

Putting  
**IPv6**  
to work



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Rocky Mountain IPv6 Task Force



# IPv6 Address Planning and Allocation Strategies

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# Topics

- Context of address planning
  - Planning process overview
  - Addressing impacts
- IPv6 address plan
  - Goals
  - Allocation techniques
  - Strategies and guidelines
- Additional resources

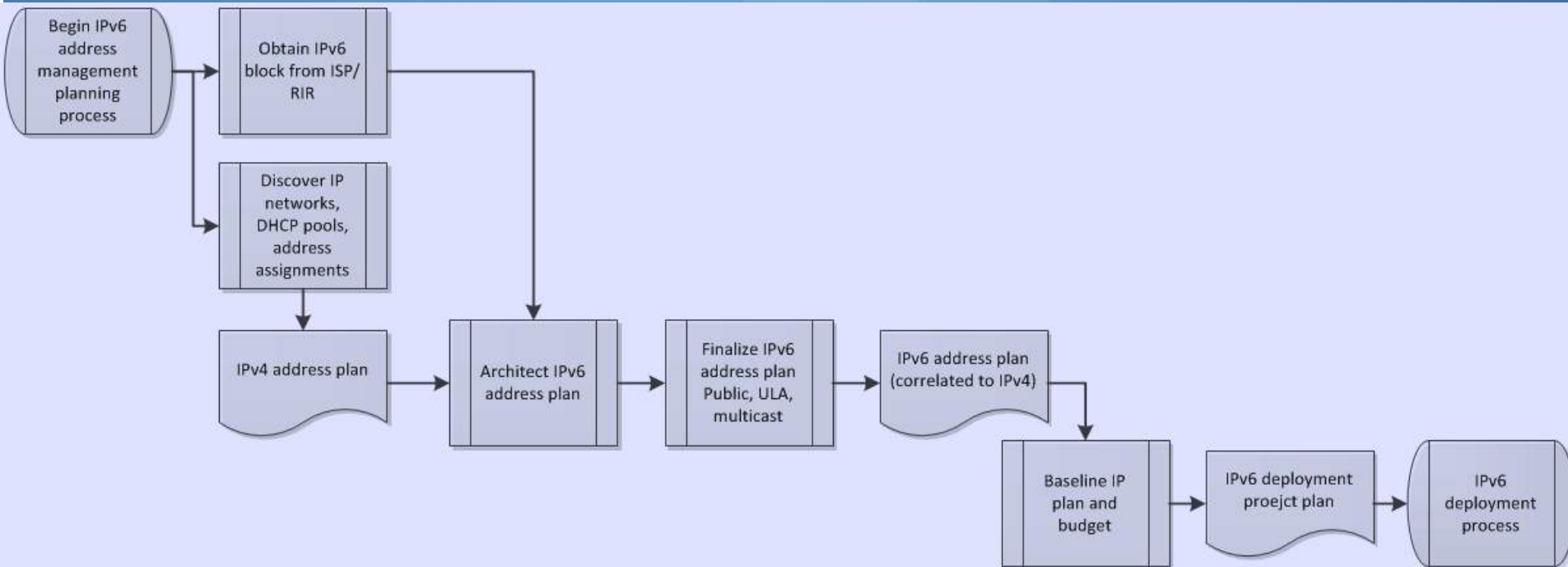


# IPv6 deployment impacts

- Infrastructure – routers, switches, printers
- Computing devices – servers, end user devices
- Applications, databases
- Security policies and enforcement
- Network and change management
- IP address management



# The IPv4 baseline



- Helps identify current IP capacity/needs
- Not necessarily useful for IPv6 address structure



# Address plan impacts

- Router functions
  - Forward IP packets to next hop on the way toward the ultimate destination
  - Based on information in the IP header
  - Based on internal routing tables
  - Based on configured router policies
- Security functions
  - Allow/disallow packet traversal
  - Based on information in the IP header
  - Based on filtering policies

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# Goals of an address plan

- Provide IP addresses to end nodes in order to...
- Enable end nodes to communicate...
  - with other nodes across the organization (or not)
  - with Internet or partner nodes (or not)
- Enable end nodes to communicate via supported media
- Facilitate network management
- Facilitate security management





# IPv6 allocation techniques

- Monotonic

- Allocate subnet ID numerically

Global Routing Prefix (n bits)	Subnet ID (m bits)	Interface ID (128 - n - m bits)

- 0000, 0001, 0010, 0011, ...

- Sparse

- Allocate subnet ID bit counting right to left

- 0000, 1000, 0100, 1100, ....

- Best fit

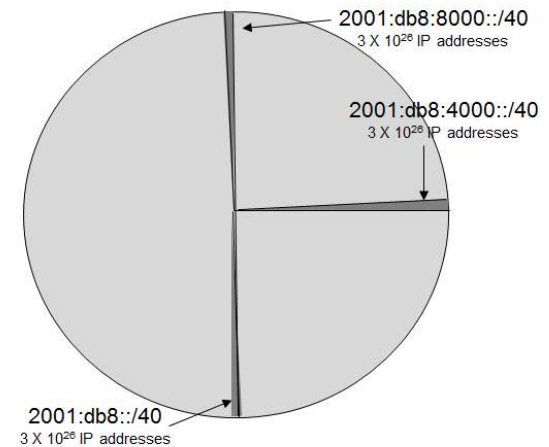
- Allocate smallest available block
- Optimizes allocation efficiency

- Random

- Prefix delegation

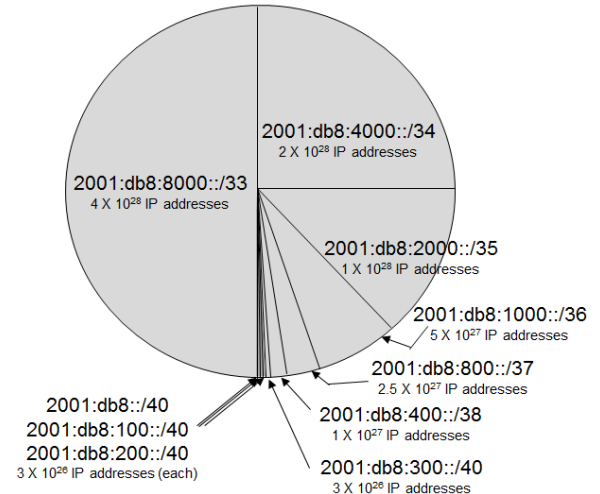
Entire pie: 2001:db8::/32

7.9 X 10<sup>28</sup> IP addresses



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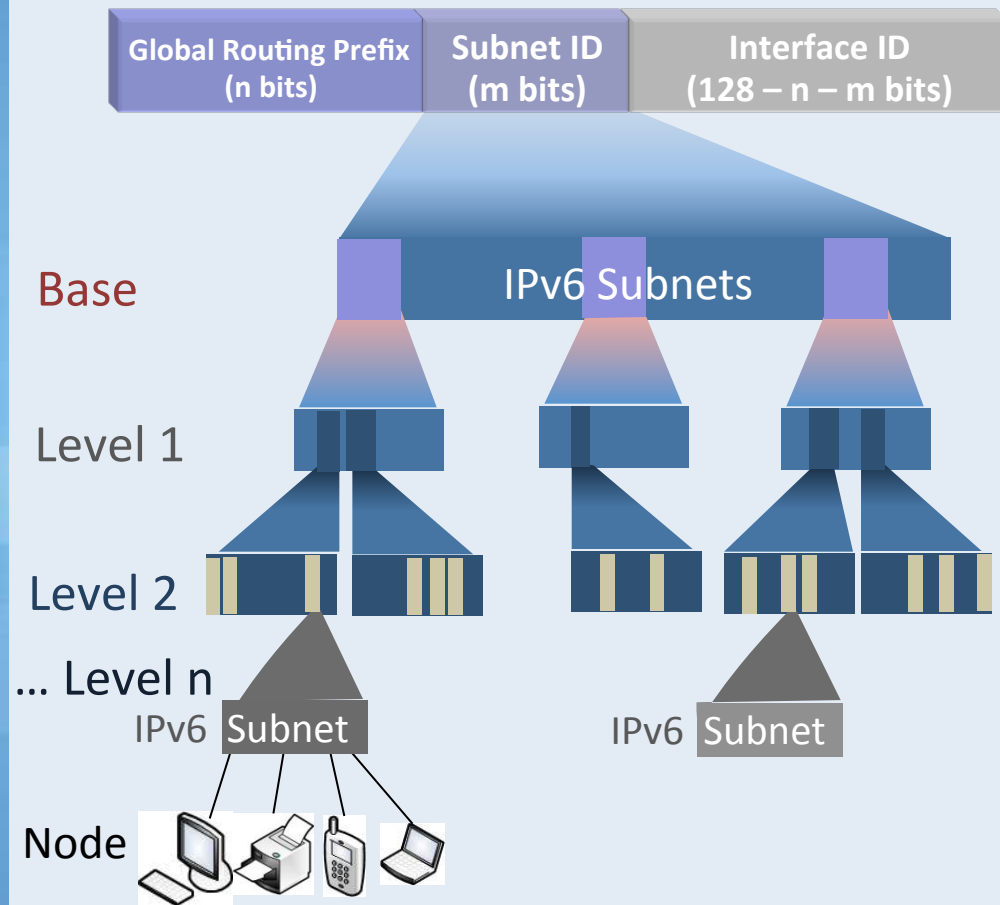
7.9 X 10<sup>28</sup> IP addresses





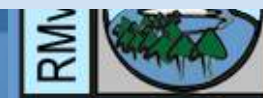
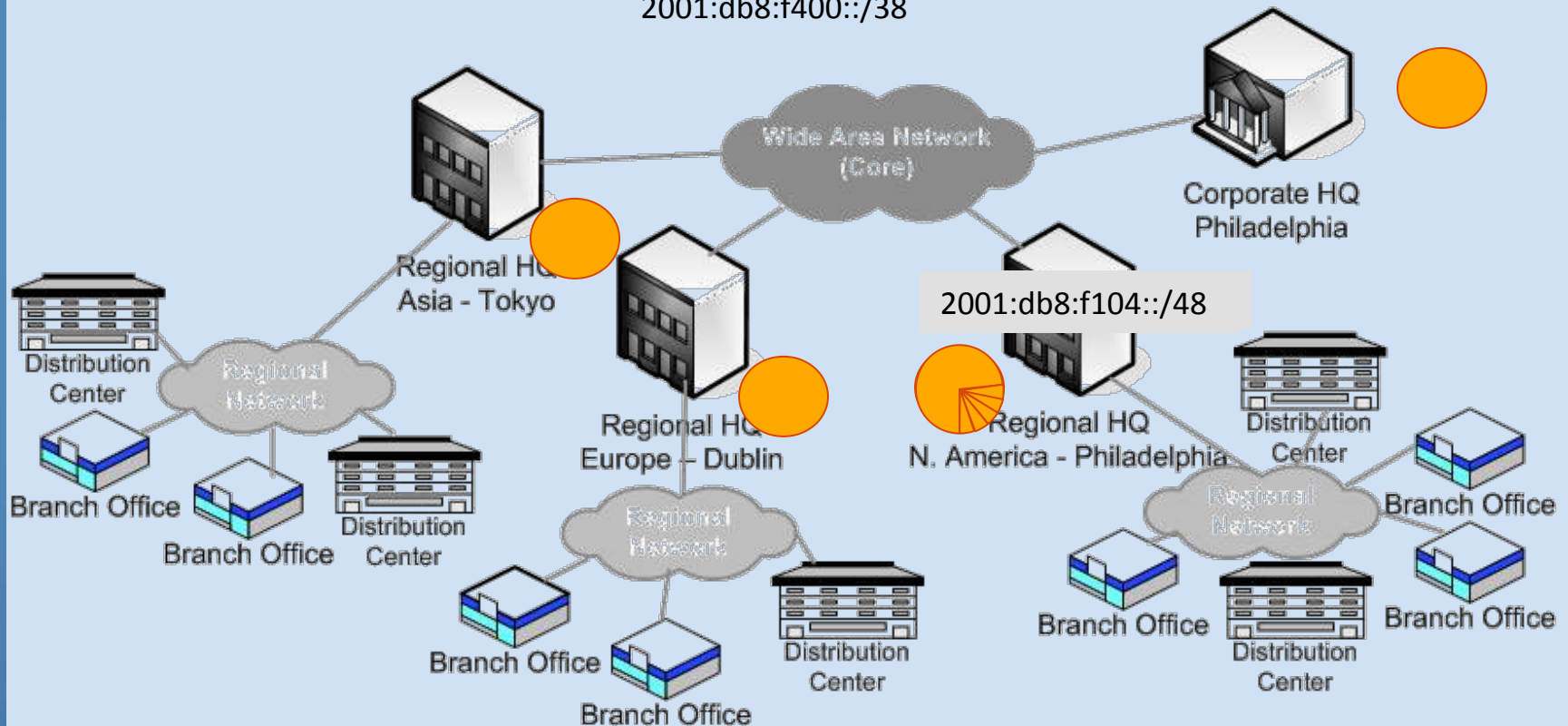
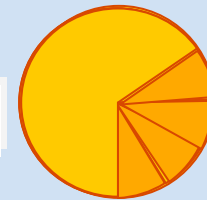
# IPv6 address allocation hierarchy

- Obtaining IPv6 space
  - RIR or ISP
  - Unique Local (ULA)
- Allocation layers
  - Common prefix (GRP)
  - Hierarchical rollup
- Node level
  - Address assignment policy
  - DNS resource records



# Geographic allocation model

2001:db8::/33  
2001:db8:8000::/34  
2001:db8:c000::/35  
2001:db8:e000::/36  
2001:db8:f800::/37  
2001:db8:f400::/38



# General block allocation guidelines

- Define IP addressing requirements
- Define your addressing hierarchy layers
  - Routing topology – core/division/regional/access
  - Application-specific routing treatment based on IP
  - Network segmentation
  - Administrative delegation
  - Management controls based on IP
- Allocation strategies
  - Allocate on 4-bit (nibble) boundaries
    - Simplifies reverse DNS configuration to hex digit boundaries
    - Simplifies association by sight for hex digit meanings
  - Sparse allocation at upper layers
  - Best-fit or random at lower (subnet) layers



# Tracking allocations

		Application			
		Data	VoIP	Wireless	Management
Geography	HQ	2001:db8:f000::/40			
	Philadelphia	2001:db8:f100::/40			
	DC1	2001:db8:f100::/48	2001:db8:f105::/48	2001:db8:f10a::/48	2001:db8:f10f::/48
	Branch 1	2001:db8:f101::/48	2001:db8:f106::/48	2001:db8:f10b::/48	2001:db8:f110::/48
	Branch 2	2001:db8:f102::/48	2001:db8:f107::/48	2001:db8:f10c::/48	2001:db8:f111::/48
	DC2	2001:db8:f103::/48	2001:db8:f108::/48	2001:db8:f10d::/48	2001:db8:f112::/48
	Branch 3	2001:db8:f104::/48	2001:db8:f109::/48	2001:db8:f10e::/48	2001:db8:f113::/48
	Dublin	2001:db8:f200::/40			
	Tokyo	2001:db8:f300::/40			

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# Tracking allocations

		Application			
		Data	VoIP	Wireless	Management
HQ		2001:db8:f000::/40	2001:db8:f400::/40	2001:db8:f800::/40	2001:db8:fc00::/40

		Application			
		Data	VoIP	Wireless	Management
HQ		2001:db8:7000::/40	2001:db8:7400::/40	2001:db8:7800::/40	2001:db8:7c00::/40

Engineering

		Application			
		Data	VoIP	Wireless	Management
HQ		2001:db8:b000::/40	2001:db8:b400::/40	2001:db8:b800::/40	2001:db8:bc00::/40
Philadelphia		2001:db8:b100::/40	2001:db8:b500::/40	2001:db8:b900::/40	2001:db8:bd00::/40
DC1		2001:db8:b100::/48	2001:db8:b500::/48	2001:db8:b900::/48	2001:db8:bd00::/48
Branch 1		2001:db8:b101::/48	2001:db8:b501::/48	2001:db8:b901::/48	2001:db8:bd01::/48
Branch 2		2001:db8:b102::/48	2001:db8:b502::/48	2001:db8:b902::/48	2001:db8:bd02::/48
DC2		2001:db8:b103::/48	2001:db8:b503::/48	2001:db8:b903::/48	2001:db8:bd03::/48
Branch 3		2001:db8:b104::/48	2001:db8:b504::/48	2001:db8:b904::/48	2001:db8:bd04::/48
Dublin		2001:db8:b200::/40	2001:db8:b600::/40	2001:db8:ba00::/40	2001:db8:be00::/40
Tokyo		2001:db8:b300::/40	2001:db8:b700::/40	2001:db8:bb00::/40	2001:db8:bf00::/40

Production

Operations

Geography



# Allocation example 1

2001:db8::/32

- By application
  - Data: 2001:db8:0000::/36
  - Voice: 2001:db8:8000::/36
  - Wireless: 2001:db8:4000::/36
  - Management: 2001:db8:c000::/36
- By region (core network)
  - Voice – HQ: 2001:db8:8000::/40
  - Voice – Philly: 2001:db8:8800::/40
  - Voice – Dublin: 2001:db8:8400::/40
  - Voice – Tokyo: 2001:db8:8c00::/40
- By business unit
  - Voice – Tokyo – Engineering:  
2001:db8:8c00::/48
  - Voice – Tokyo – Finance:  
2001:db8:8c01::/48

Policy impact:

- Application packet treatment
  - bits 33-36
  - Same router policy network wide per application
- Core network routers
  - Analyze first 40 bits
  - Core routing table  $\sim 2^4$  entries
- Each BU is allocated:
  - {apps} X {regions} blocks
- Security policies
  - Fewer entries if by app
  - More entries if by region, more by BU

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# Allocation example 2

2001:db8::/32

- By BU
  - Eng: 2001:db8:0000::/40
  - Finance: 2001:db8:8000::/40
  - Corp: 2001:db8:4000::/40
  - Sales: 2001:db8:c000::/40
- By app
  - Corp – Data : 2001:db8:4000::/44
  - Corp – Voice : 2001:db8:4080::/44
  - Corp - Wireless: 2001:db8:4040::/44
  - Corp - Mgmt: 2001:db8:40c0::/44
- By region
  - Corp – Voice– HQ: 2001:db8:4080::/48
  - Corp – Voice - Philly: 2001:db8:4081::/48
  - Corp – Voice – Dublin: 2001:db8:4082::/48
  - Corp – Voice- Tokyo: 2001:db8:4083::/48

Policy impact:

- Each BU is allocated
  - 1 block (or more based on capacity/needs)
- Application packet treatment
  - bits 41-44
  - App policy per BU
- Core network routers
  - Analyze first 48 bits
  - Core routing table  $\sim 2^{12}$  entries
- Security policies
  - Fewer entries if by BU
  - More entries if by app, more by region

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# Allocation layering summary

- Consider most frequent/urgent activities or highest needs
  - Throttle an app, isolate a site, re-route traffic, etc.
- Assess importance of routing tables sizing and performance
  - Need to minimize or a non-issue?
- Scope the homogeneity of the network
  - Site/app/BU specific IP-based policies?
- Determine importance of administrative delegation and segmentation
- Prioritize these and other IP address-based policies

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# Management of host addresses

- Management of IP address spaces
  - IPv4 public, IPv4 private, IPv6 GUA, ULA
- Host address(es) assignment strategy
  - Manual, Autoconfiguration, DHCPv6 management
    - ✓ Prefix delegation, IPv6 address assignment (stateful), IPv6 configuration initialization (combined stateful/stateless)
- Name Resolution - DNS (Domain Name System)
  - Maps hierarchical domain names to IP addresses

pc.btdiamondip.com IN AAAA 2001:db8:a04:3c:250:4ff:fe5c:b3f4

- Maps IP addresses to domain names

4.f.3.b.c.5.e.f.f.f.4.0.0.5.2.0.c.3.0.0.4.0.a.0.8.b.d.0.1.0.0.2.ip6.arpa. IN PTR pc.btdiamondip.com.

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# IP address management

- IPAM is a strategic management function
  - Organize IPv4/IPv6 address space in one cohesive inventory database
  - Manage your hierarchy, block types, naming policies and more
- Simplify address allocations
  - Perform address allocations hierarchically and logically without typing in the address!
  - Maintain single authoritative address space inventory for change control
  - Template based subnet allocation and IP address assignment within subnet
- Track IPv6 Deployment
  - Manage current IPv4 network, IPv6 deployment, ongoing IPv4/IPv6
  - Track dual stack host IPv4/IPv6 addresses
- Manage Accountability
  - Scope and delegate administrator access
  - Track administrator and IP address history for troubleshooting and audit reporting
- Automate through IT integration
  - APIs/CLIs facilitate inter-system automation



# Additional resources

- IPv6 white papers
- IPv6 Survey Report
- IPv6/IPAM books
- Free IPv6 tools - <http://goo.gl/18GUUA>
- LinkedIn - follow us!
- Blog – [ipamworldwide.blogspot.com](http://ipamworldwide.blogspot.com)
- Web
  - [www.btdiamondip.com](http://www.btdiamondip.com)
  - [www.ipamworldwide.com](http://www.ipamworldwide.com)



# Thank you

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