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Asia Pacific Network Information Centre

# HD Ratio for IPv4

APNIC16 - Address Policy SIG

Seoul, Korea

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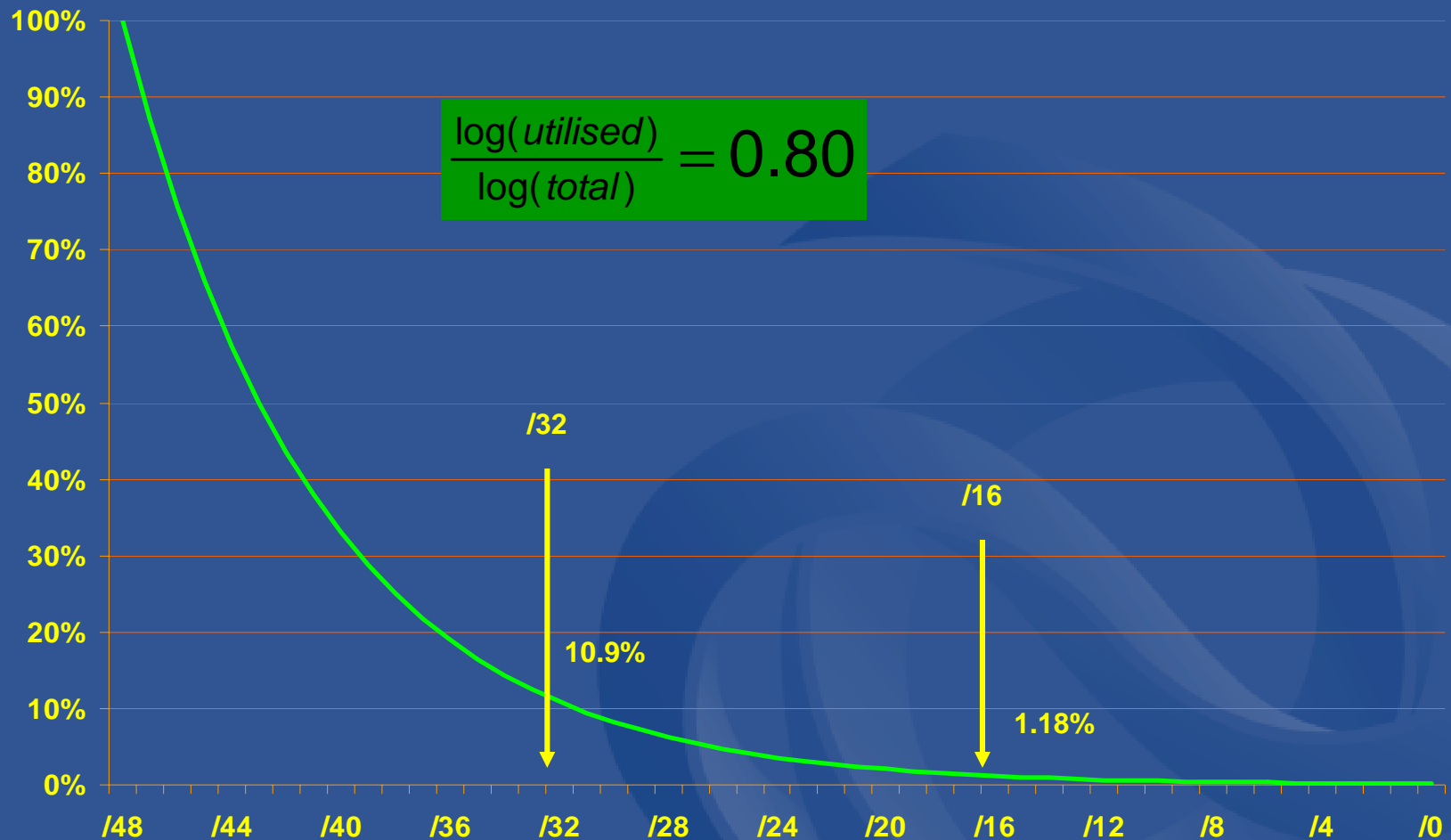
# Background

- Host Density (HD) ratio
  - Measures utilisation in hierarchically managed address space (see RFC3194 and RFC1715)
  - An HD-ratio value corresponds to a percentage utilisation which decreases as the size of the address space grows

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

- Note: calculation requires registration of individual site addresses (/48)
- The HD-ratio has been adopted for IPv6
  - LIR may receive more IPv6 space when HD=0.80

# Background - IPv6 (HD = 0.80)



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

## Problem Summary

- IPv4 fixed utilisation requirement
  - Once 80% is sub-allocated or assigned, LIR can request additional block
  - Same requirement for all address blocks, regardless of size
- No allowance for hierarchical management
  - Address management efficiency decreases for large address blocks
  - Imposes unreasonable management overhead on larger LIRs

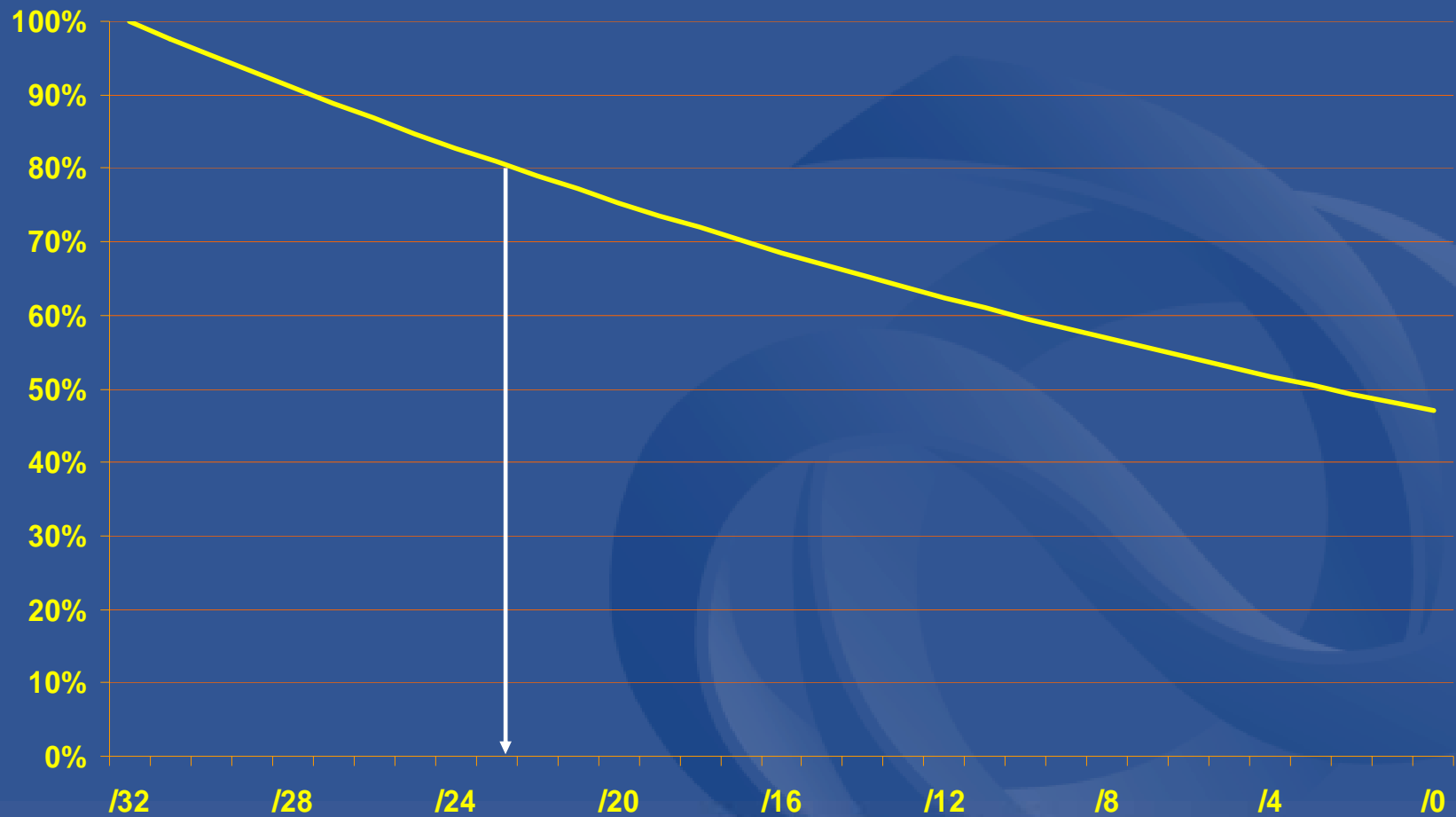


# Proposal Summary

- HD-based IPv4 utilisation requirement
  - Lower % utilisation requirement for larger blocks
  - To make allowance for hierarchical management
- Variation of HD-Ratio proposed
  - Assignment Density (AD) Ratio
- Proposed value
  - Utilisation requirement  $AD=0.966$
  - Calculated based on current 80% principle



# Proposed IPv4 utilisation (AD 0.966)



# Proposed IPv4 utilisation (AD 0.966)

Prefix	Total addrs	Utilised addrs	%
/24	256	212	82.82%
/22	1024	809	79.00%
<b>/20</b>	<b>4096</b>	<b>3087</b>	<b>75.37%</b>
/18	16384	11780	71.90%
<b>/16</b>	<b>65536</b>	<b>44949</b>	<b>68.59%</b>
/14	262144	171518	65.43%
/12	1048576	654485	62.42%
/10	4194304	2497408	59.54%
<b>/8</b>	<b>16777216</b>	<b>9529704</b>	<b>56.80%</b>



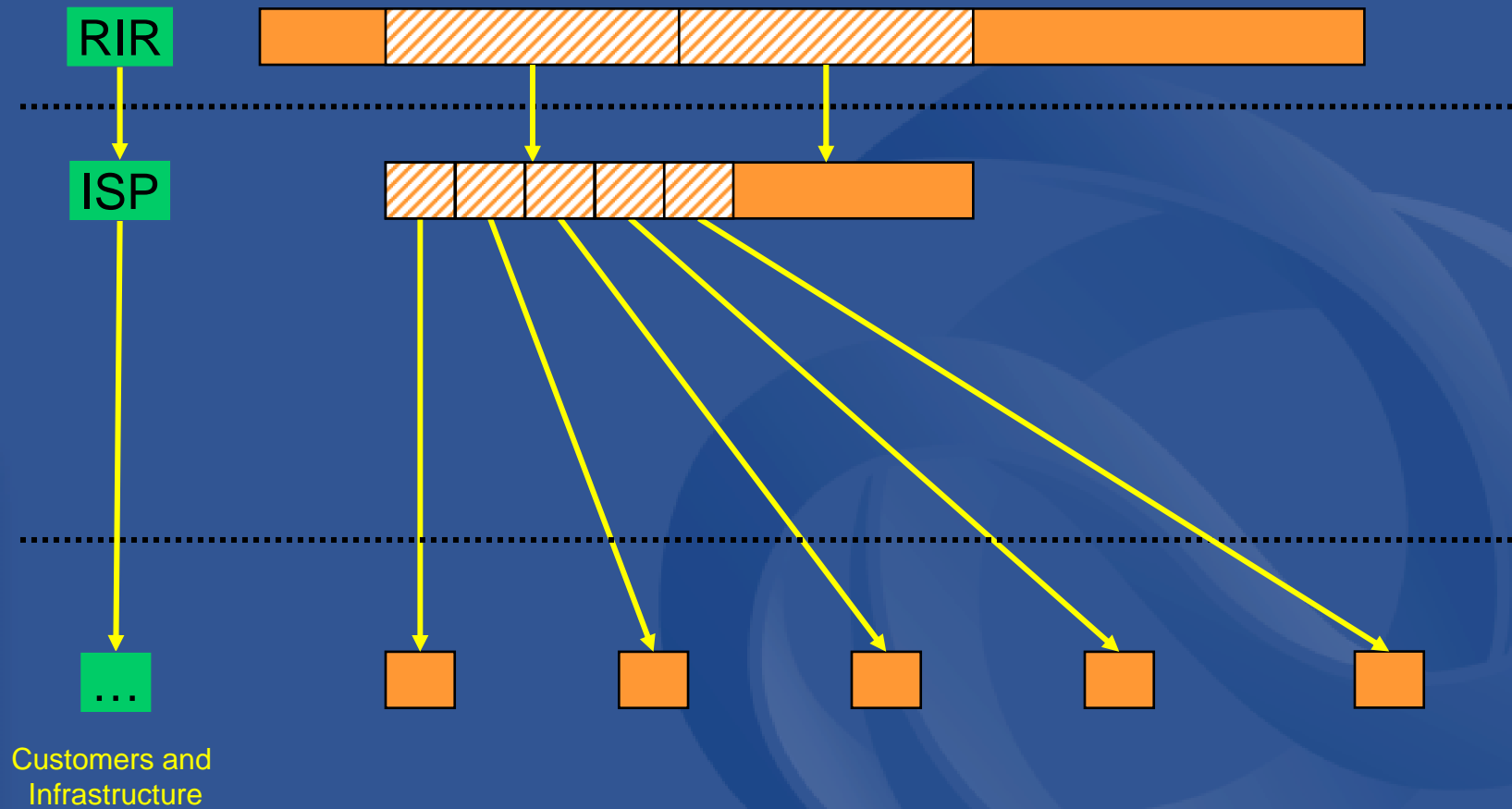
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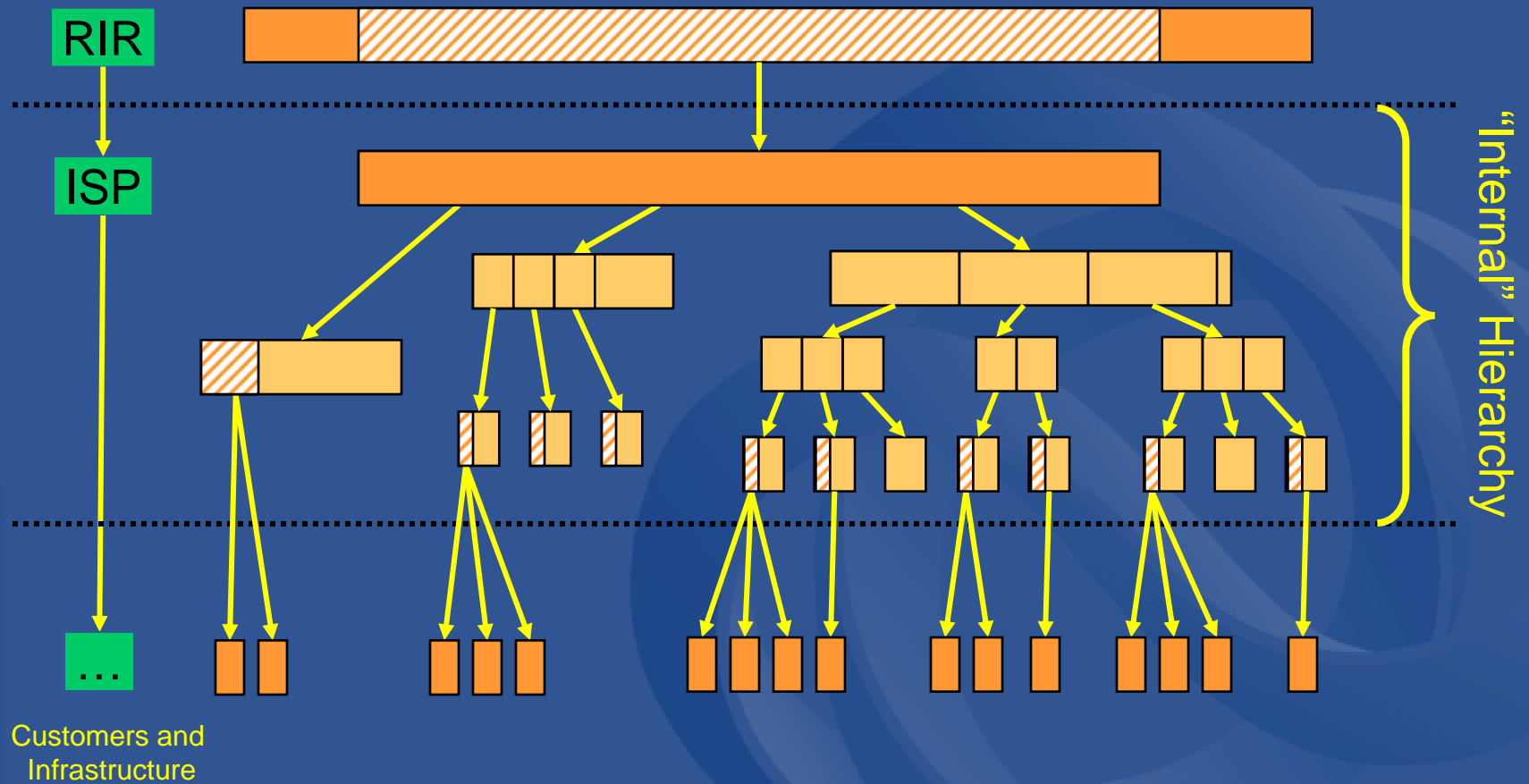
# Justification



# Allocation Hierarchy - 1



# Allocation Hierarchy - 2



# Assignment Density (AD) Ratio

- Variation of HD ratio
  - Instead of measuring host addresses actually used, measures number of addresses assigned by LIR
    - For consistency with IPv4 policies, which do not track individual host address assignments

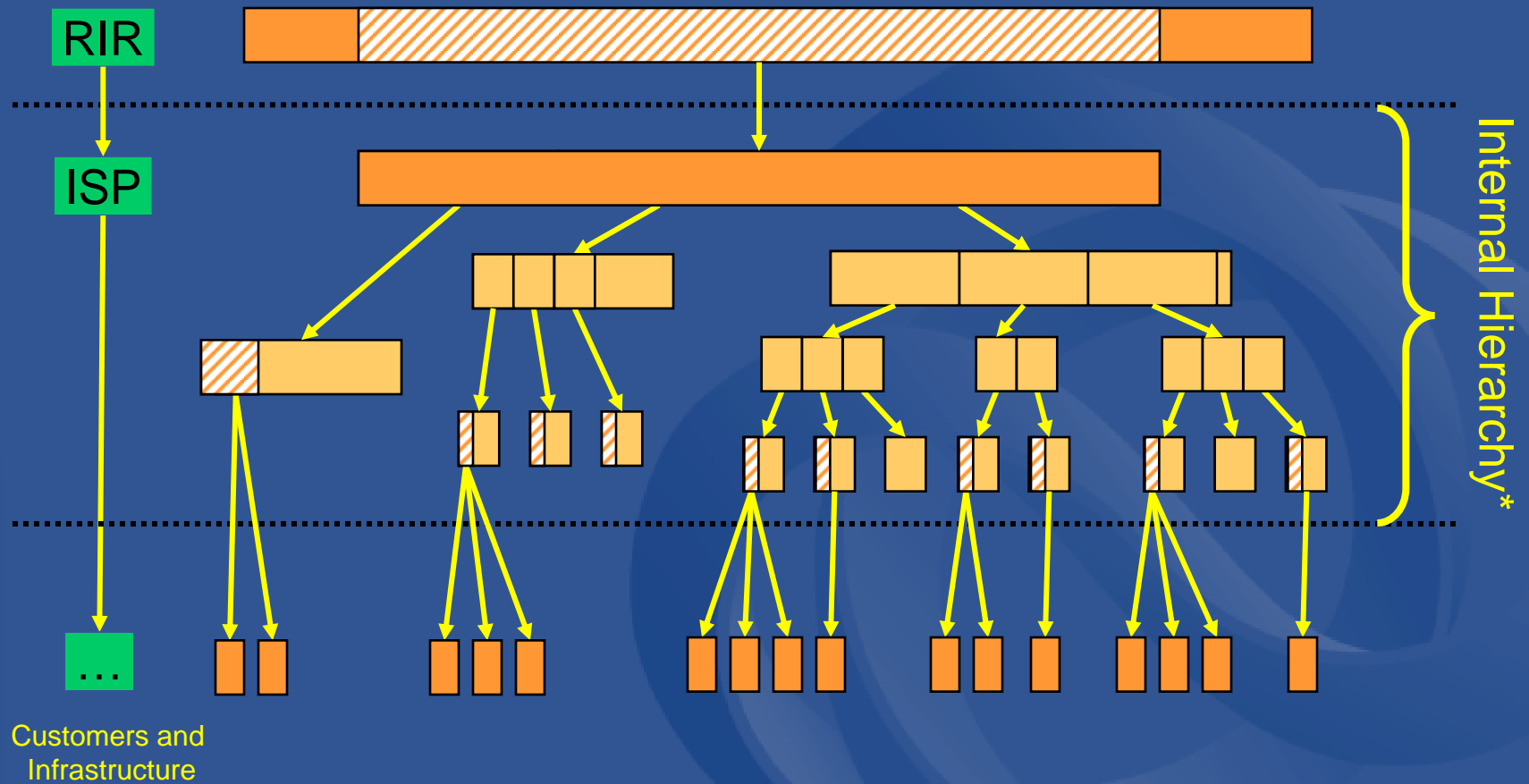
$$AD = \frac{\log(\text{assigned addresses})}{\log(\text{total addresses})}$$

- Propose to use AD Ratio as utilisation measure for IPv4
  - Need to determine appropriate value

# Selecting an AD-Ratio value

- Principles
  - Accept 80% as reasonable utilisation limit for single-level hierarchy
  - Accept corresponding lower utilisation limits for deeper hierarchies
    - 64% for 2-level hierarchy ( $80\% \times 80\%$ )
    - 51.2% for 3-level hierarchy ( $80\%^{**} 3$ )
- Apply to ISP internal hierarchy
  - We assume likely useful depth of hierarchy according to size of address space
  - Select values which appear reasonable
    - Values are theoretical only

# Allocation Hierarchy



# Selecting an AD-Ratio value

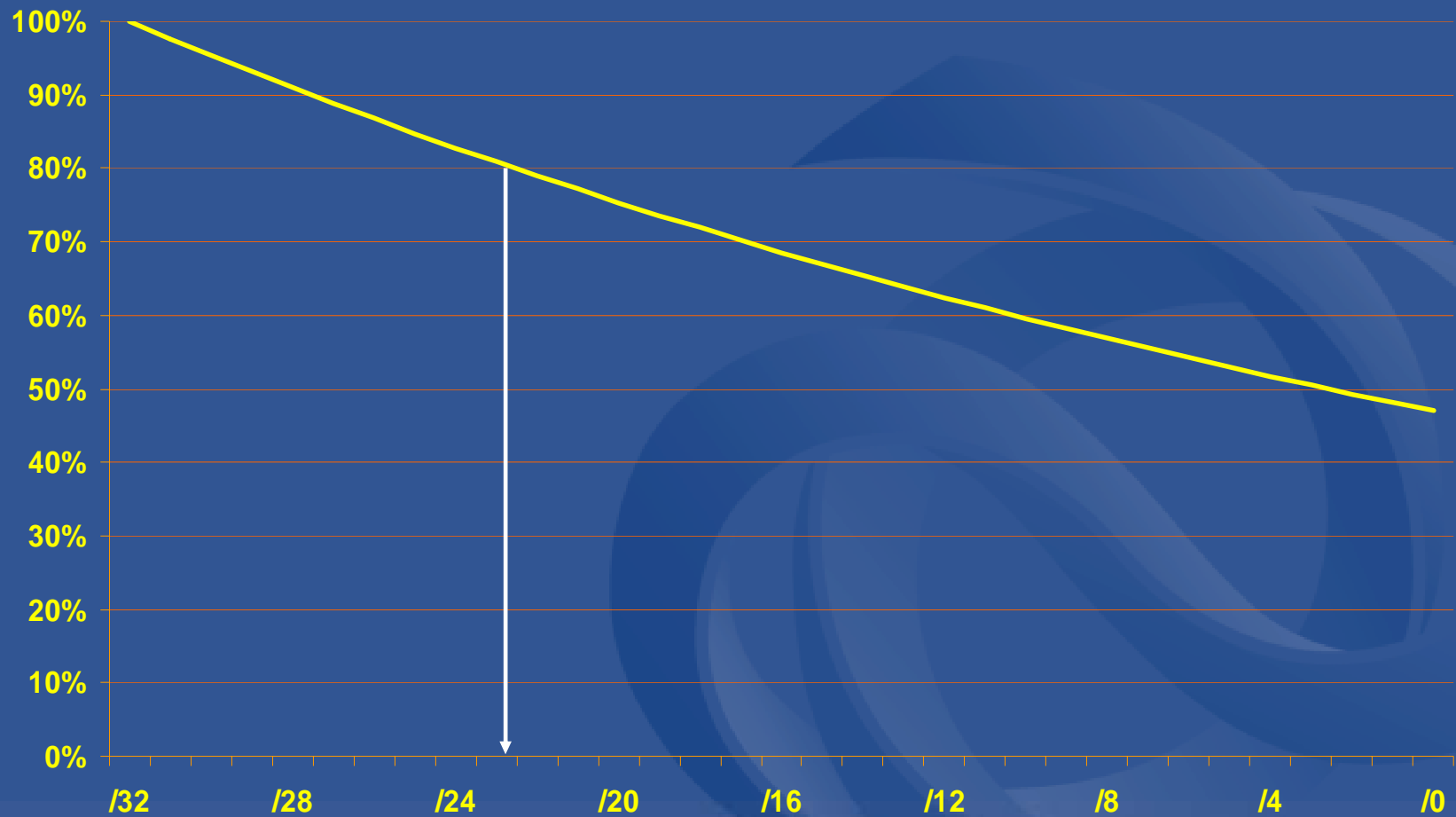
- Likely depth of ISP addressing hierarchy

Size Range (Prefix)	Depth (n)	Utilisation ( $0.80^{**n}$ )	AD Ratio (calculated)
/24 to /20	1	80%	.960 to .973
/20 to /16	1.5	72%	.961 to .970
/16 to /12	2	64%	.960 to .968
/12 to /8	2.5	57.2%	.960 to .966
/8 to /4	3	51.2%	.960 to .966

- Common AD Ratio value
  - Most conservative: 0.966
  - Least conservative: 0.961



# IPv4 utilisation (AD = 0.966)





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# Impact





# Impacts

- Administrative
  - LIR needs to incorporate new method of calculating utilisation in procedures
  - LIR would need to register infrastructure assignments/sub-allocations
  - APNIC Secretariat update internal policies, procedures and documentation
- Address space consumption
  - Initial impact
  - Ongoing impact

# Impact - Address Consumption

- Initial impact
  - Maximum impact (address “wastage”) can be calculated as difference in utilisation expectation for all allocated address space

<b>Total LIRs in sample</b>	<b>788</b>
Total address space held (actual)	4.17 (/8s)
Utilised addresses (80%)	3.32
Utilised addresses (AD 0.966)	2.53*
Extra “wasted” space	0.81
Extra “wastage” as proportion of total	19%

\* Figure calculated from sample of 788 APNIC LIRs, according to actual address space holdings

# Impact - Address Consumption

- Ongoing impact
  - Calculated by modeling the distribution of an additional /8 proportionally to all LIRs

<b>Total LIRs in sample</b>	<b>788</b>
Initial address space held (actual)	4.17 (/8s)
Additional address space allocated	1.00
Total address space now held	5.17
Utilised addresses (AD 0.966)	3.11
Additional addresses utilised	0.58
Additional addresses utilised (80%)	0.80
Extra “wasted” space	0.22
Extra “wastage” as proportion of total	22%



# Implementation

- RIR-LIR procedures
  - Replace 80% utilisation with 0.966 AD ratio
- Assignment procedures
  - Calculations rely on assignment and sub-allocation registration information
    - Preferably including infrastructure

# Summary

- HD-Ratio based utilisation requirement is accepted for hierarchical address management
  - Propose to apply to IPv4 as AD-Ratio
  - Proposed utilisation requirement 0.966
- Benefit impacts larger ISPs
  - Improves address manageability
- Address space consumption impact
  - Initial impact - up to 19% additional space required (maximum eventual impact)
  - Ongoing impact - up to 22% increase in consumption rate (maximum)



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# Questions? Feedback?