

# IP Address Management

INET 2000

Network Training Workshops

- ◆ Definitions
- ◆ Principles of Addressing
- ◆ Management
- ◆ Addressing Plan Example
- ◆ References

# Definitions

- ◆ Allocation and Assignment
  - ◆ Allocation
    - ◆ A block of address space held by an IR for subsequent allocation or assignment
  - ◆ Assignment
    - ◆ A block of address space used to address an operational network
    - ◆ May be provided to LIR customers, or used for an LIR's infrastructure ("self-assignment")

# Definitions

## ◆ Addressing

### ◆ *Non portable - 'Provider Aggregatable' (PA)*

- ◆ Customer uses members' address space
- ◆ Customer has to renumber if changing ISP
- ◆ Only way to effectively scale the Internet

### ◆ *Portable - 'Provider Independent' (PI)*

- ◆ Customer gets addresses independent from ISP
- ◆ Customer keeps addresses when changing ISP
- ◆ Bad for size of routing tables
- ◆ Customer may be filtered, flap dampened...

# Principles of Addressing

- ◆ Separate customer & infrastructure address pools
  - ◆ Manageability
    - ◆ Different personnel manage infrastructure and assignments to customers
  - ◆ Scalability
    - ◆ Easier renumbering - customers are difficult, infrastructure is easy

# Principles of Addressing

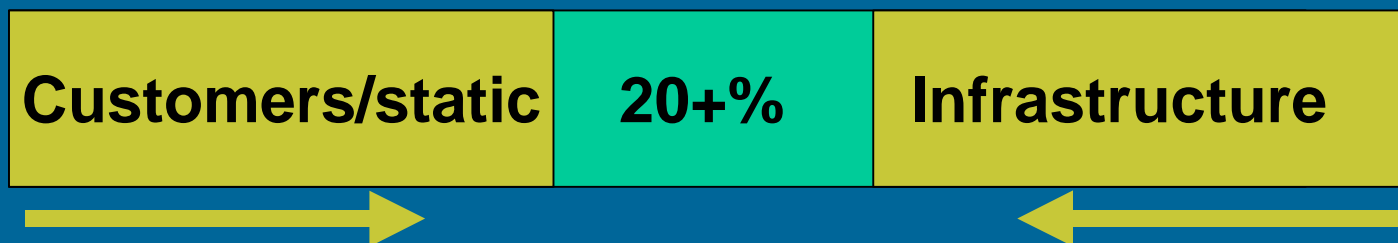
- ◆ Routing protocols
  - ◆ Use an IGP (OSPF, ISIS, EIGRP) for:
    - ◆ Carrying network infrastructure addresses used by dynamic routing protocols
  - ◆ Examples
    - ◆ Point to point addresses of backbone connections
    - ◆ Router Loopback addresses
  - ◆ Minimise what is carried in IGP for efficiency

# Principles of Addressing

- ◆ IBGP
  - ◆ Carry all other network prefixes in iBGP
- ◆ Examples
  - ◆ Customer networks
  - ◆ RAS server address pools
  - ◆ Virtual web and content hosting
  - ◆ Mail, DNS servers
- ◆ IBGP can carry 100,000k prefixes

# Management - Simple Network

- ◆ First allocation from APNIC
  - ◆ Infrastructure is known, customers are not
  - ◆ 20% free is trigger for next request

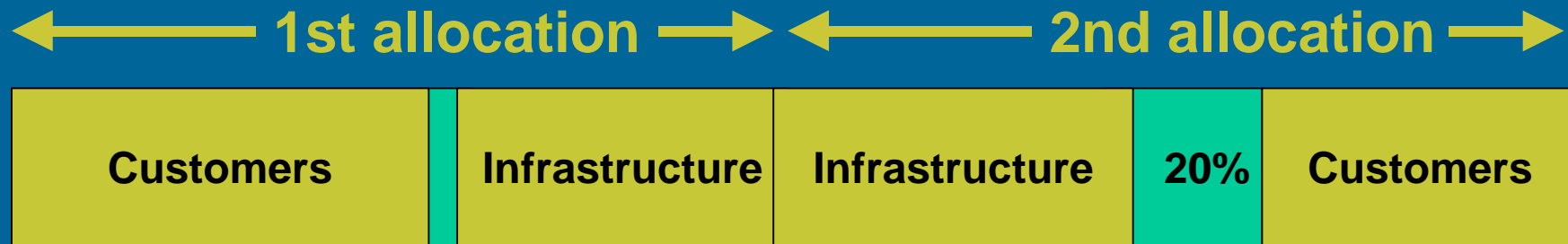


- ◆ Grow usage of blocks from edges
- ◆ Assign customers sequentially



# Management - Simple Network

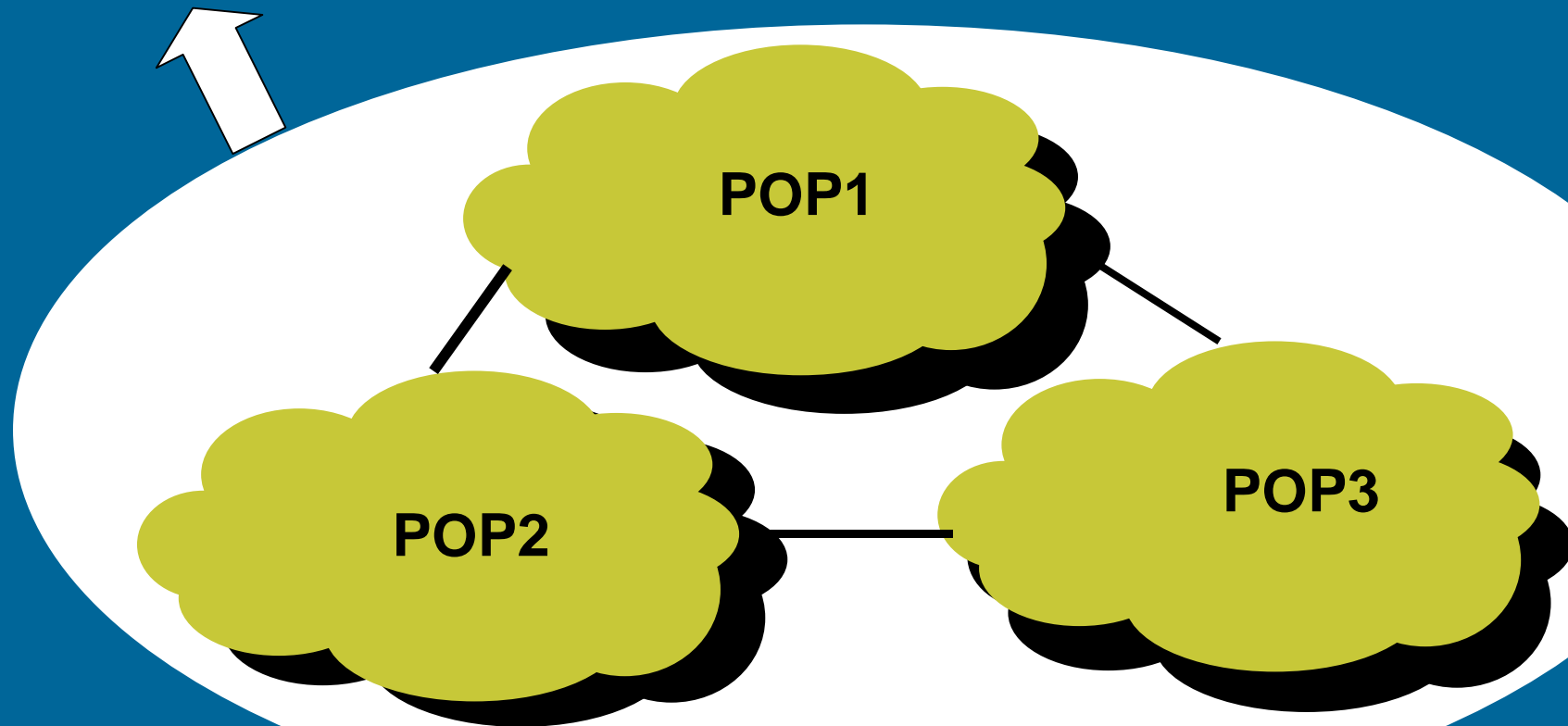
- ◆ If second allocation is contiguous



- ◆ Reverse order of division of first block
- ◆ Maximise contiguous space for infrastructure
  - ◆ Easier for debugging
- ◆ Customer networks can be discontinuous

# Management - Many POPs

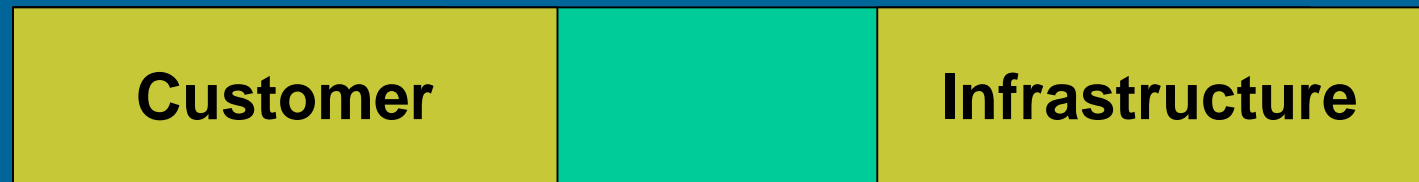
- ♦ WAN link to transit ISP



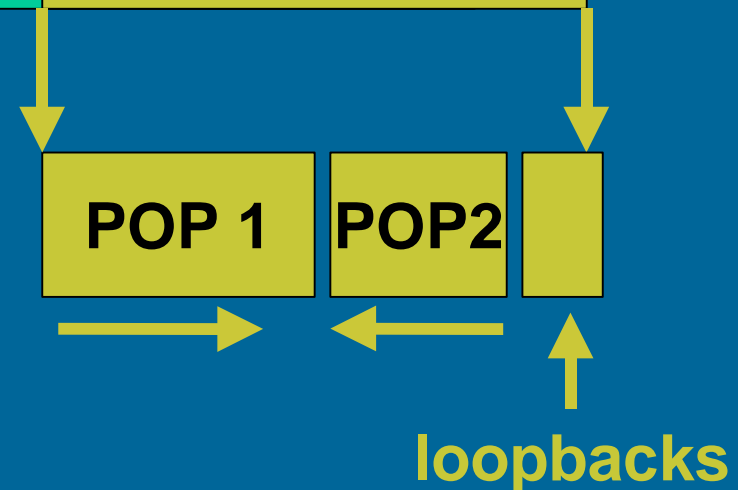
# Management - Many POPs

- ♦ POP sizes

- ♦ Choose address pool for each POP according to need



- ♦ Loopback addresses
  - ♦ Keep together in one block
  - ♦ Assists in fault-resolution
- ♦ Customer addresses
  - ♦ Assign sequentially

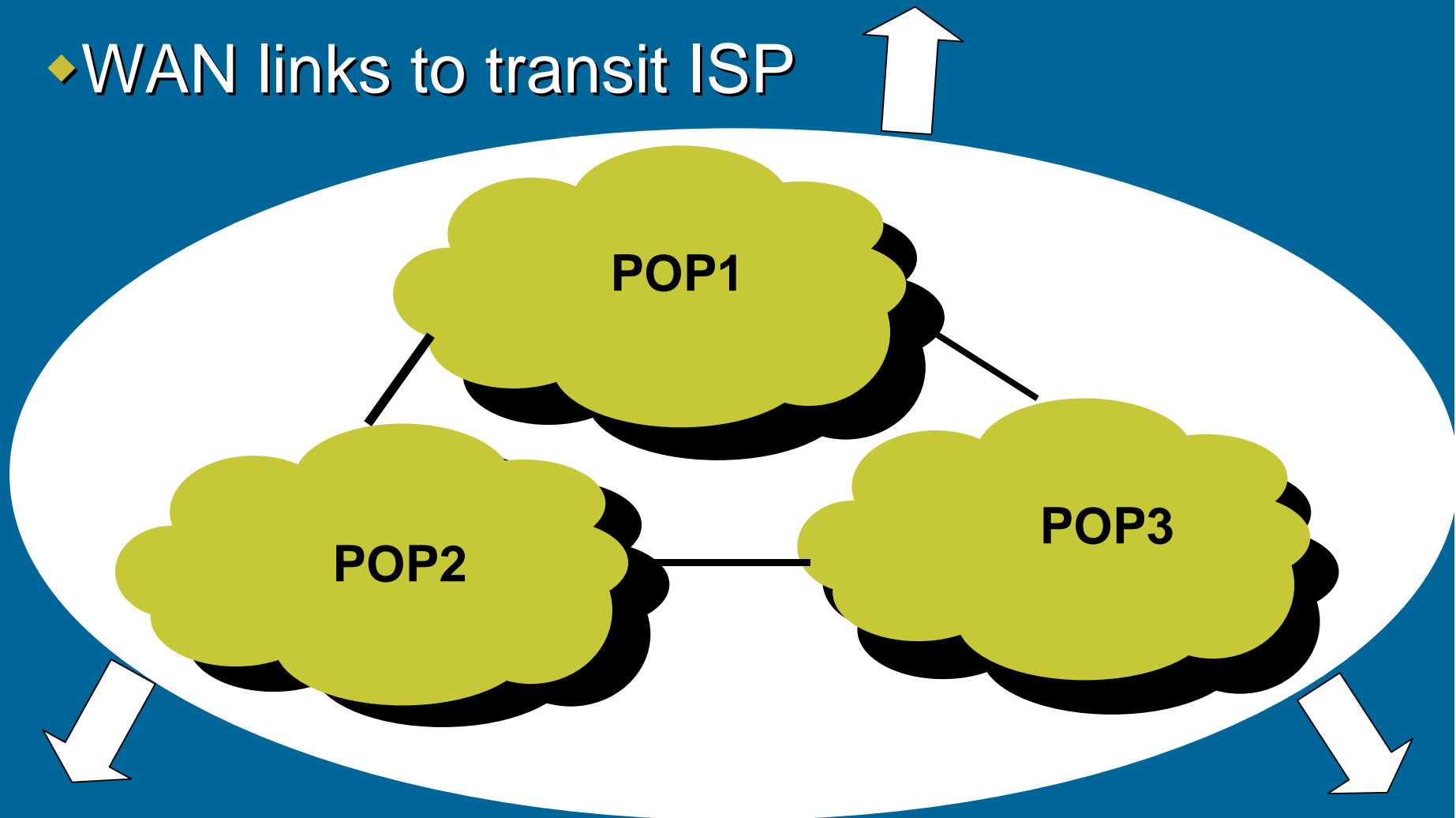


# Management - Many POPs

- ◆ /19 minimum allocation is not enough for all your POPs?
  - ◆ Deploy addresses on infrastructure first
- ◆ Common mistake
  - ◆ Reserving customer addresses on a per POP basis
- ◆ Do not constrain network plans due to lack of address space
  - ◆ Re-apply once address space has been used

# Management - Multiple Exits

- ♦ WAN links to transit ISP



# Management - Multiple Exits

- ◆ Create a 'national' infrastructure pool

National Infrastructure	20% free	POP1	POP2	POP3
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- ◆ Carry in IGP

- ◆ Eg. loopbacks, p2p links, infrastructure connecting routers and hosts which are multiply connected

- ◆ On a per POP basis

- ◆ Consider separate memberships if requirement for each POP is very large from day one.

# Addressing Plan

- ◆ To complete documentation
  - ◆ First need a technical PLAN
    - ◆ Documenting the architecture of the present and eventual goal
- ◆ IP addressing is fundamental part of network design
- ◆ IP addressing 'planning' example to follow..

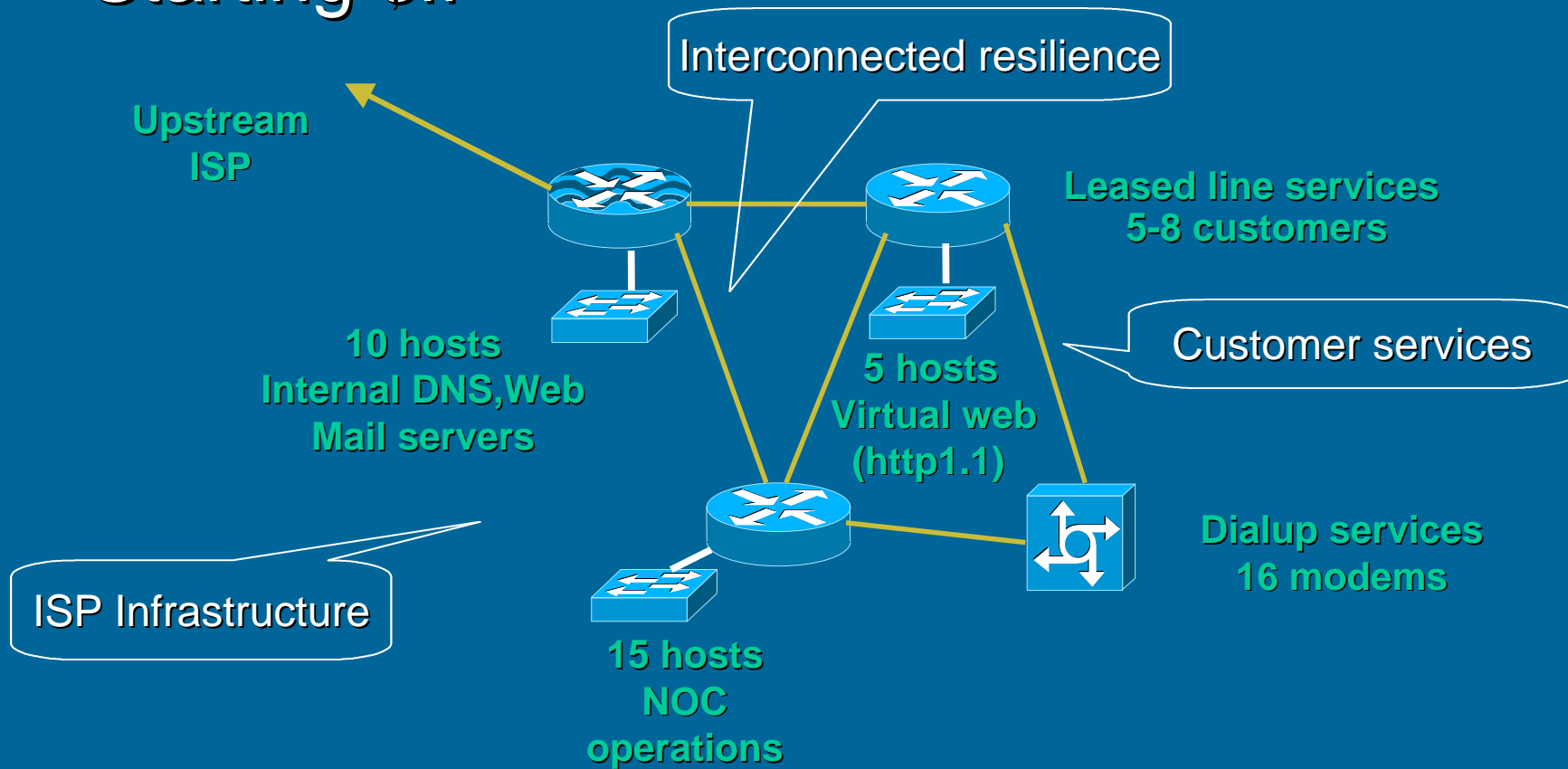
# Addressing Plan

- ◆ Identify components of network
  - ◆ Customer services
  - ◆ ISP internal infrastructure
- ◆ Identify phases of deployment
  - ◆ Starting off, 6 months, 12 months
- ◆ Identify equipment and topology changes
  - ◆ Need for redundancy
  - ◆ Need for increased scale

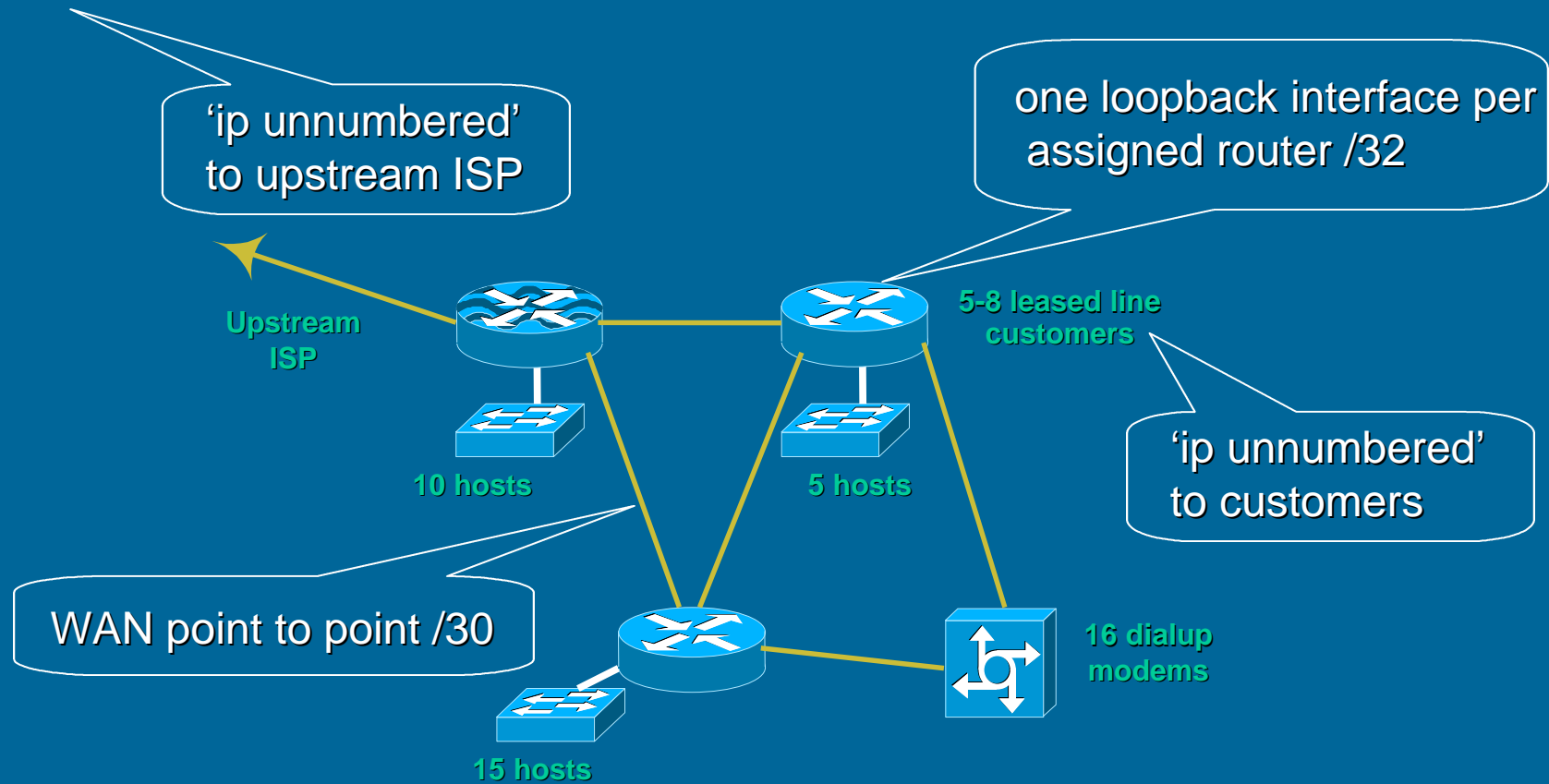


# Network Plan

## ◆ Starting off



# Network Plan



# Addressing Plan

## ◆ Initial addressing plan

-numbers of host addresses (interfaces)

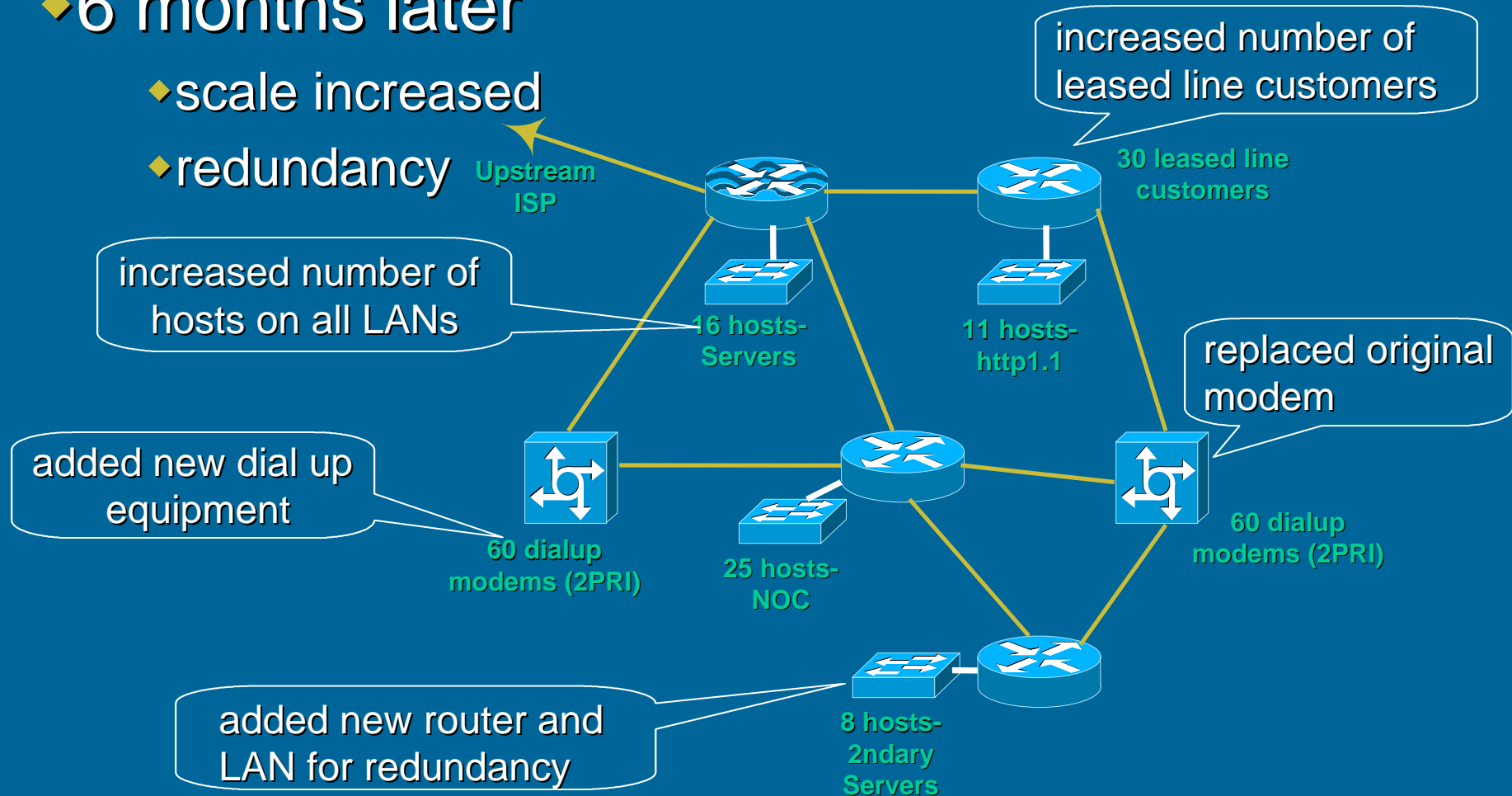


network-plan:	16	analogue dialup modems, vendor 'x'
network-plan:	5	LAN -web hosting (http1.1)
network-plan:	128	<b>5-8 leased line customers (/28)</b>
network-plan:	15	LAN -NOC and Ops management
network-plan:	10	LAN -mail,DNS, web servers internal
network-plan:	4	loopback router interfaces
network-plan:	2	router WAN ports
network-plan:	2	router WAN ports (x 5 lines)

# Network Plan

## ◆ 6 months later

- ◆ scale increased
- ◆ redundancy



# Addressing Plan

## ◆ Network plan at 6 months

-increases in hosts (interfaces)

network-plan:	16/ 60	2 PRI dialup modems, vendor 'y'
network-plan:	5/ 11	LAN -web hosting (http1.1)
network-plan:	128/ 512	30 leased line customers (pool)
network-plan:	15/ 25	LAN -NOC and Ops management
network-plan:	10/ 16	LAN -mail,DNS, web servers internal
network-plan:	4/ 6	loopback router interfaces
network-plan:	2/ 2	router WAN ports
network-plan:	2/ 2	router WAN ports (x 8 lines)
<b>network-plan:</b>	<b>0/ 60</b>	<b>2 PRI dialup modems</b>
<b>network-plan:</b>	<b>0/ 8</b>	<b>LAN-secondary servers</b>

Changed description

New hardware

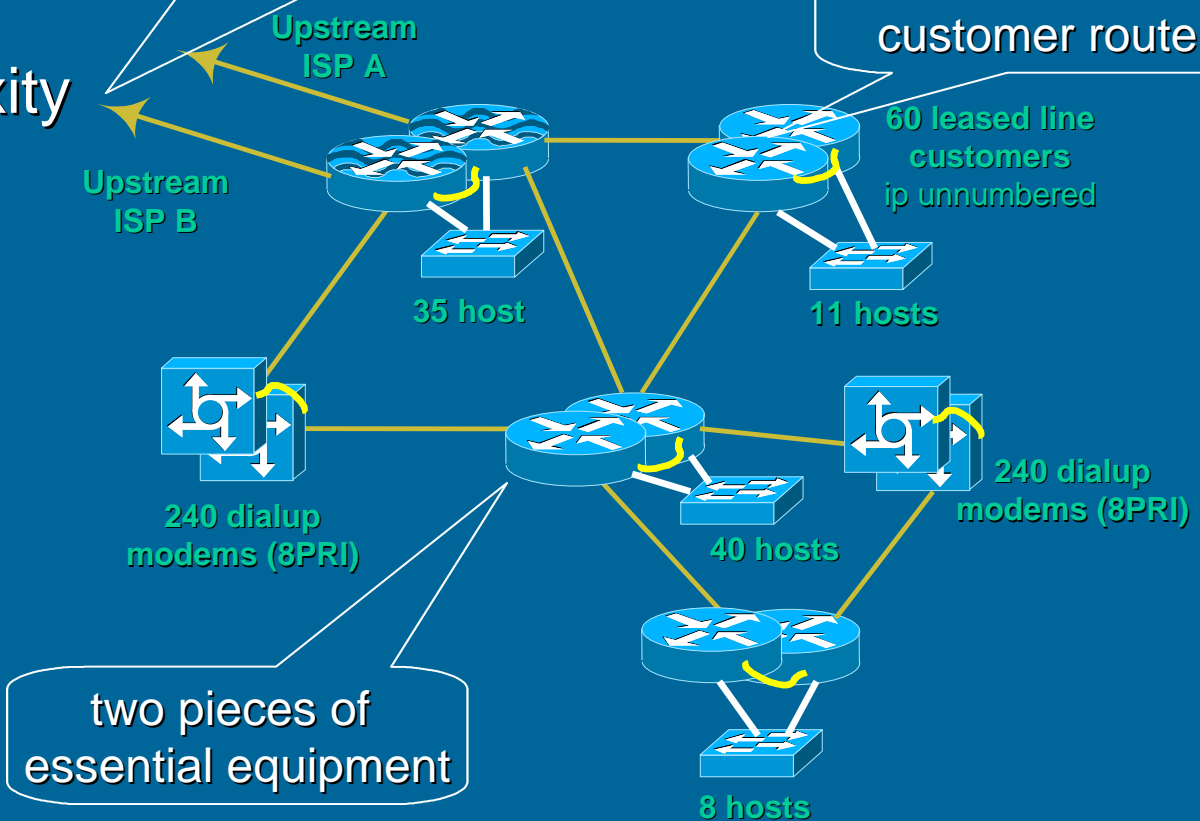
# Network Plan

## ◆ 12 months total

- ◆ site redundancy
- ◆ greater complexity
- ◆ *efficiency*

redundancy of WAN connections  
now numbered links for BGP4

added new  
customer router



# Addressing Plan

## ◆ Network plan at 12 months


-increases in hosts (interfaces)  
-one year total



network-plan:	16/60/	<b>240</b>	8 PRI dialup modems, vendor x
network-plan:	0/60/	<b>240</b>	8 PRI dialup modems, vendor y
network-plan:	5/11/	<b>11</b>	LAN -web hosting (http1.1)
network-plan:	128/512/	<b>1024</b>	60 leased line customers (pool)
network-plan:	15/25/	<b>40</b>	LAN -NOC and Ops management
network-plan:	10/16/	<b>35</b>	LAN -mail,DNS, web servers internal
network-plan:	0/8/	<b>8</b>	LAN-secondary servers
network-plan:	2/2/	<b>2</b>	router WAN ports
network-plan:	2/2/	<b>2</b>	router WAN ports (x 8 lines)
network-plan:	4/6	<b>12</b>	loopback router interfaces

# Addressing Plan

## ◆ Can now determine subnet sizes



network-plan:	<b>256</b>	<b>16/60/240</b>	8 PRI dialup modems, vendor x
network-plan:	<b>256</b>	<b>0/60/240</b>	8 PRI dialup modems, vendor y
network-plan:	<b>16</b>	<b>5/11/11</b>	LAN -web hosting (http1.1)
network-plan:	<b>1024</b>	<b>128/512/1024</b>	60 leased line customers (pool)
network-plan:	<b>64</b>	<b>15/25/40</b>	LAN -NOC and Ops management
network-plan:	<b>64</b>	<b>10/16/35</b>	LAN -mail,DNS, web servers internal
network-plan:	<b>8</b>	<b>0/8/8</b>	LAN-secondary servers
network-plan:	<b>4</b>	<b>2/2/2</b>	router WAN ports
network-plan:	<b>4</b>	<b>2/2/2</b>	router WAN ports (x 8 lines)
network-plan:	<b>16</b>	<b>4/6/12</b>	loopback router interfaces



# Addressing Plan

## ◆ Addressing plan for network-plan

- ◆ determination of relative subnet addresses
- ◆ re-ordered **large to small** according to relative subnet size




network-plan:	<b>0.0.0.0</b>	1024	128/512/1024	60 leased line customers (pool)
network-plan:	<b>0.0.4.0</b>	256	16/60/240	8 PRI dial up modems, vendor x
network-plan:	<b>0.0.5.0</b>	256	0/60/240	8 PRI dial up modems, vendor y
network-plan:	<b>0.0.6.0</b>	64	10/16/35	LAN -mail,DNS, web internal
network-plan:	<b>0.0.6.64</b>	64	15/25/40	LAN -NOC and Ops management
network-plan:	<b>0.0.6.128</b>	16	5/11/11	LAN -web hosting (http1.1)
network-plan:	<b>0.0.6.144</b>	16	0/8/8	LAN -secondary servers
network-plan:	<b>0.0.6.160</b>	16	4/6/12	loopback router interfaces
network-plan:	<b>0.0.6.176</b>	4	2/2/2	router WAN ports (x8)

- 
- ◆ cumulative total 0.0.6.208

# Addressing Plan

## ◆ Addressing plan for network-plan

### ◆ determination of subnet masks



network-plan:	0.0.0.0	<b>255.255.252.0</b>	1024	128/512/1024	60 leased line customers
network-plan:	0.0.4.0	<b>255.255.255.0</b>	256	16/60/240	8 PRI dial up modems, vendor x
network-plan:	0.0.5.0	<b>255.255.255.0</b>	256	0/60/240	8 PRI dial up modems, vendor y
network-plan:	0.0.6.0	<b>255.255.255.192</b>	64	10/16/35	LAN -mail,DNS, web internal
network-plan:	0.0.6.64	<b>255.255.255.192</b>	64	15/25/40	LAN -NOC & Ops management
network-plan:	0.0.6.128	<b>255.255.255.240</b>	16	5/11/11	LAN -web hosting (http1.1)
network-plan:	0.0.6.144	<b>255.255.255.240</b>	16	0/8/8	LAN -secondary servers
network-plan:	0.0.6.160	<b>255.255.255.240</b>	16	4/6/12	loopback router interfaces
network-plan:	0.0.6.176	<b>255.255.255.252</b>	4	2/2/2	router WAN ports (x 8 )

# Addressing Plan

## ◆ Addressing plan for network-plan

- ◆ connect to the Internet (full-time, part-time)?



network-plan:	0.0.0.0	255.255.252.0	<b>YES</b>	1024	128/512/1024	60 leased customers
network-plan:	0.0.4.0	255.255.255.0	<b>PART</b>	256	16/60/240	8 PRI dial up modems..
network-plan:	0.0.5.0	255.255.255.0	<b>PART</b>	256	0/60/240	8 PRI dial up modems..
network-plan:	0.0.6.0	255.255.255.192	<b>YES</b>	64	10/16/35	LAN -mail,DNS, web internal
network-plan:	0.0.6.64	255.255.255.192	<b>YES</b>	64	15/25/40	LAN -NOC & Ops managemen
network-plan:	0.0.6.128	255.255.255.240	<b>YES</b>	16	5/11/11	LAN -web hosting (http1.1)
network-plan:	0.0.6.144	255.255.255.240	<b>YES</b>	16	0/8/8	LAN -secondary servers
network-plan:	0.0.6.160	255.255.255.240	<b>YES</b>	16	4/6/12	loopback router interfaces
network-plan:	0.0.6.176	255.255.255.252	<b>YES</b>	4	2/2/2	router WAN ports (x 8 )

# Addressing Plan

## ◆ Addressing plan complete

- ◆ total planned for customer assignments /22
- ◆ total planned for ISP infrastructure /24 + /23

network-plan:	0.0.0.0	255.255.252.0	YES	1024	128/512/1024	60 leased line customers
network-plan:	0.0.4.0	255.255.255.0	PART	256	16/60/240	8 PRI dial up modems..
network-plan:	0.0.5.0	255.255.255.0	PART	256	0/60/240	8 PRI dial up modems..
network-plan:	0.0.6.0	255.255.255.192	YES	64	10/16/35	LAN -mail,DNS, web internal
network-plan:	0.0.6.64	255.255.255.192	YES	64	15/25/40	LAN -NOC & Ops managemen
network-plan:	0.0.6.128	255.255.255.240	YES	16	5/11/11	LAN -web hosting (http1.1)
network-plan:	0.0.6.144	255.255.255.240	YES	16	0/8/8	LAN -secondary servers
network-plan:	0.0.6.160	255.255.255.240	YES	16	4/6/12	loopback router interfaces
network-plan:	0.0.6.176	255.255.255.252	YES	4	2/2/2	router WAN ports (x 8 lines )

## ◆ detailed, efficient and accurate

# Where To Get IP Addresses

- ◆ APNIC
  - ◆ <http://www.apnic.net>
- ◆ ARIN
  - ◆ <http://www.arin.net>
- ◆ RIPE NCC
  - ◆ <http://www.ripe.net>
  - ◆ Membership required
- ◆ Fees are charged for services by all RIRs

# Policy References

- ◆ APNIC

- ◆ <http://www.apnic.net/docs/add-manage-policy.html>

- ◆ ARIN

- ◆ <http://www.arin.net/regserv/IPv4services.htm>

- ◆ RIPE NCC

- ◆ <http://www.ripe.net/ripe/docs/ripe-185.html>

- ◆ RFC2050: *RIR Allocation Guidelines*

- ◆ <http://ftp.apnic.net/ietf/rfc/rfc2000/rfc2050.txt>

# Recommended Reading

- ◆ Classless techniques
  - ◆ CIDR
    - ◆ <http://ftp.apnic.net/ietf/rfc/rfc1000/rfc1517-19.txt>
    - ◆ Network Addressing when using CIDR  
<ftp://ftp.uninett.no/pub/misc/eidnes-cidr.ps.Z>
    - ◆ Variable Length Subnet Table  
<http://ftp.apnic.net/ietf/rfc/rfc1000/rfc1878.txt>
- ◆ Private Address Space
  - ◆ *Address Allocation for Private Internets*
    - ◆ <http://ftp.apnic.net/ietf/rfc/rfc1000/rfc1918.txt>
  - ◆ Counter argument: *Unique addresses are good*
    - ◆ <http://ftp.apnic.net/ietf/rfc/rfc1000/rfc1817.txt>



# Questions?