IPv6 Address Management:

is there a better way?

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Overview

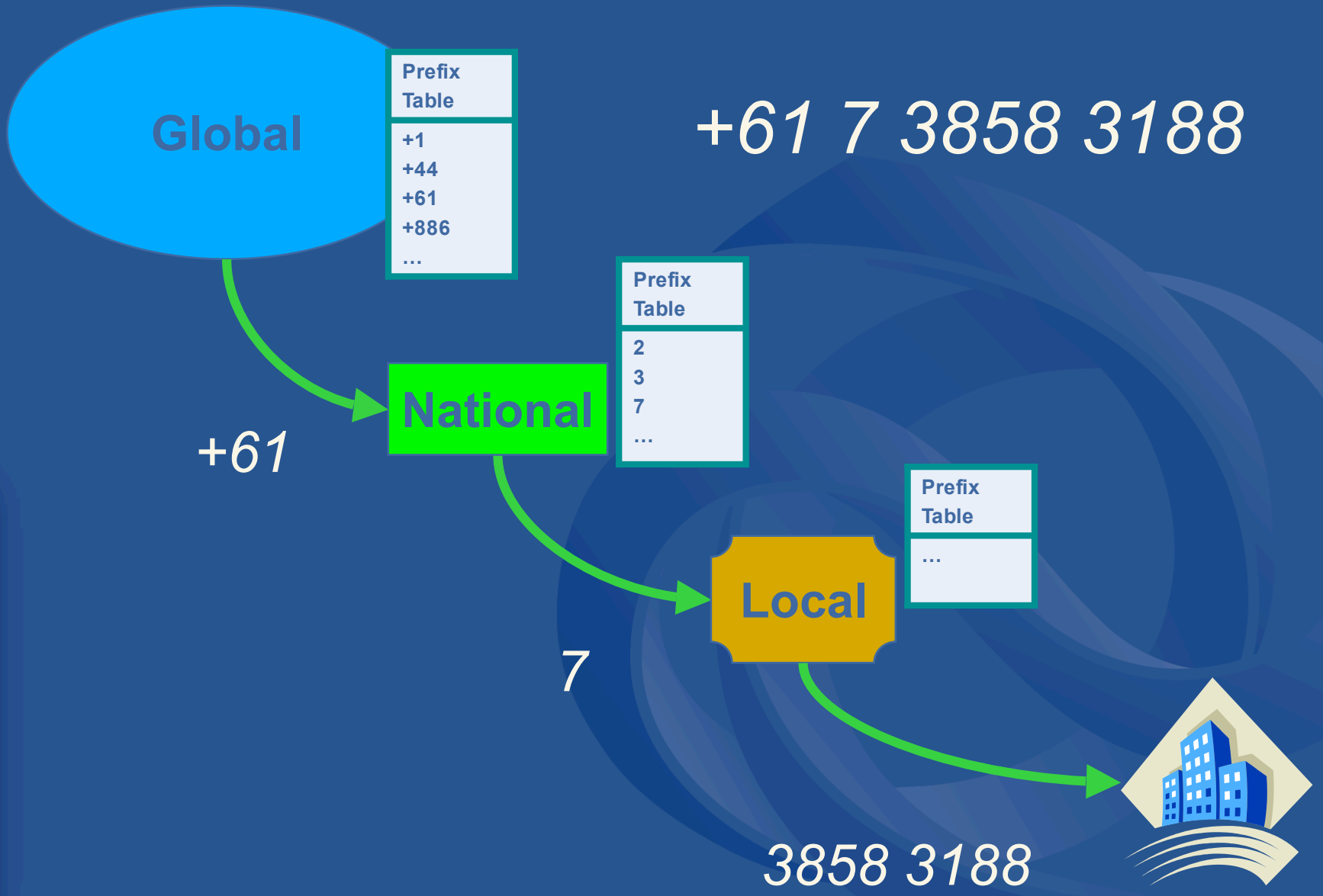
- Introduction
  - What is an IP address?
  - IP address routing
- How are IP addresses managed?
  - Administrative and Operational views
- Internet architecture and geography
- Can we do it better?
- Conclusion

What is an IP Address?

What is an Address?

- *An identifier which includes information about how to find its subject*
  - (according to some rules of interpretation)
- Normally hierarchical
  - Each part provides more specific detail
- For example…
  - +61 7 3858 3188
  - www.apnic.net
  - pwilson@apnic.net
  - 202.12.29.142

Telephone Network Routing

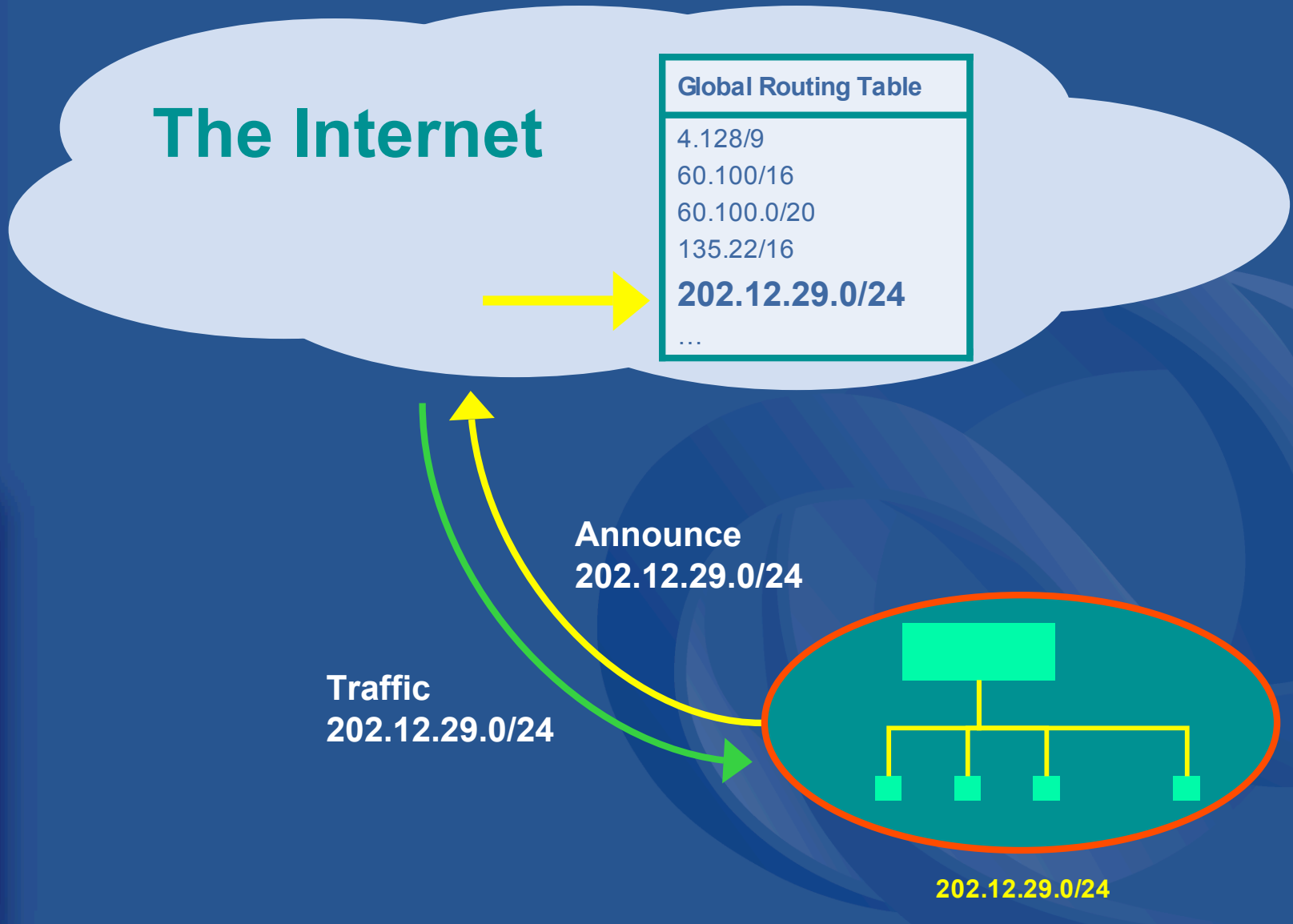


What is an IP Address?

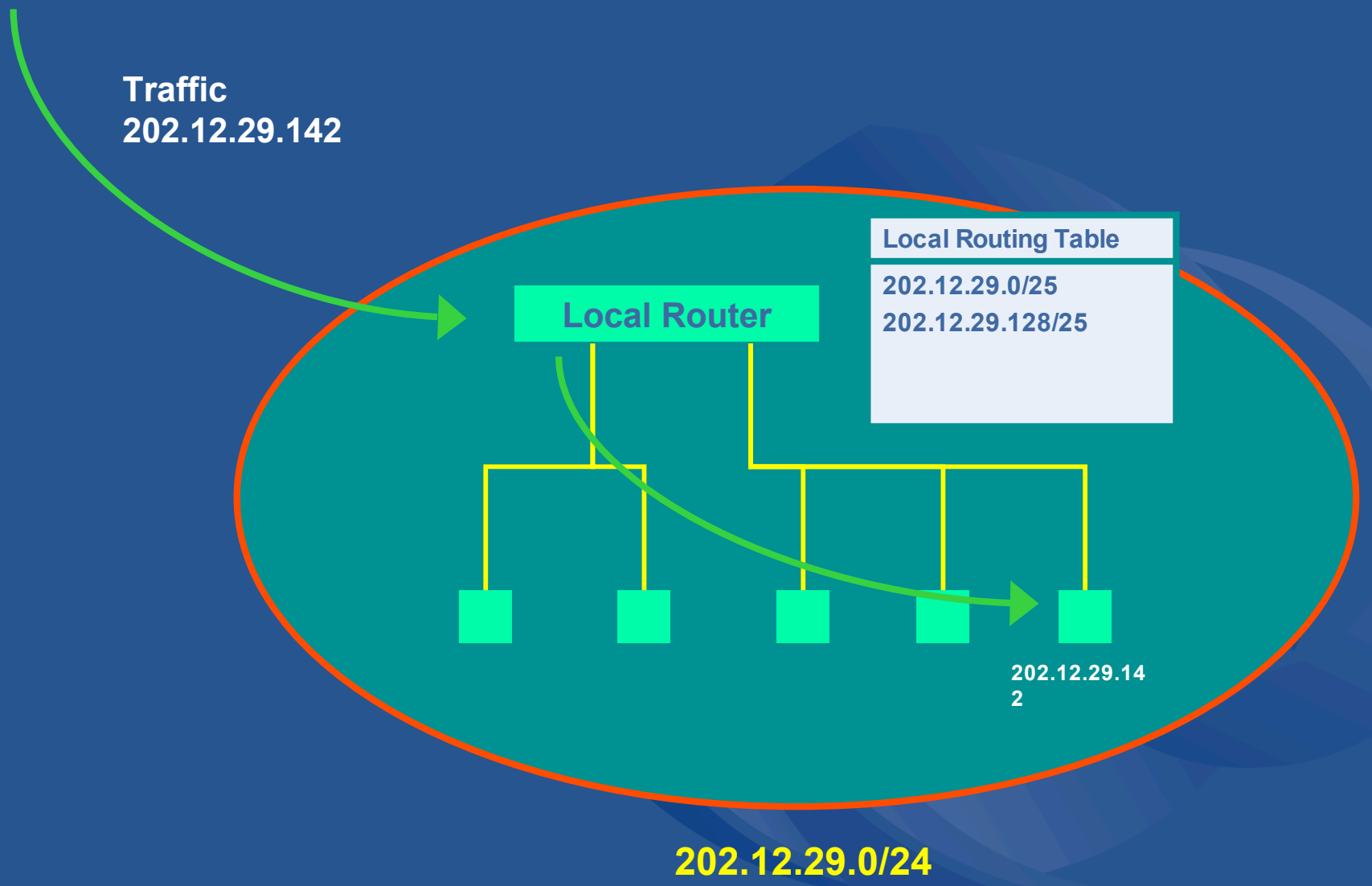
- *Internet identifier including information about how to reach a network location*
  - (via the Internet routing system)
- IPv4: 32-bit* number
  - 4 billion different addresses available
  - E.g. 202.12.29.142
- IPv6: 128-bit* number
  - 16 billion billion addresses available
  - E.g. 2001:0400:3c00::

* bit = binary digit

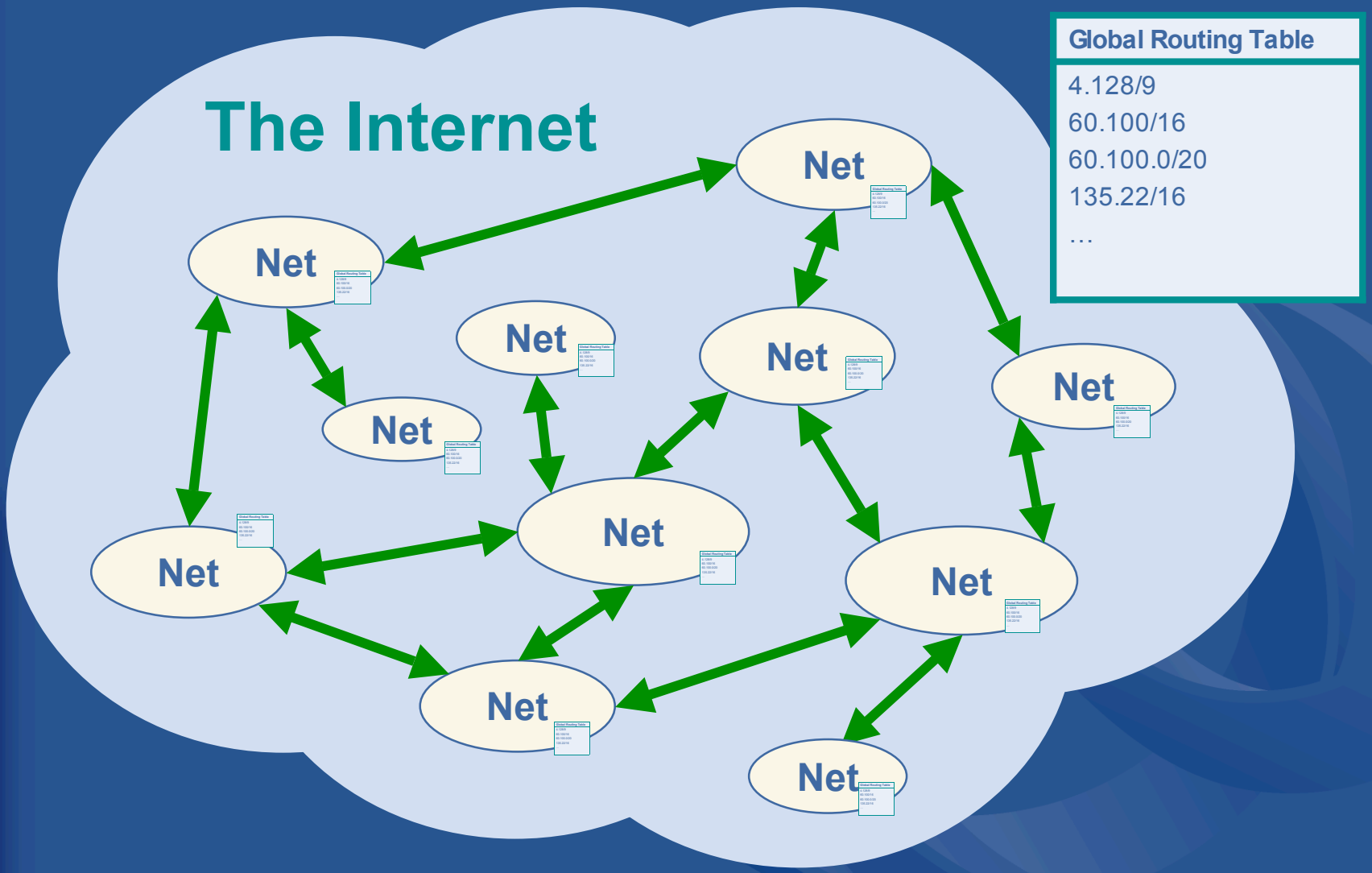
Internet Address Routing



Internet Address Routing



Global Internet Routing

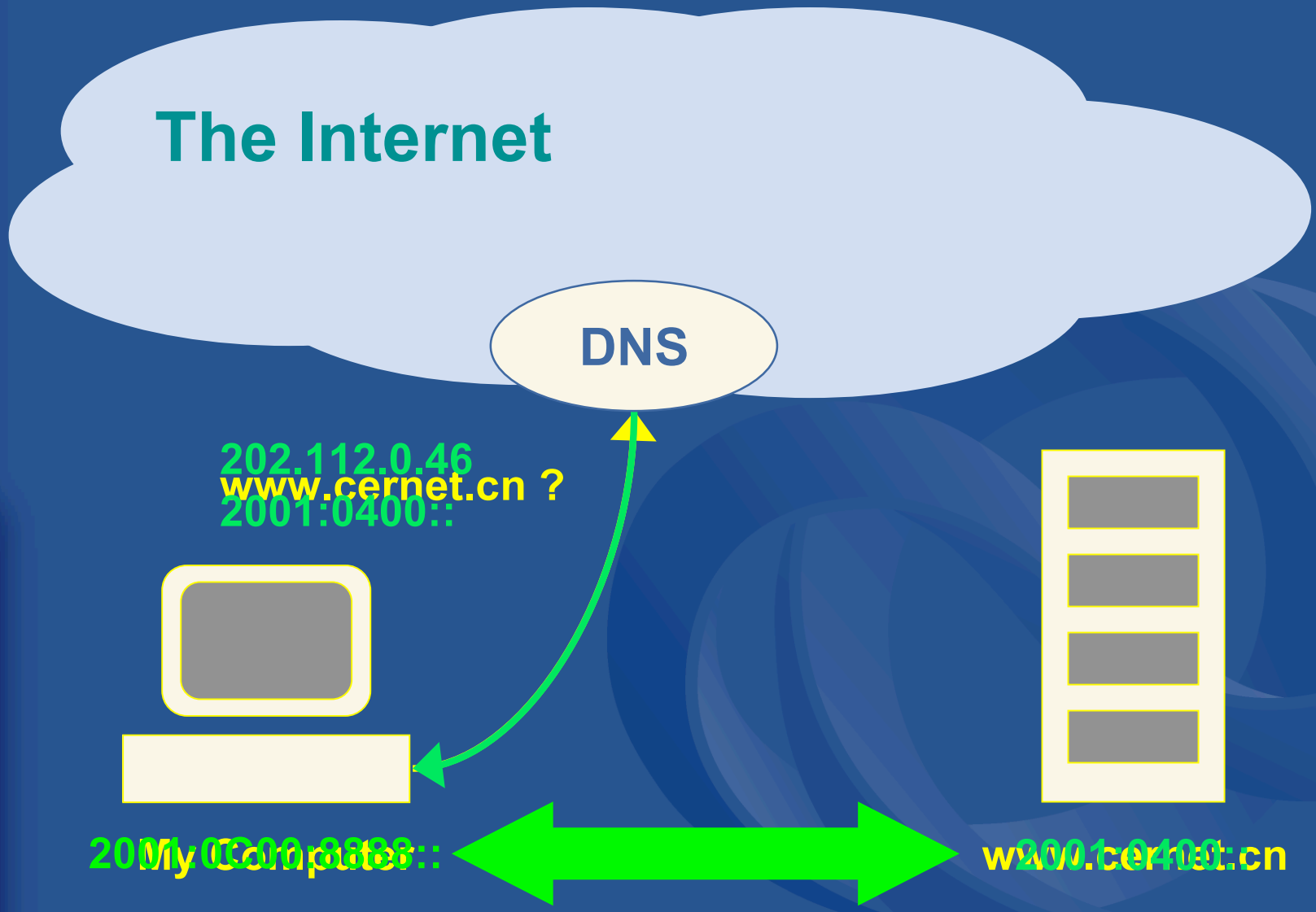


What else is an IP Address?

- Internet infrastructure addresses
- Uniquely assigned to infrastructure elements
- Globally visible to the entire Internet
- A finite “Common Resource”
- Never “owned” by address users

- Not dependent upon the DNS

IP addresses are not domain names…



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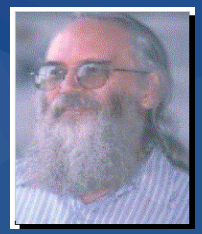
How are IP Addresses managed?

Administrative view

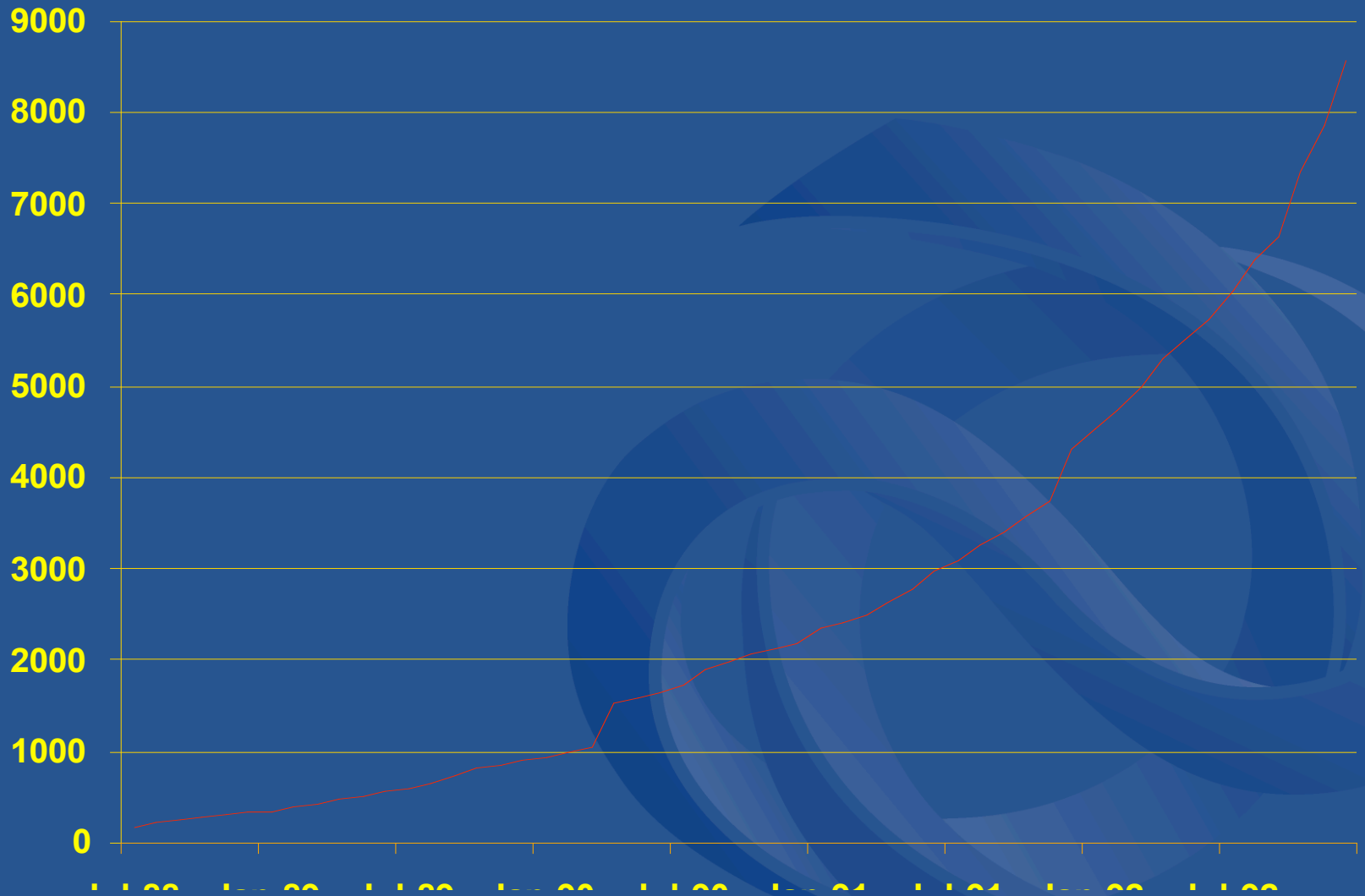
The early years: 1981 – 1992

1981:

"The assignment of numbers is also handled by Jon. If you are developing a protocol or application that will require the use of a link, socket, port, protocol, or network number **please contact Jon to receive a number assignment**." (RFC 790)



Global Routing Table: ’88 - ’92



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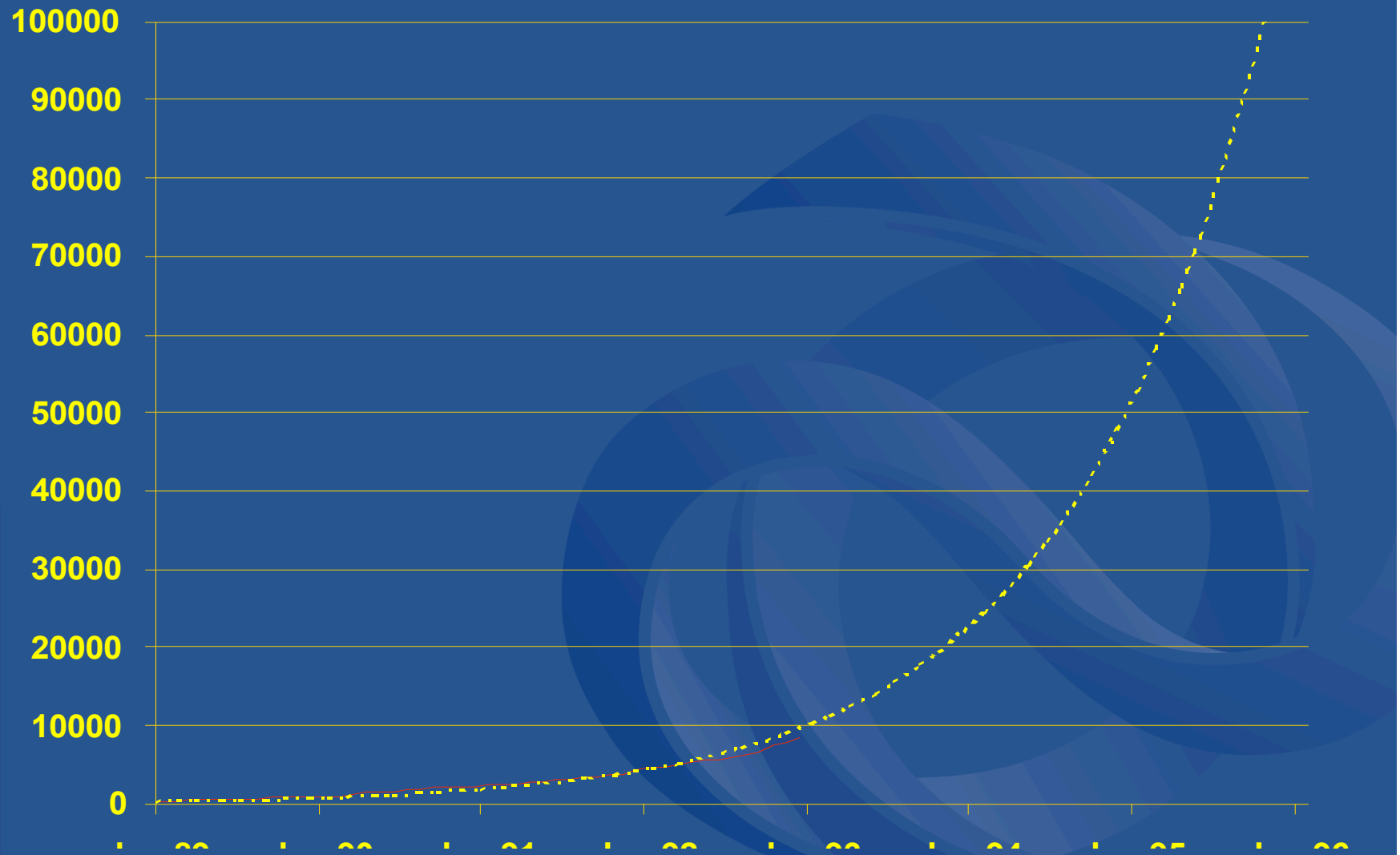

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The boom years: 1992 – 2001

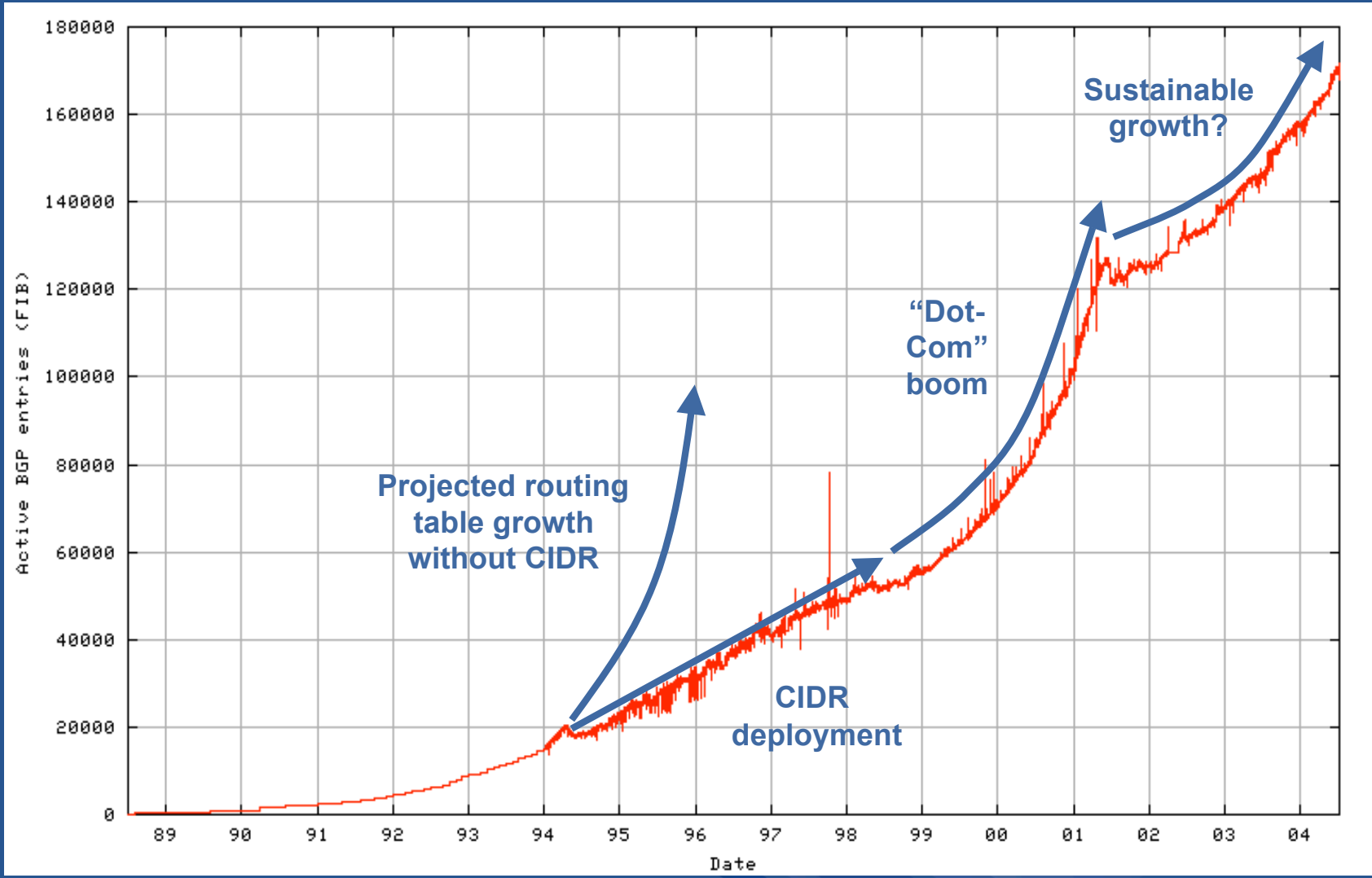
1992:

"It has become clear that … these problems are likely to become critical within the next one to three years." (RFC1366)

"…it is [now] desirable to consider delegating the registration function to an organization in each of those geographic areas." (RFC 1338)

Recent years: 2002 – 2005

Global routing table



http://bgp.potaroo.net/as1221/bgp-active.html

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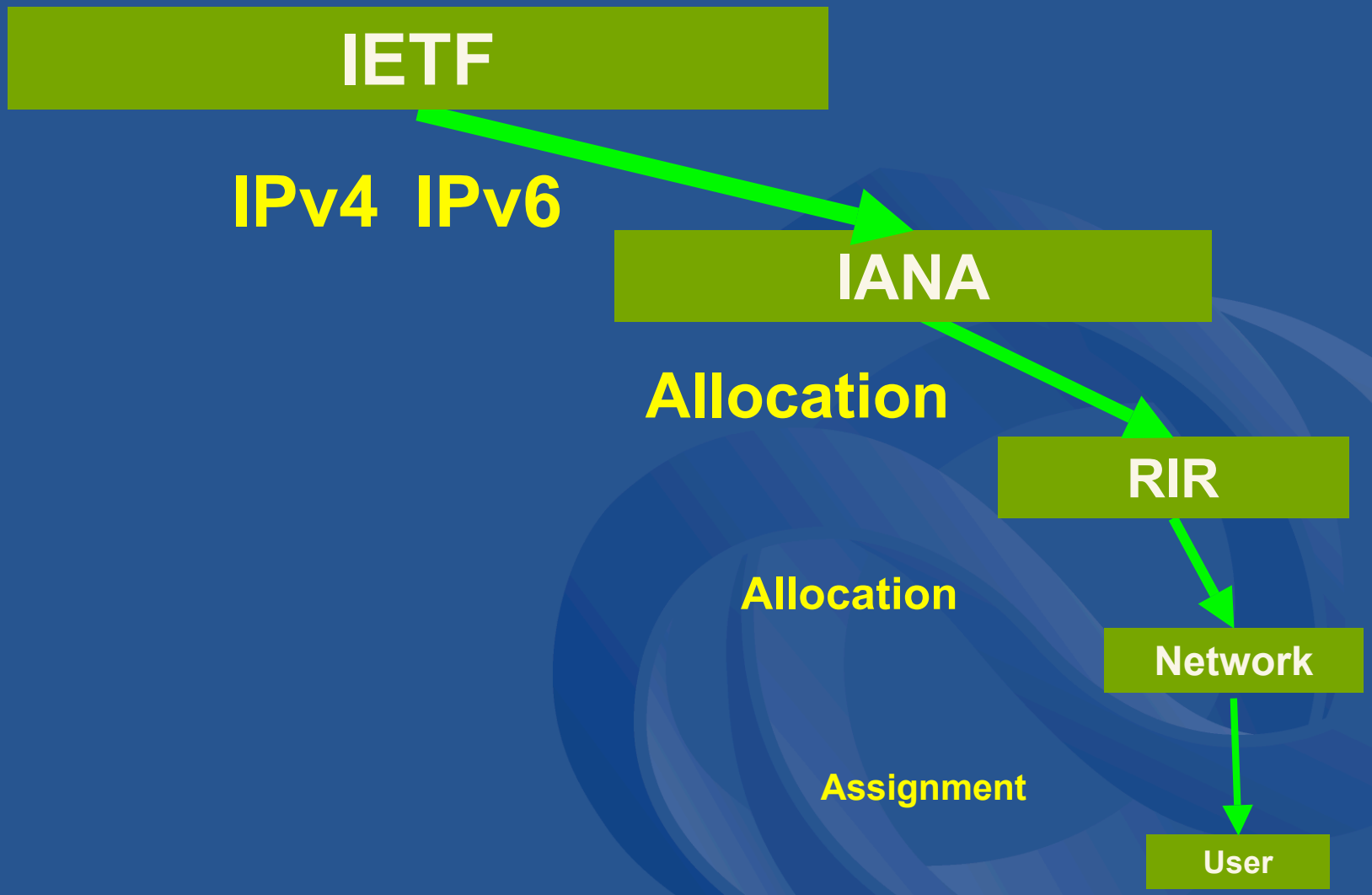
How are IP Addresses managed?

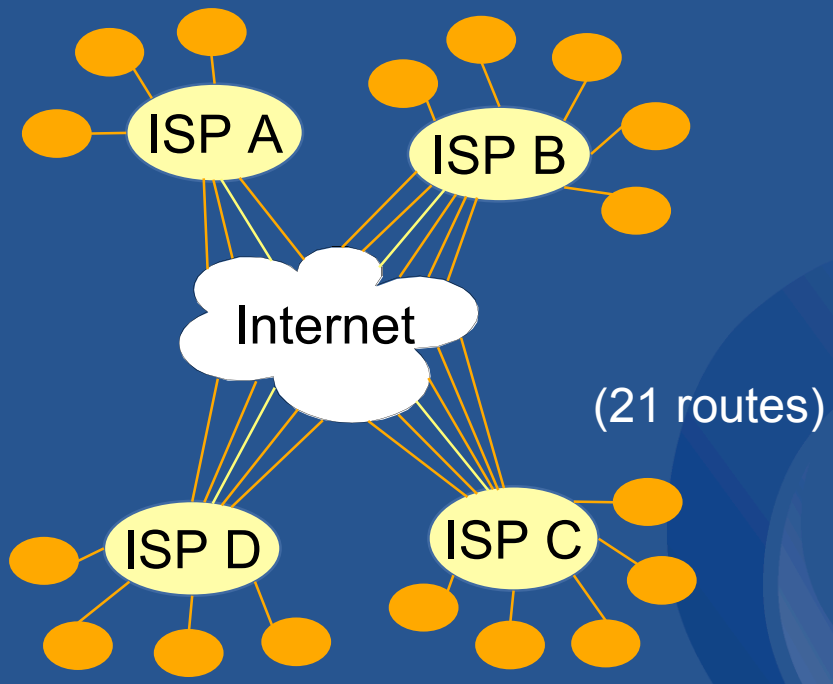
Operational view

Where do IP addresses come from?



IP Address Aggregation

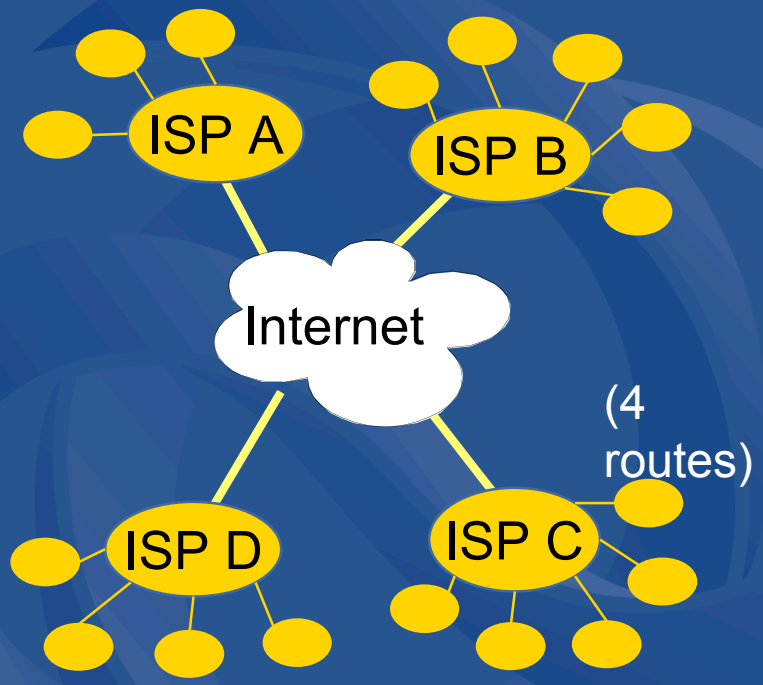
No Aggregation



(21 routes)

(Portable Assignments)

Aggregation



(4 routes)

(Non-portable Assignments)

Allocation and assignment

APNIC
Allocates
to APNIC Member

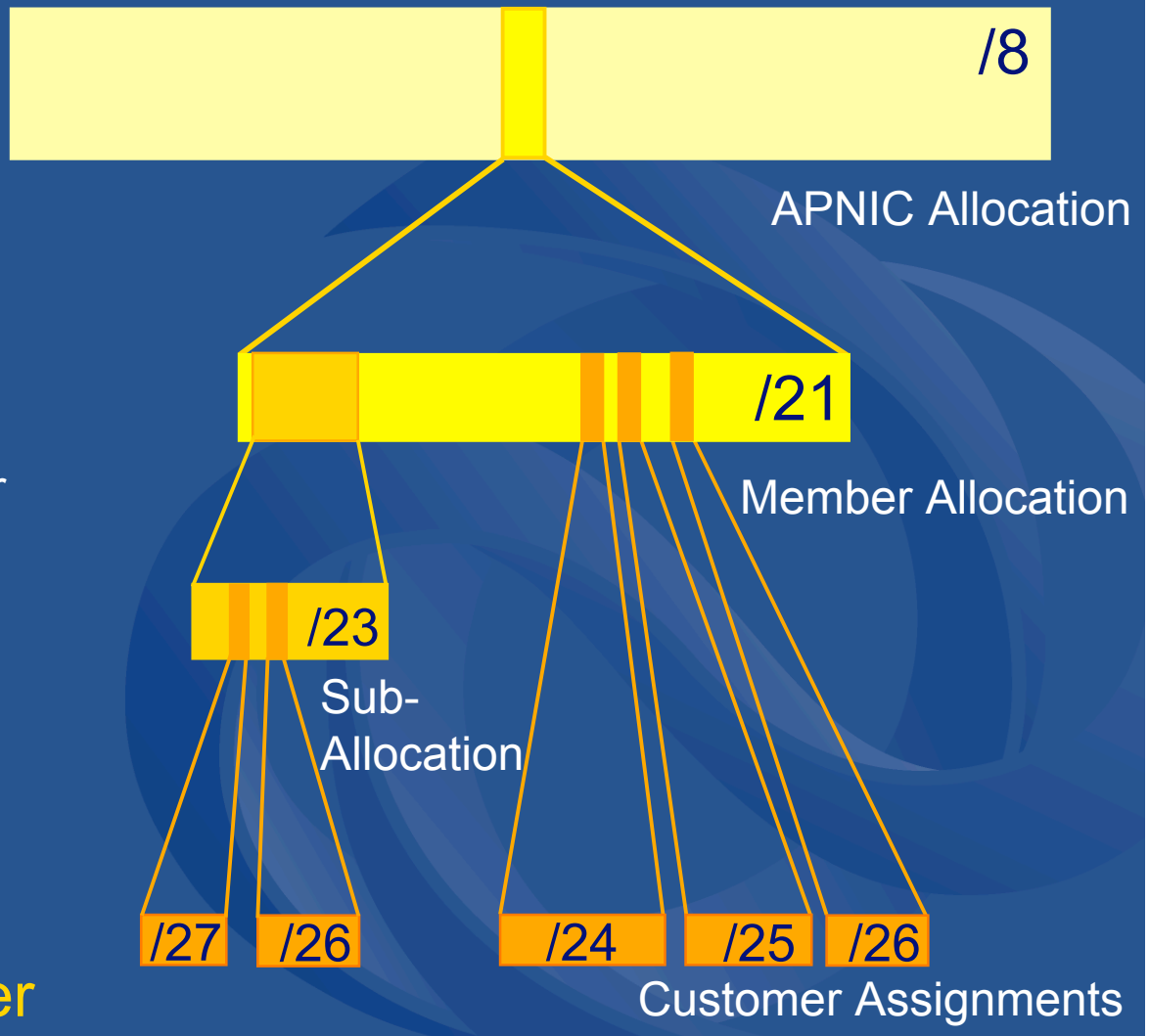
APNIC Member

Allocates
to downstream

Assigns
to end-user

Downstream
Assigns
to end-user

Customer / End User



Provider-based address management

- Under CIDR, networks are responsible for control of routing table growth
  - ISP networks receive portable addresses
  - Customer routes are aggregated
- ISP allocations are limited
  - Must justify a certain “minimum allocation” in order to receive address space
- Portable assignments are limited
  - End users cannot easily obtain portable addresses
  - Addresses come from upstream ISP

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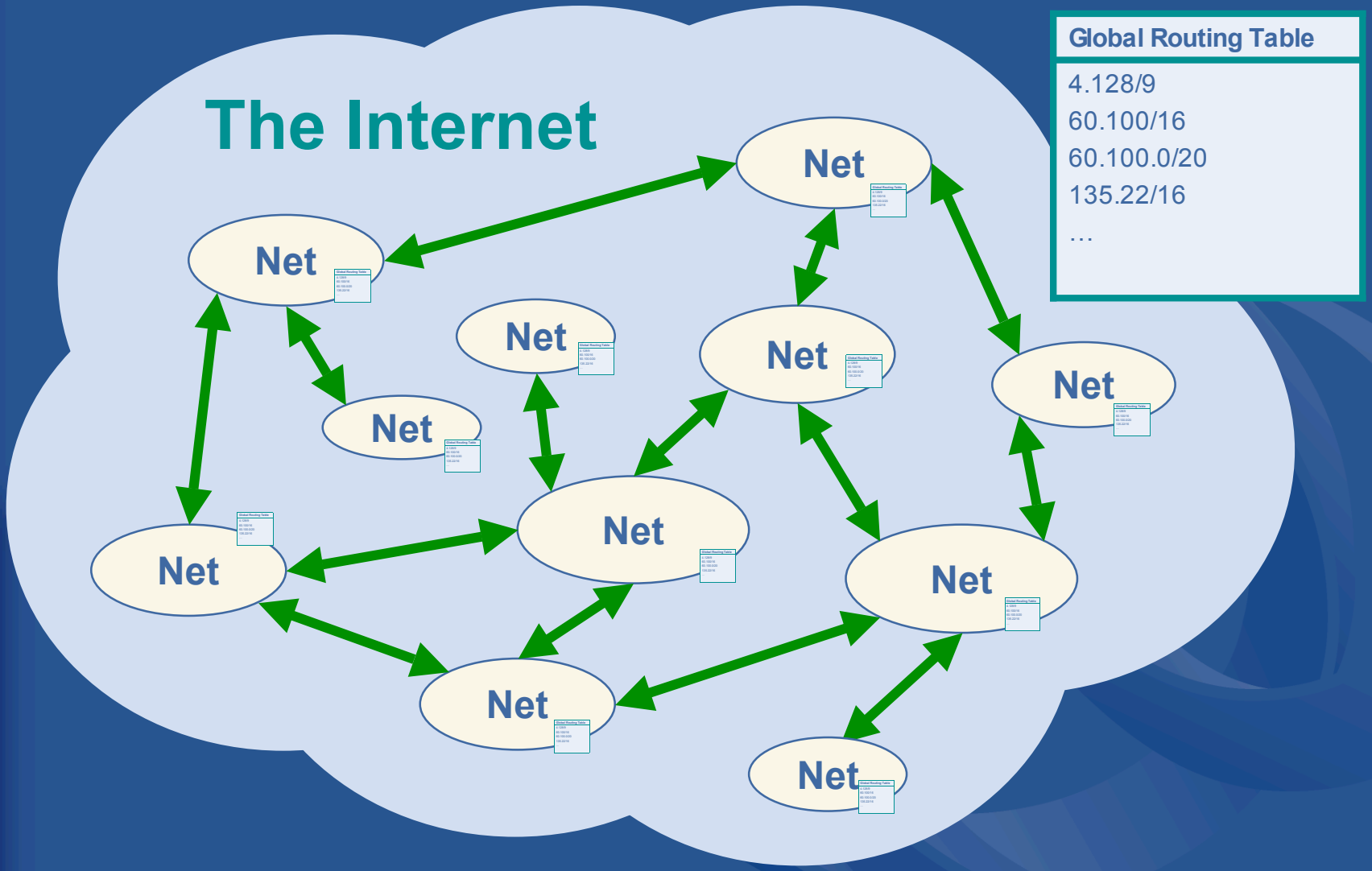
Geography of the Internet

IP Address view

Internet Geography



Internet Geography

- "Nations" of the Internet are networks
  - "Frontiers" are border routers
  - "Treaties" are peering relationships between networks
- It's a very dynamic world…
  - New nations are formed daily
  - New borders are established hourly
  - Routing tables change by the minute
  - Driven almost entirely by industry
  - No centralised control
- Very different from "traditional" networks
  - Telephony for example

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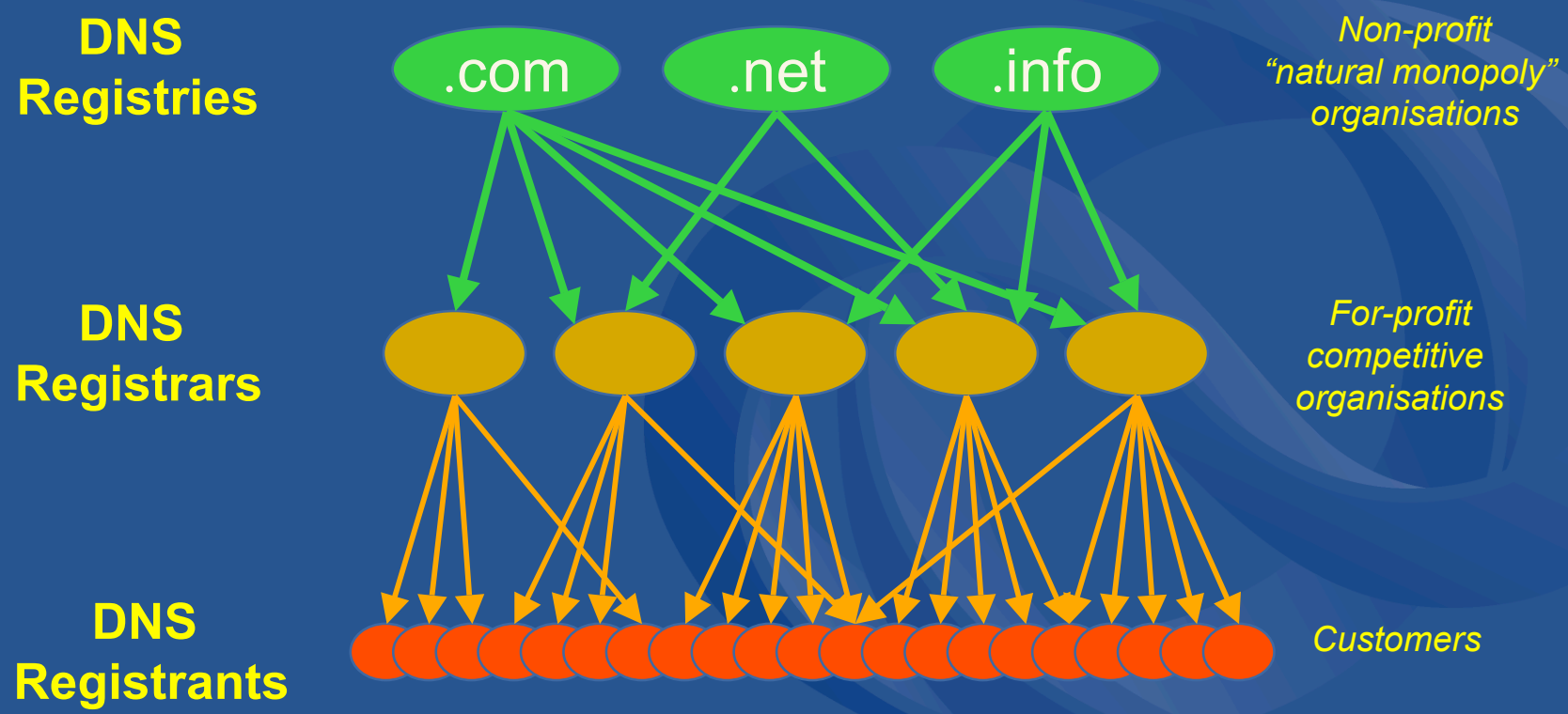
How else can we do it?

The “old way”

- The early IANA model had problems
- Administrative centralisation
  - Alleviated by RIR (and NIR) models
- Routing table expansion
  - Provider-based addressing now necessary for Internet growth and stability
  - Disadvantage: It is difficult for end-users to receive portable address space
  - However: some mechanisms exist for special cases

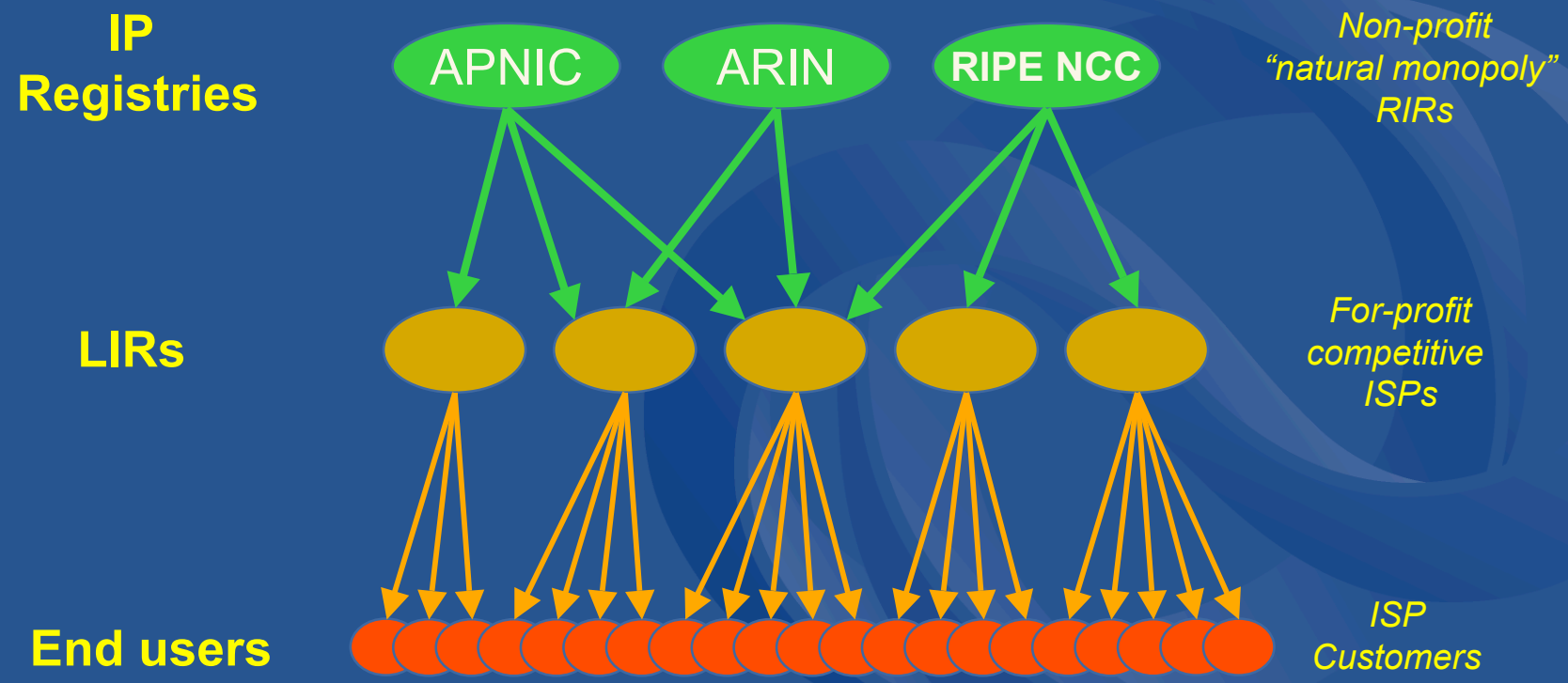
Registry-Registrar model (DNS)

- Introduced by ICANN for GTDs c.a. 2000
  - Also by many countries for ccTLDs



Registry-Registrar model (RIRs)

- RIR system already incorporates 2-level model, similar to the new DNS model



Competitive RIR Model

- RIRs represent single point of unique responsibility, similar to many others…
  - DNS registries
  - Root zone manager
  - Standards bodies: ITU, IEEE, W3C
  - International barcode registry
  - Traditional land titles offices etc.
- Over the years, some have proposed a system of competitive RIRs
  - Provide choice to service users
  - Provide competitive incentive for efficiencies
  - Better service and lower prices

Competitive RIR Model

- RIRs hold a responsibility for common outcomes
  - On behalf of regional and global communities
  - Competitive model is inconsistent with this charter
  - Some central authority cannot be avoided
  - RIR structure and policy development processes provide strong safeguards
- Risks
  - Competition may result in rapid exhaustion of address space
  - Fragmentation of Internet through inconsistent policies

Geographical Distribution

- Some have proposed to use a telephony-like model for IP address management
- However the geography of telephony is very different
  - Countries and country prefixes are fixed
  - Static bi-lateral peering arrangements
  - Telephone numbers are localised and extensible
- To impose a telephony-like regime would impose a major change
  - Substantial risks involved

What are RIRs?

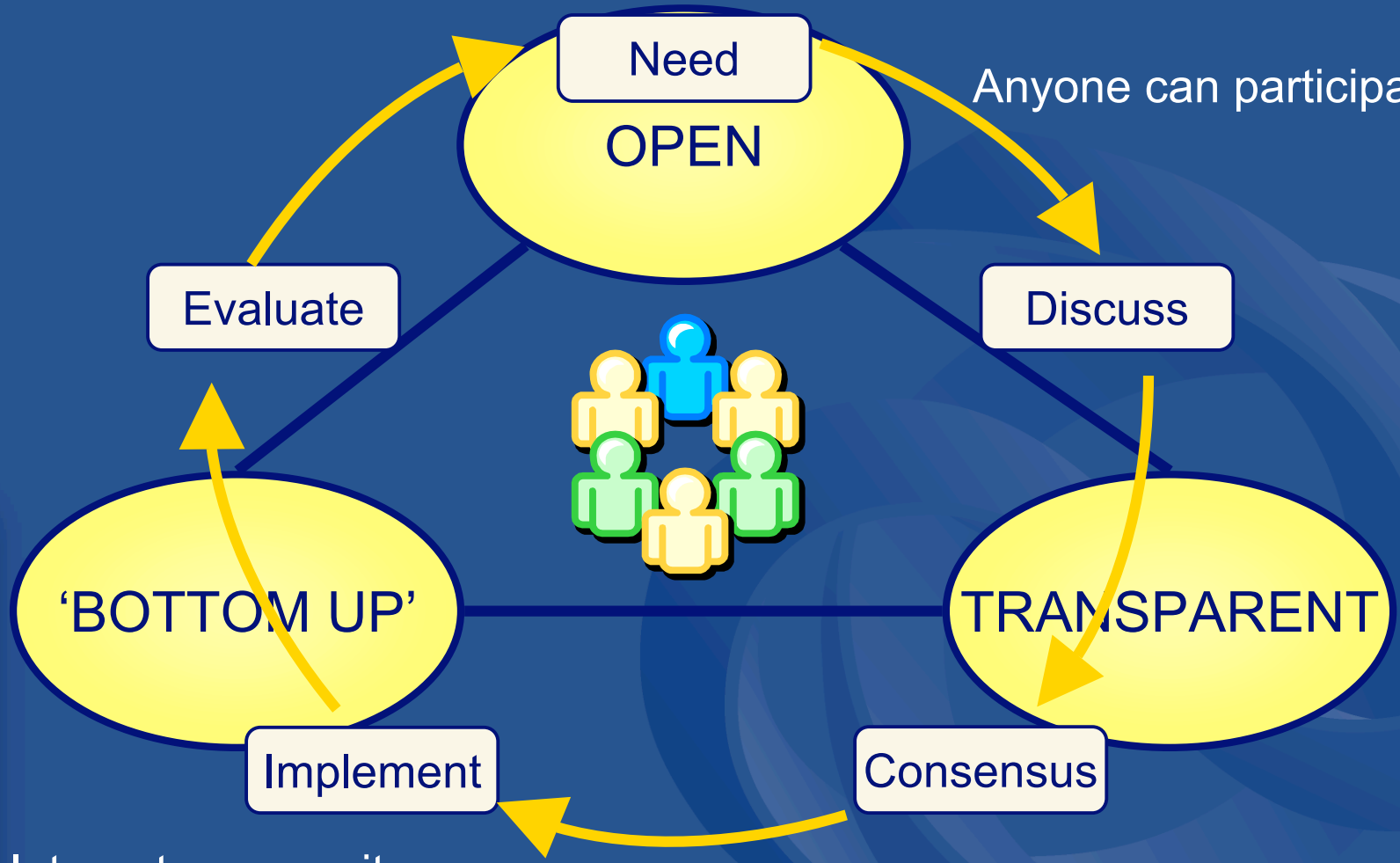
What are RIRs?

- Regional Internet (address) Registries
  - Industry self-regulatory structures
  - Non-profit, open membership bodies
- First established in early 1990's
  - In response to call from IETF (RFC1366)
  - To satisfy emerging technical/admin needs
  - Voluntarily by consensus of community
- In the "Internet Tradition"
  - Consensus-based, open and transparent

What do RIRs do?

- Internet resource management
  - Primarily, IP addresses – IPv4 and IPv6
  - Registration services (“whois”)
- Training, outreach and liaison
  - Training courses, seminars, conferences…
  - Liaison: IETF, ICANN, ITU, regional orgs…
  - Newsletters, reports, web sites…
- Policy development and coordination
  - Open Policy Meetings and processes

RIR Policy Development



Summary

Summary

- Internet address management has a history of 25 years
  - RIR history is 12 years
- Current IP address management system has served the Internet well
  - Massive expansion and the dot-com boom
- Current system is dynamic and able to be changed by evolution
  - Open policy process
- Revolutionary changes to this system have unknown consequences

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Thank You

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