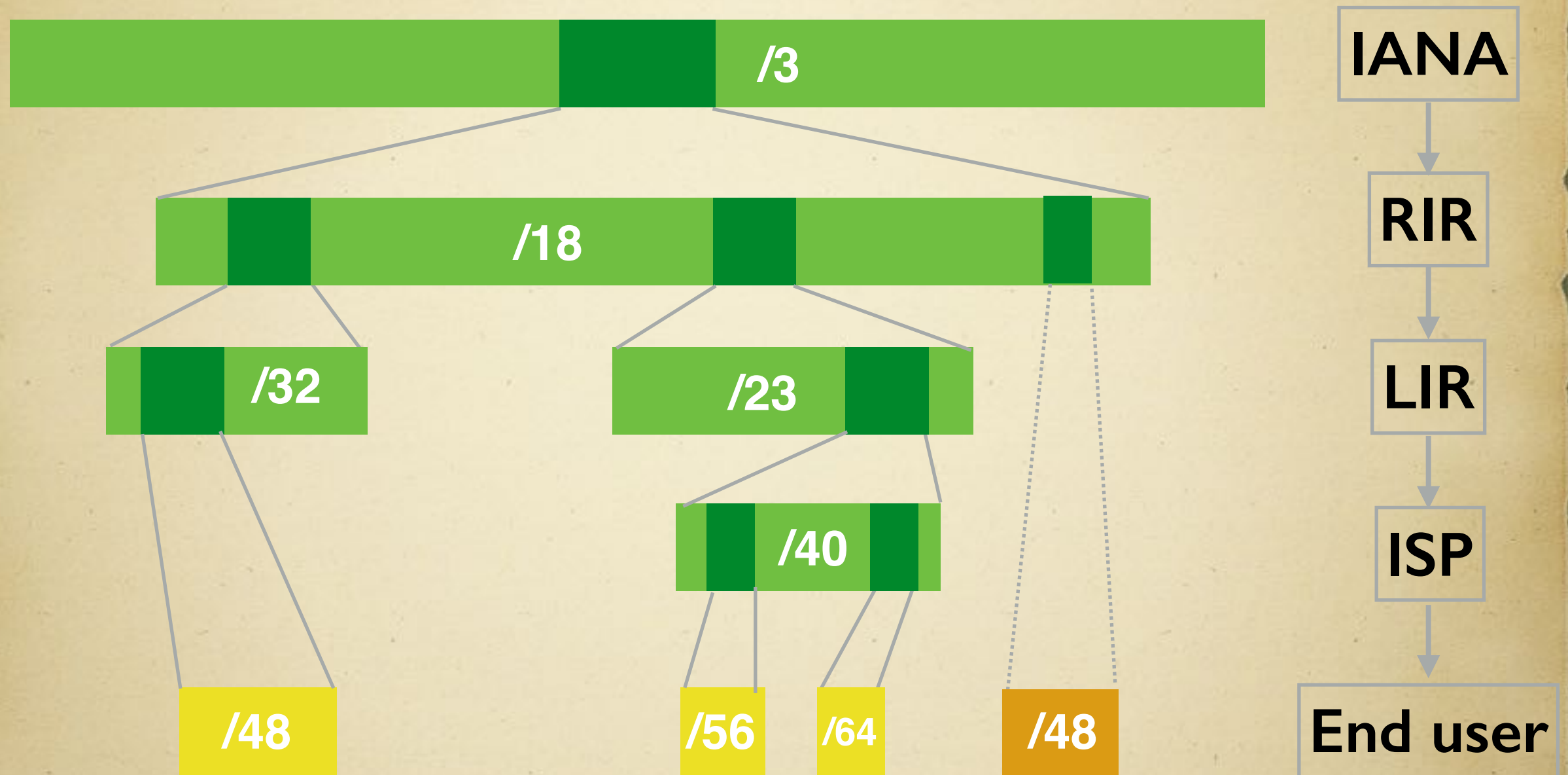
10.485.048



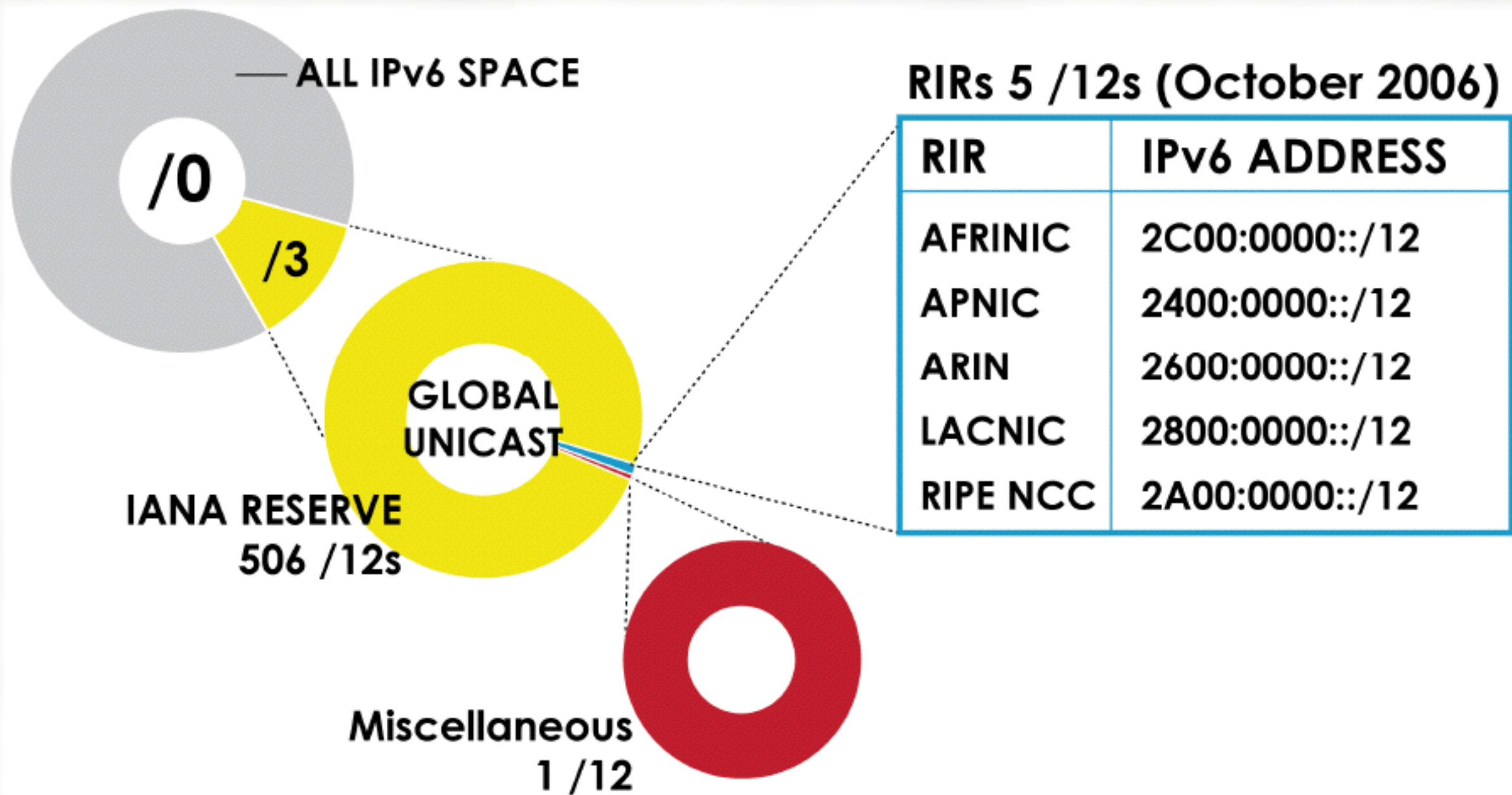
Comparison

	IPv4	IPv6
Address space	32 bits	128 bits
Possible addresses	2^{32}	2^{128}
Address format	192.0.2.1	2001:db8:3:4:5:6:7:8
Header length	20bytes	40bytes
Header fields	14	8
IPsec	optional	SHOULD*

Address Distribution



Address Distribution



Address Notation

- IPv6 consists of 8 fields each 16 bits long
- Written in hexadecimal numerals (base 16)

2001:0db8:1234:5678:9abc:def0:1234:5678

Address Notation

2001:0db8:0be0:75a2:0000:0000:0000:0001

Leading zeros can be left out

2001:db8:be0:75a2:0:0:0:1

Consecutive fields of zeros can be replaced with ::

2001:db8:be0:75a2::1

Address Notation

2001:0db8:0000:0000:0000:0000:0000:0000

If there are several consecutive fields of zeros only one can be replaced with ::

2001:db8::10:0:0:1

You can choose which one

2001:db8:0:0:10::1

The same IP address. Both notations are valid but the first one is recommended

For more info see "[A Recommendation for IPv6 Address Text Representation \(RFC5952\)](#)"

EUI-64

- 64-bit extended unique identifier (EUI)
- Derived from 48-bit MAC address

00:0c:29:0c:47:d5

+ ff:fe

00:0c:29:ff:fe:0c:47:d5

Modified EUI-64

- Used in stateless address autoconfiguration (SLAAC)
- 7th bit from the left, the universal/local (U/L) bit, needs to be inverted

00 (L) → 02 (U)

02:0c:29:ff:fe:0c:47:d5

- The reason for inverting can be found in RFC4291 section 2.5.1.

Modified EUI-64

IPv6 prefix

2001:db8:be0:75a2::/64

and modified EUI-64 from MAC address

02:0c:29:ff:fe:0c:47:d5

Results in the following IPv6 address

2001:db8:be0:75a2:020c:29ff:fe0c:47d5

SLAAC Address Construction

Routing prefix	Subnet identifier	Interface identifier
0-64 bits	0-64 bits	64 bits

- Routing prefix + subnet identifier = 64 bits
- /64 is the smallest prefix that can be assigned to a customer
- Usually a customer is assigned /48 - /64

Subnetting

2001:0db8:0be0:75a2:0000:0000:0000:0001
Routing prefix /48 Subnet /16 65536 x /64

2001:0db8:0be0:75a2:0000:0000:0000:0001
Routing prefix /52 /12 4096 x /64

2001:0db8:0be0:75a2:0000:0000:0000:0001
Routing prefix /56 /8 256 x /64

2001:0db8:0be0:75a2:0000:0000:0000:0001
Routing prefix /60 /4 16 x /64

Address Types

Type	Range
Link local	fe80::/10
Global unicast	2000::/3
Multicast	ff00::/8
Unique local	fc00::/7

Special Addresses

Type	Range
Loobpack	::1/128
Documentation	2001:db8::/32
6to4	2002::/16
Unspecified address	::/128
Teredo	2001::/32
Anycast	2001:db8:db1b:1e3::/64

http://www.tcpipguide.com/free/t_IPv6MulticastandAnycastAddressing-5.htm

Unique Local Address

- Meant to never be used on the Internet
- fc00::/7 prefix is reserved for ULA
- Divided into fc00::/8 and fd00::/8
- fd00::/8 currently is the only valid ULA prefix
 - fc00::/8 prefix has not been defined
- ULA is not meant to be used same way as IPv4 private addresses (as in RFC1918) like 192.168/16 prefix together with NAT.
- ULA was designed for labs or other resources like internal networks at remote sites that never need to (or should ever) talk to the Internet

Anycast Address

- Multiple nodes can have the same address
- Send to any one member of this group (usually the nearest)
- Indistinguishable from unicast address
- Use cases: load balancing, content delivery networks (CDN)

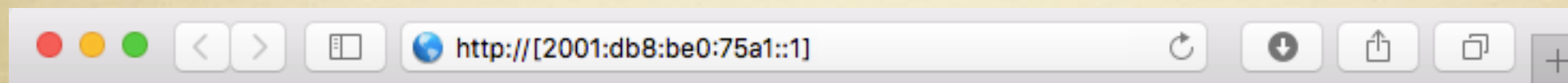
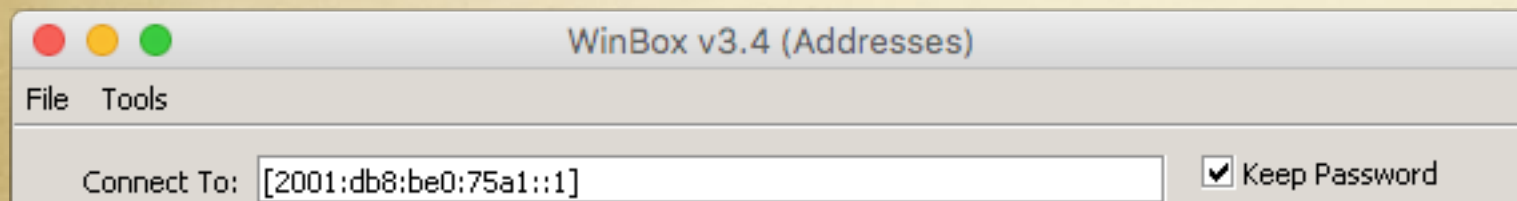
IPv4-mapped IPv6 address

- IPv6 address that holds an embedded IPv4 address
- Is used to represent the addresses of IPv4 nodes as IPv6 addresses

IPv4 address	IPv4-mapped IPv6
192.0.2.123	::ffff:192:0:2:123

For more info see [RFC4291 section 2.5.5.2](#)

Connecting to Global IPv6 host

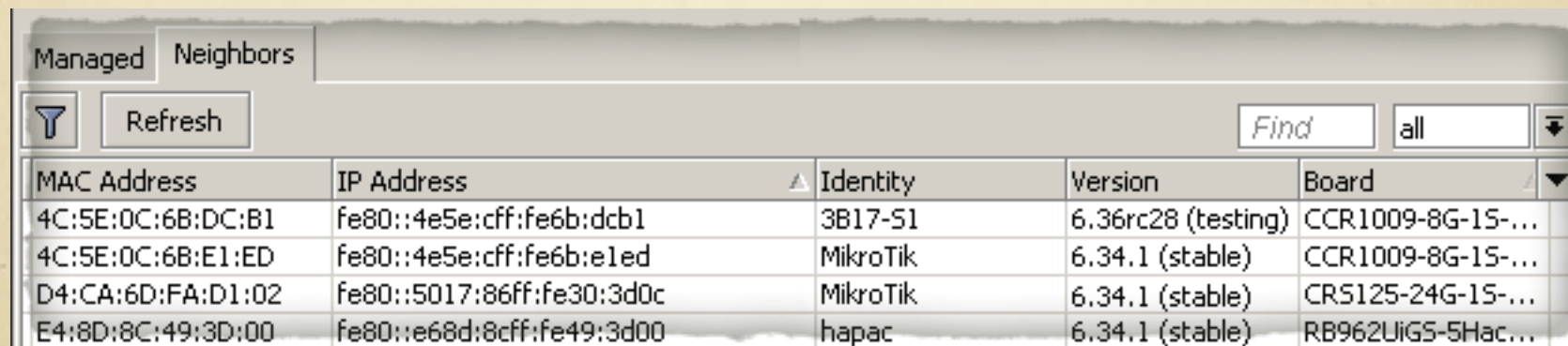


```
scp supout.rif admin@[2001:db8:be0:75a1::1]:
```

IPv6 address written in brackets

IPv6 Connectivity

- Link-local address can be used to connect when the device has no globally routed IPv6 address
- Alternative to MAC WinBox

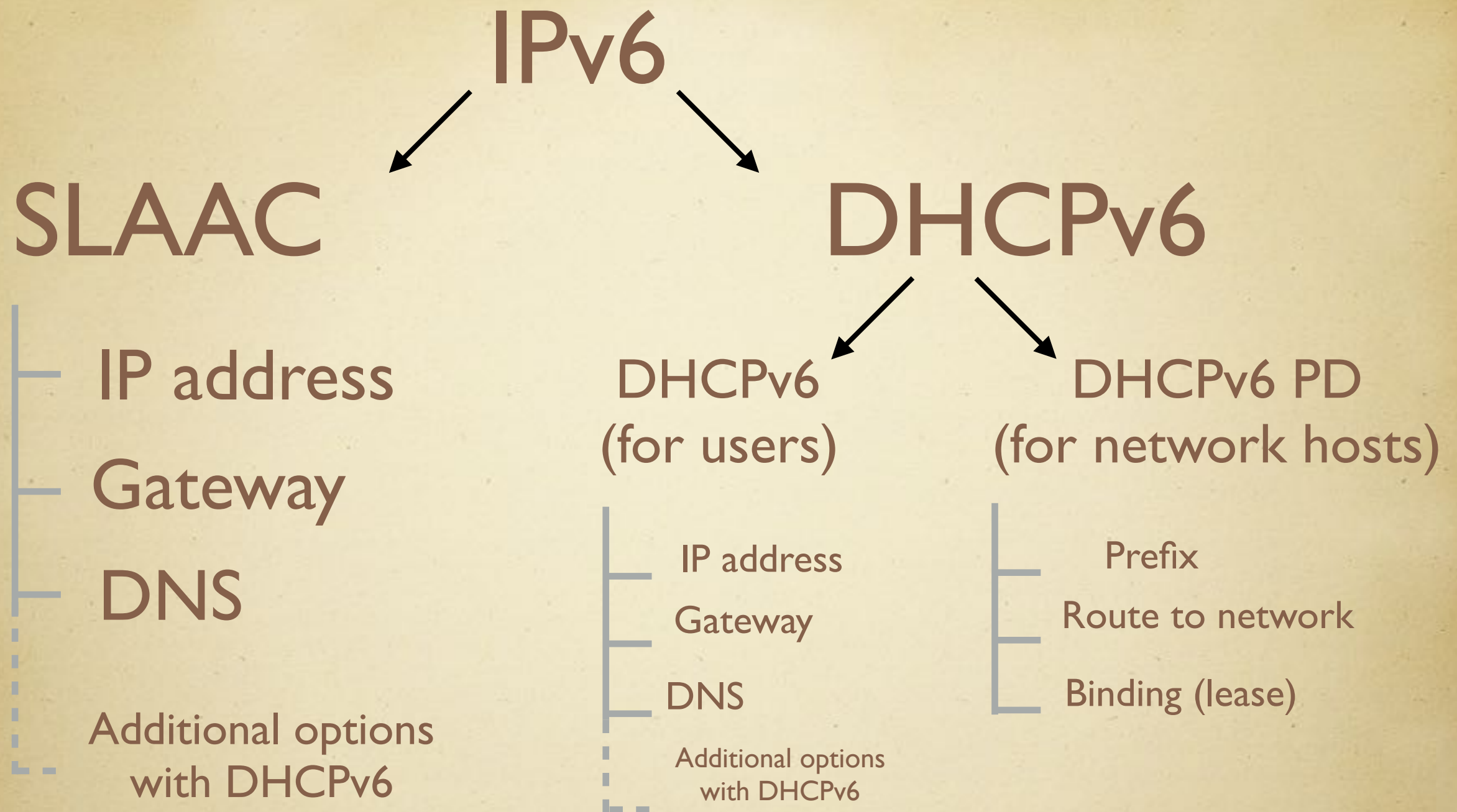


The screenshot shows the 'Neighbors' tab in WinBox. It features a filter icon, a 'Refresh' button, a 'Find' search bar with the text 'all', and a table of neighbors. The table has columns for MAC Address, IP Address, Identity, Version, and Board. The data rows show four neighbors: 4C:5E:0C:6B:DC:B1 (fe80::4e5e:cff:fe6b:dcb1, 3B17-S1, 6.36rc28 (testing), CCR1009-8G-15-...), 4C:5E:0C:6B:E1:ED (fe80::4e5e:cff:fe6b:e1ed, MikroTik, 6.34.1 (stable), CCR1009-8G-15-...), D4:CA:6D:FA:D1:02 (fe80::5017:86ff:fe30:3d0c, MikroTik, 6.34.1 (stable), CRS125-24G-15-...), and E4:8D:8C:49:3D:00 (fe80::e68d:8cff:fe49:3d00, hapac, 6.34.1 (stable), RB962UiGS-5Hac-...).

MAC Address	IP Address	Identity	Version	Board
4C:5E:0C:6B:DC:B1	fe80::4e5e:cff:fe6b:dcb1	3B17-S1	6.36rc28 (testing)	CCR1009-8G-15-...
4C:5E:0C:6B:E1:ED	fe80::4e5e:cff:fe6b:e1ed	MikroTik	6.34.1 (stable)	CCR1009-8G-15-...
D4:CA:6D:FA:D1:02	fe80::5017:86ff:fe30:3d0c	MikroTik	6.34.1 (stable)	CRS125-24G-15-...
E4:8D:8C:49:3D:00	fe80::e68d:8cff:fe49:3d00	hapac	6.34.1 (stable)	RB962UiGS-5Hac...

WinBox → Neighbors

- 'ssh [fe80::e68d:8cff:febd:ea40%n6]' can be used from command line. Be sure to add % and interface name through which to connect – as it is not a routable address and routing table does not know anything about it.



- PD = prefix delegation
- Currently RouterOS supports SLAAC and DHCPv6 PD server but does not support DHCPv6 server.

Security

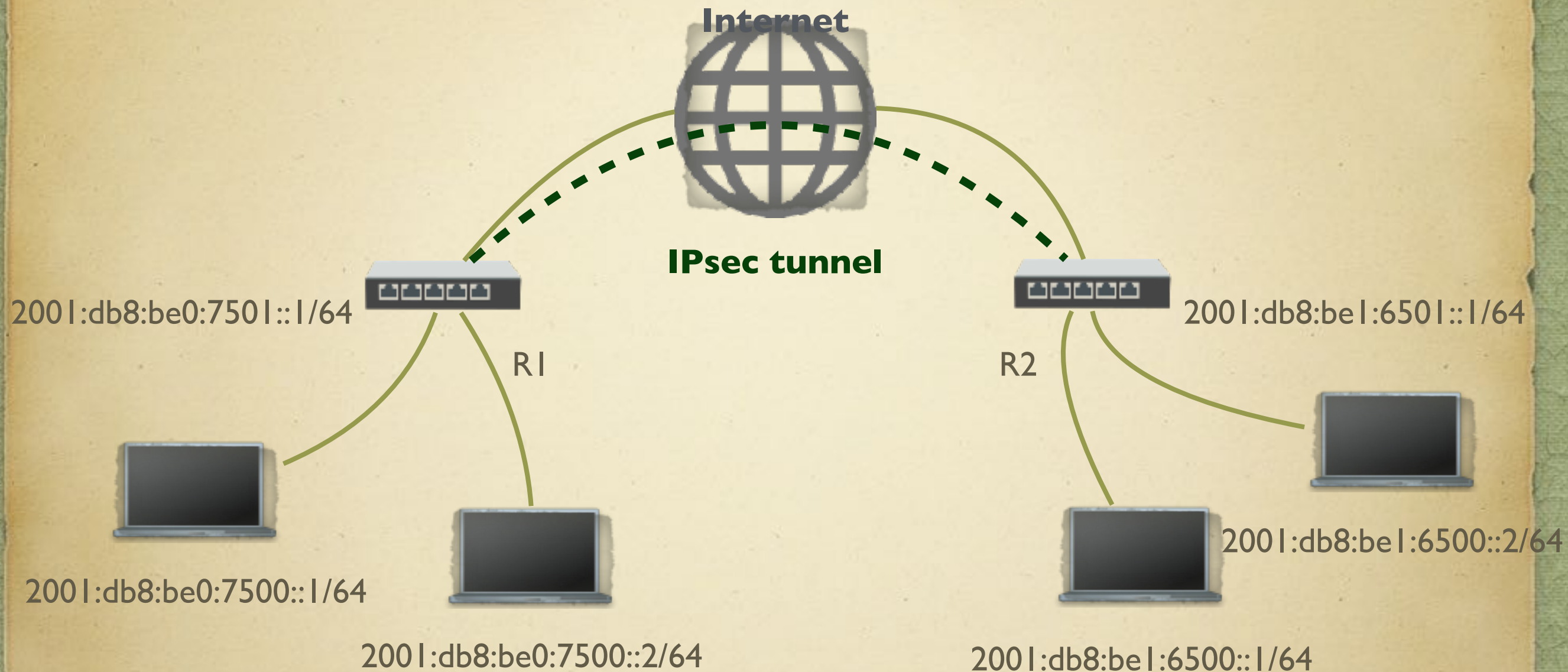


IPsec

- IPv6 Node Requirements (RFC6434) states that all IPv6 nodes **SHOULD** support IPsec

SHOULD - means that there may exist valid reasons in particular circumstances to ignore a particular item, but the full implications must be understood and carefully weighed before choosing a different course

IPsec Tunnel Mode



Transition Mechanisms



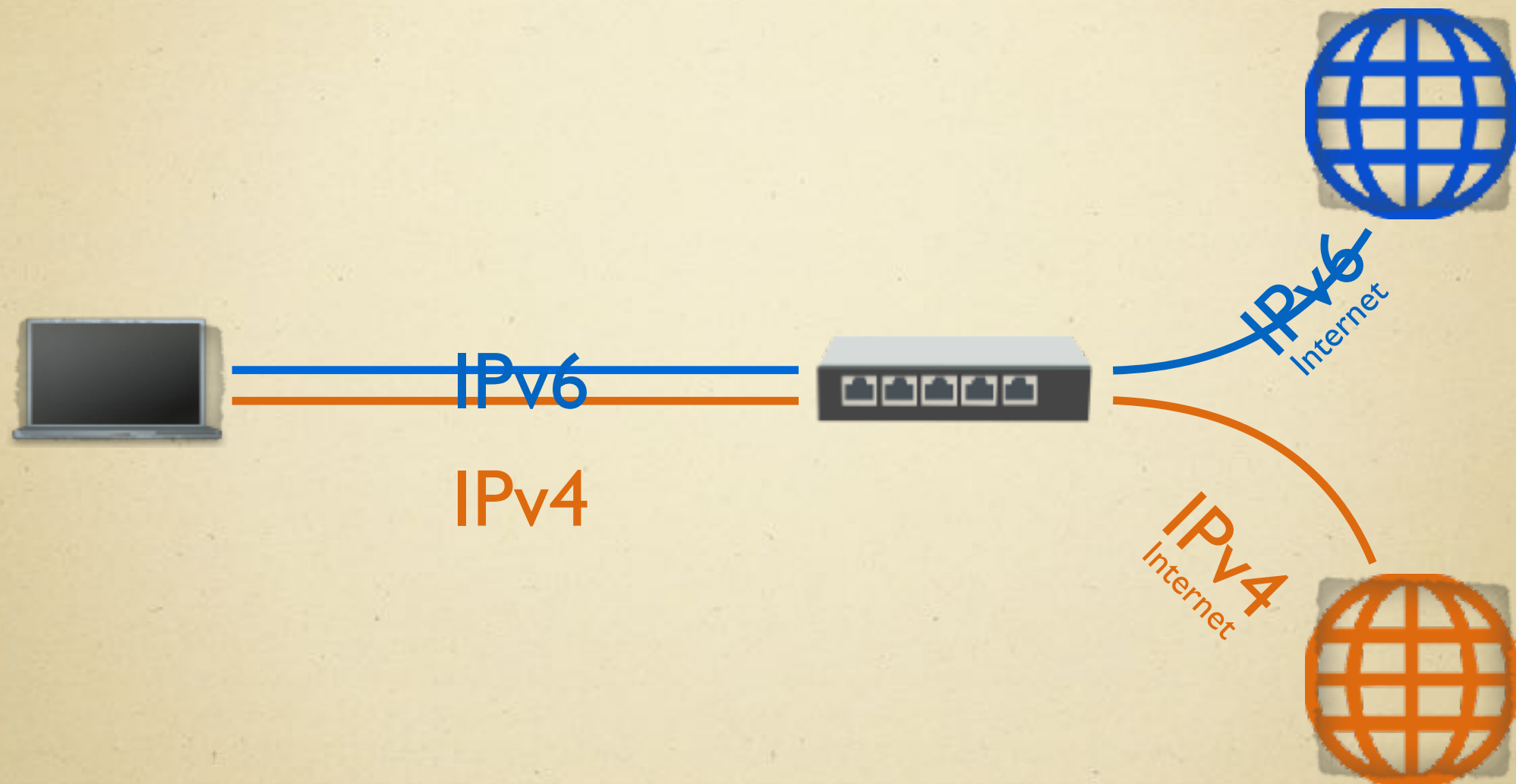
Transition Mechanisms

- Dual stack
- 6to4
- 6RD
- Teredo
- DS-lite (Dual stack lite)

Dual Stack

- Fully functional IPv4 and IPv6 work side by side
- The most recommended way of implementing IPv6
- Also endorsed by RIPE

Dual Stack



Client node has both IPv4 and IPv6 connectivity

6to4

- Allows IPv6 packets to be transmitted over an IPv4 network
- IPv6 packets are encapsulated in IPv4 packets
- Delivered to a 6to4 relay via IPv4 network
- Decapsulated and sent forward as IPv6 packets
- Intended only as a transition mechanism, not as a permanent solution

• Described in RFC3056 - <https://tools.ietf.org/html/rfc3056>

6to4



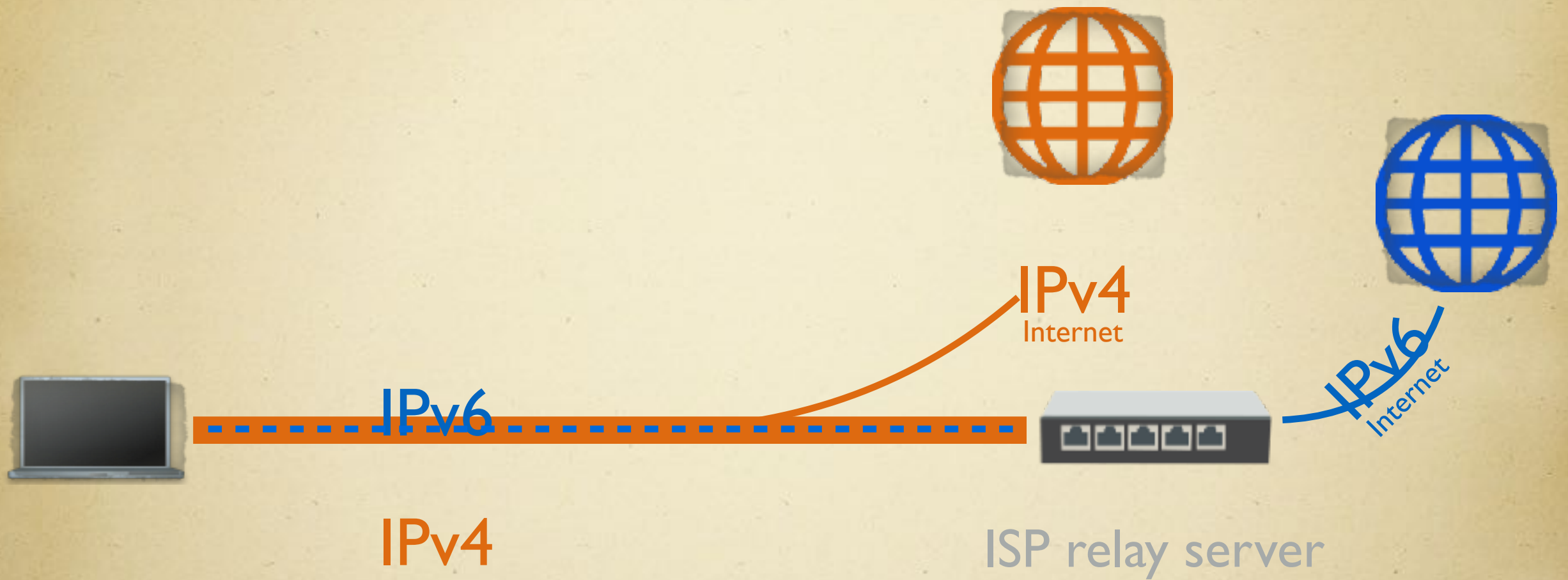
6to4

- Hurricane Electric (tunnelbroker.net) provides a 6to4 service with ready to use configuration for RouterOS

6RD

- IPv6 Rapid Deployment is 6to4 derivative
- IPv6 relay is controlled by your ISP
- From client to ISP is IPv4 network only
- On the client side additional software is needed to encapsulate IPv6 into IPv4 packets
- Described in [RFC5569](#)

6RD



Teredo

- Teredo encapsulates IPv6 traffic into IPv4 UDP packets
- The traffic is sent through IPv4 Internet
- Unlike 6to4, Teredo works behind an IPv4 NAT
- Uses Teredo prefix 2001::/32

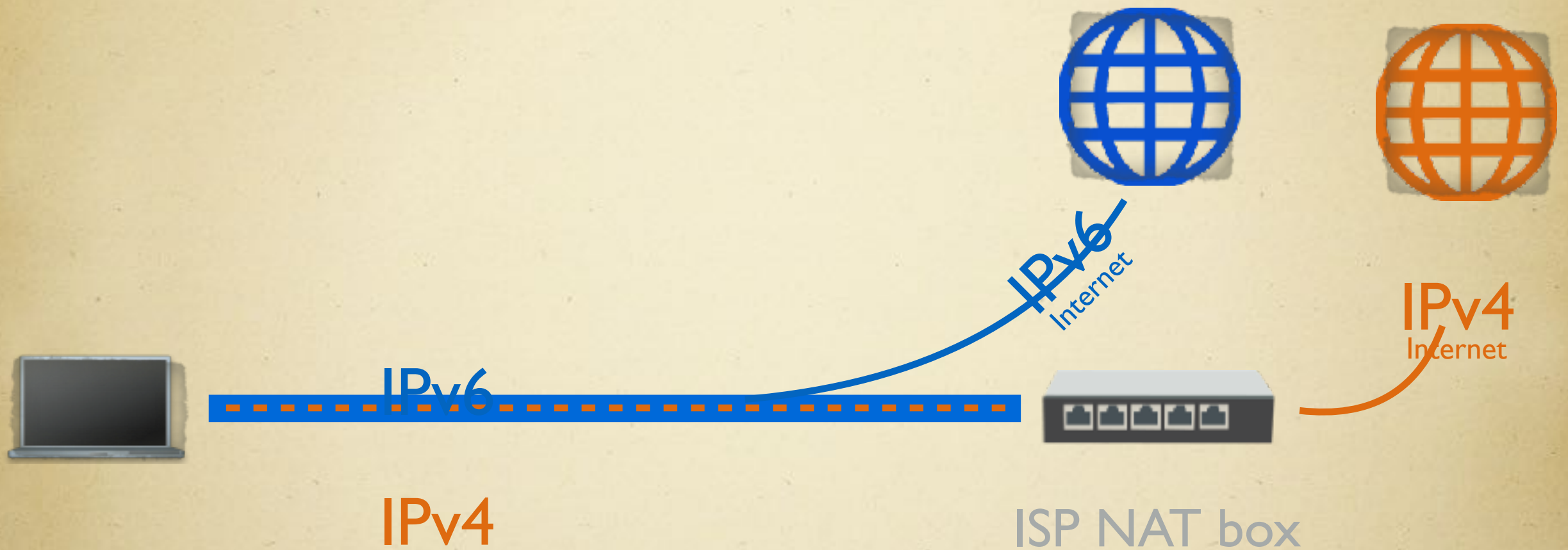
Teredo

- Can only provide a single IPv6 address per tunnel endpoint
- Cannot be used to distribute addresses to multiple hosts like 6to4
- Developed by Microsoft
- Described in RFC4380

DS-lite

- Dual stack lite
- IPv6 only links are used between the ISP and the client
- Client has native IPv6 connectivity
- When an IPv4 packet needs to be sent, it is encapsulated into an IPv6 packet

DS-lite



DS-lite

- Sent to the ISP's NAT box which decapsulates and forwards it as IPv4 traffic
- NAT is centralized at the ISP level
- Clients use private IPv4 addresses (e.g. 10.0.0.0/8, 172.16.0.0/12, 192.168.0.0/16)
- ISP → Client network is IPv6 only

- Currently RouterOS does not support DS-lite

Any Questions

????????

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Good Luck

Enjoy your MUM