

System Administration

Week 05, Segment 4.

Networking I: IP Allocation & Exhaustion

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<https://stevens.netmeister.org/615/>

IPv4 Basics

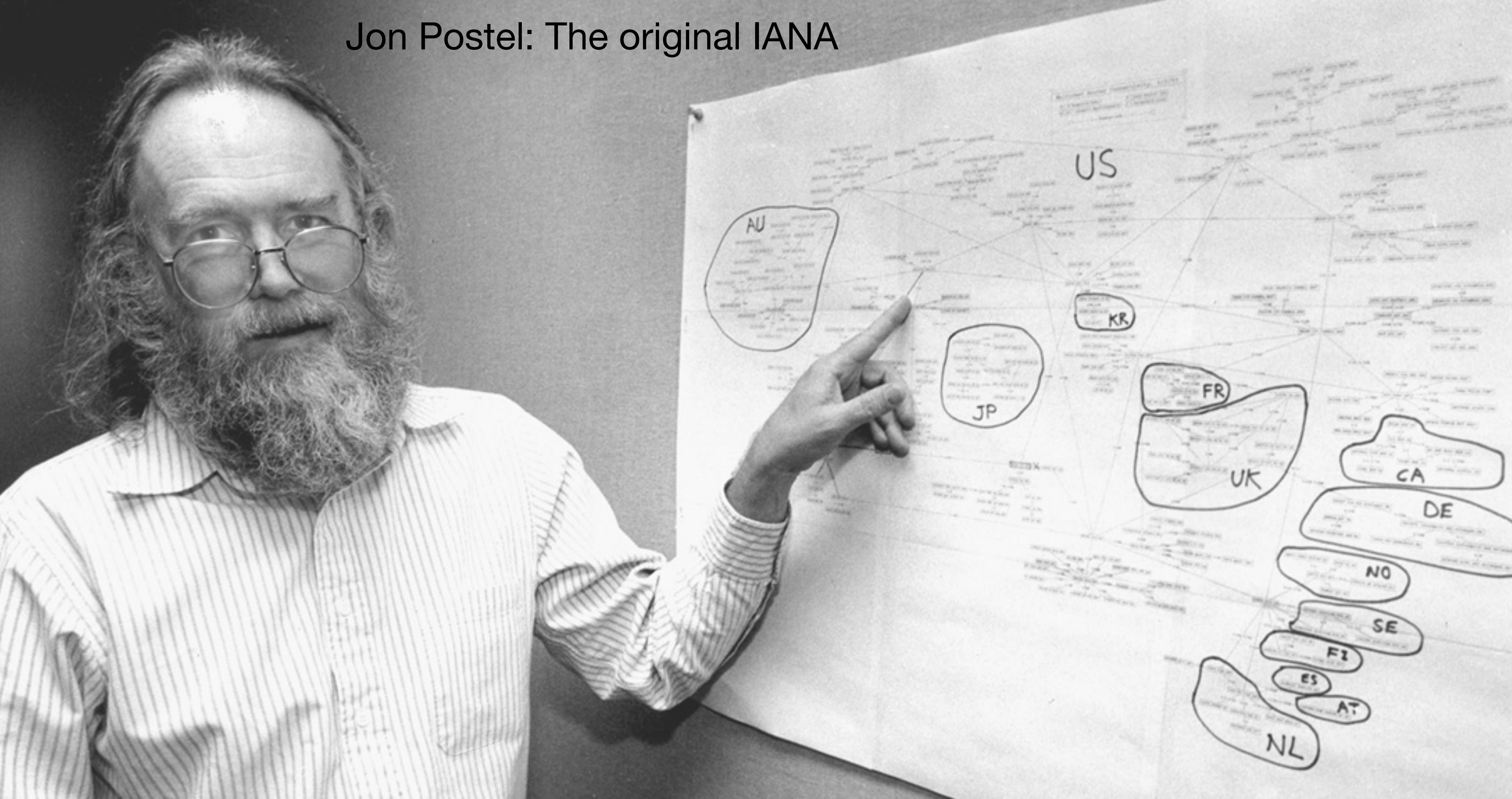
IPv4 addresses are 32-bit numbers...

10011011 11110110 00111000 00001011

...meaning we can have 2^{32} IP addresses:

$$2^{32} = 4,294,967,296$$

Jon Postel: The original IANA

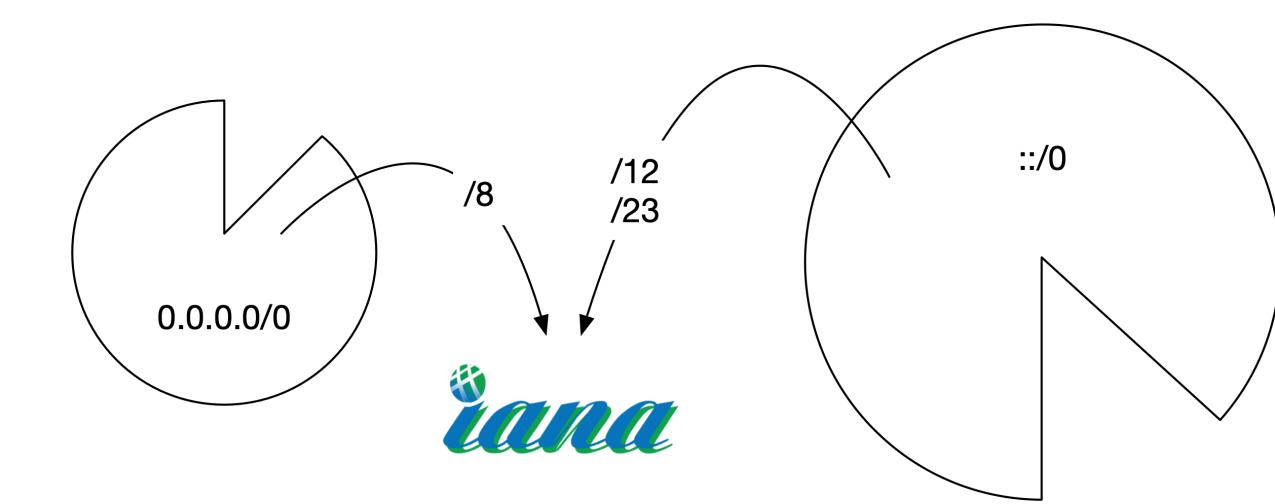


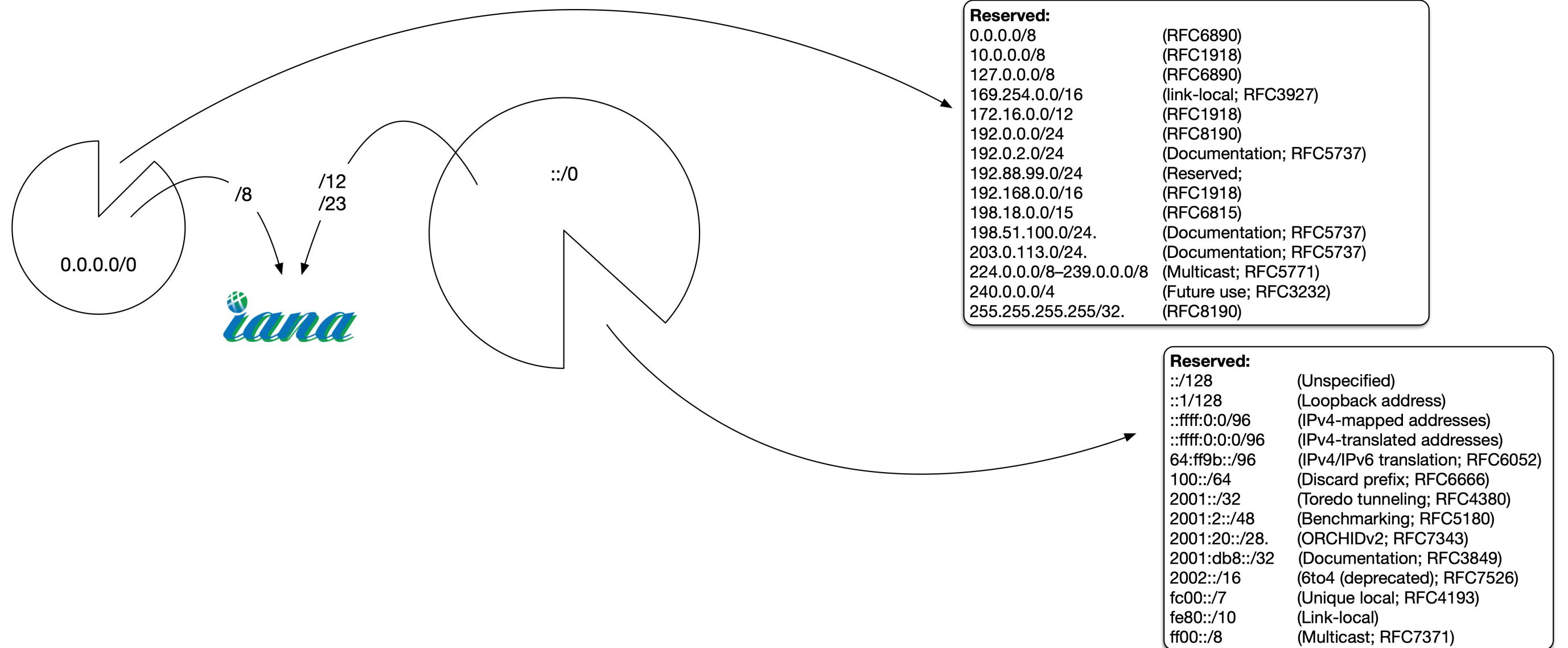
Internet Governance I: IANA



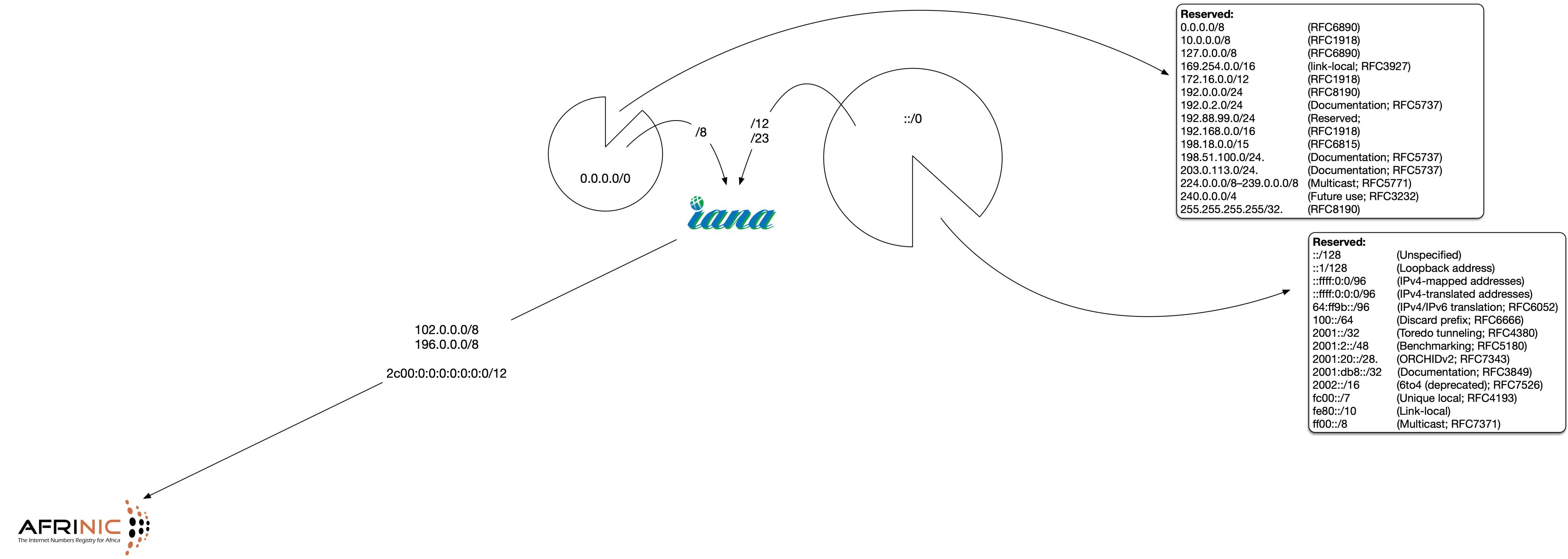
<https://www.iana.org/>

**The Internet Assigned Numbers Authority (IANA)
oversees global IP address/AS number allocation, root
zone management etc.**

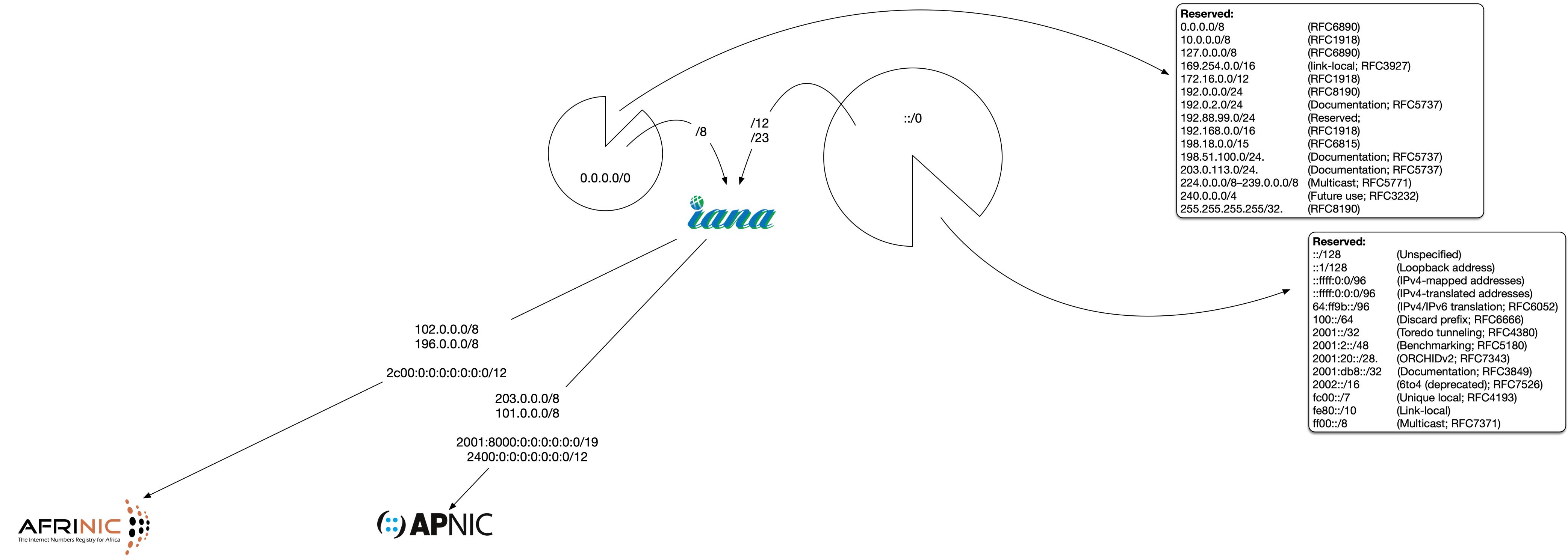




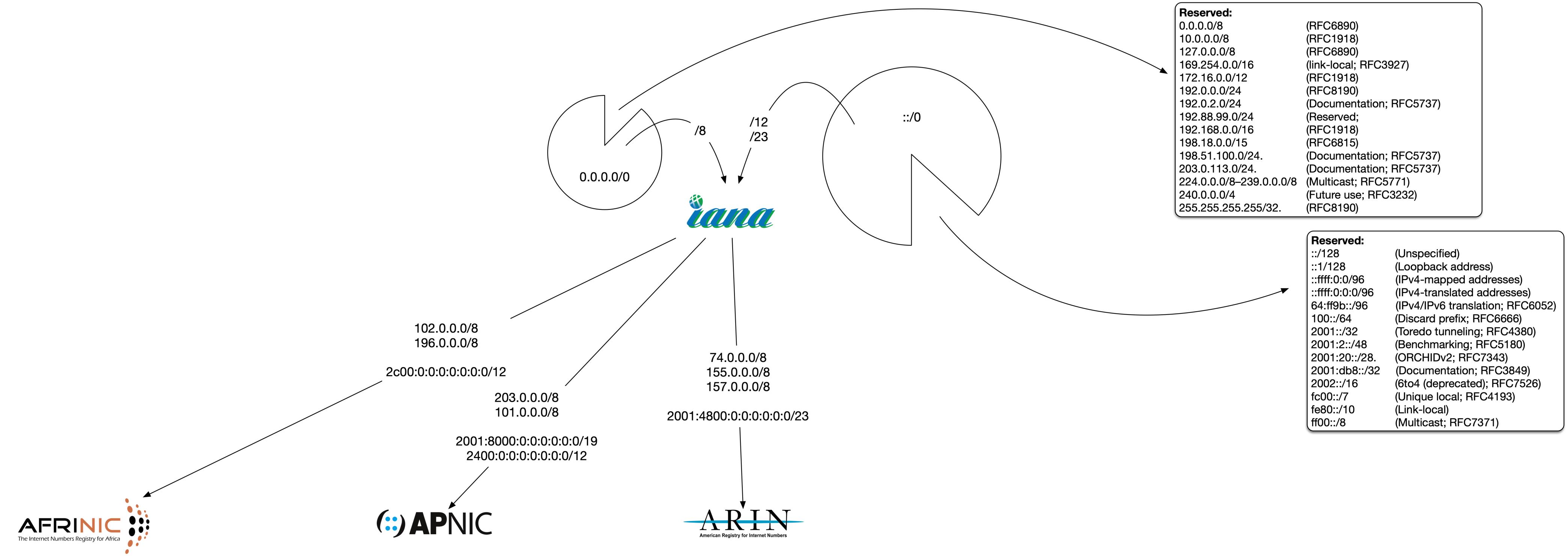
RIR = Regional Internet Registry



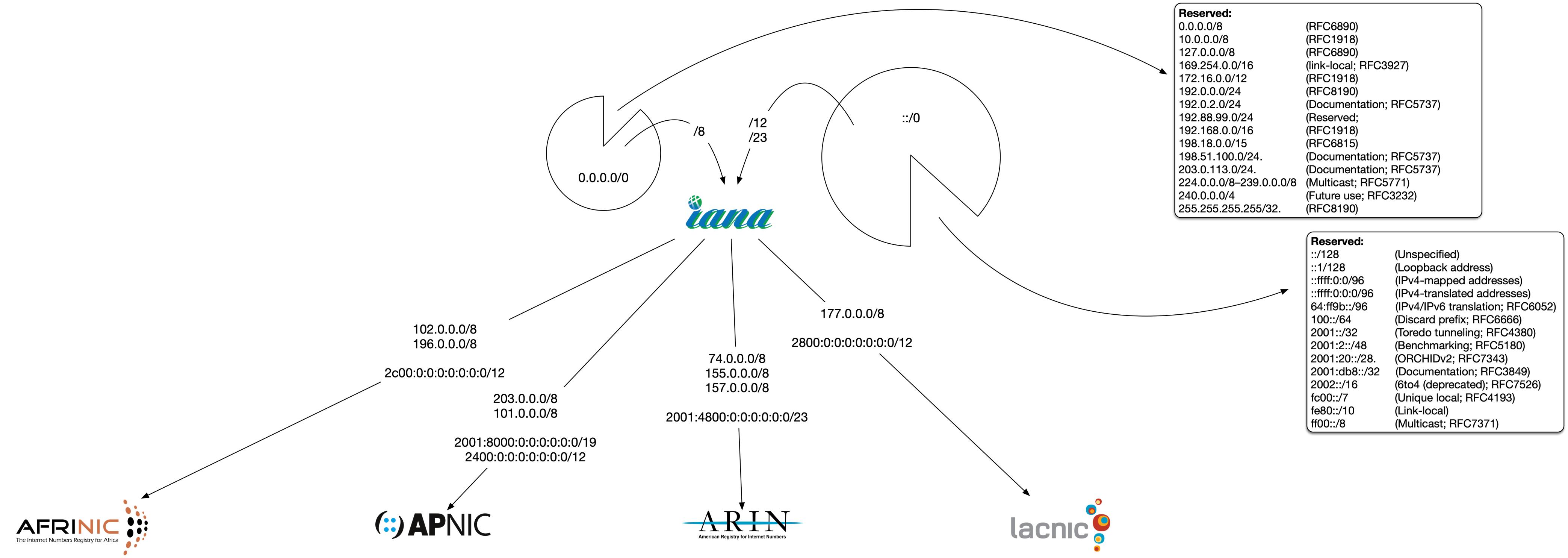
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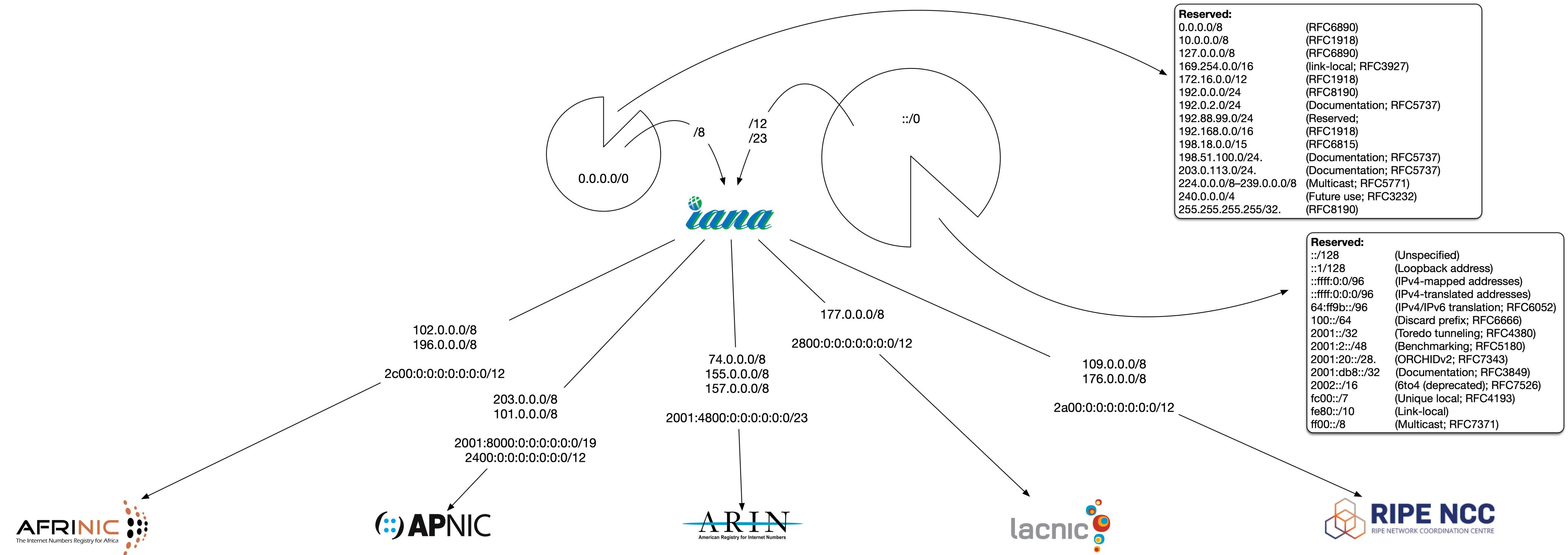
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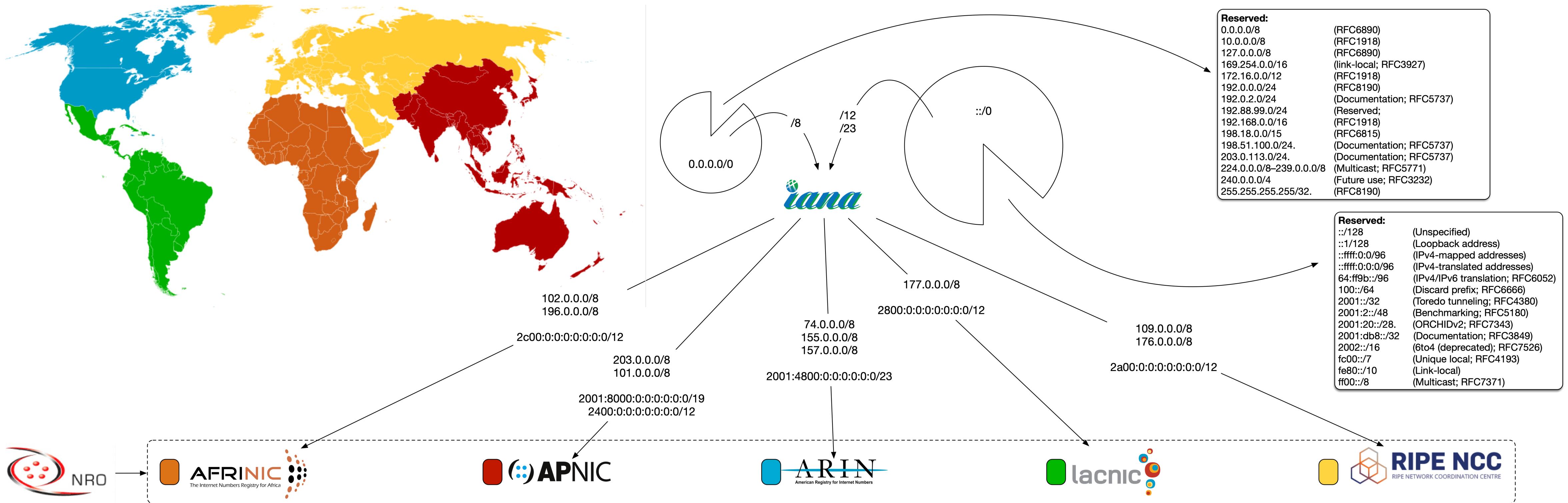


RIR = Regional Internet Registry



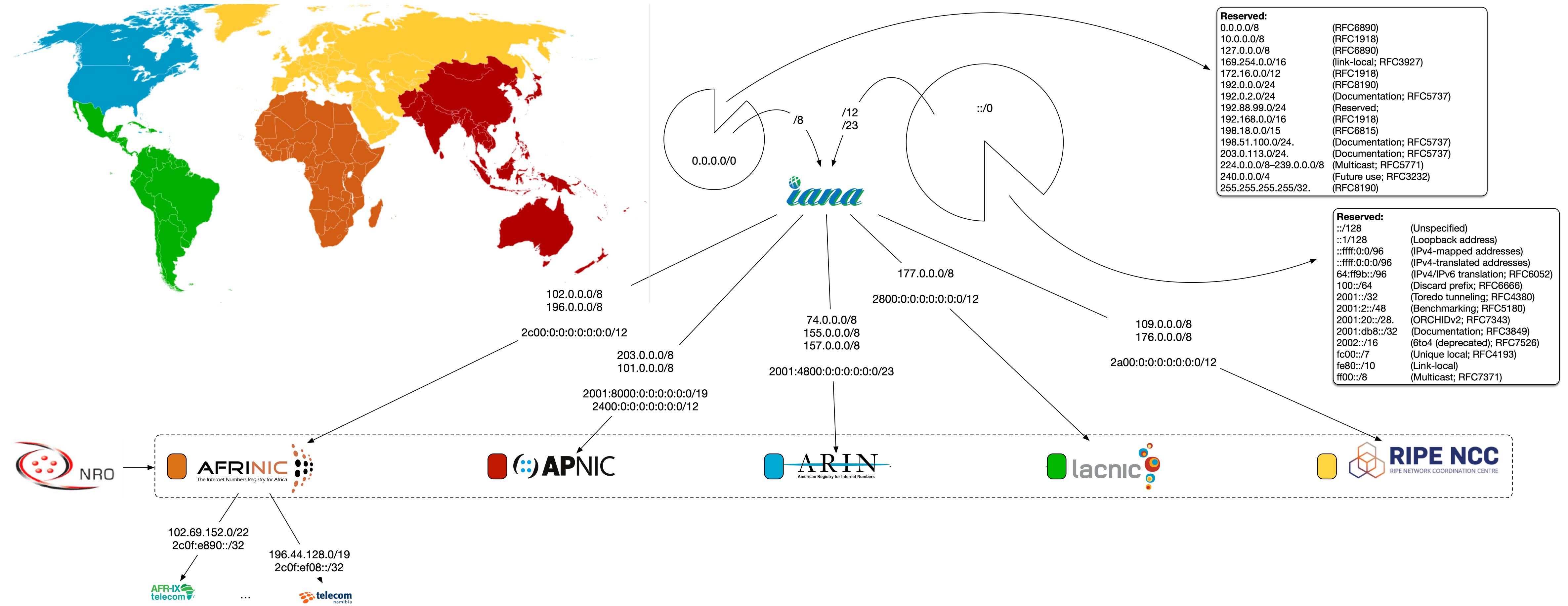
See also: <https://xkcd.com/195/>

RIR = Regional Internet Registry



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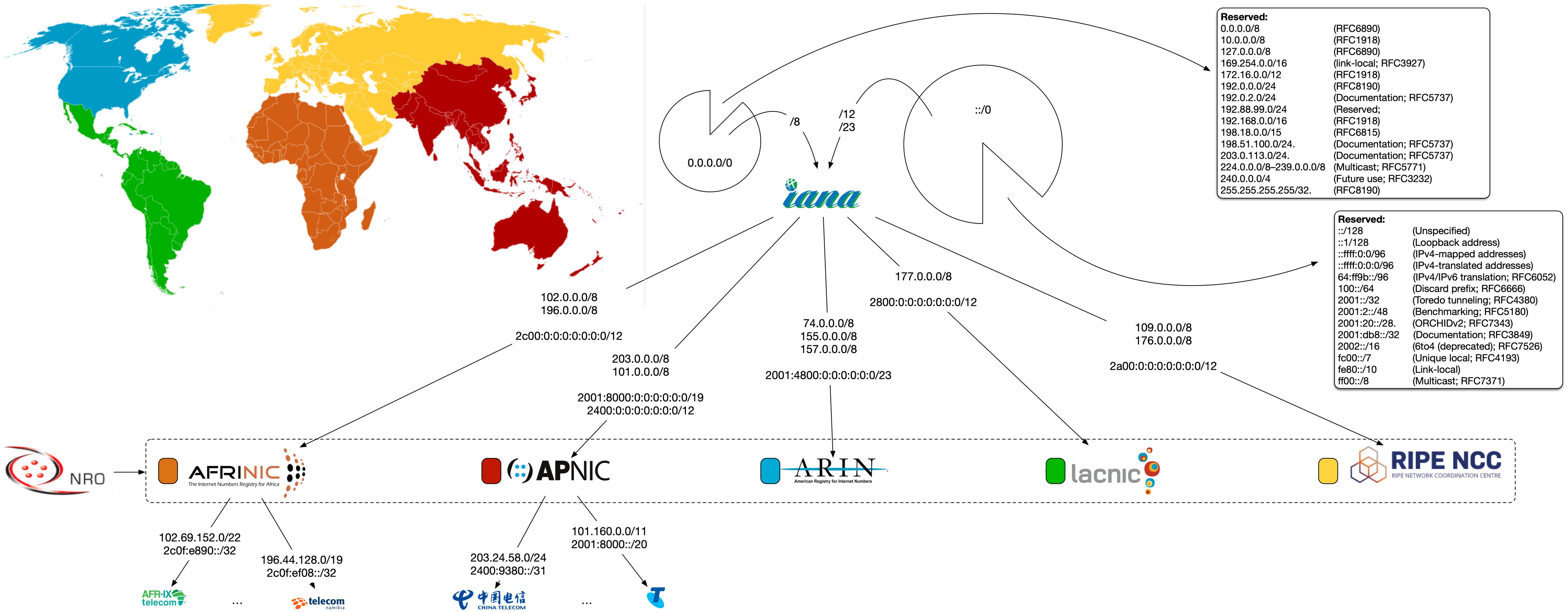
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LIR = Local Internet Registry

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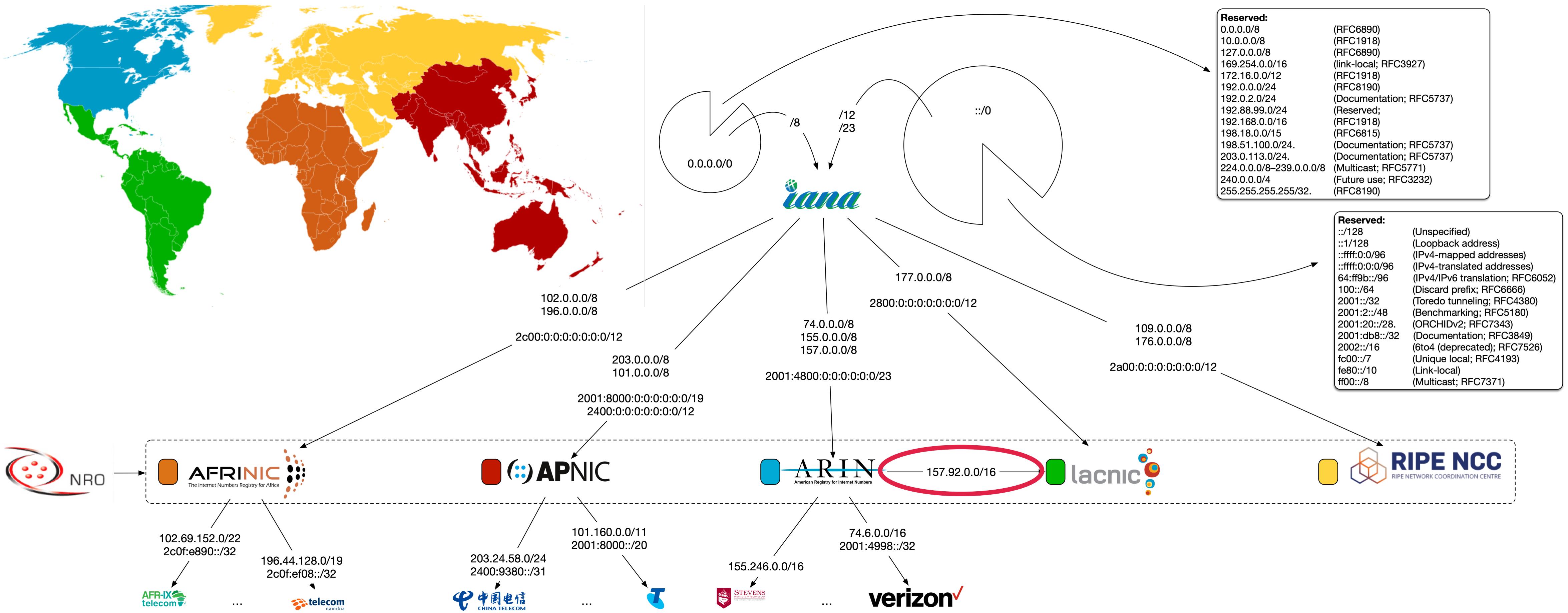
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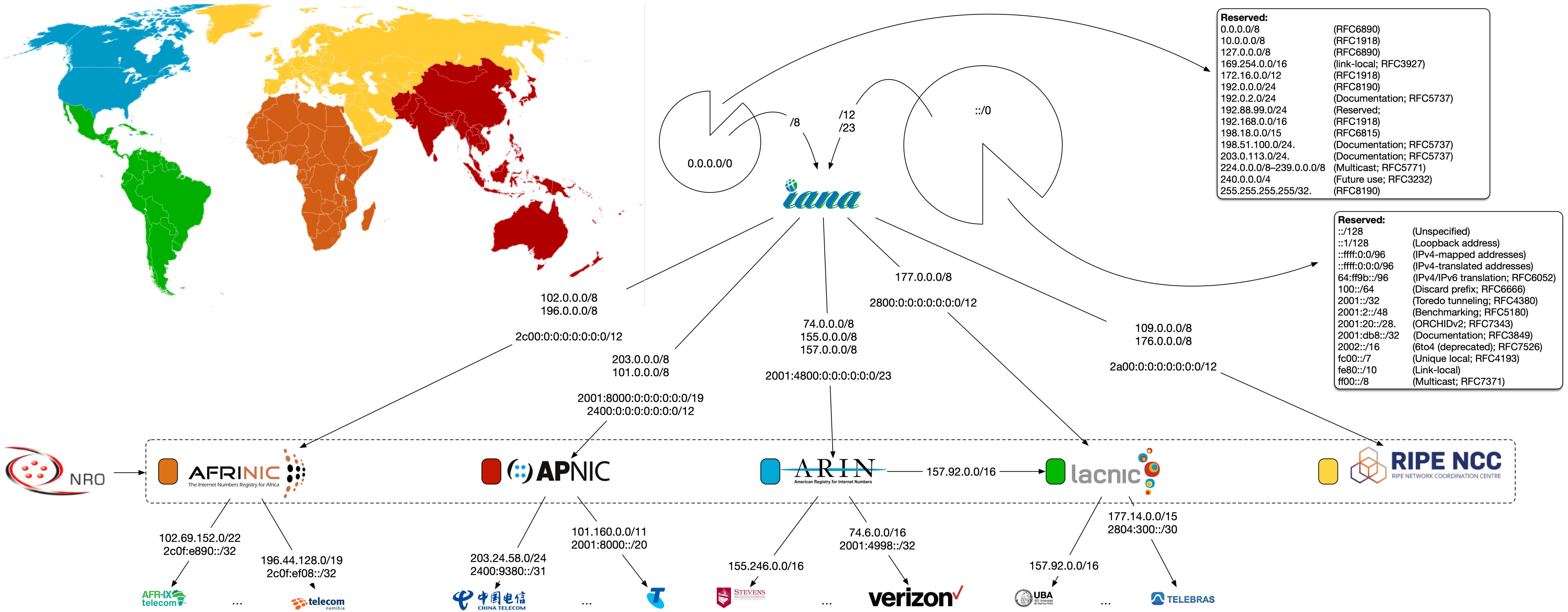
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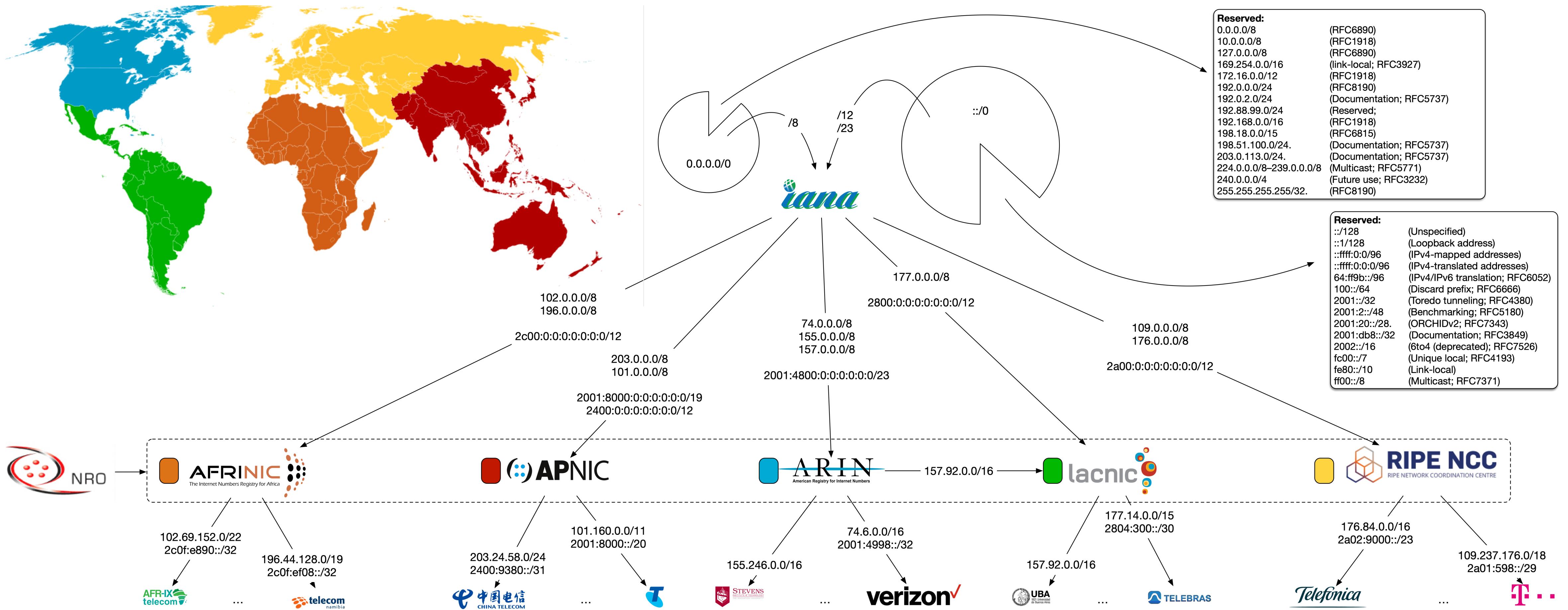
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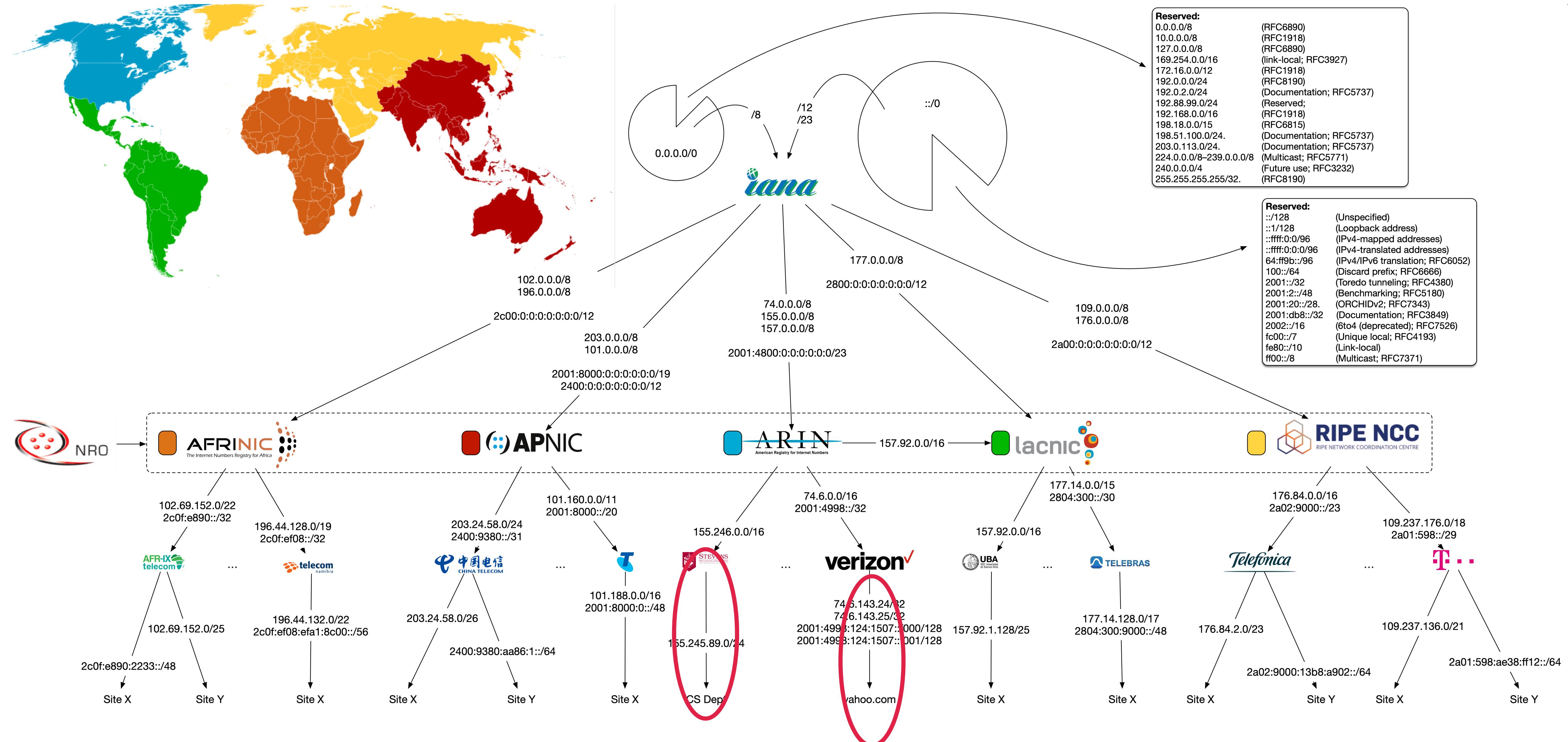
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10011011	11110110	00111000	00001011					
					/32	Host route		
					/30	"Glue network" (Point-to-point)		
					/29	Smallest multi-host network		
					/28	Small LAN		
					/27	Small LAN		
					/26	Small LAN		
					/25	Large LAN		
					/24	Large LAN		
					/20	Small ISP / Large business		
					/19	LIR / ISP / Large business		
					/18	LIR / ISP / Large business		
					/17	LIR / ISP / Large business		
					/16	LIR / ISP / Large business		
					/8	RIR		

IPv4 Basics

A screenshot of a Twitter card. The card has a light gray background with rounded corners. At the top left is a circular profile picture of Jan Schaumann. To the right of the picture is the name "Jan Schaumann" in bold black font, followed by the handle "@jschauma". At the top right is the Twitter logo. Below the profile information is the tweet text: "Don't believe there's nothing as permanent as a temporary solution? Vint Cerf chose 32 bits for IPv4 in 1976: "enough to do an experiment"". Underneath the tweet text is the timestamp "1:16 AM · Mar 31, 2014". To the right of the timestamp is a small circular icon with an "i" inside. At the bottom of the card are engagement metrics: a heart icon with the number "107", a speech bubble icon with the number "197", and a link icon with the text "Copy link to Tweet".

Jan Schaumann
@jschauma

Don't believe there's nothing as permanent as a temporary solution? Vint Cerf chose 32 bits for IPv4 in 1976: "enough to do an experiment"

1:16 AM · Mar 31, 2014

107 197 Copy link to Tweet

<https://twitter.com/jschauma/status/450441590302318592>

IPv4 Exhaustion

Approximately 13% of the entire IPv4 space!

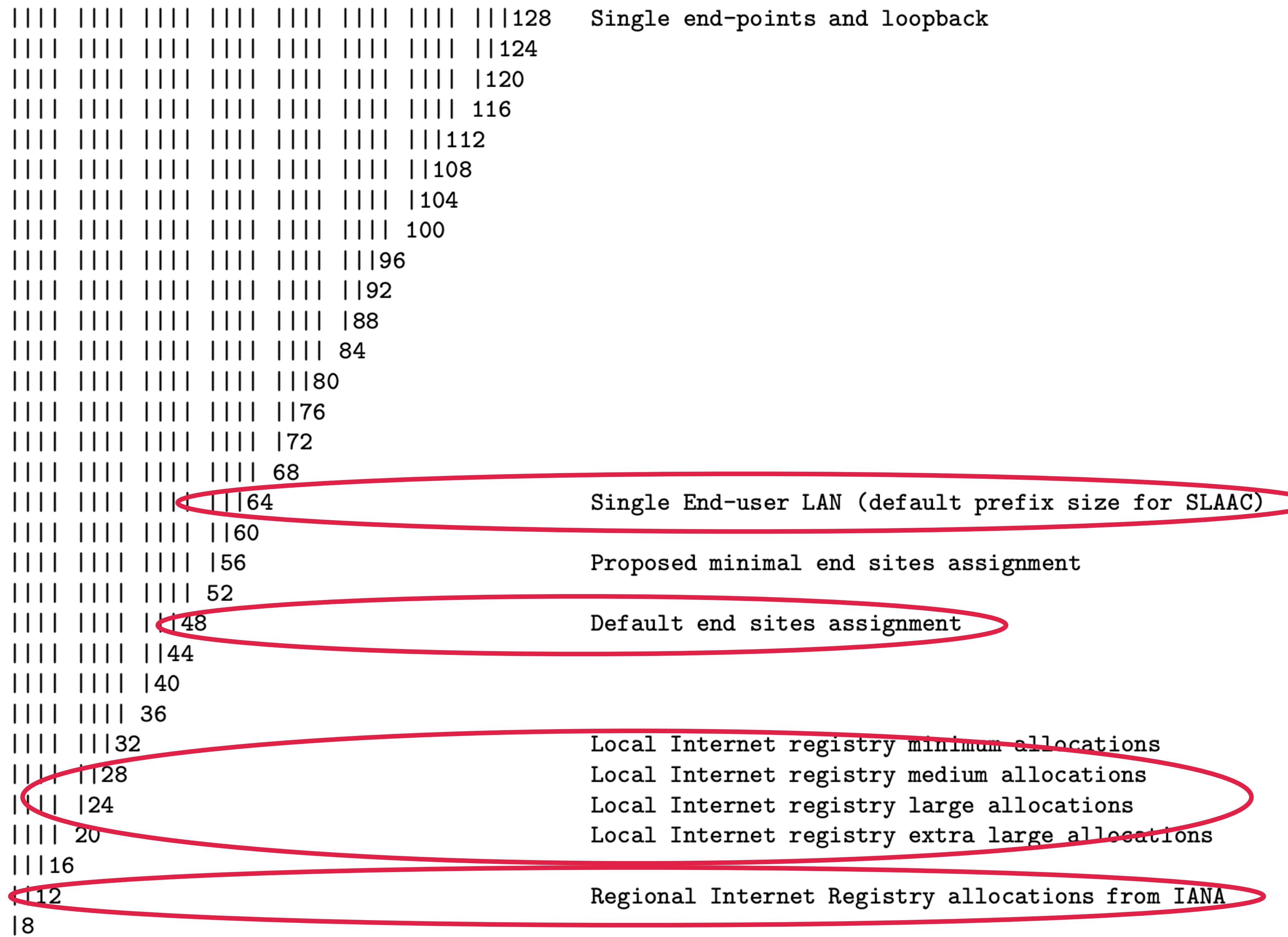
- private IP space (RFC1918): 10.0.0.0/8, 172.16.0.0/12, 192.168.0.0/16
- Otherwise reserved (RFC5735, etc.): 0.0.0.0/8, 100.64.0.0/10, 127.0.0.0/8,
169.254.0.0/16, 192.0.0.0/24, 192.0.2.0/24, 192.88.99.0/24,
198.18.0.0/15, 198.51.100.0/24, 203.0.113.0/24
- class D (224.0.0.0/4) and E (240.0.0.0/4)
- class As (16M addresses each!) initially handed out liberally to e.g., ATT, Apple,
MIT, Stanford, Xerox, ...
- subnetting often inefficient
- IoT does – once again – not help at all

IPv4 Exhaustion

- IANA Address Pool Exhaustion: 2011-02-03
- APNIC reached final /8: 2011-04-19
- RIPE NCC reached final /8: 2012-09-14
- LACNIC reached final /8: 2014-06-10
- ARIN reached final /8: 2015-09-24
- AFRINIC reached final /11: 2020-01-13

Pssst, IPv6 was introduced in RFC1883 in 1995...

2001:0db8:0123:4567:89ab:cdef:1234:5678



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...meaning we can have 2^{32} IP addresses:

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Examples

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Step-by-Step Solutions



Elementary Math



Algebra



Plotting & Graphics

Science & Technology ▾



Units & Measures



Physics



Chemistry



Engineering

Society & Culture ▾



People



Arts & Media



Dates & Times



Words & Linguistics

Everyday Life ▾



Personal Health



Personal Finance



Surprises



Entertainment

Exercises

- Pick a few well-known internet sites – can you find out what IP blocks they have allocated?
- Try to identify a popular ISP in each geographical region; can you identify net blocks they have been assigned and how they divide them to their customers?
- Review IPv4 exhaustion counters and stats at AFRINIC, the last RIR to exhaust its assigned space. How many IPv4 IPs are still available to its customers?
- IPv4 addresses now being a scarce (and thus valuable) resource, research which private companies own the largest chunks and how companies trade net blocks.

Coming up: the physical internet, or “Just how, exactly, do we get bits from, say, New Jersey to Europe, Africa, or South America?”

Links

- IANA Wikipedia Page:
https://en.wikipedia.org/wiki/Internet_Assigned_Numbers_Authority
- Regional Internet Registry Wikipedia Page:
https://en.wikipedia.org/wiki/Regional_Internet_registry
- List of reserved IPv4 /8 address blocks:
https://en.wikipedia.org/wiki/List_of_assigned_/_8_IPv4_address_blocks
- IANA IPv4 Address Space Registry:
<https://www.iana.org/assignments/ipv4-address-space/ipv4-address-space.xhtml>
- Map of the Internet:
<https://xkcd.com/195/>