

IPv6 Address Management Past, Present and Future

ITU SG2

30 April 2003

Geneva, Switzerland

Anne Lord, APNIC

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

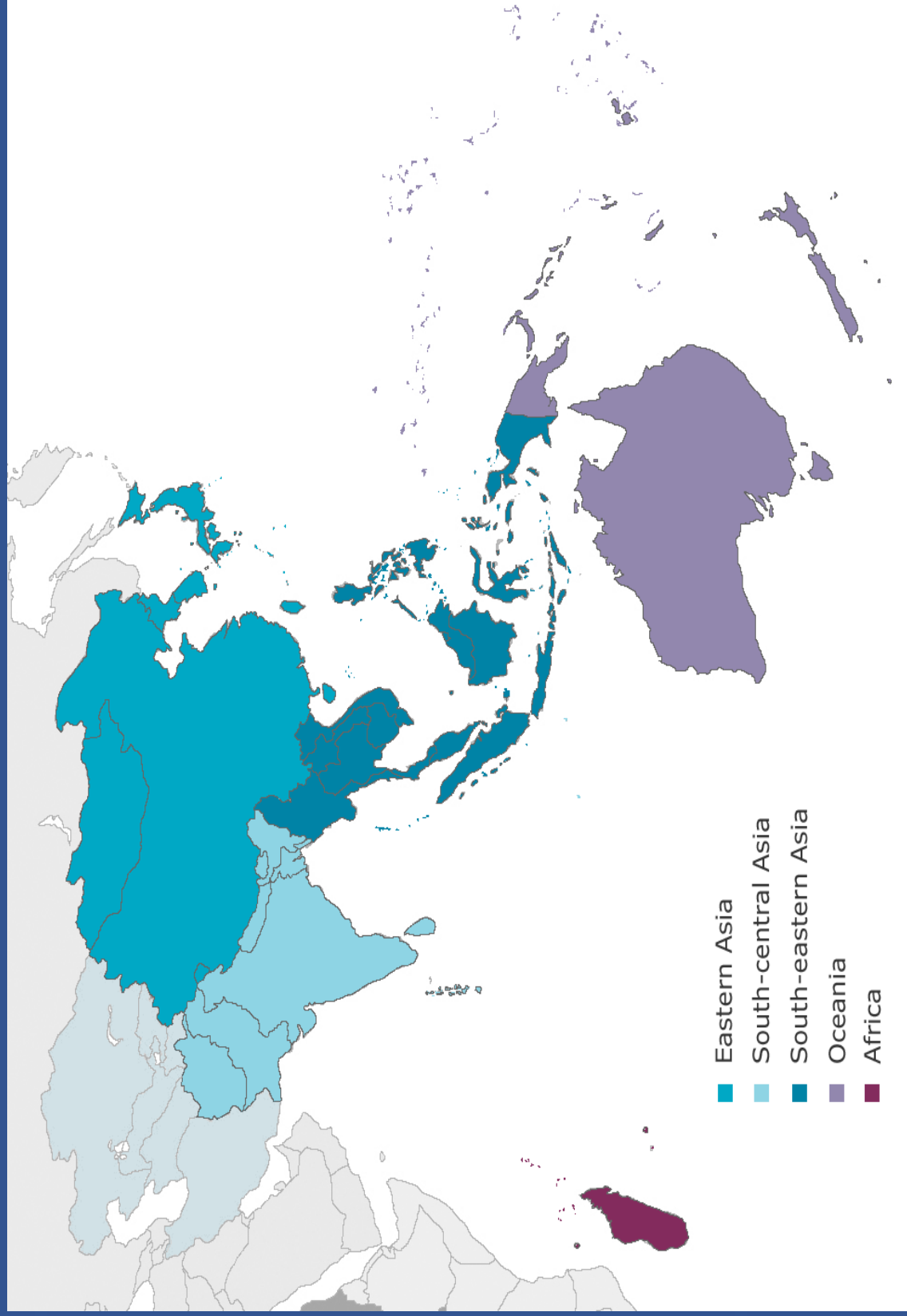
What does APNIC do?

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*)

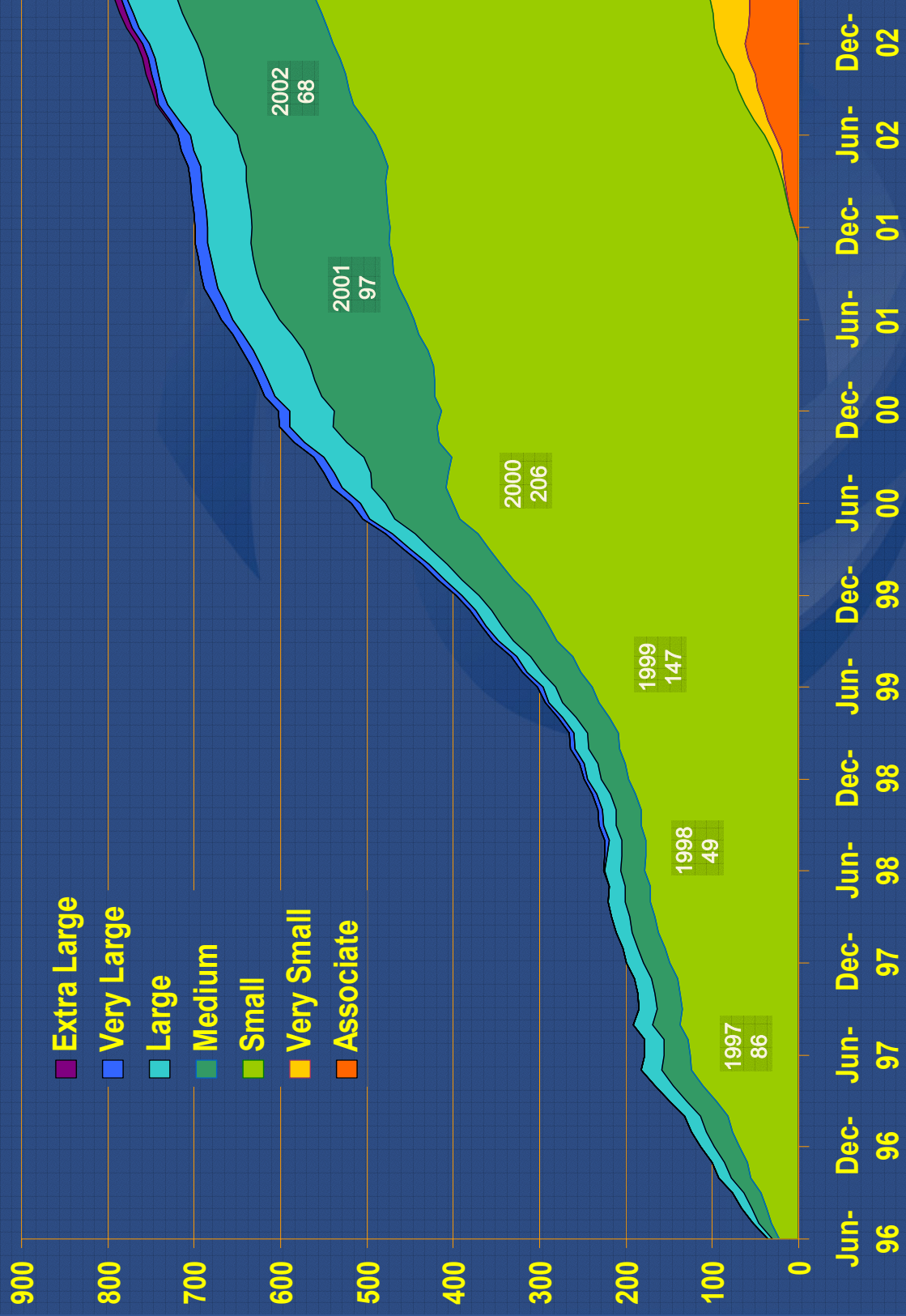
What else does APNIC do?

- 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?

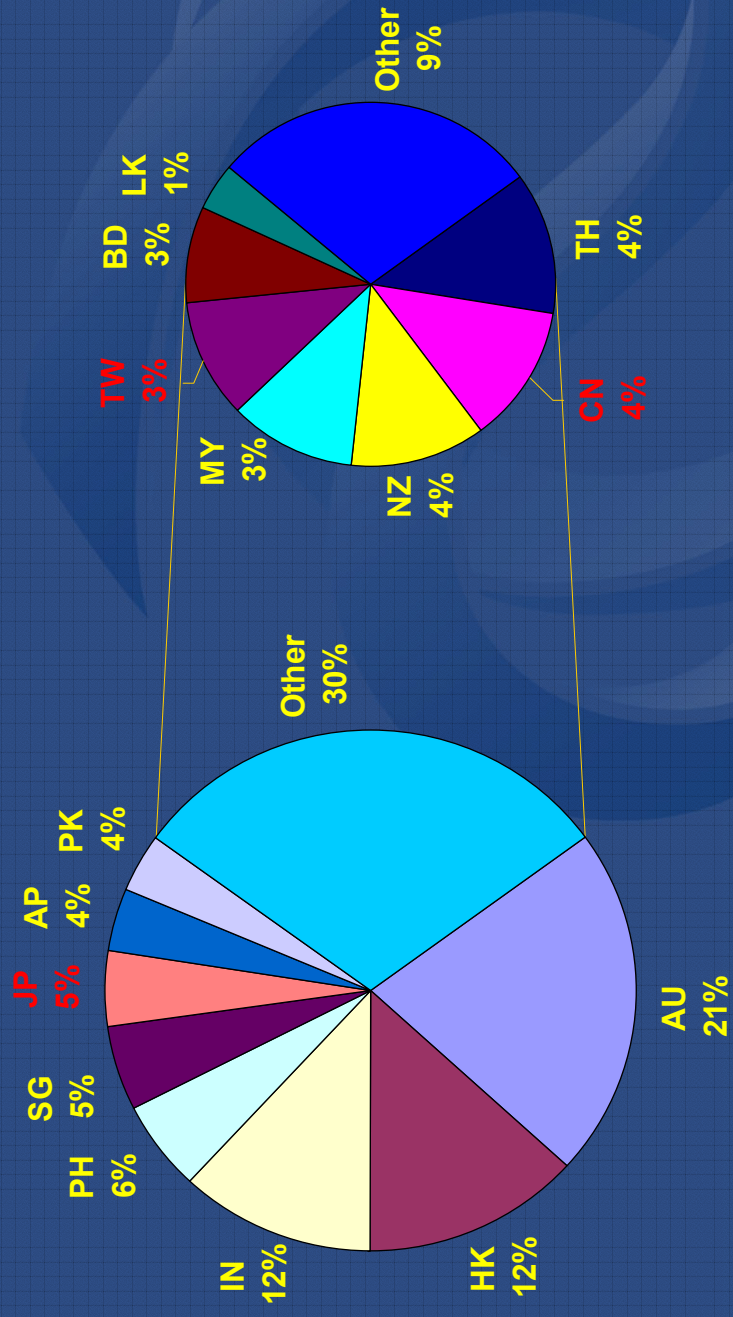


Total APNIC Membership



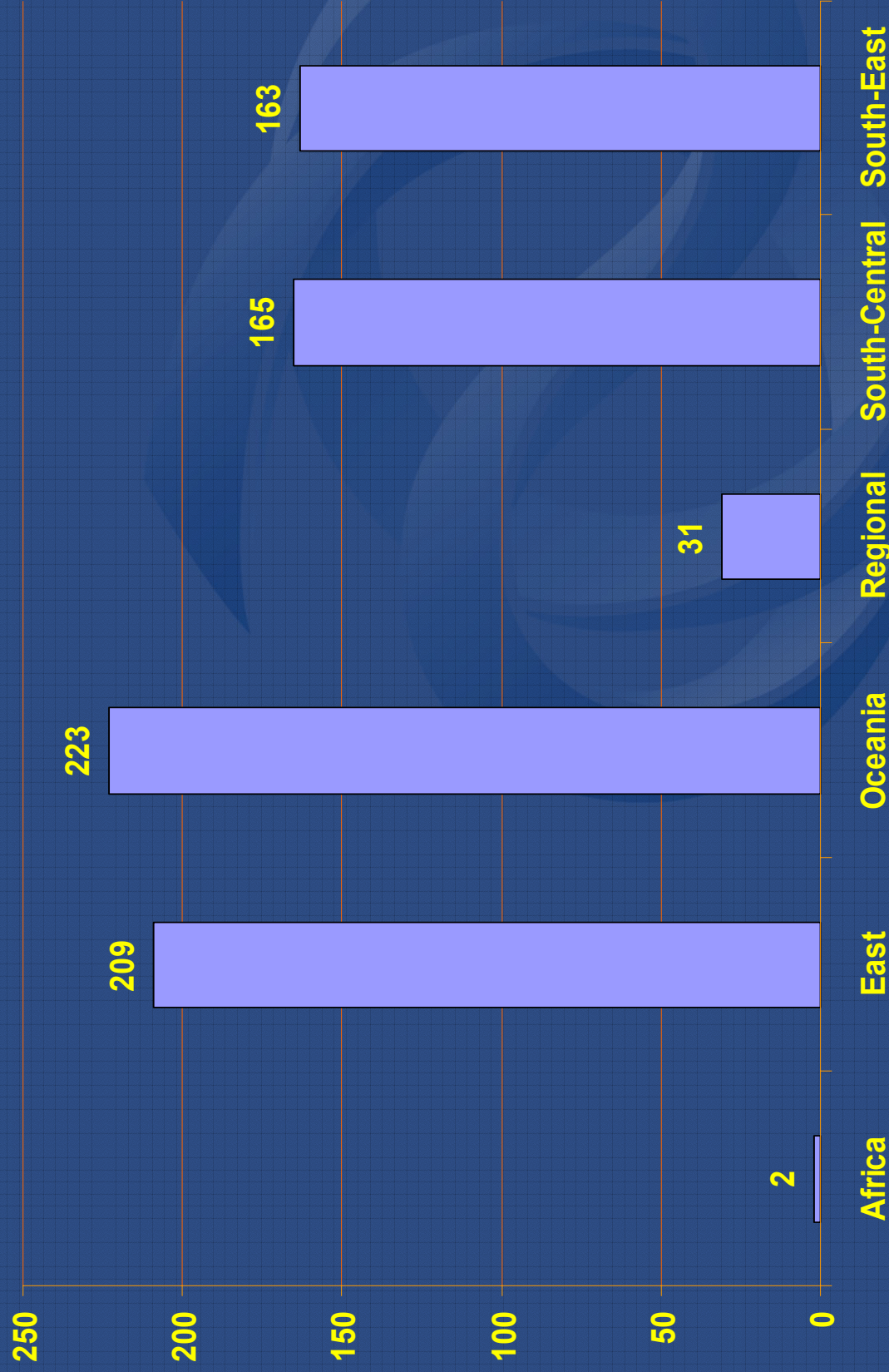


Total APNIC Membership





Sub-regional Distribution



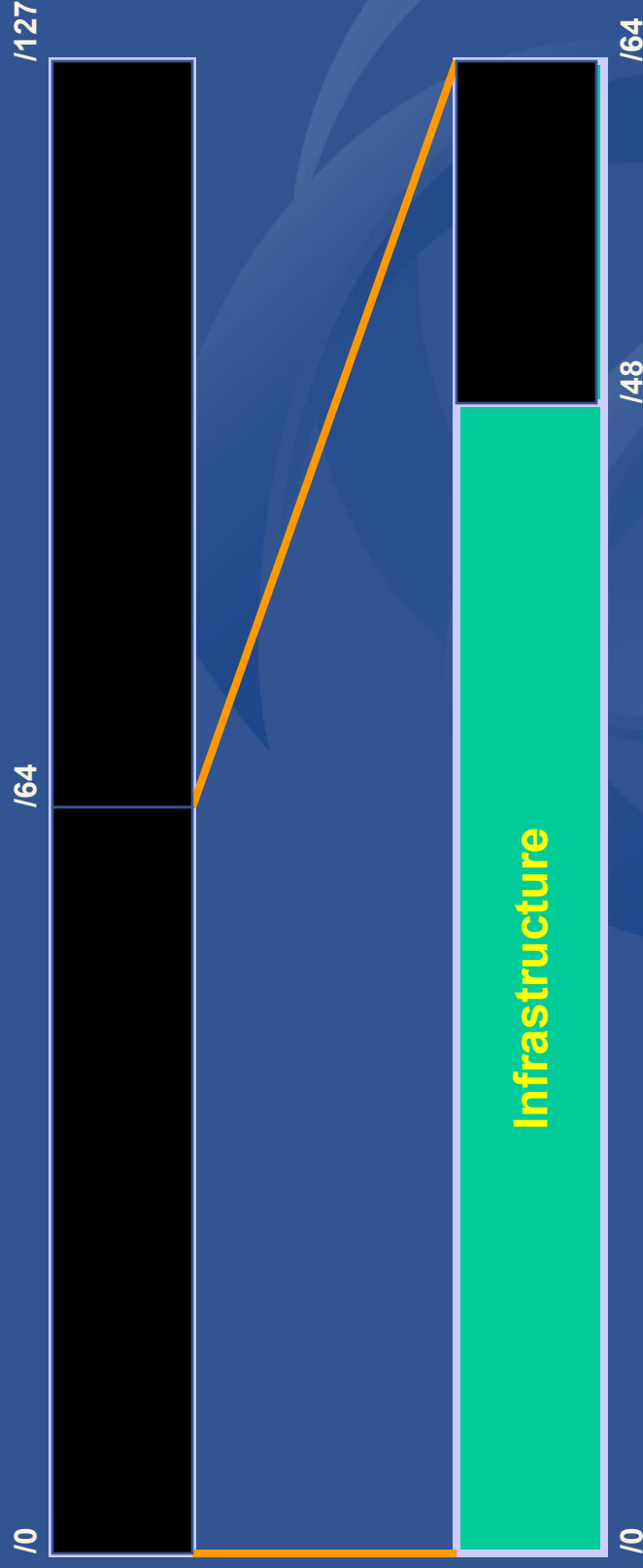


IPv6 Policy Development

IPv6 Policy History

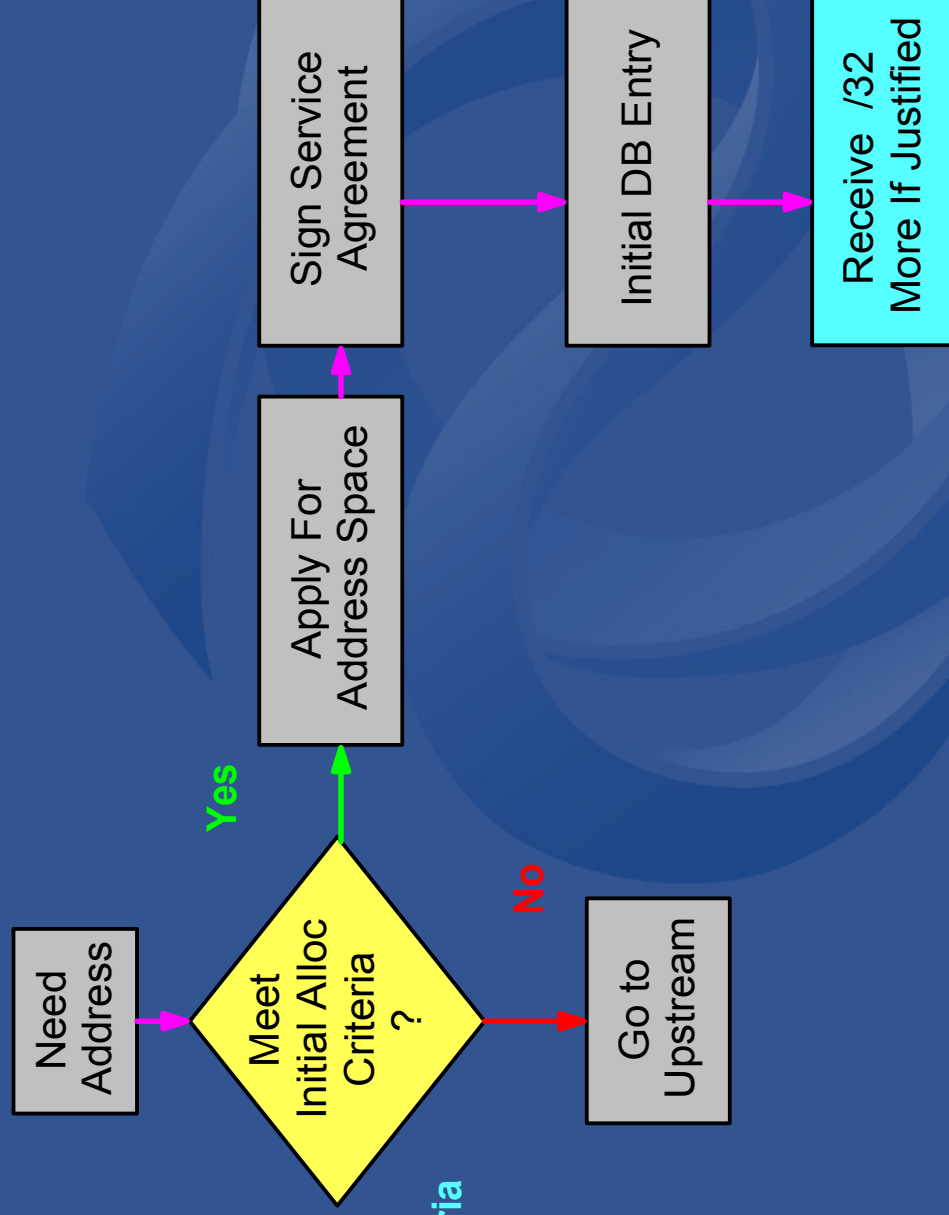
- **Apr 1999** – Joint RIR Consensus
 - Interim policy
 - IPv6 allocations begin
- **Oct 1999** – Policy Review Begins
- **Jul 2001** – Joint RIR Consensus
 - Policy and technical boundaries
 - End site assignments [RFC 3177]
- **May 2002** – Joint RIR Consensus
 - Initial allocation size to ISP/LIR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

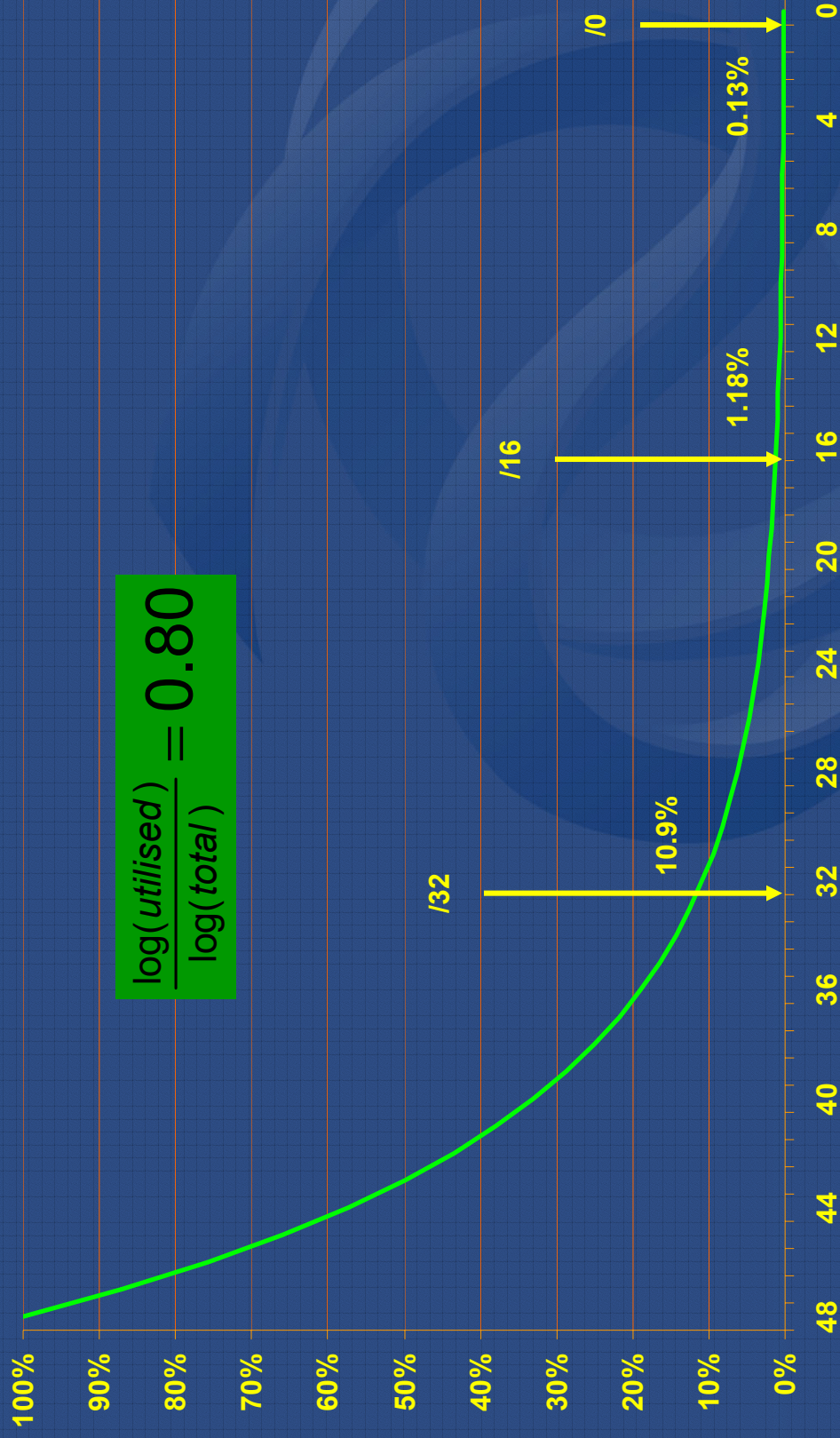
$$Utilisation = \frac{assigned}{available}$$

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

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



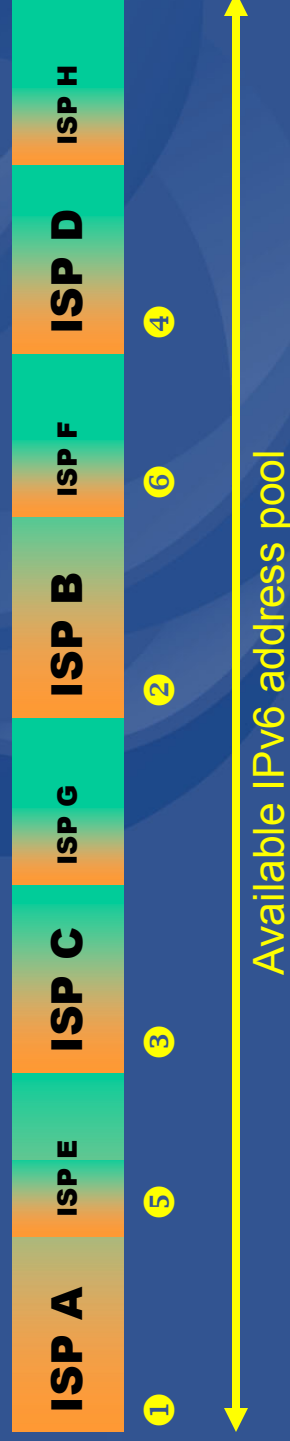
ISP has 2 prefixes after 3 requests!

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

Anne Lord
anne@apnic.net