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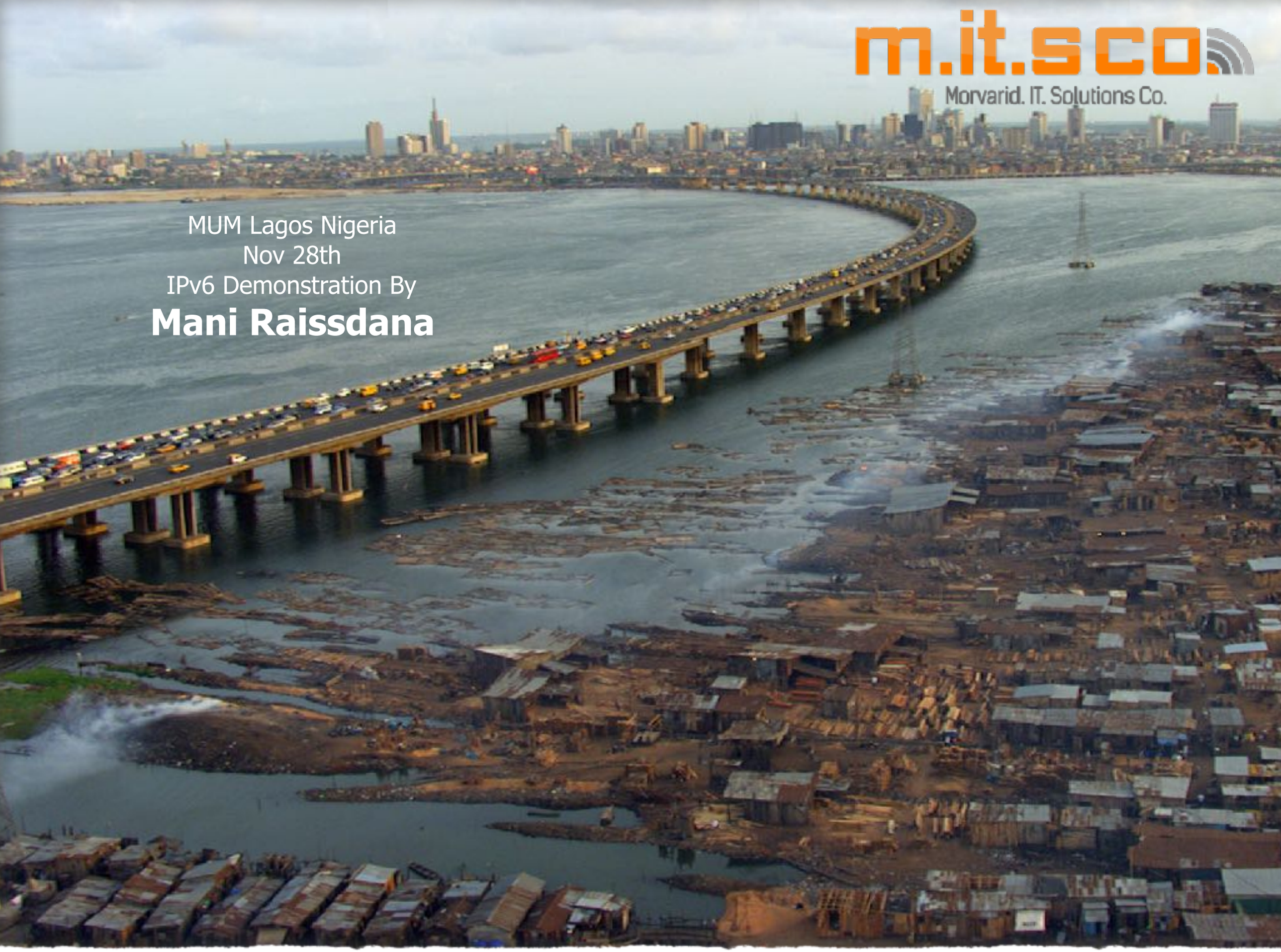
MUM Lagos Nigeria
Nov 28th
IPv6 Demonstration By

Mani Raissdana



Mani Raissdana

MikroTik Certified Trainer
CTO & Co-Founder of

m.it.sco
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

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- **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

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

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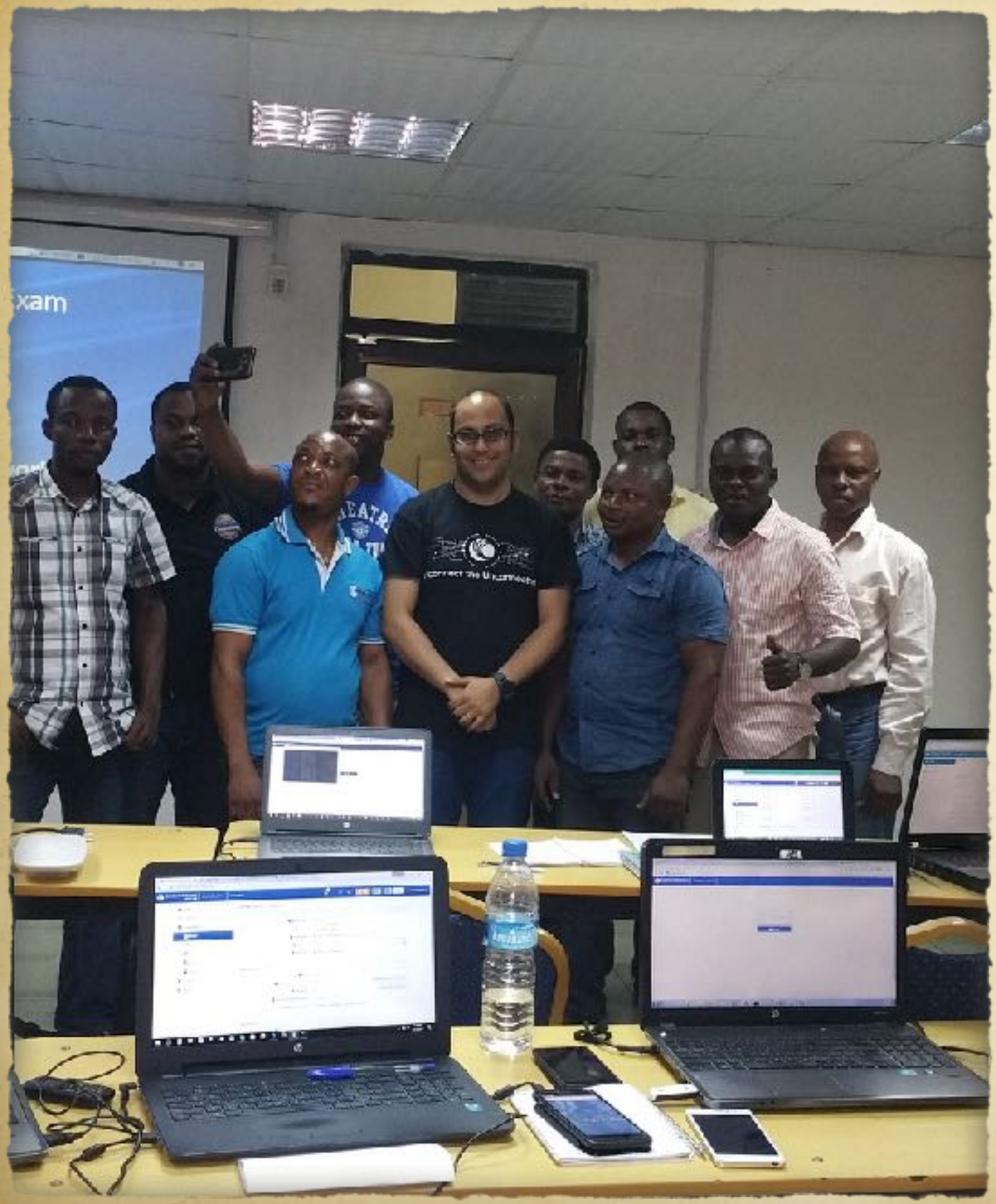
December 08-09 Nigeria, Lagos, M.IT.S Co. - Mani Raissdana (MTCIPv6), English

Table of contents




MikroTik
Routing the World

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

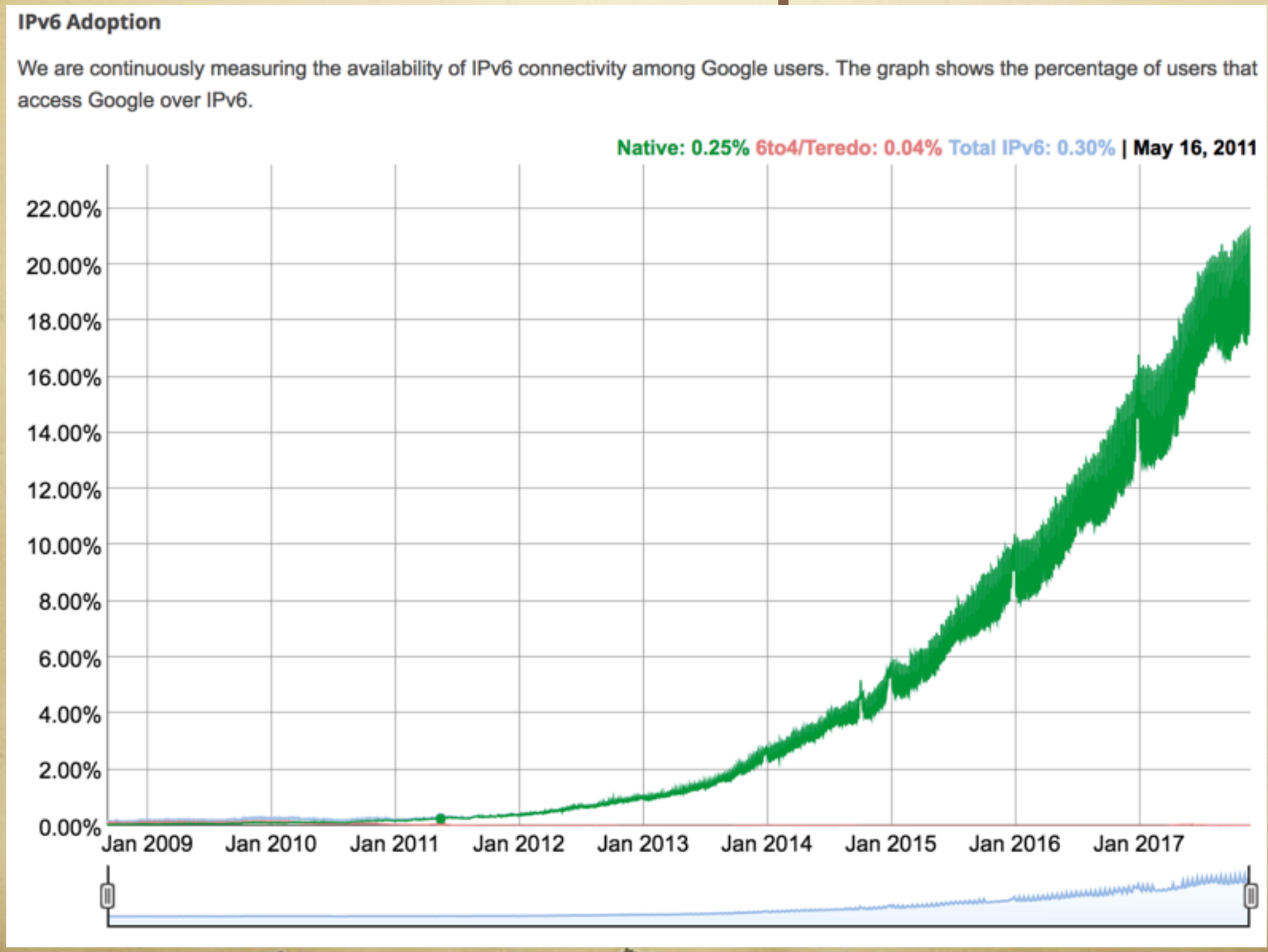
Why MikroTik

Why MikroTik for IPv6

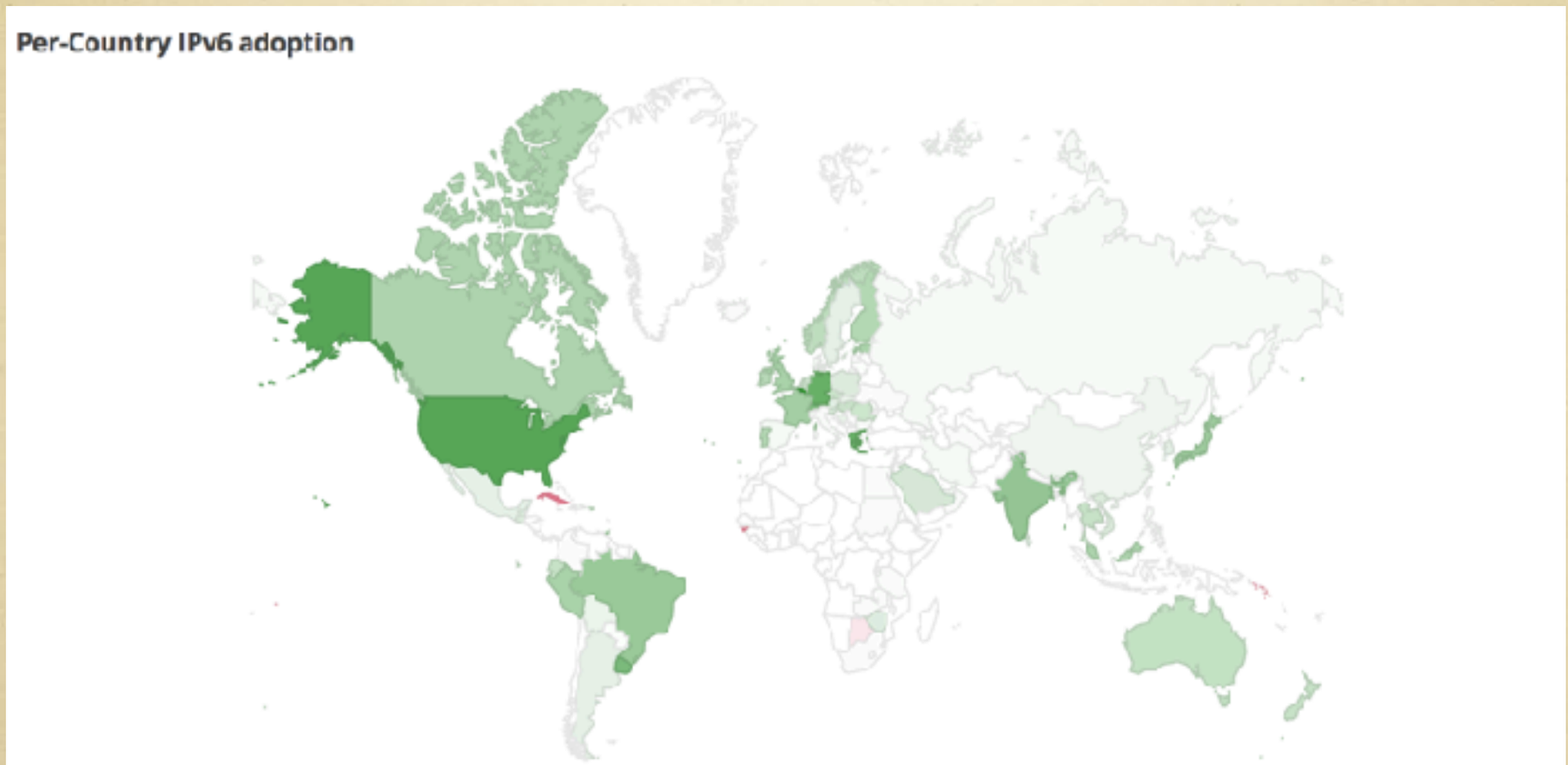
- Because MikroTik is simply the best, the Easiest and the Cheapest platform to deploy, migrate and support IPv6
- Because MikroTik gives you awesome ways to
- Monitor
- Troubleshoot
- or manage assignments and distribution

Assignment and distribution

IPv6 Adoption



IPv6 per country Adoption



World | Africa | Asia | Europe | Oceania | North America | Central America | Caribbean | South America

The chart above shows the availability of IPv6 connectivity arcund 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

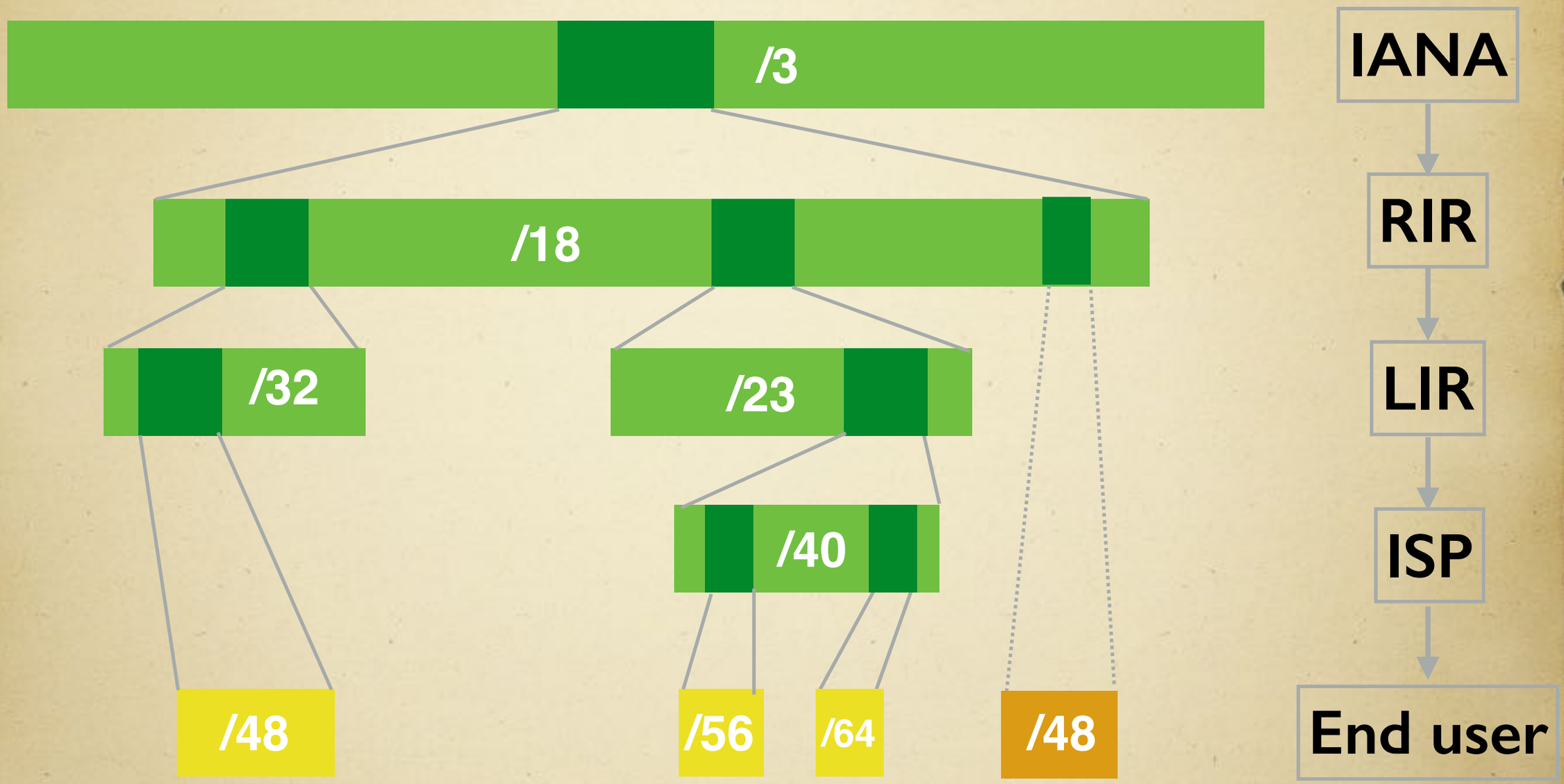
Remaining v4 IPs by RIR

10.7%	12.965.461	AFRINIC
0.7%	5.811.460	APNIC
0.0%	0	ARIN
1.5%	2.943.508	lacnic
1.3%	10.485.048	RIPE NCC

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



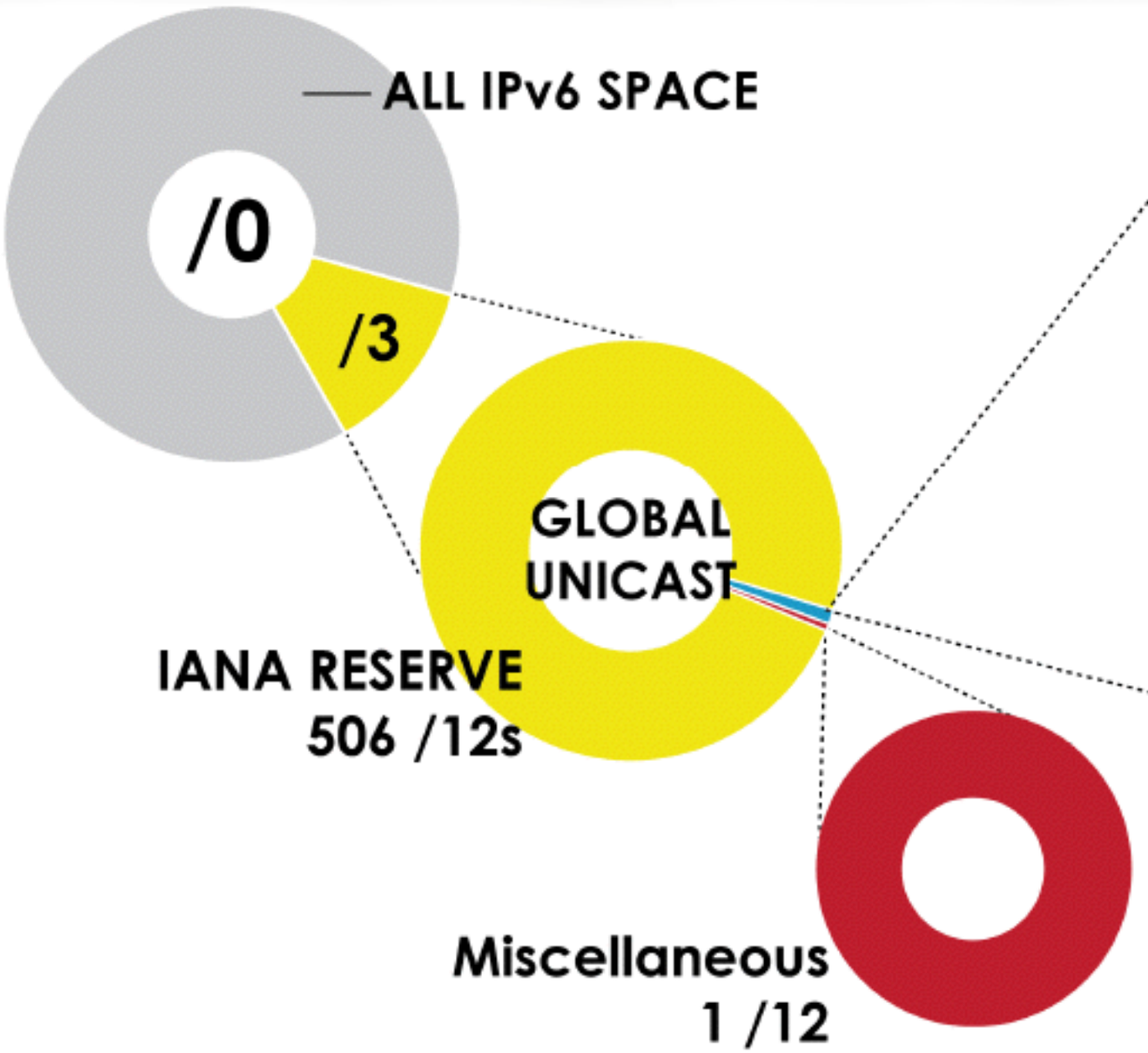
Allocation

Provider Aggregatable (PA) Assignment

Provider Independent (PI) Assignment

Source: RIPE NCC

Address Distribution



RIRs 5 /12s (October 2006)

RIR	IPv6 ADDRESS
AFRINIC	2C00:0000::/12
APNIC	2400:0000::/12
ARIN	2600:0000::/12
LACNIC	2800:0000::/12
RIPE NCC	2A00:0000::/12

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

2001:0db8:0000:0000:0010:0000:0000:0001

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)

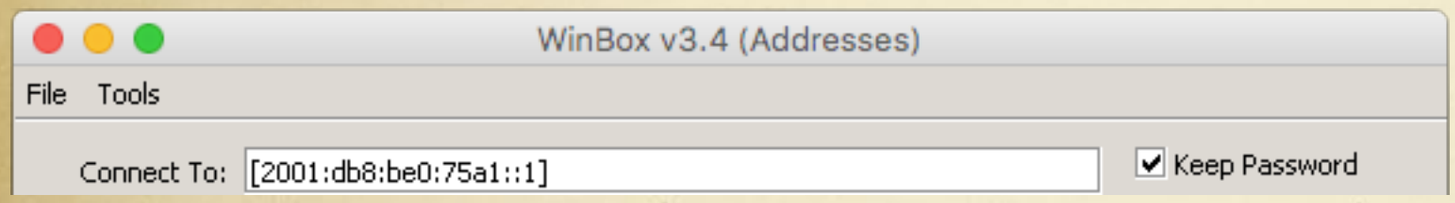
IPv4-mapped IPv6 address

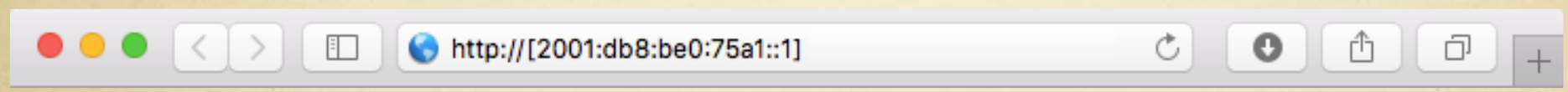
- IPv6 address that holds an embedded IPv4 address
- Is used to represent the addresses of IPv4 nodes as IPv6 addresses

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



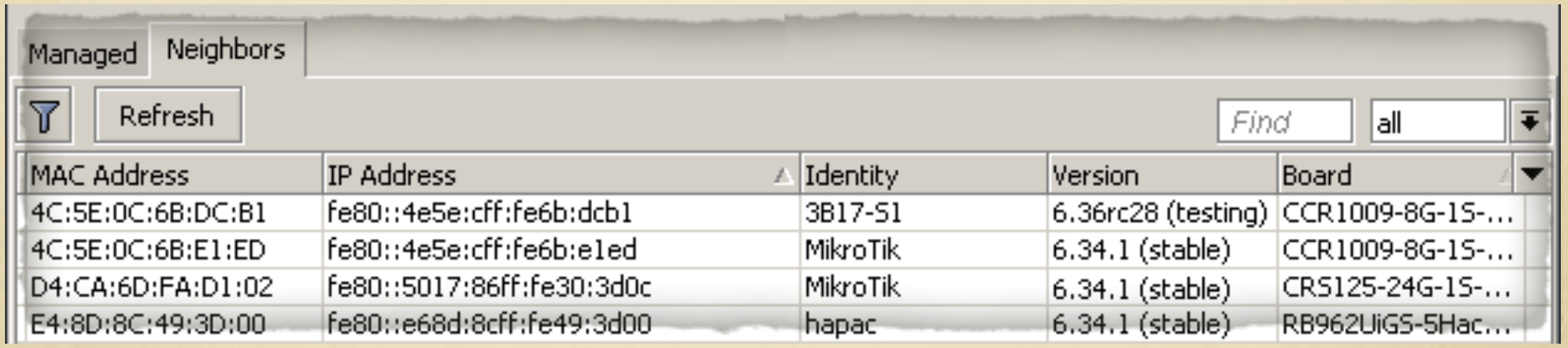



```
scp supout.rif admin@[2001:db8:be0:75a1::1]:
```

IPv6 address written in brackets

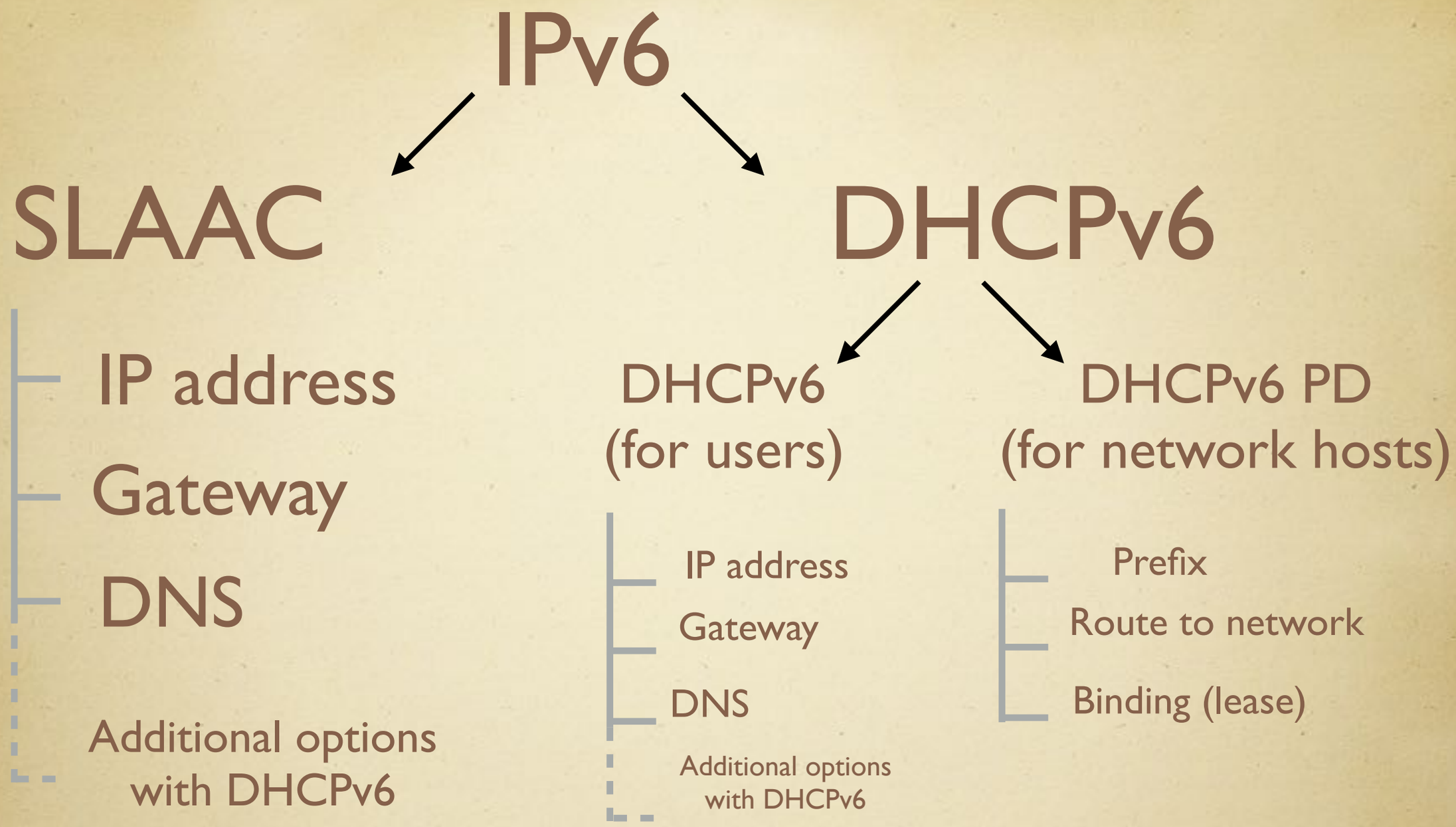
IPv6 Connectivity

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



WinBox → Neighbors

- 'ssh [fe80::e68d:8cff:febd:ea40%en6]' 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.

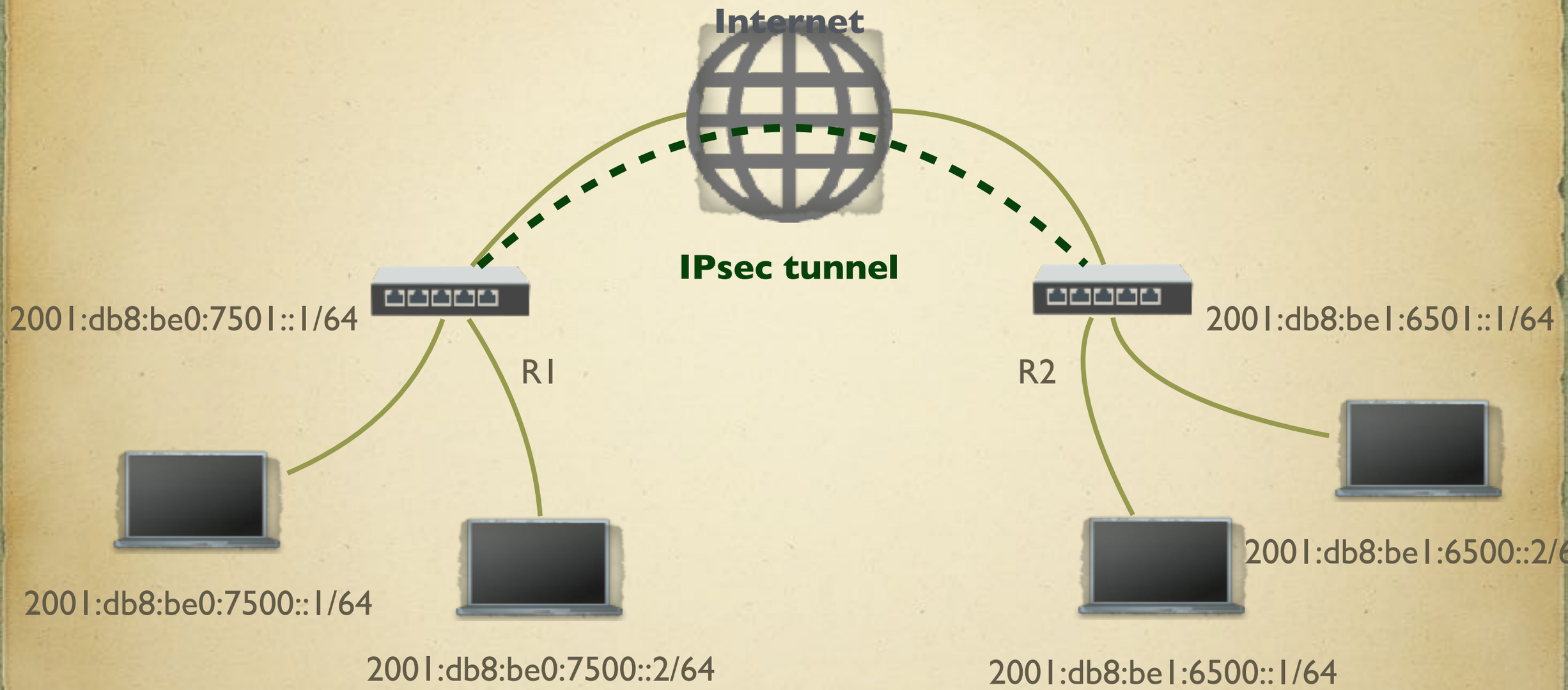
Security

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

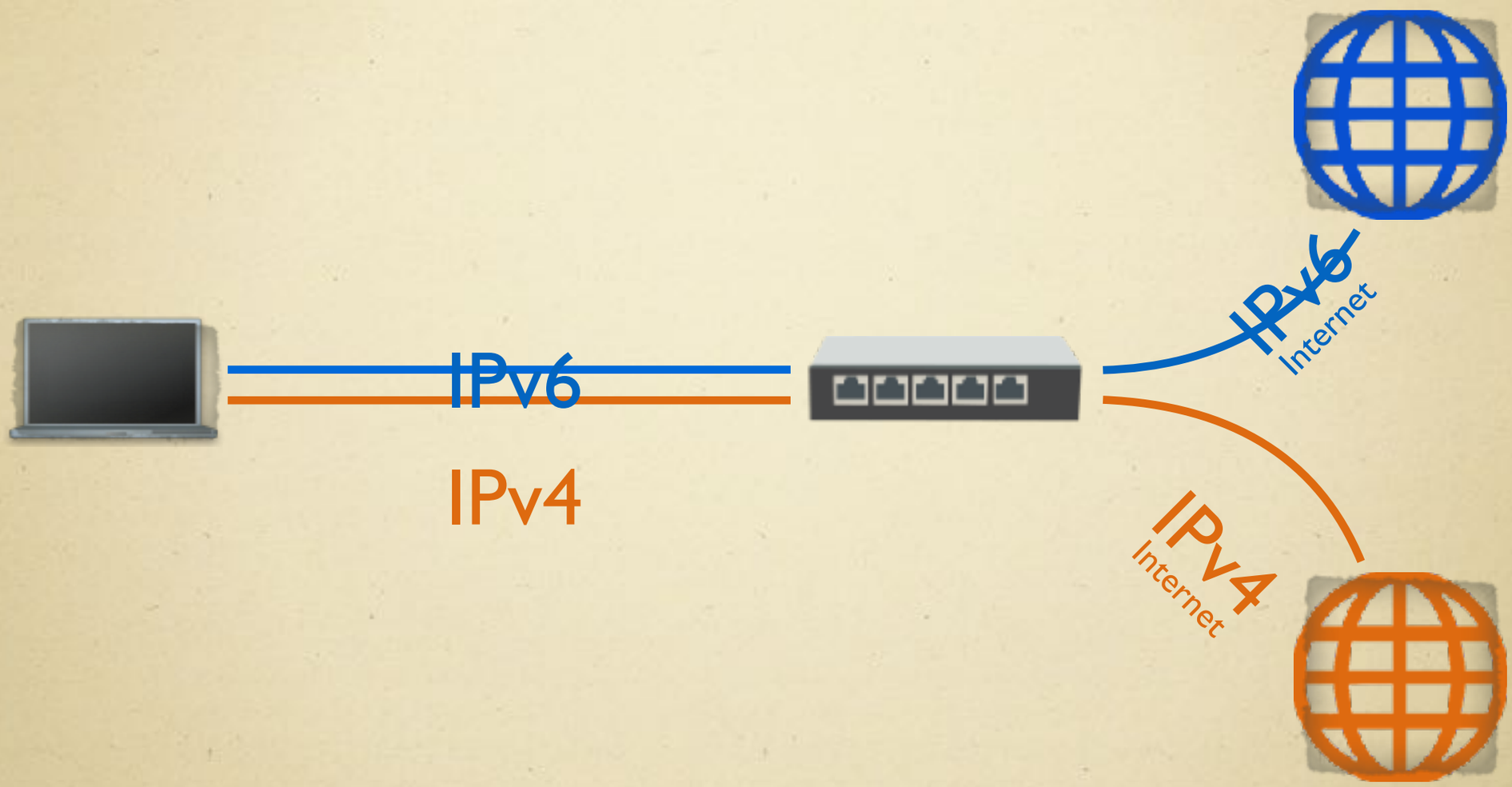
Transition Mechanisms

- 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



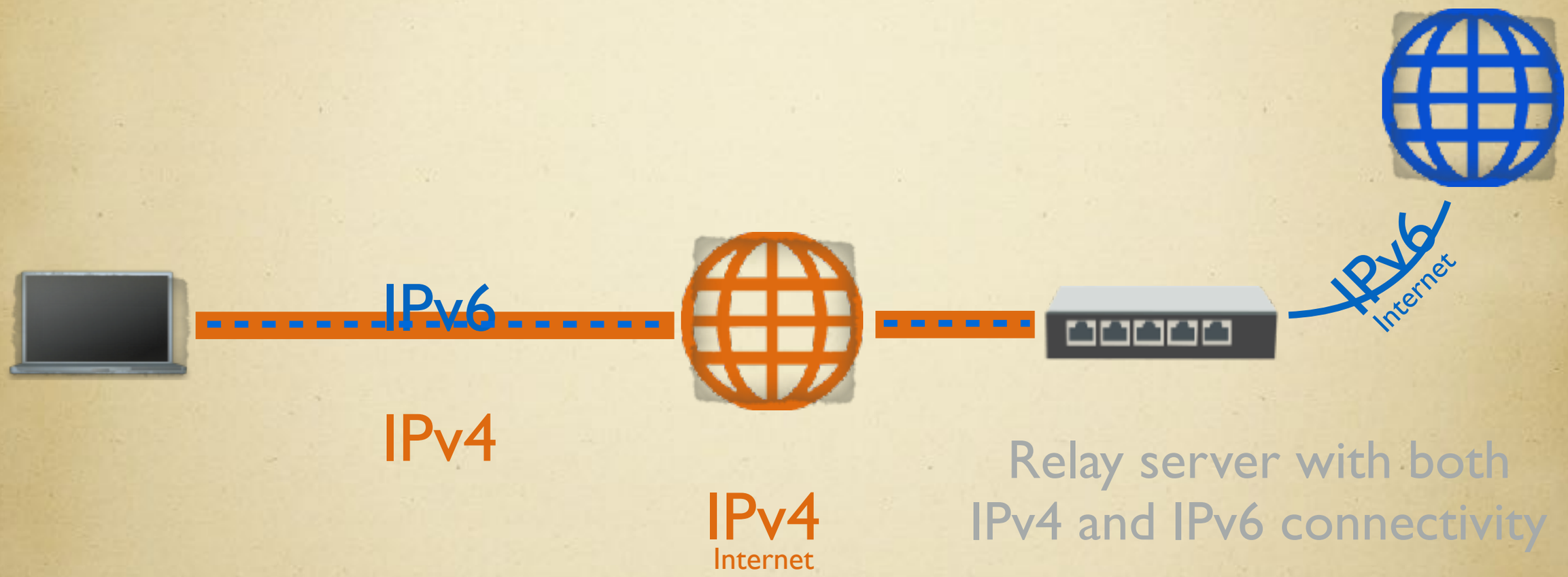
Client node has both IPv4 and IPv6 connectivity

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

- Descibed in RFC3056 - https://tools.ietf.org/html/rfc3056

6to4



Relay server with both
IPv4 and IPv6 connectivity

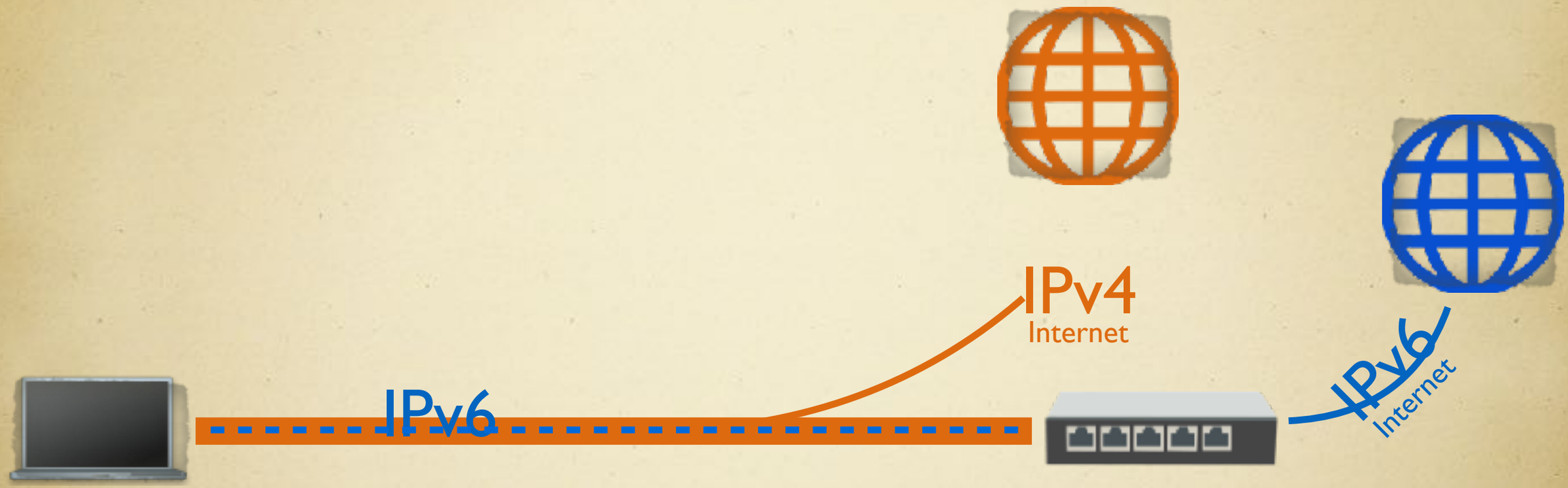
6to4

- 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

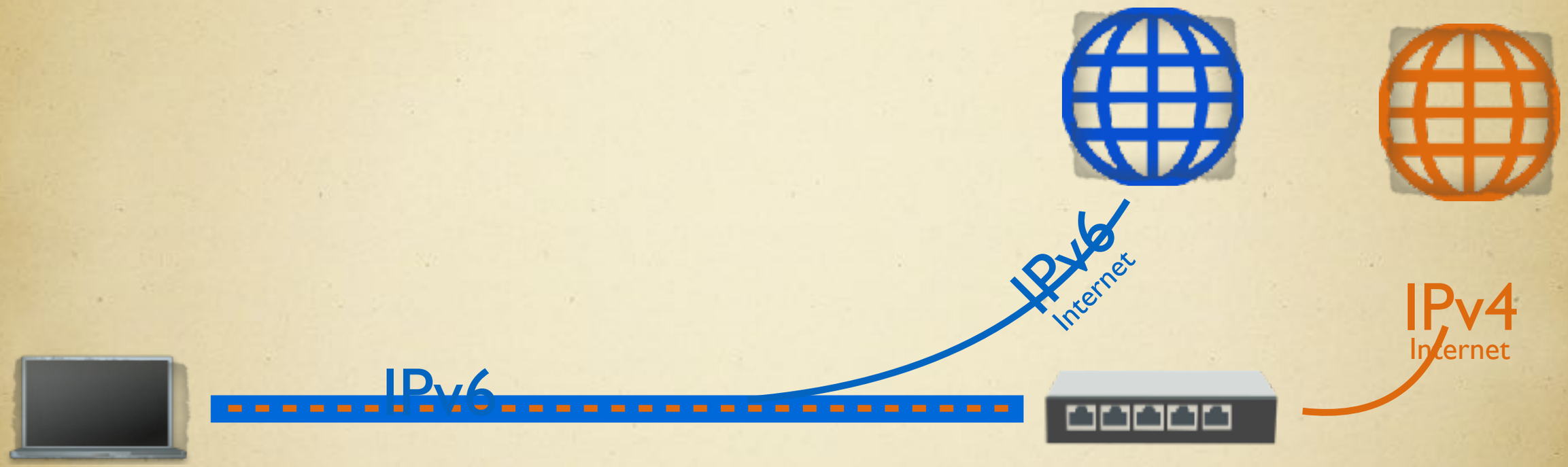
Teredo

- 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 and 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