



Planning & Implementing IPv6

Brian Horn

MikroTik MUM – Denver, CO
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Brian Horn

- BSEE, MIEEE
 - Broadcast TV Systems Engineering – 20 years
 - Computer Systems & Network Engineering
 - Since early 1980's when Ethernet was 10Base5
 - MikroTik Certified Trainer
- Founded Winters Broadband in 2002
 - WISP in rural CA
- Founded WISP TRACON in 2014
 - MikroTik Training and Consulting
 - Partner with Andis Arins (Router.lv)



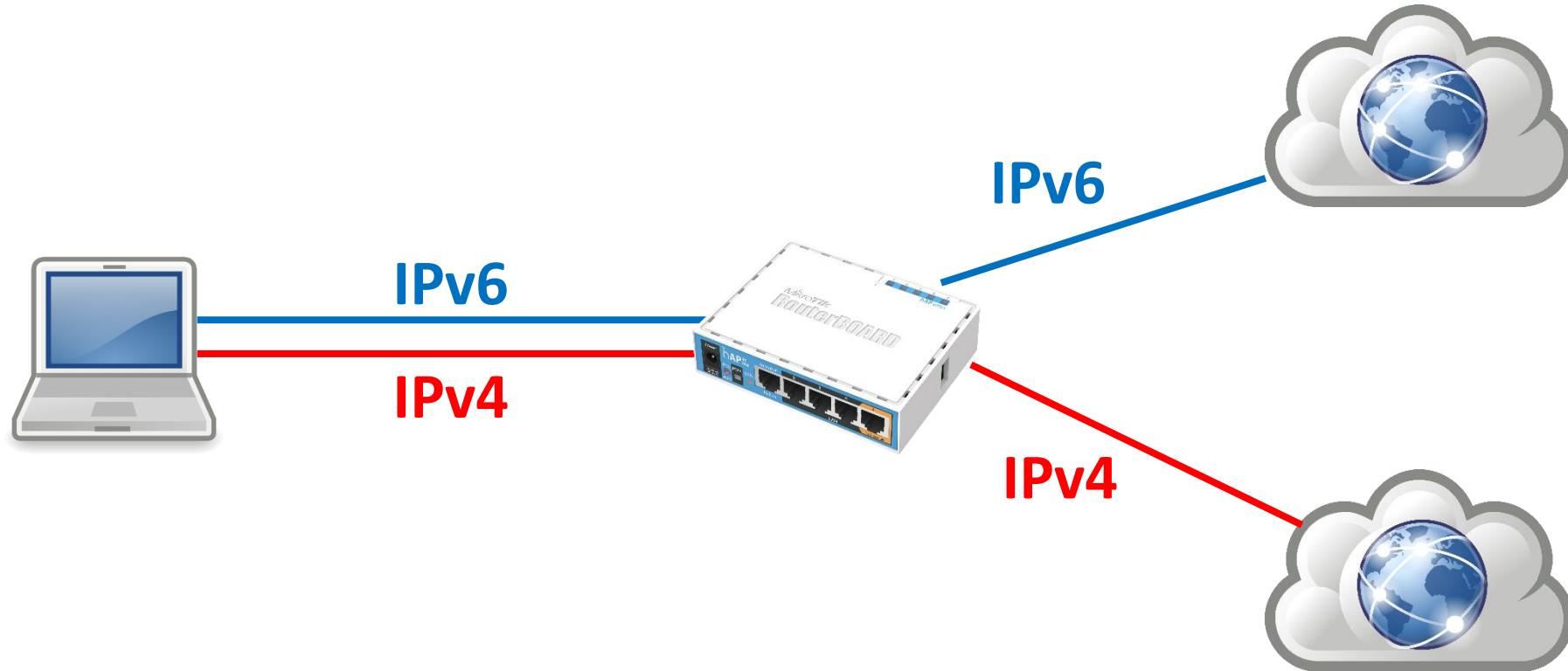
Winters Broadband IP Addresses

- ARIN Assignments
 - ASN
 - /22 IPv4 address block
- Routed network – 64 sites
 - OSPF
 - Customers all have public static IP
 - /32 IP addressing used to conserve IPv4 addresses
- Planning
 - Growing at rate of 150 customers/year
 - IPv4 addresses will be depleted in 18 months

Network Planning

- Continual process addressing
 - Network growth and upgrades
 - Performance
 - Redundant links
 - Redundant power
 - Bandwidth requirements
 - Providers – AT&T, Cogent, ...
 - Customers
 - Residential 3 to 25 Mbps
 - Business up to 100 Mbps
 - IP address pool and management

IPv6 Strategy



Planning Questions

- Why should I deploy IPv6?
- When should I deploy IPv6?
- Where do I get those addresses?
- What do I know about IPv6?
- Where do I get the information I need to make informed decisions?
- What network upgrades will I need to make?
- What will it cost?
- How long will it take?

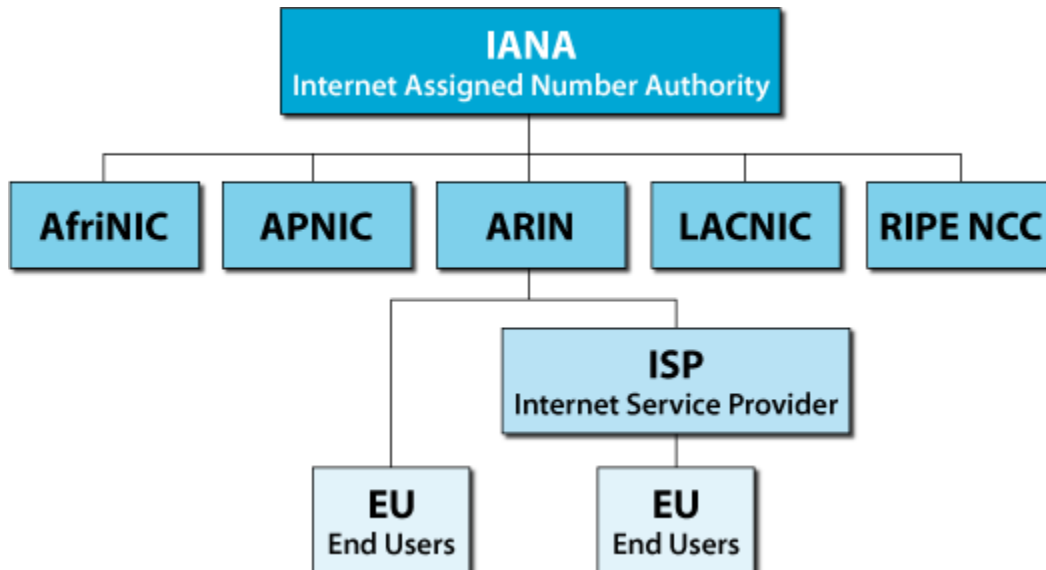
If you have the answers you can create a plan

IPv4 Overview

- IPv4
 - Deployed in 1981
 - 2^{32} addresses
 - 4,294,967,294 addresses
 - Classful addressing used until 1993
 - Class A (/8) = 16,777,216 addresses
 - Class B (/16) = 65,536 addresses
 - Class C (/24) = 256 addresses
 - Address blocks now being auctioned
 - /24 costs ~ \$4,000 for 256 addresses
 - /20 costs ~ \$51,000 for 4,096 addresses

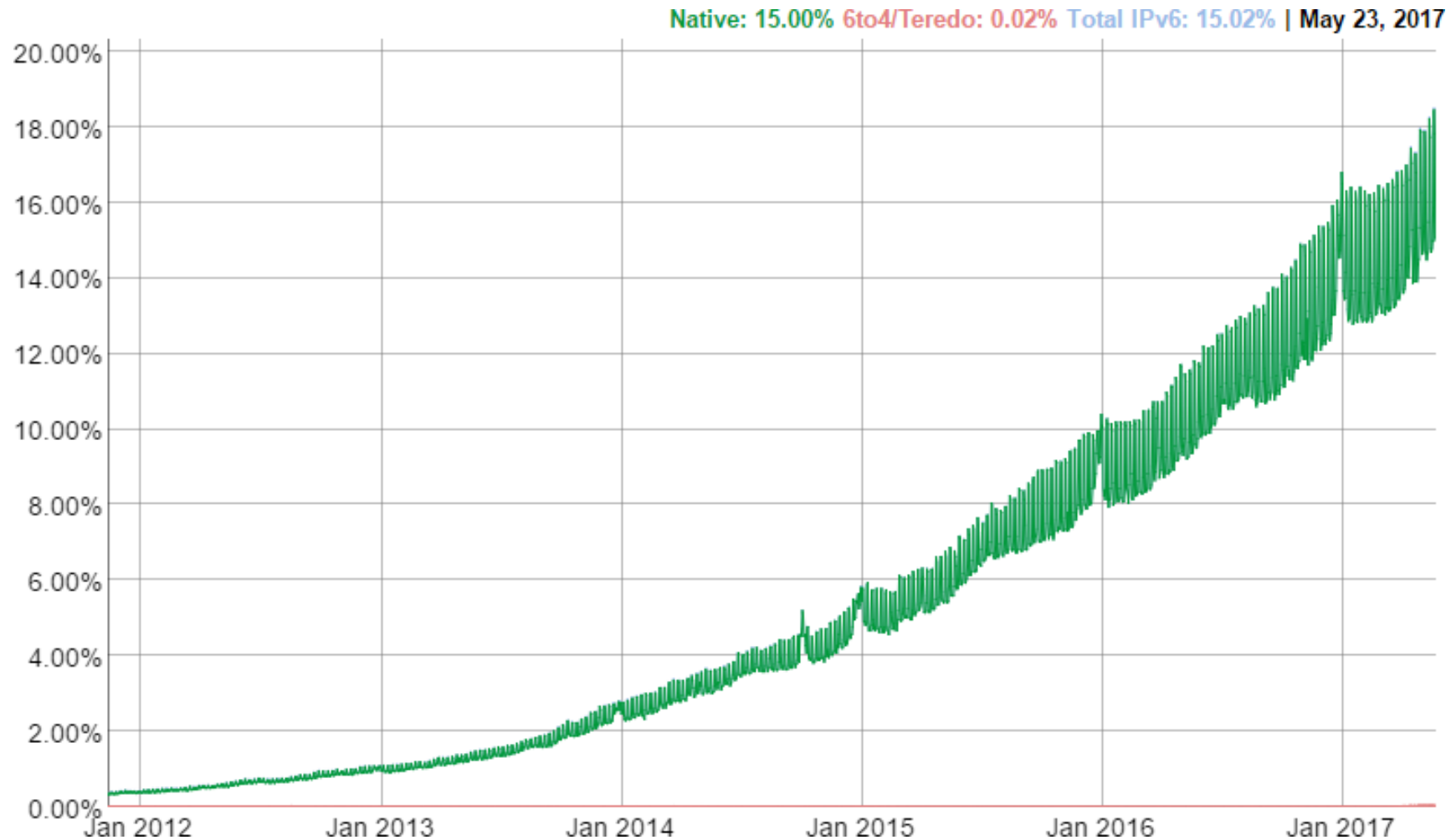
IPv6 Overview

- IPv6
 - Deployed in 1999
 - 2^{128} addresses
 - 340,282,366,920,938,463,463,374,607,431,768,211,456
 - Address assignment available from RIR



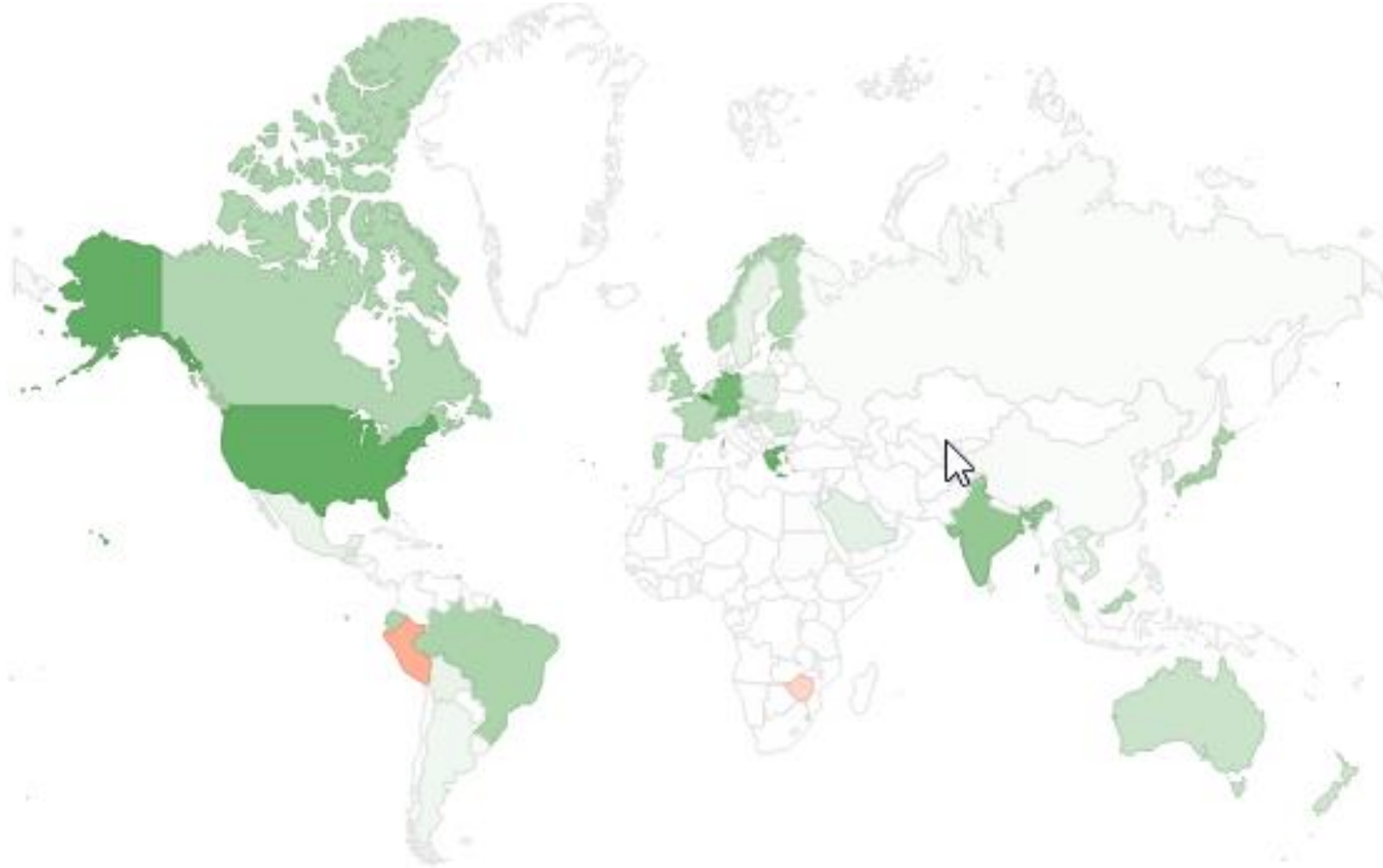
Registry	Geographic Region
AFRINIC	Africa, portions of the Indian Ocean
APNIC	Portions of Asia, portions of Oceania
ARIN	Canada, many Caribbean and North Atlantic islands, and the United States
LACNIC	Latin America, portions of the Caribbean
RIPE NCC	Europe, the Middle East, Central Asia

IPv6 Adoption



<https://www.google.com/intl/en/ipv6/statistics.html#tab=ipv6-adoption&tab=ipv6-adoption>

Per Country IPv6 Adoption



ARIN IPv6 Policy and Fees

- If you have a AS and IPv4 allocation you can request an IPv6 block

Service Category	Fee	IPv4 Block Size	IPv6 Block Size
3X-Small *	\$250	/24 or smaller	/40 or smaller
2X-Small	\$500	Larger than /24, up to and including /22	Larger than /40, up to and including /36
X-Small	\$1,000	Larger than /22, up to and including /20	Larger than /36, up to and including /32
Small	\$2,000	Larger than /20, up to and including /18	Larger than /32, up to and including /28
Medium	\$4,000	Larger than /18, up to and including /16	Larger than /28, up to and including /24
Large	\$8,000	Larger than /16, up to and including /14	Larger than /24, up to and including /20
X-Large	\$16,000	Larger than /14, up to and including /12	Larger than /20, up to and including /16
2X-Large	\$32,000	Larger than /12, up to and including /10	Larger than /16, up to and including /12
3X-Large	\$64,000	Larger than /10, up to and including /8	Larger than /12, up to and including /8
4X-Large	\$128,000	Larger than /8, up to and including /6	Larger than /8, up to and including /4
5X-Large	\$256,000	Larger than /6	Larger than /4

Addressing those questions

Q: Why should I deploy IPv6?

A: Buying IPv4 addresses expensive and not a long term strategy

Q: When should I deploy IPv6?

A: Plan to complete project in 12 months

Allow for the unforeseen.

Q: Where do I get those addresses?

A: Requested and received /36 IPv6 assignment

No additional cost

New ARIN Member

- Request an ASN
 - Multi-homed + \$500
- Request an IPv6 block
 - “In no case shall an ISP receive smaller than a /32 unless they specifically request a /36. In no case shall an ISP receive more than a /16 initial allocation.”

Service Category	Fee	IPv4 Block Size	IPv6 Block Size
2X-Small	\$500	Larger than /24, up to and including /22	Larger than /40, up to and including /36
X-Small	\$1,000	Larger than /22, up to and including /20	Larger than /36, up to and including /32
Small	\$2,000	Larger than /20, up to and including /18	Larger than /32, up to and including /28
Medium	\$4,000	Larger than /18, up to and including /16	Larger than /28, up to and including /24
Large	\$8,000	Larger than /16, up to and including /14	Larger than /24, up to and including /20
X-Large	\$16,000	Larger than /14, up to and including /12	Larger than /20, up to and including /16

IPv4 Block to Facilitate IPv6 Deployment

ARIN Policy 4.10

When ARIN receives its last /8 IPv4 allocation from IANA, a contiguous /10 IPv4 block will be set aside and dedicated to facilitate IPv6 deployment. Allocations and assignments from this block must be justified by immediate IPv6 deployment requirements. Examples of such needs include: IPv4 addresses for key dual stack DNS servers, and NAT-PT or NAT464 translators. ARIN staff will use their discretion when evaluating justifications.

This block will be subject to a minimum size allocation of /28 and a maximum size allocation of /24. ARIN should use sparse allocation when possible within that /10 block.

IPv6 Knowledge & Experience

- What do you know about IPv6?
 - It a complicated string of numbers and letters
2001:db8:14:ae8::34e:1437
 - My PC has an IPv6 address (ipconfig)
- Limited pool of people with IPv6 knowledge and experience at this time
 - Including service providers

Information Sources

- Internet search
 - wiki.mikrotik.com
 - mum.mikrotik.com
- MTCIPv6E training course
- Consultants
- Books
 - IPv6 PRIMER: A Concise and Practical Guide for IT Professionals and Students

MikroTik Certified Training – MTCIPv6E

- Two day course focused on IPv6
 - MTCNA certification is a prerequisite
 - Recommend also having MTCRE certification
- Course Outline
 - Introduction to IPv6
 - IPv6 Protocol
 - IPv6 Packet
 - IPv6 Security
 - Transition Mechanisms
 - Interoperability



Network Upgrades

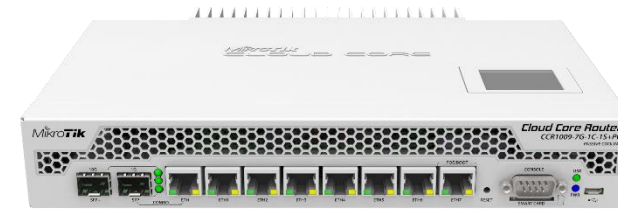
What upgrades do I need to make to my equipment?

MikroTik Simplifies the Task

MikroTik Routers



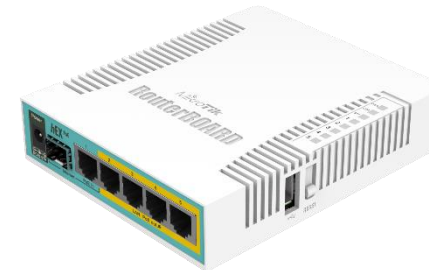
Data Center



Tower Site



Customer



Micro POP

MikroTik Wireless



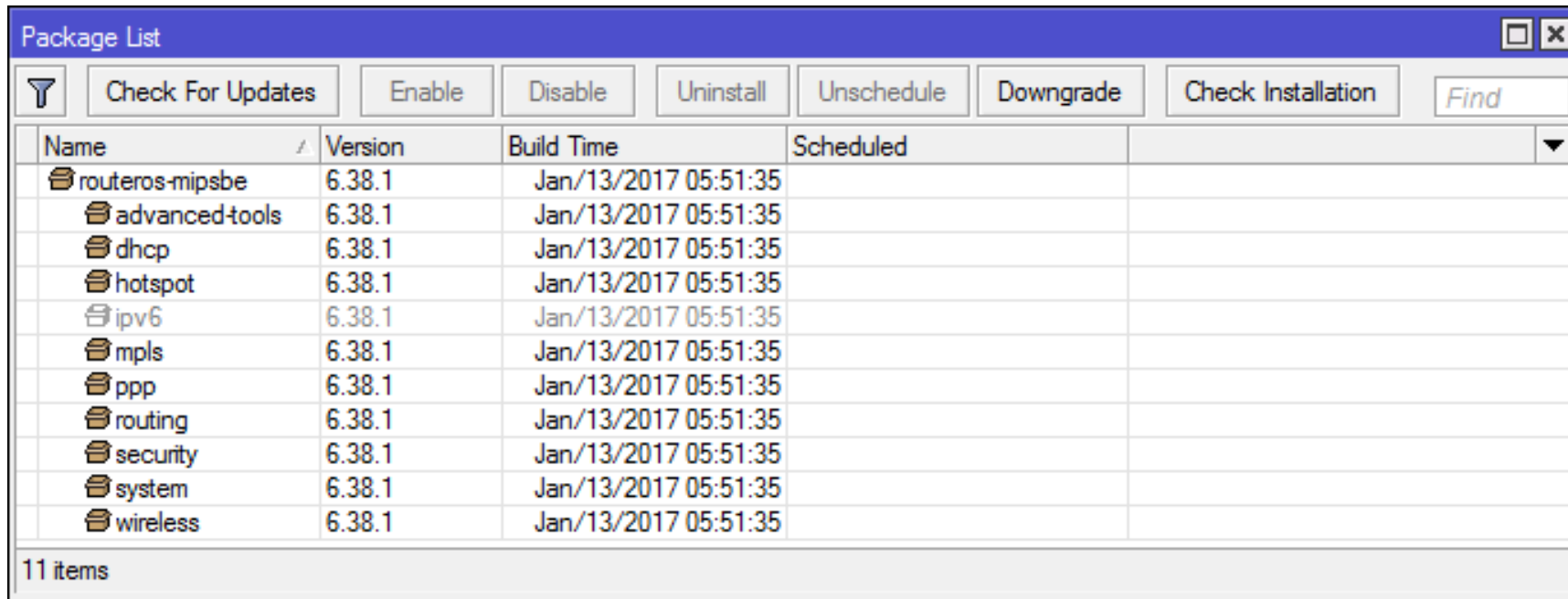
Backhaul



CPE

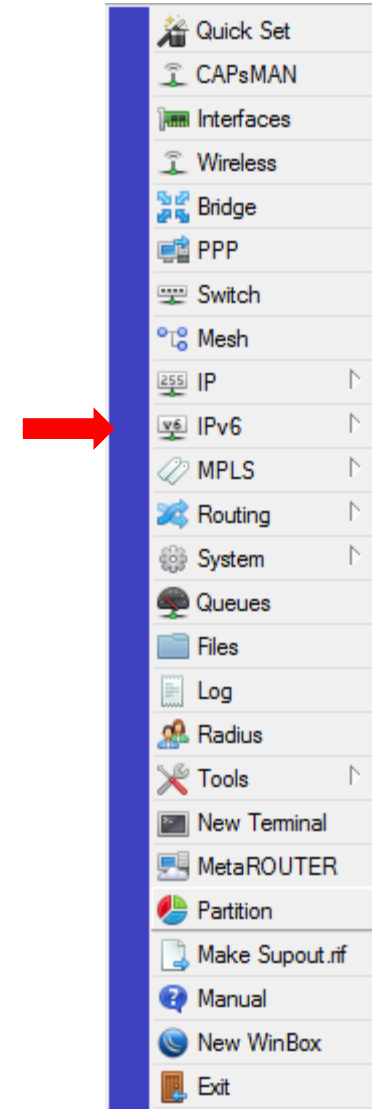
IPv6 on RouterOS

- Included as a package that needs to be enabled



Name	Version	Build Time	Scheduled
routeros-mipsbe	6.38.1	Jan/13/2017 05:51:35	
advanced-tools	6.38.1	Jan/13/2017 05:51:35	
dhcp	6.38.1	Jan/13/2017 05:51:35	
hotspot	6.38.1	Jan/13/2017 05:51:35	
ipv6	6.38.1	Jan/13/2017 05:51:35	
mpls	6.38.1	Jan/13/2017 05:51:35	
ppp	6.38.1	Jan/13/2017 05:51:35	
routing	6.38.1	Jan/13/2017 05:51:35	
security	6.38.1	Jan/13/2017 05:51:35	
system	6.38.1	Jan/13/2017 05:51:35	
wireless	6.38.1	Jan/13/2017 05:51:35	

11 items



RoutersOS Features

- Routing
 - OSPF
 - BGP
- Tunnels
 - IPIPv6
 - EoIPv6
 - GRE6
- PPP
- Tools
 - Ping
 - Traceroute
 - Torch
 - Traffic generator
 - E-mail
 - Netwatch
 - Traffic flow

Questions You Need to Consider

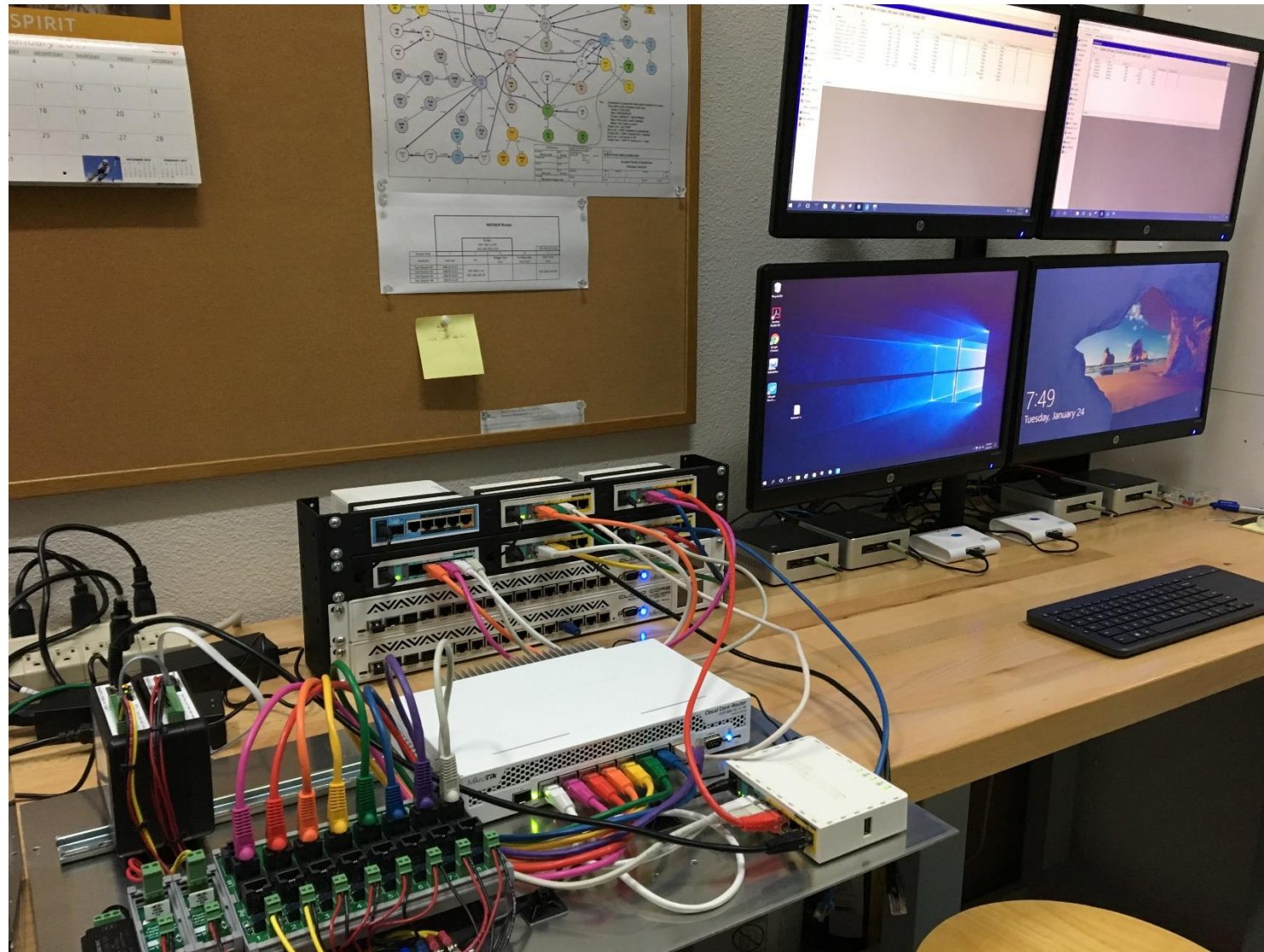
- What will it cost?
 - Depends on what equipment you need to replace
 - IPv6 capable?
 - “Hand me down” upgrade strategy can save you money
- How long will it take?
 - Depends on how well you plan and how effective your upgrade process is

You should now be in a position to plan and implement your IPv6 implementation

IPv6 Subnet Strategy

- ARIN assigned a /36 IPv6 block of addresses
- Assigning a /64 to a customer
 - Minimum recommended IPv6 assignment
 - 18,446,744,073,709,551,616 addresses
- Allows a /48 to be assigned to 4,096 service sites
 - Allows assignment of 65,536 /64's to each siteor
- Allows a /50 to be assigned to 16,384 service sites
 - Allows assignment of 16,384 /64's to each site

Configuration Validation & Testing



Implementation Goal

