Asia Pacific Network Information Centre

APNIC

IPv6 Address Management Past, Present and Future

ITU SG2

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Geneva, Switzerland

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Overview

- Introduction to APNIC

- IPv6 policy development
- IPv6 policies overview
- Future IPv6 policies – a proposal

Introduction to APNIC

What is APNIC?

- Regional Internet Registry (RIR) for the Asia Pacific Region
  - Regional authority for Internet Resource distribution
  - IP addresses (IPv4 and IPv6), AS numbers, reverse DNS delegation
  - Provide services to ~800 ISPs
- Industry self-regulatory body
  - Established in 1993
  - Consensus-based, open and transparent
  - Non-profit, neutral and independent
  - Open membership-based structure

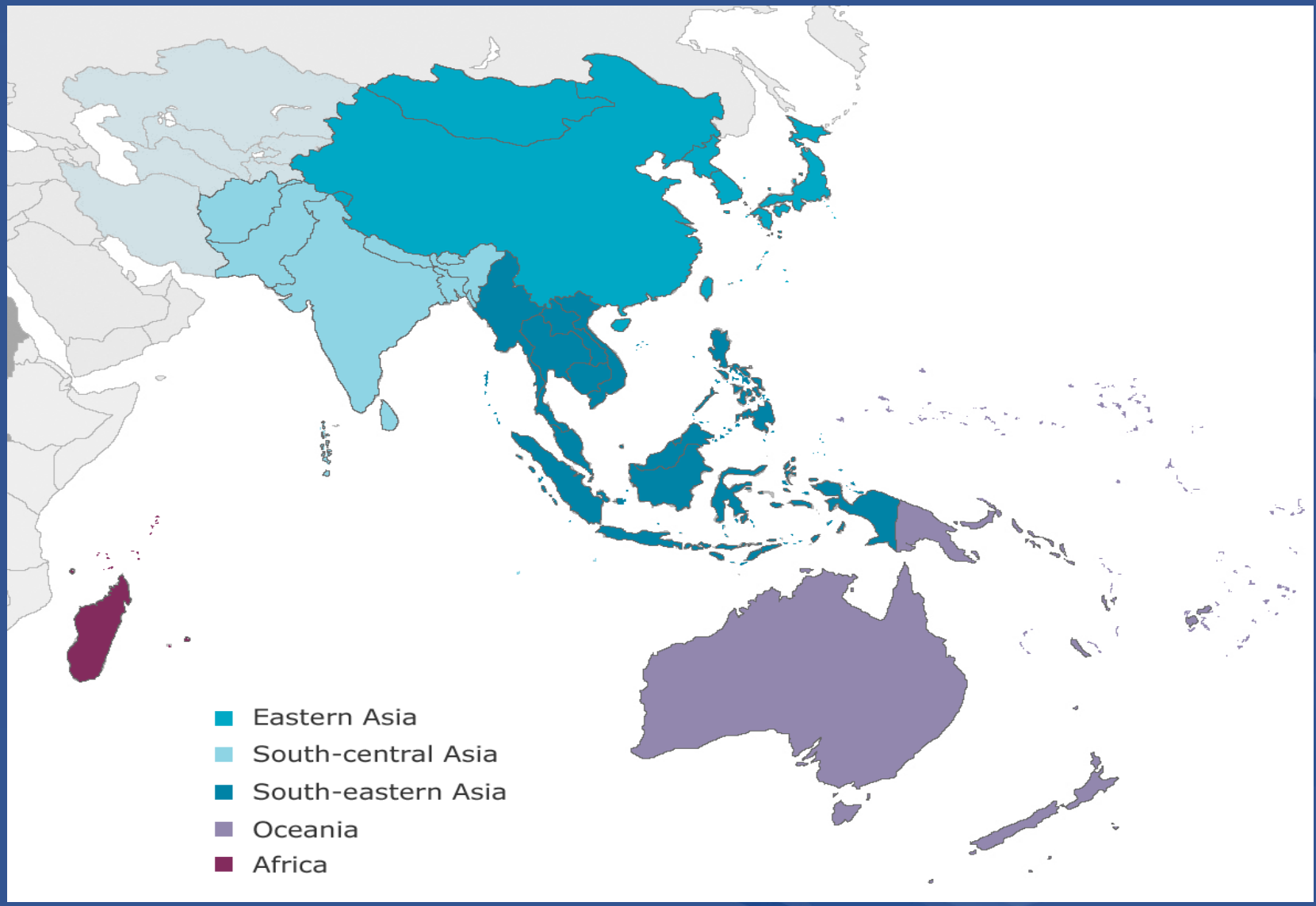
What does APNIC do?

1. Internet resource management
   - IP address allocation to ISPs and NIRs
   - IP address assignment to end users
   - AS number assignments
2. Resource registration
   - Authoritative registration server: *whois.apnic.net*
   - Internet routing registry: *irr.apnic.net*
3. DNS management
   - Delegate reverse DNS zones/domains
   - Authoritative DNS servers
     - *in-addr.arpa, ip6.arpa (ip6.int)*

What else does APNIC do?

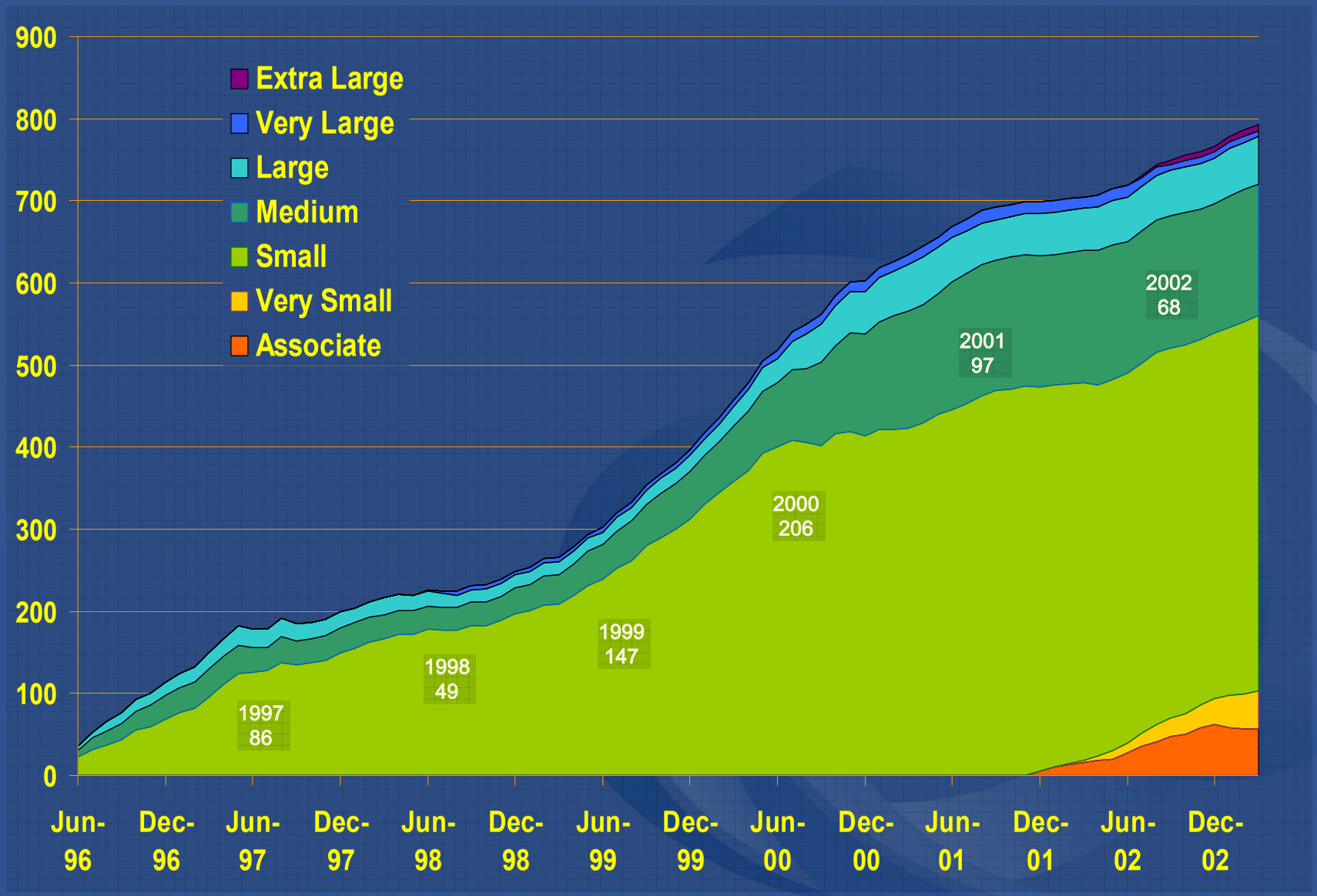
- Policy development and coordination
  - APNIC Open Policy Meetings: 2 per year
    - SIGs, WGs, BOFs, Training
  - ASO and ICANN processes
  - Liaison: RIRs, IETF, ITU, other stakeholders
- Training and outreach
  - Frequent regional training courses
  - Presentations, seminars, conferences etc
- Publications
  - Newsletter, web site, mailing lists etc
  - Regional and global resource reports

Where is APNIC?

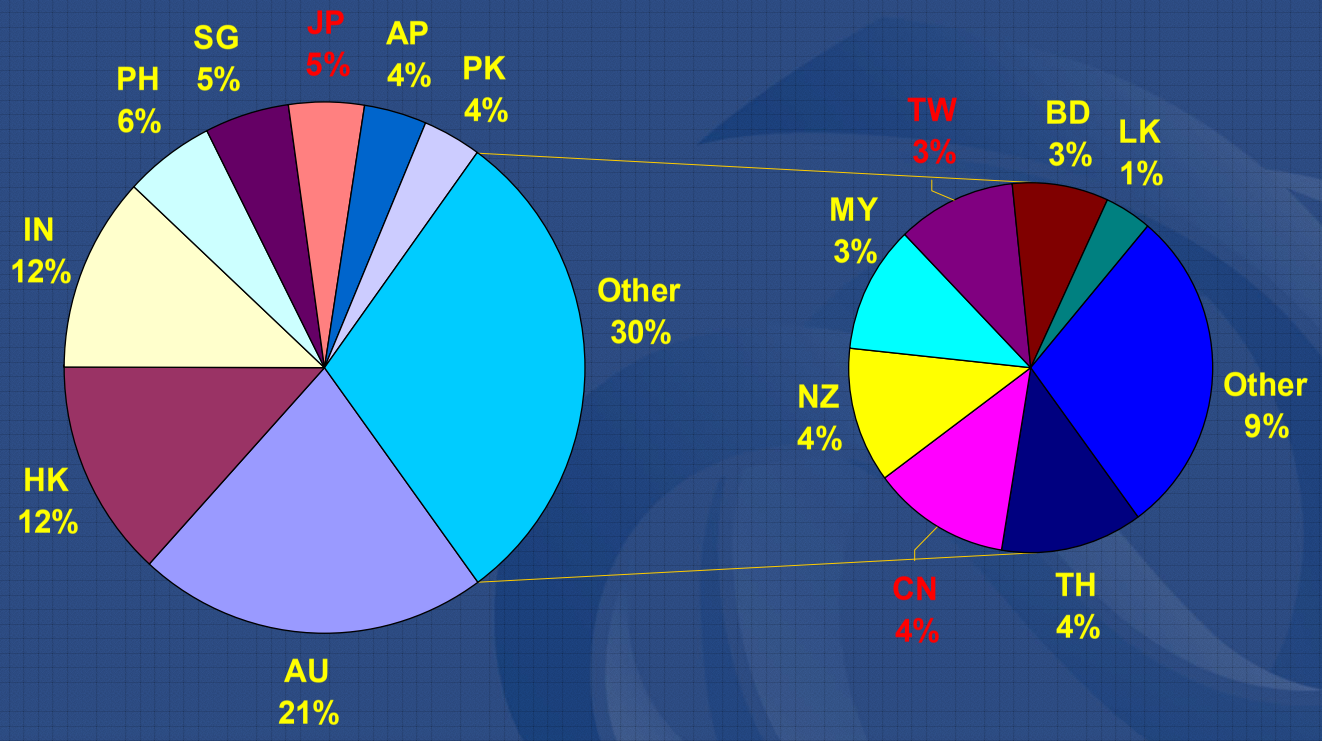


Ref http://www.un.org/depts/dhl/maplib/worldregions.htm

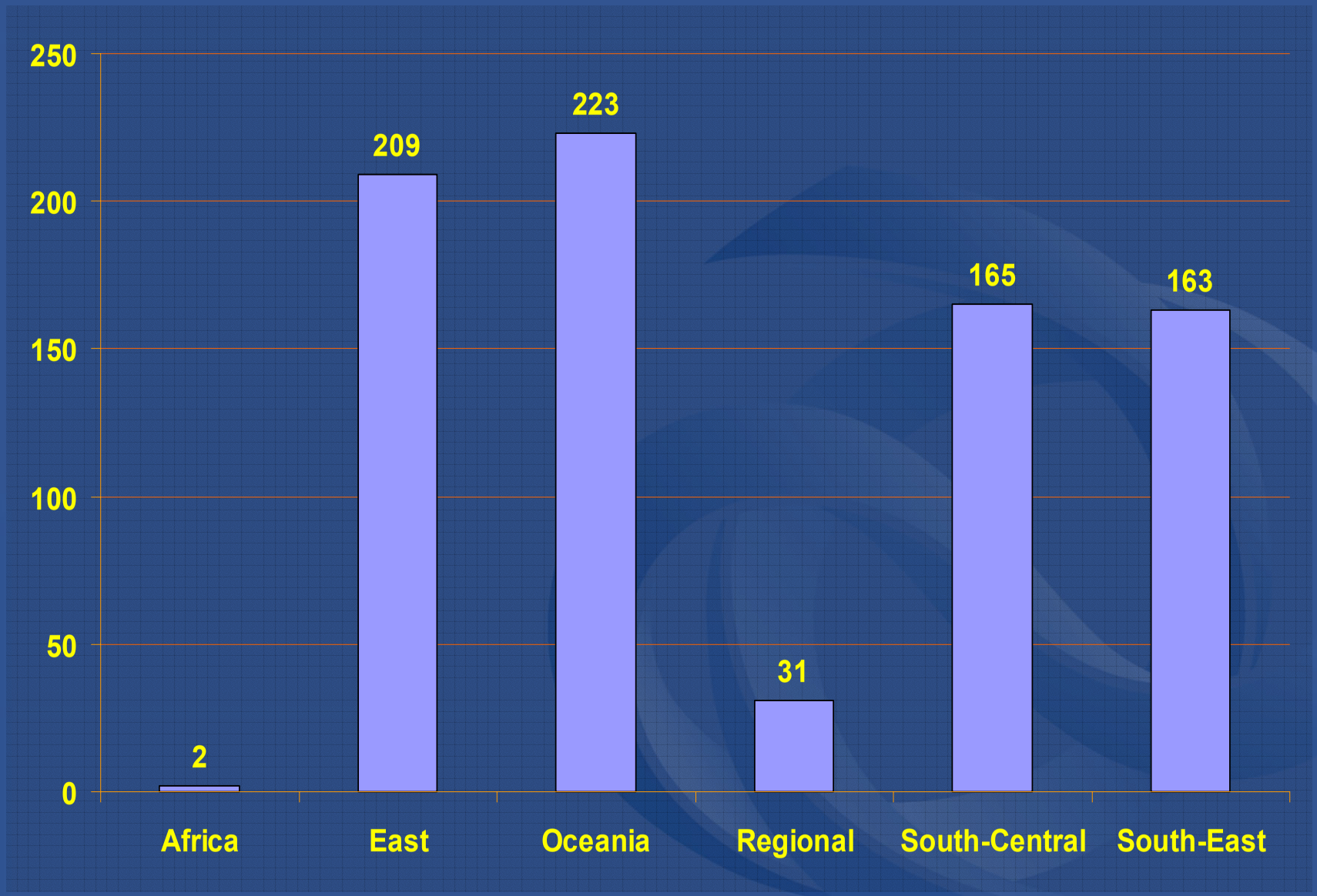
Total APNIC Membership



Total APNIC Membership



Sub-regional Distribution



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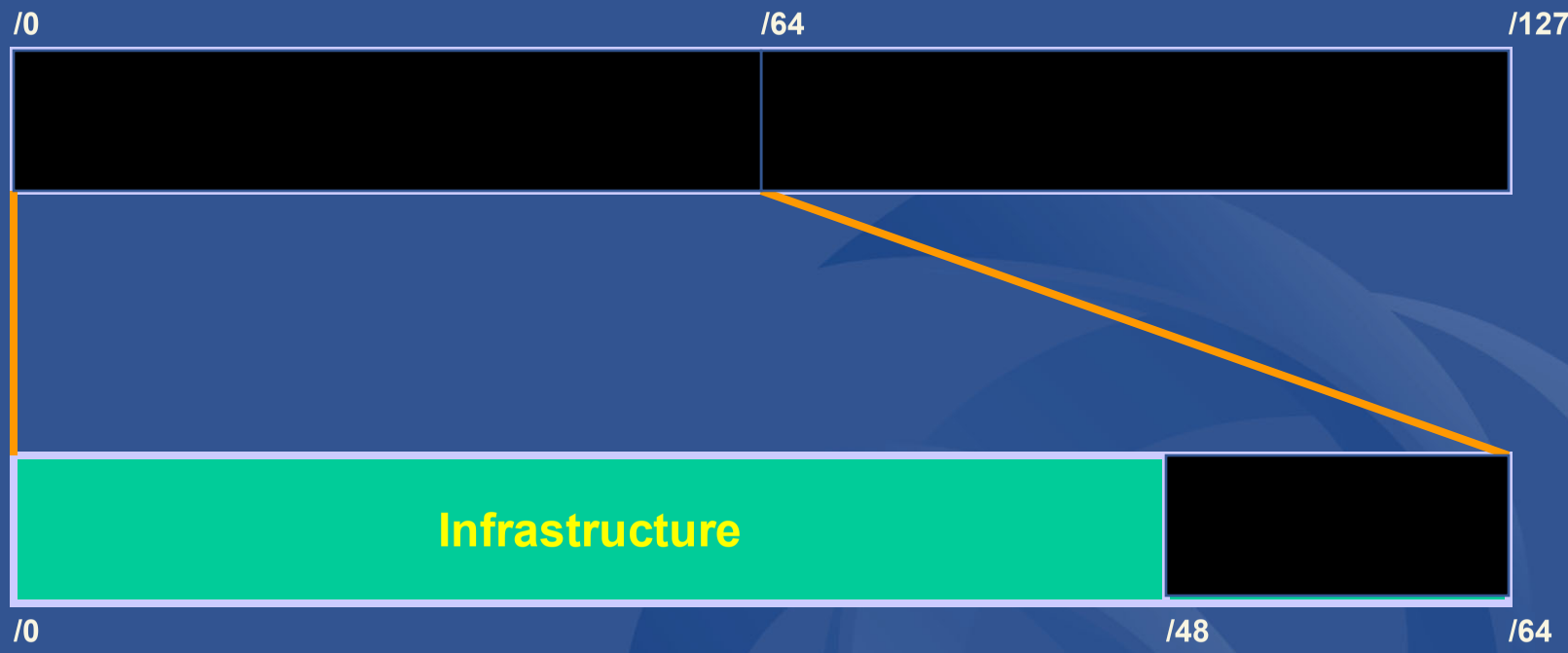
IPv6 Policy Development

IPv6 Policy History

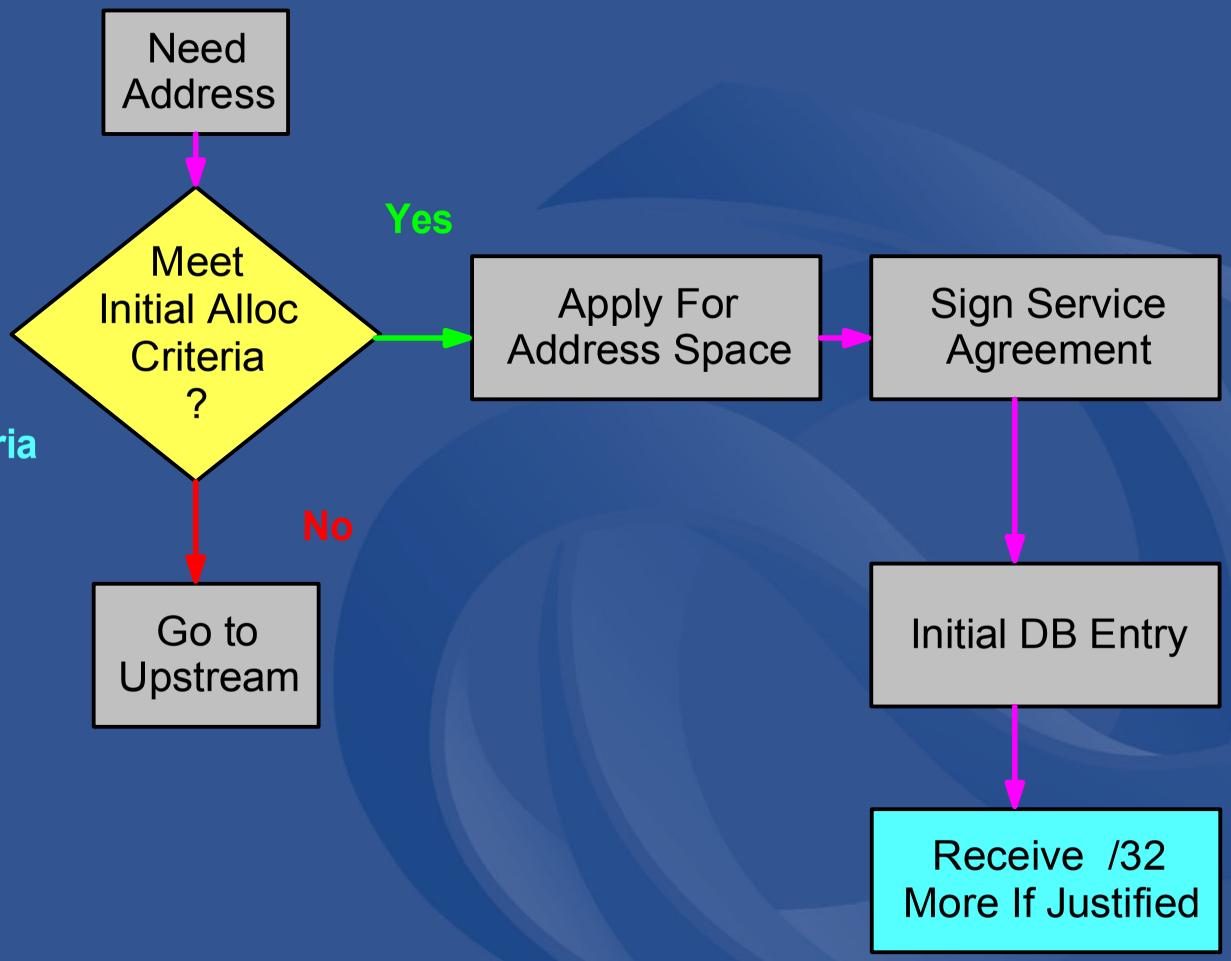
- Apr 1999 – Joint RIR Consensus
  - Interim policy
  - IPv6 allocations begin
- Oct 1999 – Policy Review Begins
- Jul 2001 – Joint RIR Consensus
  - Policy and technical boundaries
  - End site assignments [RFC 3177]
- May 2002 – Joint RIR Consensus
  - Initial allocation size to ISP/LIR
  - Initial allocation criteria

IPv6 Address Architecture



- IPv6 provides 2^{48} site addresses?
  - = 281,474,976,710,656
  - = 281 thousand billion addresses

IPv6 Initial Allocation Criteria & Process



Initial Allocation Criteria

* Not An End-Site
* Be An ISP/LIR
* Plan To Provide:
  - IPv6 Connectivity
  - 200 /48 In 2 Years

“End Site” Assignments

- Default assignment /48 for all End Sites
  - Providing /16 bits of space for subnets
- End Site defined as an end user of an ISP where:
    - The ISP assigns address space to the end user
    - The ISP provides Internet transit service to the end user
    - The ISP advertises an aggregate prefix route that contains the end user's assignment
  - ISP POPs are also defined as End Sites

IPv6 Assignments

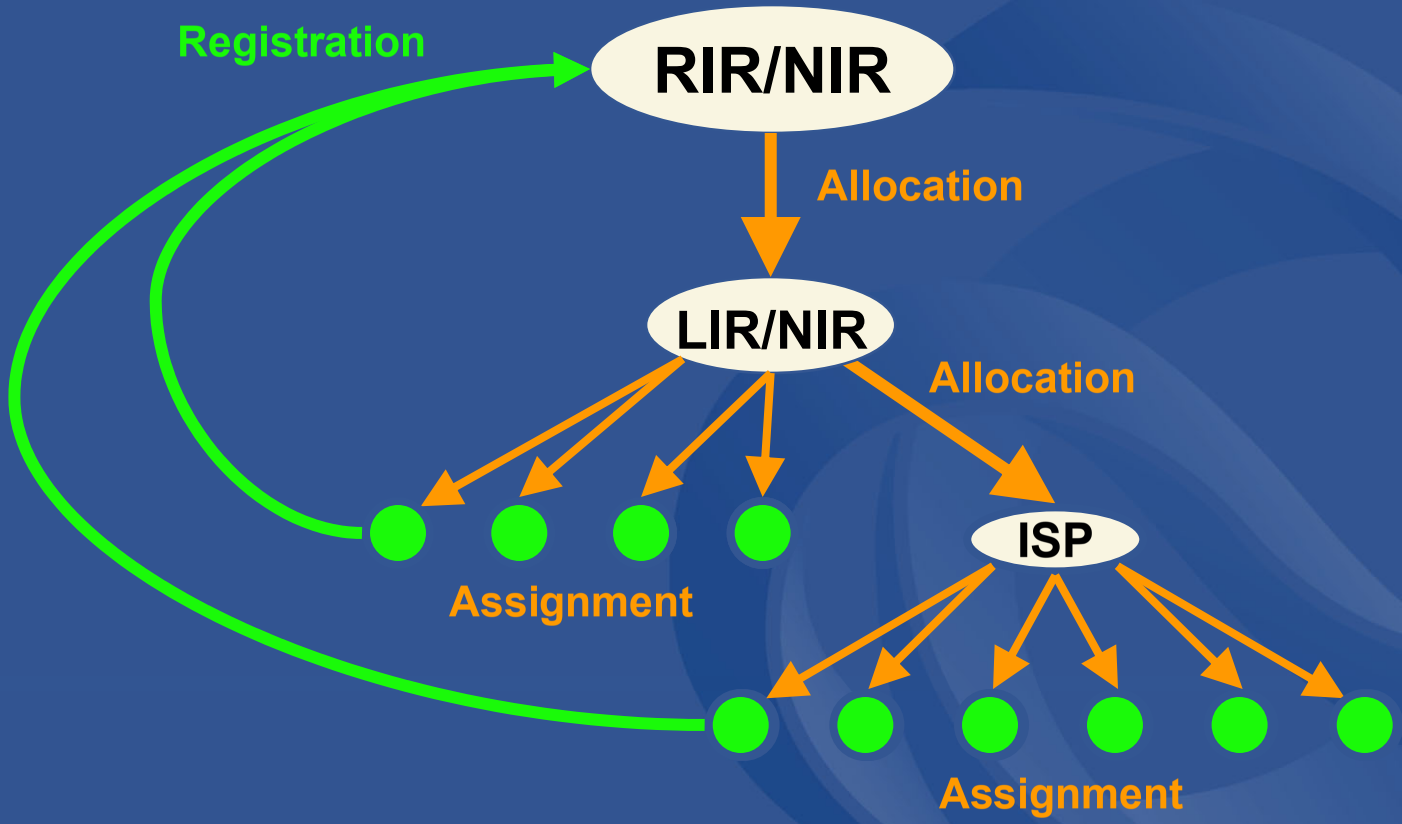
- Larger assignments: Multiple /48s
  - Some end sites will need more than one /48
  - Requests to be reviewed at RIR level
- Smaller assignments: /64
  - Single subnet devices should receive /64 only
  - e.g. simple mobile phone
- Smaller assignments: /128
  - Devices with no subnets should receive /128 only
  - e.g. remote sensor
- See RFC3177 (Sep 2001)

IPv6 Utilisation

- IPv6 assignments to End Sites are used to determine utilisation of IPv6 address blocks
  - All assignments must be registered
  - Utilisation is determined from registrations
  - Intermediate allocation hierarchy not considered

IPv6 Registration

- LIR is responsible for all registrations



IPv6 Utilisation Requirement

- Subsequent allocation may be requested when IPv6 utilisation requirement is met
- Utilisation of IPv6 address space is measured differently from IPv4 using the “Host Density-Ratio” (rfc3194)

IPv6 Utilisation Requirement

- Under IPv4, address space utilisation measured as simple percentage:

$$Utilisation = \frac{assigned}{available}$$

- IPv4 utilisation requirement is 80%
  - When 80% of address space has been assigned or sub-allocated, LIR may receive more
  - E.g. ISP has assigned 55,000 addresses from /16

$$\frac{assigned}{available} = \frac{55{,}000}{65{,}536} = 84\%$$

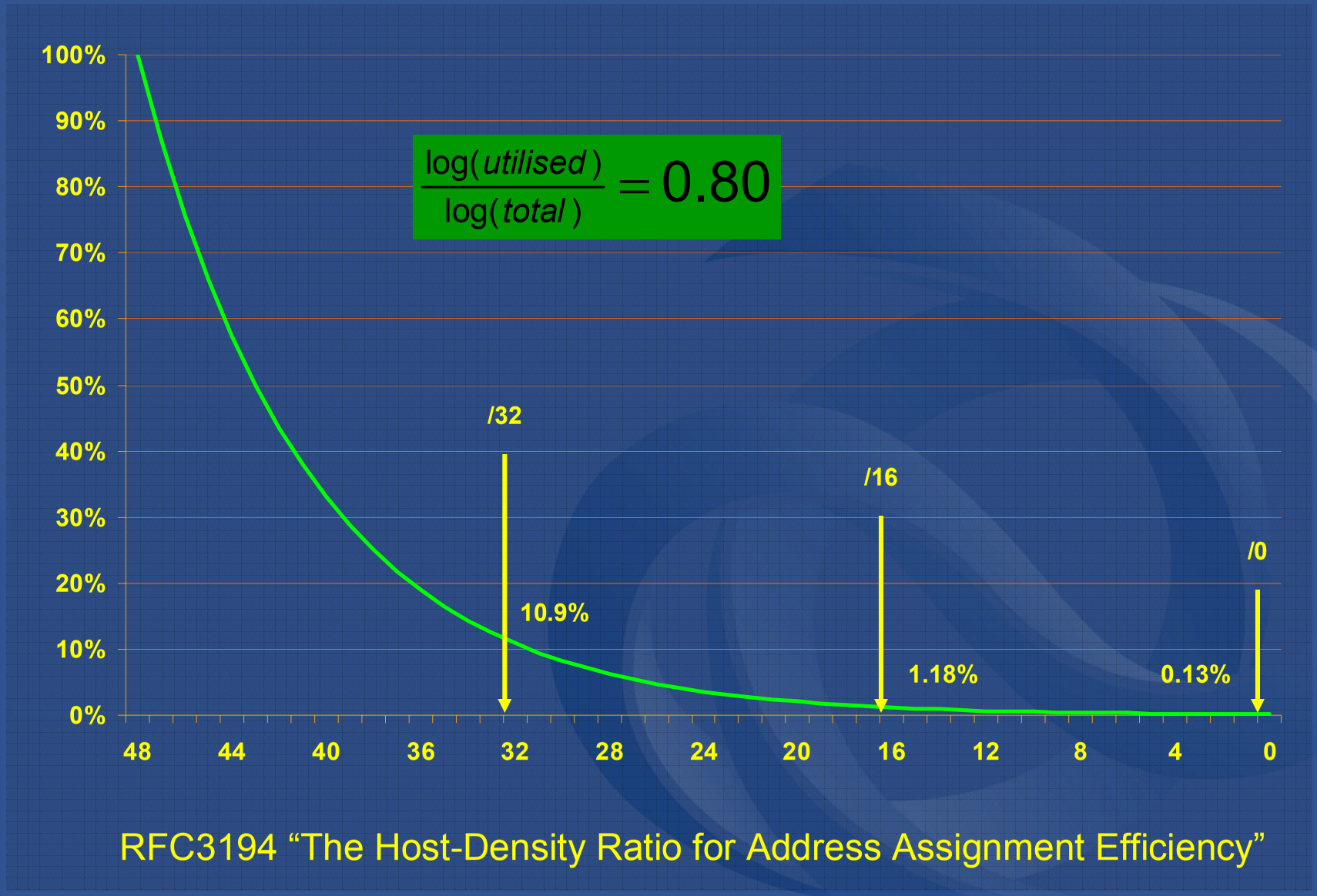
How to Measure Utilisation in IPv6

- Addresses utilised will be far fewer than addresses available
- Percentage utilised must reduce as address space grows
  - Because of hierarchical addressing architecture
- HD-Ratio defines utilisation in hierarchical address space, measured according to end-site assignments

$$HD = \frac{\log(utilised)}{\log(total)}$$

- Value of 0.8 regarded as reasonable
  - This corresponds to comfortable trade-offs between pain and efficiency" (RFC3194, 2001)

IPv6 Utilisation (HD = 0.80)



RFC3194 “The Host-Density Ratio for Address Assignment Efficiency”

Subsequent Allocation

- Subsequent allocation can be made when ISP's existing address space reaches utilisation of HD = 0.80
- Other address management policies should also be met
  - Correct registrations
  - Correct assignment practices etc
- Subsequent allocation size is at least double
  - Resulting IPv6 Prefix is at least 1 bit shorter
  - Or sufficient for at least 2 years requirement

Other Conditions

- License model of allocation
  - Allocations are not considered permanent, but always subject to review and reclamation
  - Licenses renewed automatically while addresses in use, consistent with policies
- Existing /35 allocations
  - A number of /35s have been assigned under provisional IPv6 policy
  - Holders of /35s are eligible to request /32

IPv6 Policy - Summary

- New policy now active globally
- Policy is subject to review *always*
  - Policies evolve as experience is gained
  - Any member of the community may propose changes, alternatives
- Review is starting now
  - Initial allocation criteria under review
  - Size of initial allocation may be reviewed
- Public mailing lists and documentation
  - http://www.apnic.net/ipv6

IPv6 Resource Management
RIR Proposal

Background and Motivation

- IANA-RIR allocation system
  - Unchanged in 10+ years
  - Major IPv4 address space fragmentation
    - Many ISPs have many separate prefixes
  - IPv6 should not go the same way
- Proposal for new system for IPv6
  - Designed to minimise fragmentation
    - Most ISPs will have 1 prefix for many years
- Document development
  - Document jointly authored by RIRs
  - Published as *ripe-261*

Current Allocation System

- IANA allocates to RIR
  - RIR maintains a pool of addresses
  - Attempts to maximise aggregation within pool
    - Short-term reservations
    - Sparse allocation
- RIRs allocate to LIRs/ISPs
  - When pool runs low, RIR receives more from IANA
  - Subsequent allocations to existing ISPs cannot be aggregated

Current Allocation System (IPv4)

❶ 212/8

❷ 212.100/16

❸ 212.101/16

212.100/15

❹ 213/8

❺ 213.50/16

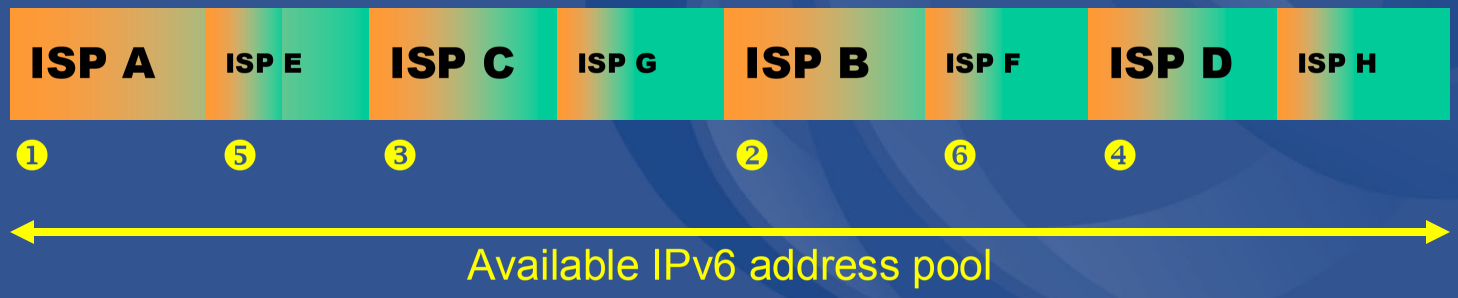
ISP has 2 prefixes after 3 requests!

Current Allocation System

- IPv4
  - IANA to RIR allocation unit: /8
  - RIR to LIR/ISP: /20… /10…
  - Many ISPs have multiple prefixes
- IPv6
  - IANA to RIR allocation unit: /23 (64 x /29)
  - RIR to LIR/ISP: /32 minimum
  - IPv6 swamp is being created already
    - Maximum reservation per ISP is /29

Proposal

- "Sparse Allocation" system
  - Maximise "distance" between separate portable allocations
  - Maximise chance of aggregation of subsequent allocations
  - Implemented as list of address prefixes to be allocated in order
- For example…



Proposal

- Sparse allocation system will maximise aggregation
  - Simple system, easily understood
    - Otherwise known as “binary chop”
  - Used in practice by RIRs already (IPv4)
    - Within large address blocks (e.g. /8)
  - Used in other allocation systems
    - e.g. dynamic memory allocation

Proposal

- Benefits increase as address pool increases
  - Existing system breaks down in “overflow condition”
    - i.e. where pool becomes too crowded or full, and another pool must be allocated
  - Therefore RIRs propose to share a single global pool
    - Known as Common Address Pool (CAP)
    - Managed by RIRs jointly, under “Common Registry Service” (CRS)

Proposal

- CAP needs to be as large as possible
  - to ensure long life of single pool
  - to avoid unaggregatable allocations
- So…
  - IANA to allocate 2000::/3 (FP001) for CAP
    - For management by CRS
    - This address space already designated by IETF as Global Unicast, for allocation by RIRs

Allocation Request Process

1. First IPv6 allocation to ISP
   - RIR sends request to CRS for new block of specified size
   - CRS allocates next entry from list of start addresses
2. Subsequent allocation to ISP
   - RIR sends request to CRS for expansion of existing allocation for that ISP (to certain specified size)
   - CRS provides extension of existing allocation
     - If extension is not available, non-contiguous prefix will be allocated

Avoiding Fragmentation

- Distance between neighboring allocations is initially very large
  - "Dumb" algorithm can be used initially
- However, some ISP allocations will grow faster
  - Threatening to "collide" with neighbour
- "Smarter" algorithm for new allocations
  - e.g. If existing preceding allocation has grown to occupy more than a certain % of address space available to it, select next start address from the list

Other Details

- Review of allocation process
  - Initial number of allocations limited to 2048
  - Providing each ISP with up to /14 (!)
    - Commence review after 1024th entry (2-3 years?)
- Common Registry Service (CRS)
  - Function to rotate between RIRs
  - 'Master' server at one RIR
    - Mirror servers elsewhere
- Reverse DNS requirements (ip6.arpa)
  - CRS administers master DNS server
  - Other RIRs will be mirrors of master

Disadvantages

- Requires single large allocation
  - Maybe “Putting all our eggs in one basket”
  - RIR proposal is to utilise very large block, only one-eighth of IPv6 address space
- Not possible to identify specific blocks allocated to specific RIRs/regions
  - e.g. for filtering purposes
  - RIRs note that this is not possible in IPv4 due to historical allocations

Further information

- Document available from
  - http://www.ripe.net/ripe/docs/ipv6-sparse.html
- APNIC IPv6 SIG
  - http://www.apnic.net/meetings
  - http://www.apnic.net/lists

How Long will IPv6 last?

How long will IPv6 last?

- IPv6 address space is not very large, under current allocation policies
  - Total of 36 site addresses per person in 2010 (10 billion population)
- Space will be ‘rapidly’ exhausted, and policies will require review
- How will we do the next transition?
  - Has anyone thought about this?

Thank You

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