# IPv6 Elite Panel

Addressing the IPv6 Internet

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APNIC

APNIC

Internet address management

- APNIC is the Regional Internet Registry (RIR) for the Asia Pacific Region
  - Regional authority for Internet Resource distribution
  - IP addresses (IPv4 and IPv6), AS numbers
  - Critical infrastructure services, Policy coordination, Education and Training, International liaison

- Private-sector, industry self-regulatory body
  - Established in 1993, in the "Internet Tradition"…
  - Consensus-based, open and transparent
  - Non-profit, neutral and independent

- Product of global trend to deregulation
  - But equally open and accessible to all interested parties

Regional Internet Registries
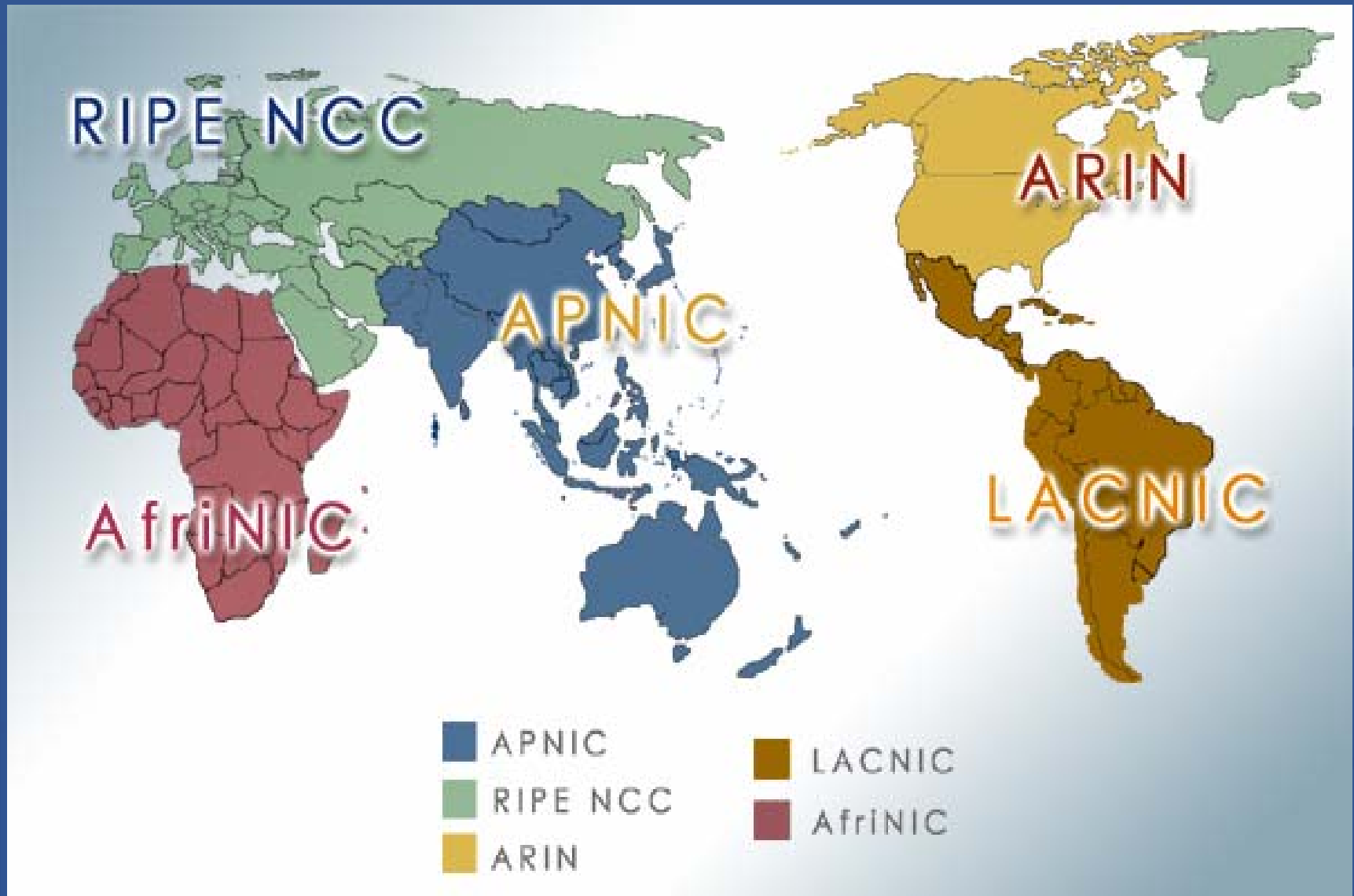
Internet for Everything?

- No longer just "Internet for Everyone"
- "Peer to peer" between any pair of devices, not just people on computers
  - appliances, automobiles, buildings, cameras, control units, embedded systems, home networks, medical devices, mobile devices, monitors, output devices, phones, robots, sensors, switches, VPNs
- No more NAT ("fog on the Internet")
- Eventually, every device will be connected to the Internet
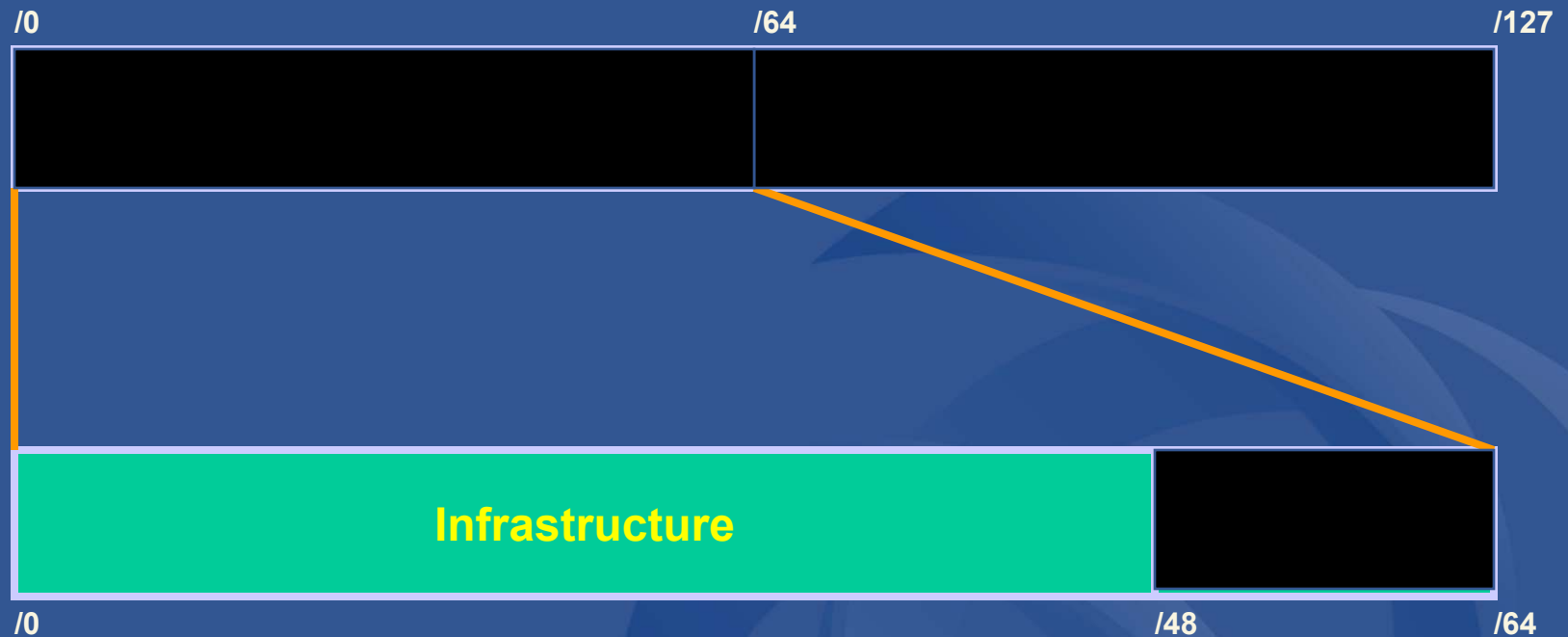 - and every device will need an address

How many addresses?

IPv4: 32 bits

- IPv4 provides 2^{32} addresses
  = 4,294,967,296 addresses
  = 4 billion addresses

IPv6: 128 bits

- IPv6 provides 2^{128} addresses?
  = 340,282,366,920,938,463,463,374,607,431,770,000,000
  = 340 billion billion billion billion addresses

IPv6 address architecture

/0		/64		/127

Infrastructure

/0		/48	/64

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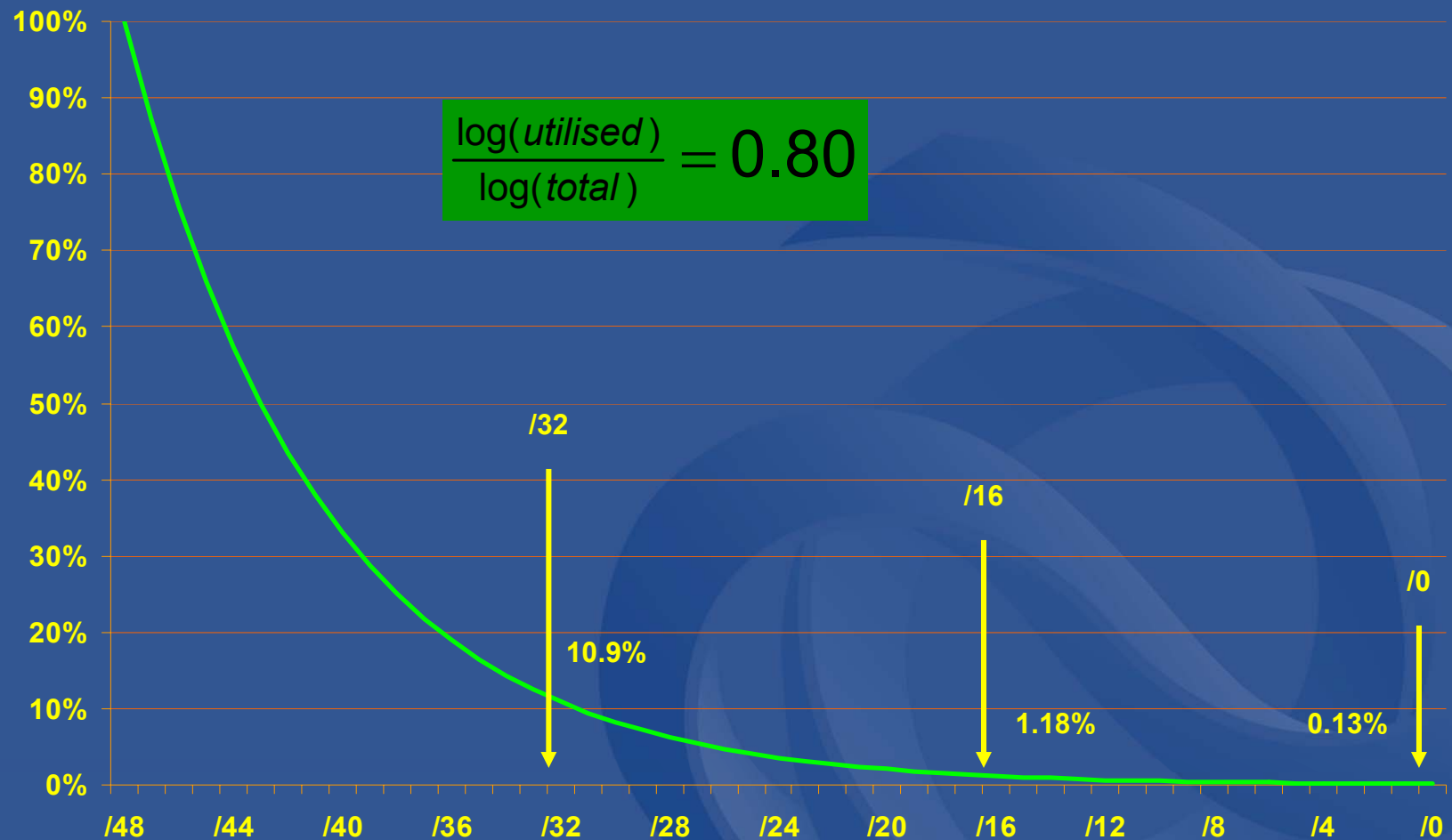 = 281,474,976,710,656

  = 281 thousand billion addresses

IPv6 utilisation

- Addresses utilised will be far fewer than addresses available
- Percentage utilised must reduce address space grows
  - Because of hierarchical addressing architecture
- HD-Ratio (Host Density Ratio) defines utilisation in hierarchical address space

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

- Value of 0.8 regarded as reasonable
  - "values of 80% or less corresponds to comfortable trade-offs between pain and efficiency" (RFC3194, 2001)

IPv6 utilisation (HD = 0.80)

$$\frac{\log(utilised)}{\log(total)} = 0.80$$

/32

/16

/0

10.9%

1.18%

0.13%

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%

/48 /44 /40 /36 /32 /28 /24 /20 /16 /12 /8 /4 /0

RFC3194 "The Host-Density Ratio for Address Assignment Efficiency"

How many addresses?

Total site addresses, and addresses/person

– 2050: Projected earth population = 10 billion

Address size (bits)	Total addresses available	Addresses per person (2050)
128	340 billion[4]	34 billion[3]
64	18 billion[2]	1.8 billion
48	281 thousand billion	28 thousand
48 (HD = 0.80)	362 billion	36

- IPv6 will provide 0.0013 x 248 site addresses!
  – = 362,703,572,709
  – = 362 billion

What is a "site" ?

/0	/64	/127

/0	/48	/64

- Each site (/48) provides 2^{16} subnets
  - 65536 subnets
  - Each subnet can have unlimited devices
  - Much much larger than a "Class B" in IPv4 terms

What is a "site" ?

- RFC3177: Any location requiring subnets, with independent Internet connectivity
- Many possible examples
  - Office, home, or apartment network
  - Intelligent building
  - Car with multiple onboard systems
  - Mobile phone with accessory networks
  - Any mobile device with multiple connected networks
  - Robots, complex embedded systems
  - Other sophisticated devices…

- A person could have many of these
- A company could have many more

Future address management

- Current IPv6 allocation and assignment policies are simple and easy
  - Consciously support fast IPv6 deployment
  - However, wasteful in the long-term
- We will eventually need to be more careful with address management
- For example:
  - Reduce minimum size of end-site assignment
  - Tighten criteria for portable (ISP) allocation
  - Reduce size of initial portable allocation
  - Adjust HD-Ratio utilisation requirement

After IPv6 - the next transition?

- Transition from IPv4 to IPv6 is very hard
  - Will take many years
  - Many details to be determined
  - Some still say it will never happen !

- What about the next transition?
  - When the Internet is thousands or millions of times larger than today's internet
  - What magic will be needed?

- Conclusion
  - IPv6 addresses are easy to get, at the moment
  - But we must make IPv6 last a long time, possibly "forever"
  - Addresses will probably be harder to get, in future

Thank You

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