Good ISPs have No Class

Musings on Addressing

Howard C. Berkowitz

hcb@clark.net

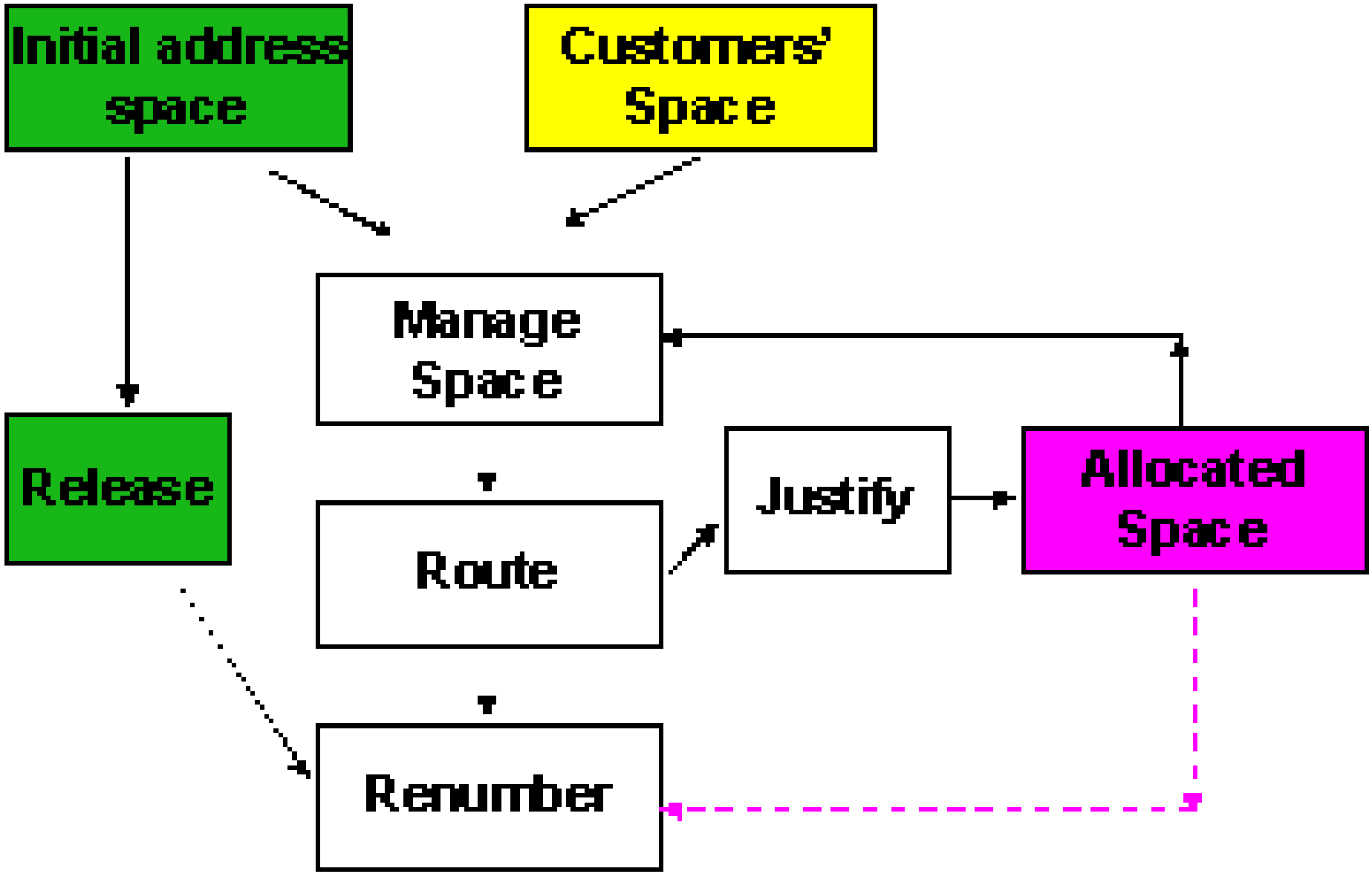
(703)998-5819

www.netarchitecture.com

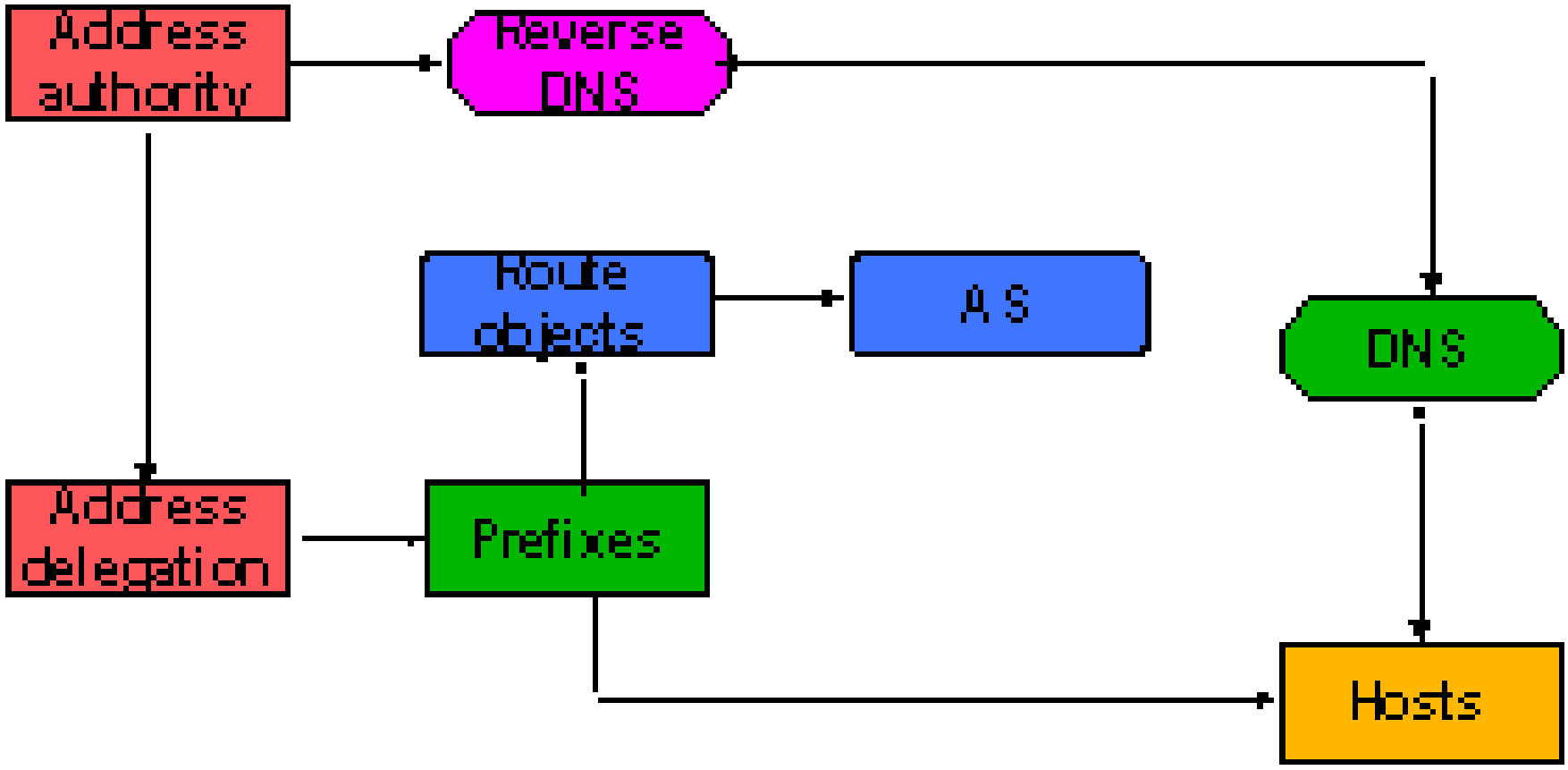
Musings

- Dealing with Classful Customer Addresses
- Obtaining and Justifying Address Space
- Managing Address Space
- Renumbering

A Life Cycle


Initial address space
Customers' Space
Manage Space
Release
Route
Justify
Allocated Space
Renumber

More than Just Addresses

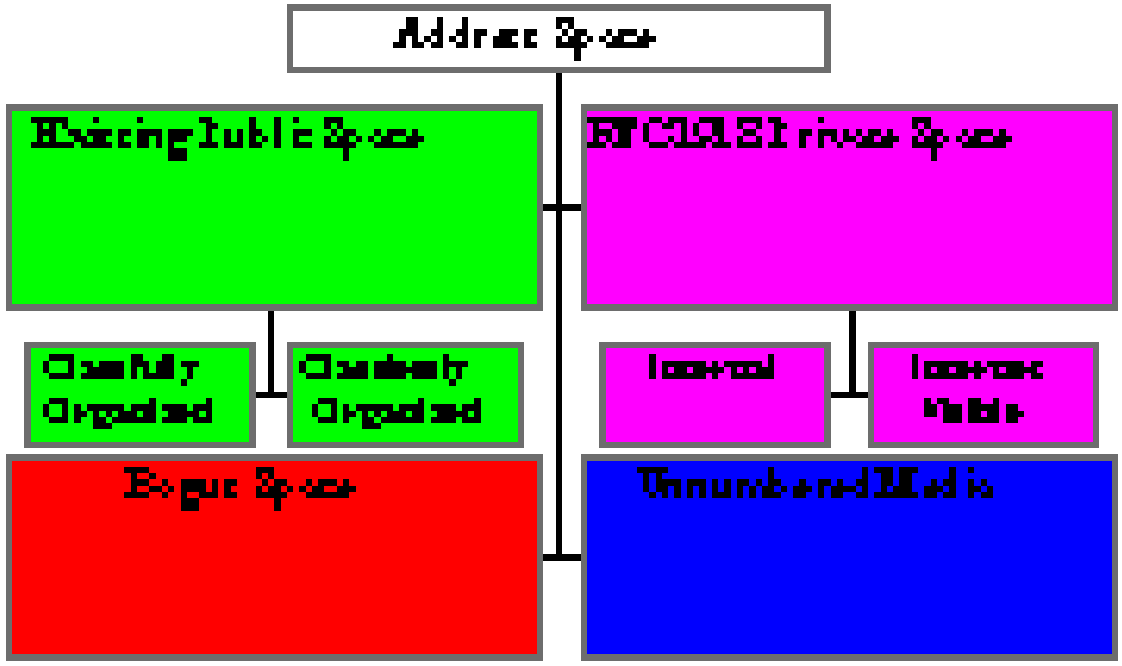


Dealing with Classful Customer Addresses

Be careful what you sell. It may do exactly what the customer expects.

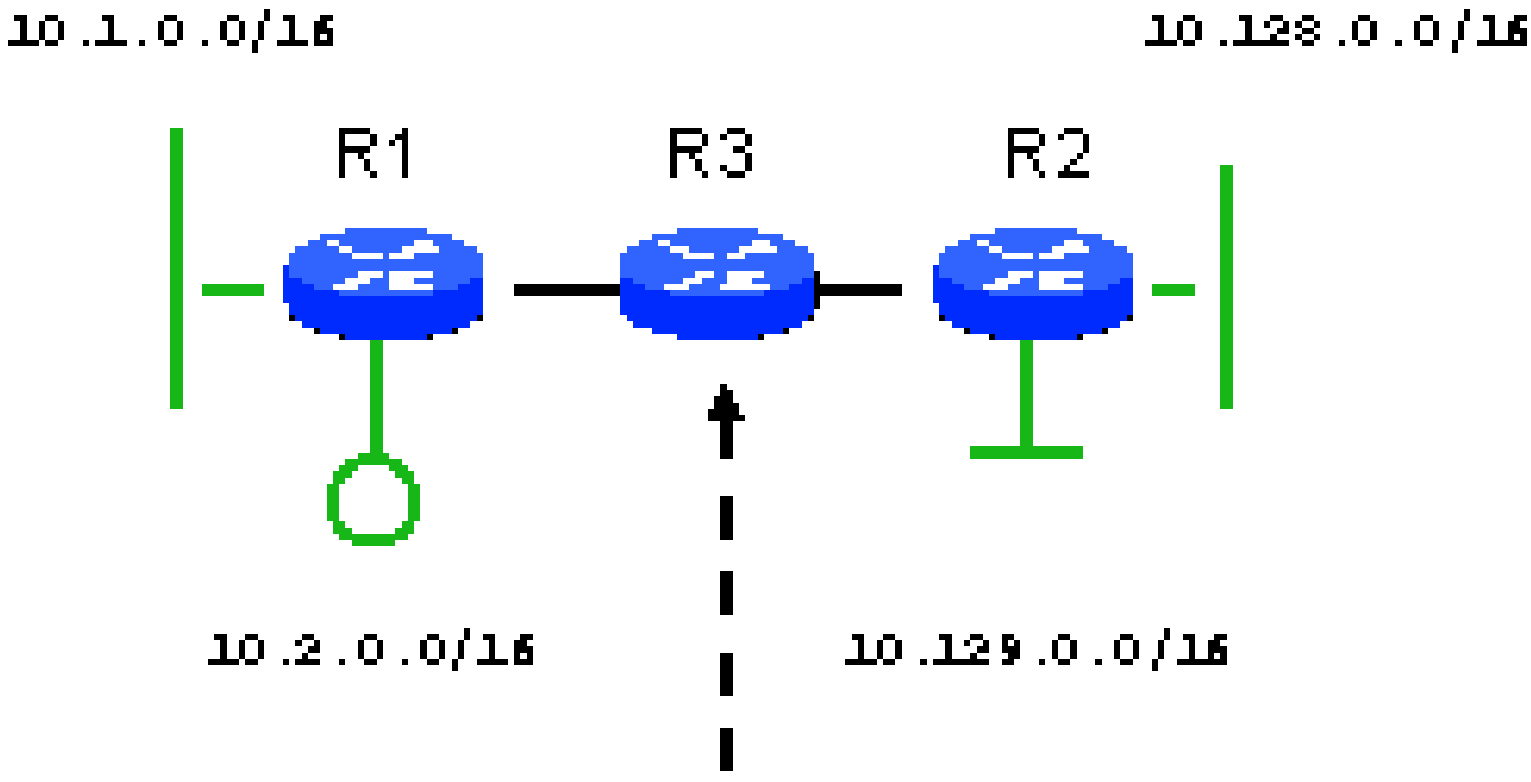
Ferengi Rule of Acquisition #32

Customer Address Space



Discontiguous Subnets

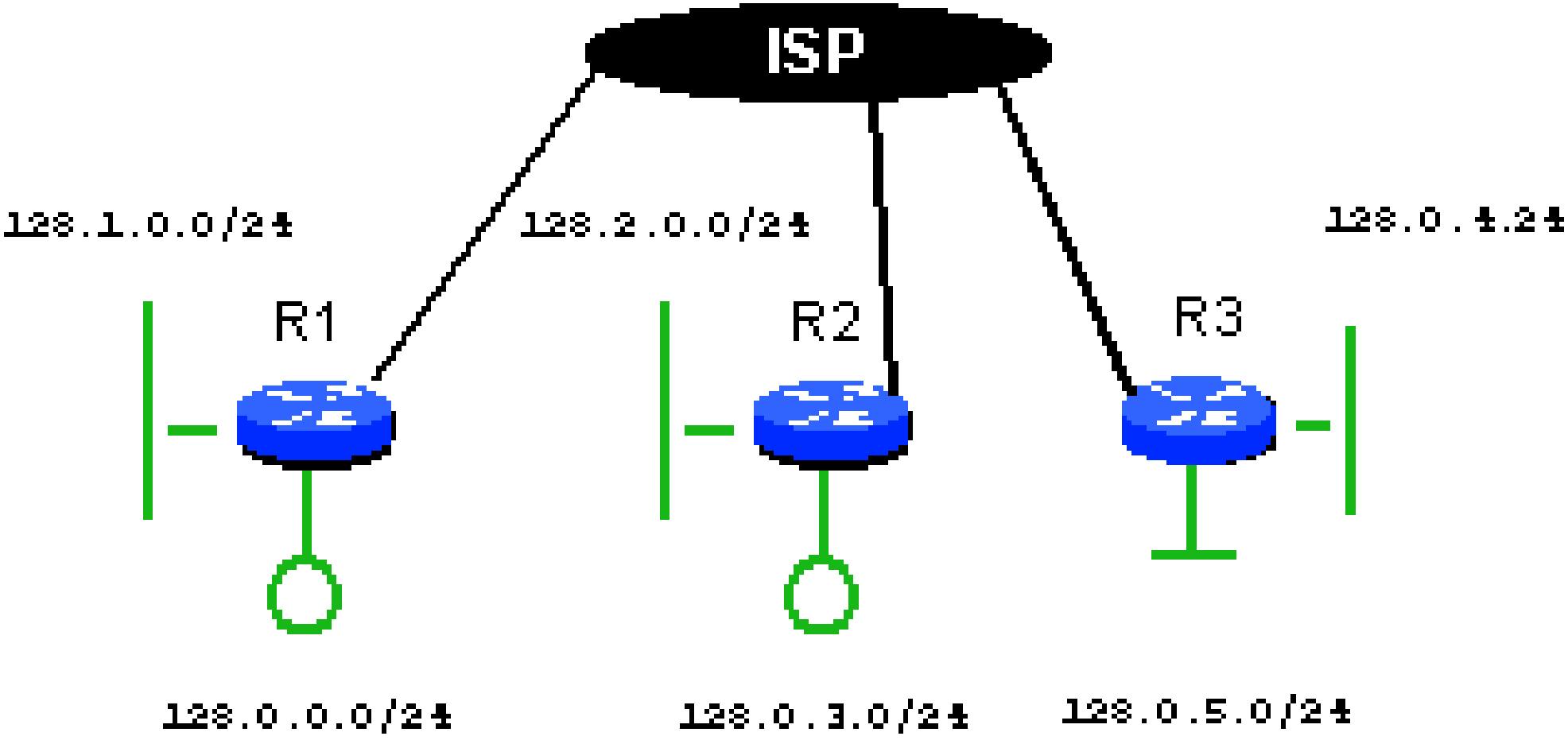
The Usual Enterprise-Oriented Picture



If R3 only knows about "network 10,"
where does it send a packet for 10.64.0.0?

Discontiguous Subnets

Now it's the ISP's Problem

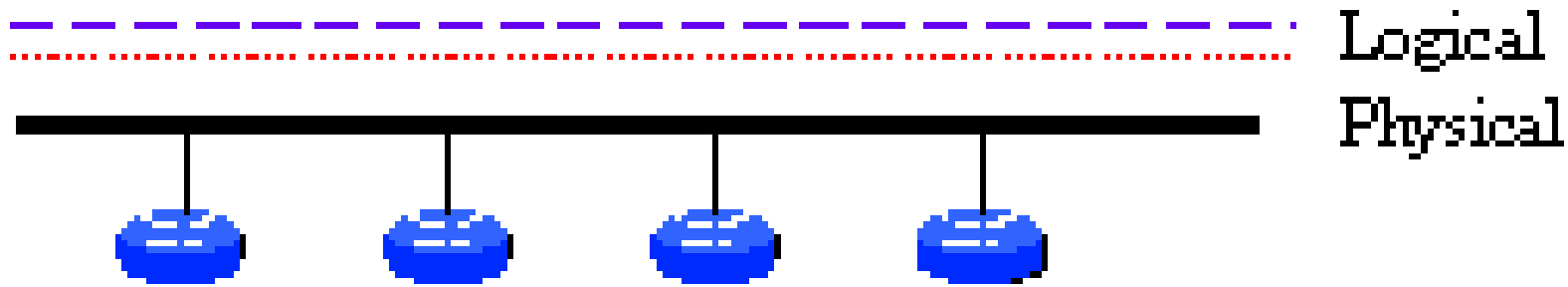


Healing Discontiguous Networks Techniques

- Secondary addressing
- IP over IP tunneling
- IP unnumbered
- Static routes
- Network address translation

- Best way
  - How to classless environment
  - No more discontiguity
- Care needed to deal with routing table growth
  - Summarize where practical
  - Address assignment must be more careful

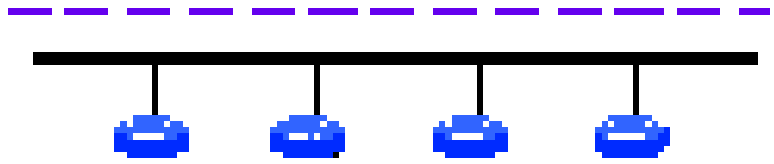
Secondary Addresses



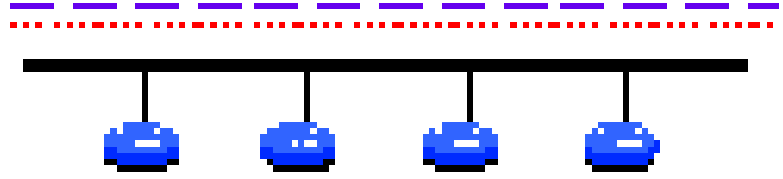
- **Multiple prefixes on physical medium**
  - True physical or VLAN
- **Applications**
  - Increase available host addresses on medium
  - Repair subnet discontiguity
  - Make mixed switch/bridge with router system transparent
- **Can cause problems with OSPF and EIGRP**
  - But less likely to be needed in classless environment

Logical and Physical Combinations

Single physical
Single logical

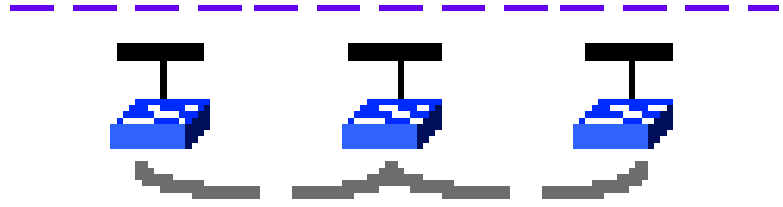


Single physical
Multiple logical



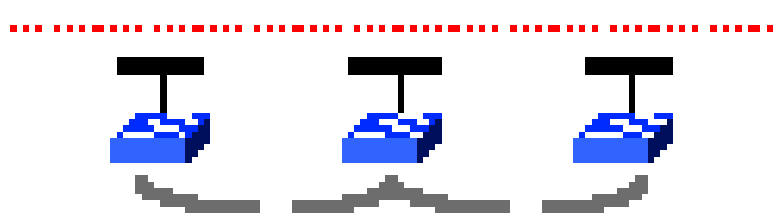
Secondaries

Multiple physical
Single logical



VLAN

Multiple physical
Multiple logical

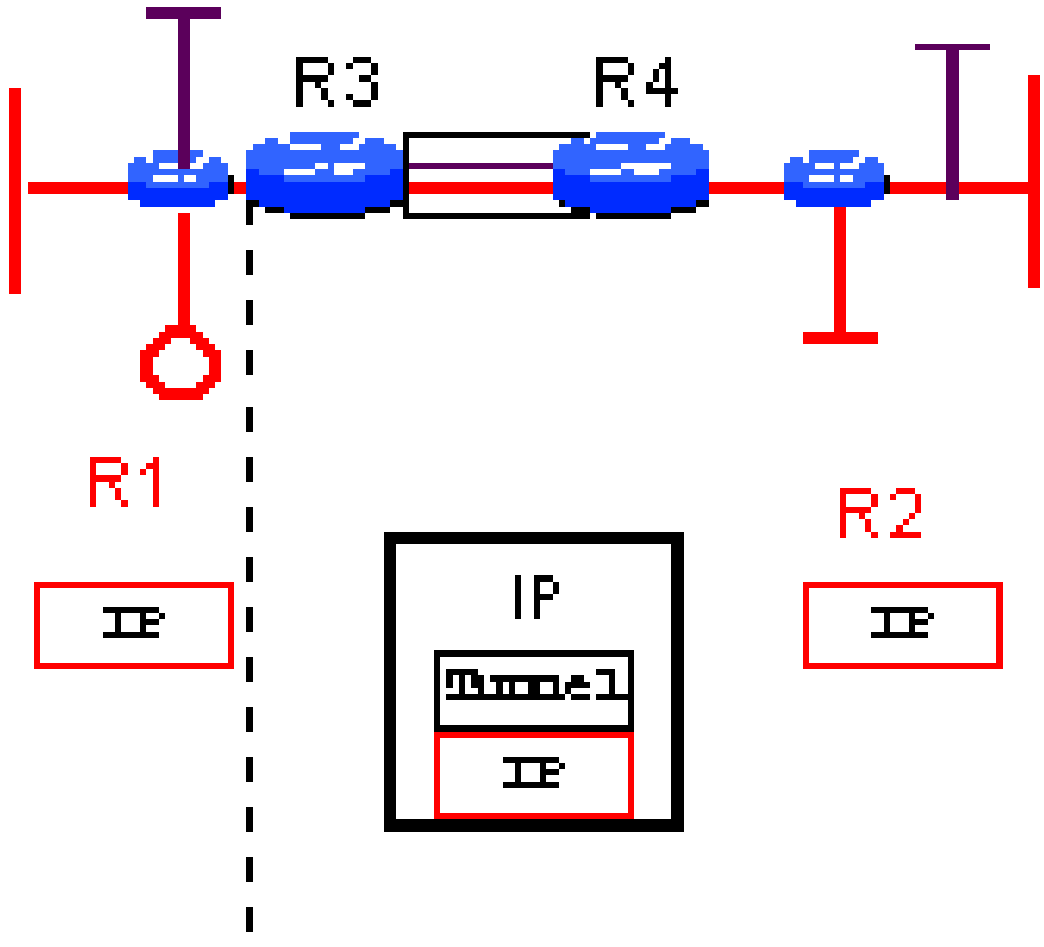


VLAN with Secondaries

Secondary Addresses Cisco Configuration Warnings

- **Every router interface on a common medium**
  - should have the same number of `ip address` statements
  - Subnets/prefixes should appear in the same order
    - Primary on one should be primary on all
    - First secondary subnet should be first secondary on all, etc.
- **Current OSPF and EIGRP**
  - Only operate on the primary address

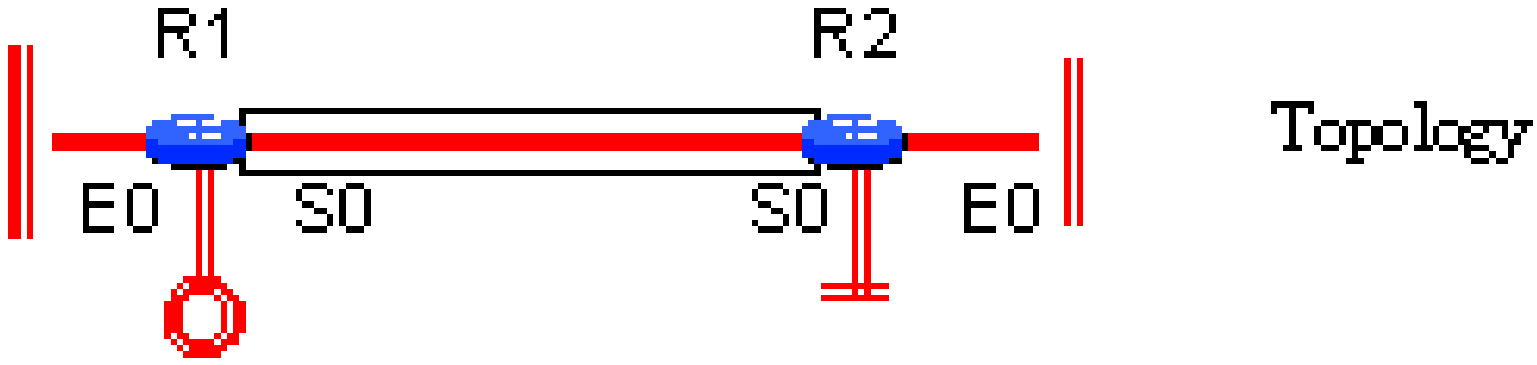
IP-over-IP Tunneling



Topology

Protocol Header Flow

IP Unnumbered

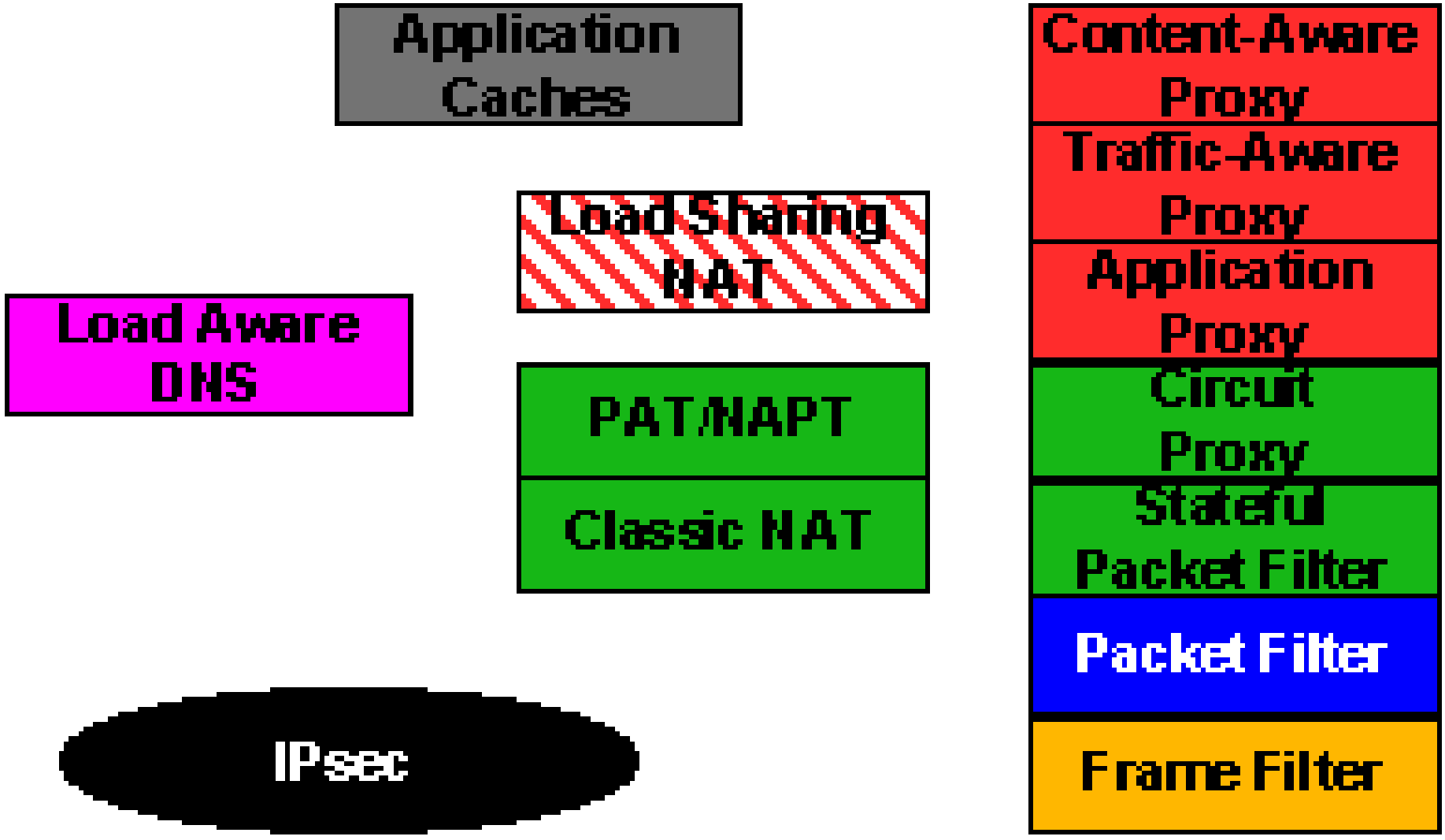


- **R1 and R2 form a "virtual router"**
- **The serial link has no ip address**
  - All packets arriving at S0 of either router immediately go to its E0
  - All packets generated at E0 go onto serial link
- **Conserves addresses but makes management harder**

Private Address Space

- **Three blocks**
  - 10.0.0.0/8
  - 172.16.0.0/12
  - 192.168.0.0/16
- **Easy to filter as contiguous blocks**
  - deny 10.0.0.0 0.255.255.255
  - deny 172.16.0.0 0.15.255.255
  - deny 192.168.0.0 0.0.255.255
- **Can be translated if necessary**
  - Network address translation needs to be understood

NATs and Proxies



Getting Address Space

Rules are always subject to interpretation

Ferengi Rule of Acquisition #284

CIDR and VLSM are the same

- **CIDR usually discussed in general Internet context**
  - Uses arbitrary length prefixes to reduce workload in key Internet routers
- **VLSM usually discussed in enterprise context**
  - Uses arbitrary length prefixes to have better usage of enterprise address space
- **Customers often confused**

Allocation vs. Assignment

- **Policy defined in RFC 2050**
- **Allocation**
  - "own" the address space
  - Meant primarily for providers
- **Assignment**
  - "lent" the address space by provider
  - Enterprise address aggregated into provider's space

User Allocation Policies

- **Preferences:**
  - Get space from provider
  - Get space from provider's provider
  - Get unique space
- **Unique space may not be globally routable**
- **Getting more space may require renumbering and/or NAT**
- **Situation becomes much more complex when there is a need to "multihome"**

Provider Allocation Policies
The Quest for /19

- **/19 is highly desirable for global routability**
- **Not a panacea**
  - further restrictions may apply to blocks in classical Class A or B space
  - See http://www.nanog.org/filter.html
- **But to get a /19 the normal way...**
  - You must demonstrate approximately 8K present user addresses, based on no more than 6 month growth
  - You must show efficient use
  - Yet you may need to renumber

Provider Allocation Policies Issues

- **Large carriers, especially Sprint, limit the length of prefix lengths**
  - Provider-independent addresses assigned to their customers
  - Transit advertisements received from their customers
  - Assignments of other carrier address space to their customers
    - Will Sprint provide backup to a joint customer of Sprint and World** that uses World** address space?
- **/19 prefixes are generally globally routable**
- **Rumors abound that filters may go**

New Provider Allocation Policies

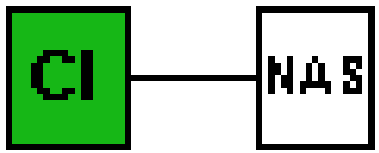
ARIN only

- **To be eligible for direct /19 allocation, carrier must:**
  - Have efficiently used a /21 and can prove it
  - Agree to renumber out of the /21 in 18 months and return the space
  - Be multihomed
- **ISP will receive a /20 but can advertise the /19**
  - If the rest of the /19 not used in 18 months,
  - The ISP must go back to advertising the /20.

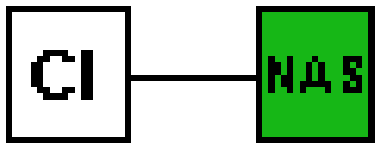
Address Registries Like Efficient Usage Techniques

- **Dynamic addressing**
  - LAN
    - » DHCP
    - » BOOTP
  - WAN
    - » Local address pools
    - » PPP IPCP
    - » DHCP proxy services
- **Aggregated routing announcements**
- **May complicate management**
  - Registry policy (RFC2050) response: life is hard and then you die. So?
  - Link DNS and dynamic assignment

Address Sources for Dialups

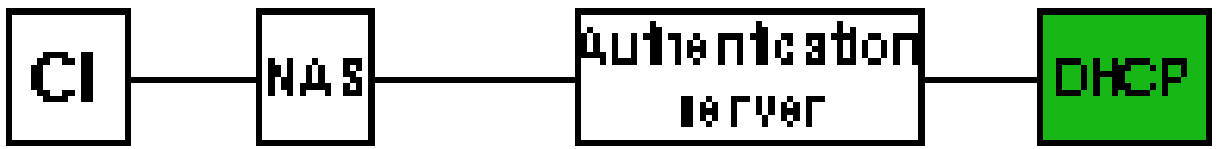


IPCP client proposes address



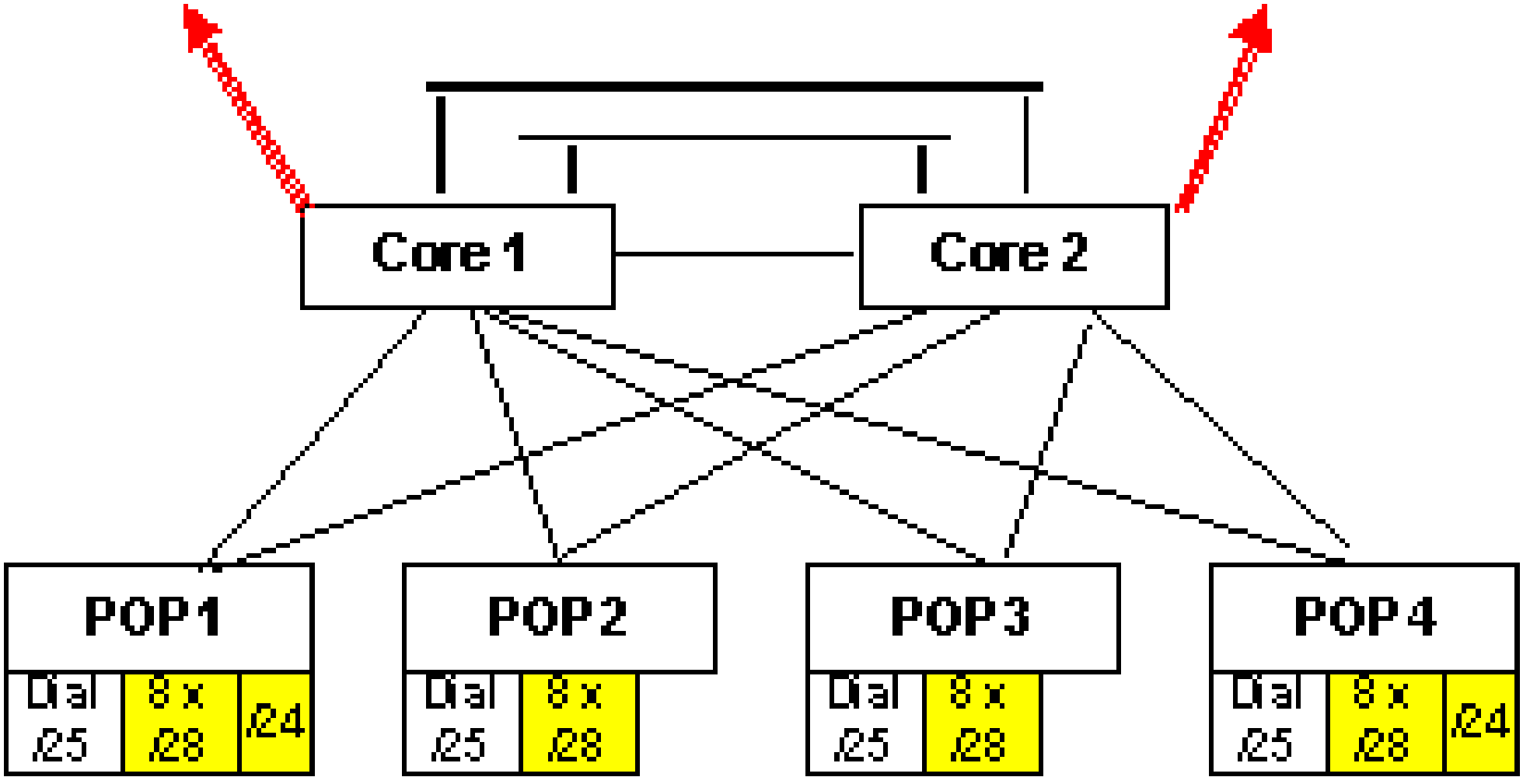
IPCP client requests address from NAS pool

IPCP client requests address from NAS; NAS obtains from RADIUS/TACACS

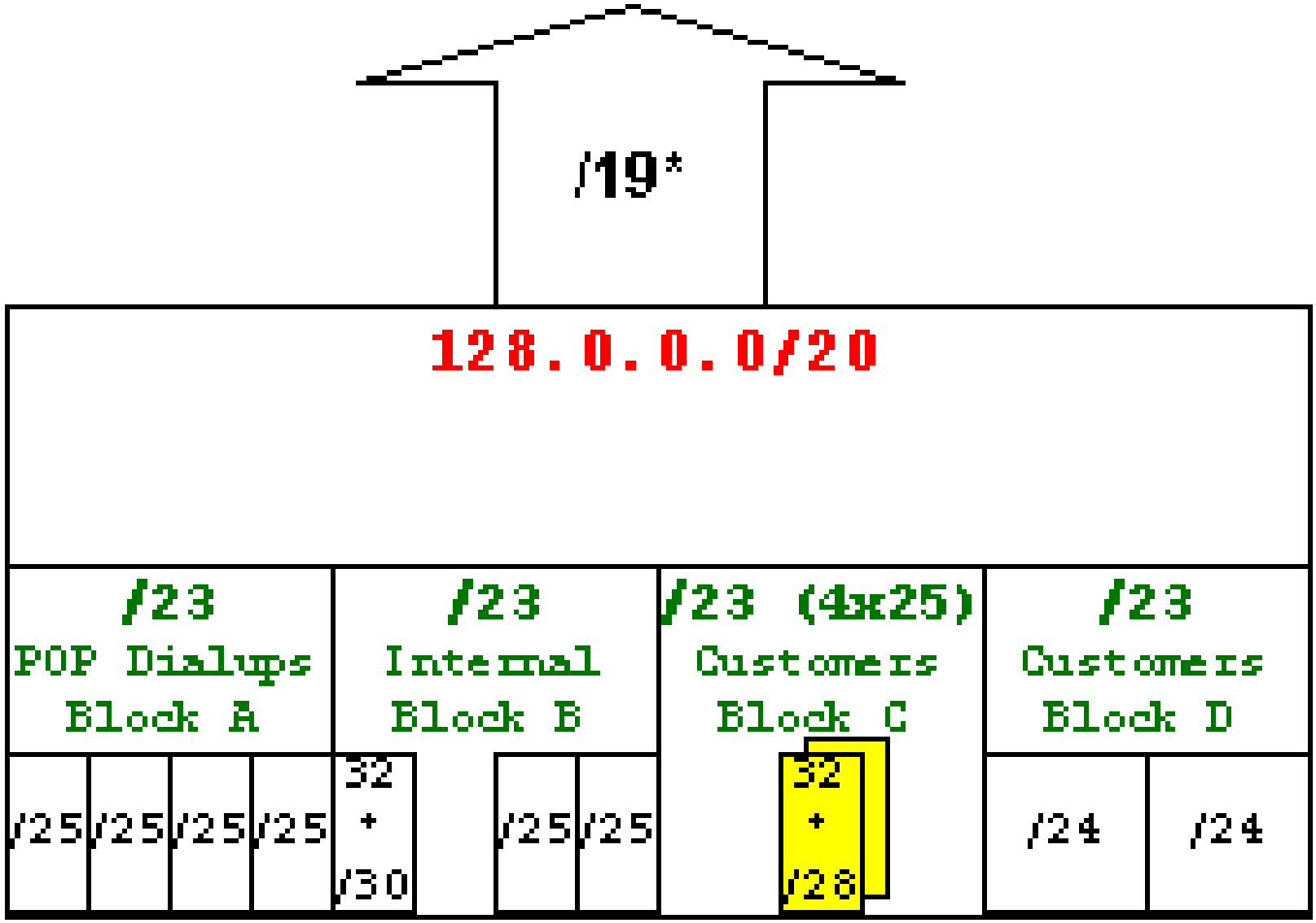


IPCP client requests address from NAS; NAS obtains from RADIUS/TACACS

An ISP Topology



An ISP Address Plan



Managing Address Space

It's hard to be a team player
when you're
used to being omnipotent

The Q Entity

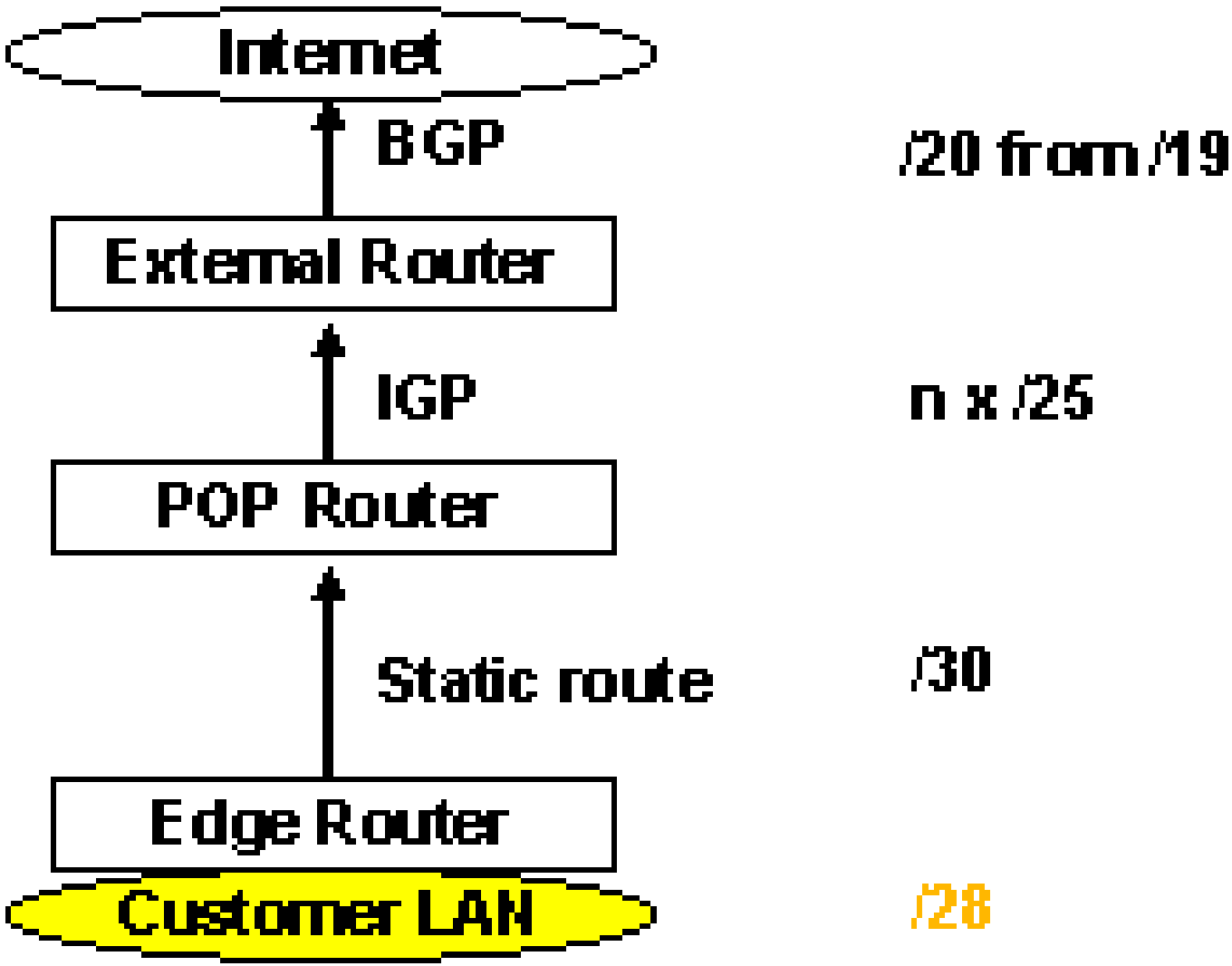
Laws of Address Administration

- **Avoid entering an address more than once**
- **Automate configuration updating**
  - TFTP or telnet/expect
  - Replace v.s. merge
  - Scheduled reboot
- **Document automatically**
  - For troubleshooting
  - For justifying address allocation

What Addresses do you Need to Manage?

- **Customer assigned blocks**
- **POP/□Dialup**
  - xDSL, cable, etc. NOT a solved problem
- **Infrastructure**
  - Inter-router links
  - Server farms
    - Virtual domains
    - DNS, DHCP, SNMP, etc.
  - Inter-AS links

Customer Connectivity Model



1. Capture Customer Information

- Domain name
- Remote router name `router`
- Next available /30 for POP
  - Create variable `wanPrefix`
- Next available /28 assigned to POP
  - Create variable `lanPrefix`
- DLCI's at remote and distribution

2. Remote Router

```
int e0
ip addr (lanPrefix + 14) 255.255.255.240
int S0.rmtDLCI
ip addr (wanPrefix + 2)  255.255.255.252
ip route 0.0.0.0/0 (wanPrefix+1)
-------------------------------------
<router-e0>          IN A (lanPrefix + 14)
(lanPrefix+14)       IN PTR <router-e0>
<router-s0-DLCI> IN A (wanPrefix + 2)
(wanPrefix + 2)  IN PTR <router-s0-DLCI>
! SOA,NS, MX, firewall, etc. as necessary
```

3. Distribution Router

```
ip route (lanPrefix)/0 (wanPrefix + 2)
int S0.distDLCI
ip addr (wanPrefix + 1) 255.255.255.252
! blackhole as appropriate
-----------------------------------
<distrouter-s0-DLCI>
  IN A (wanPrefix + 1)
(wanPrefix + 2)
  IN PTR <distrouter-s0-DLCI>
```

4. Audit/Justify

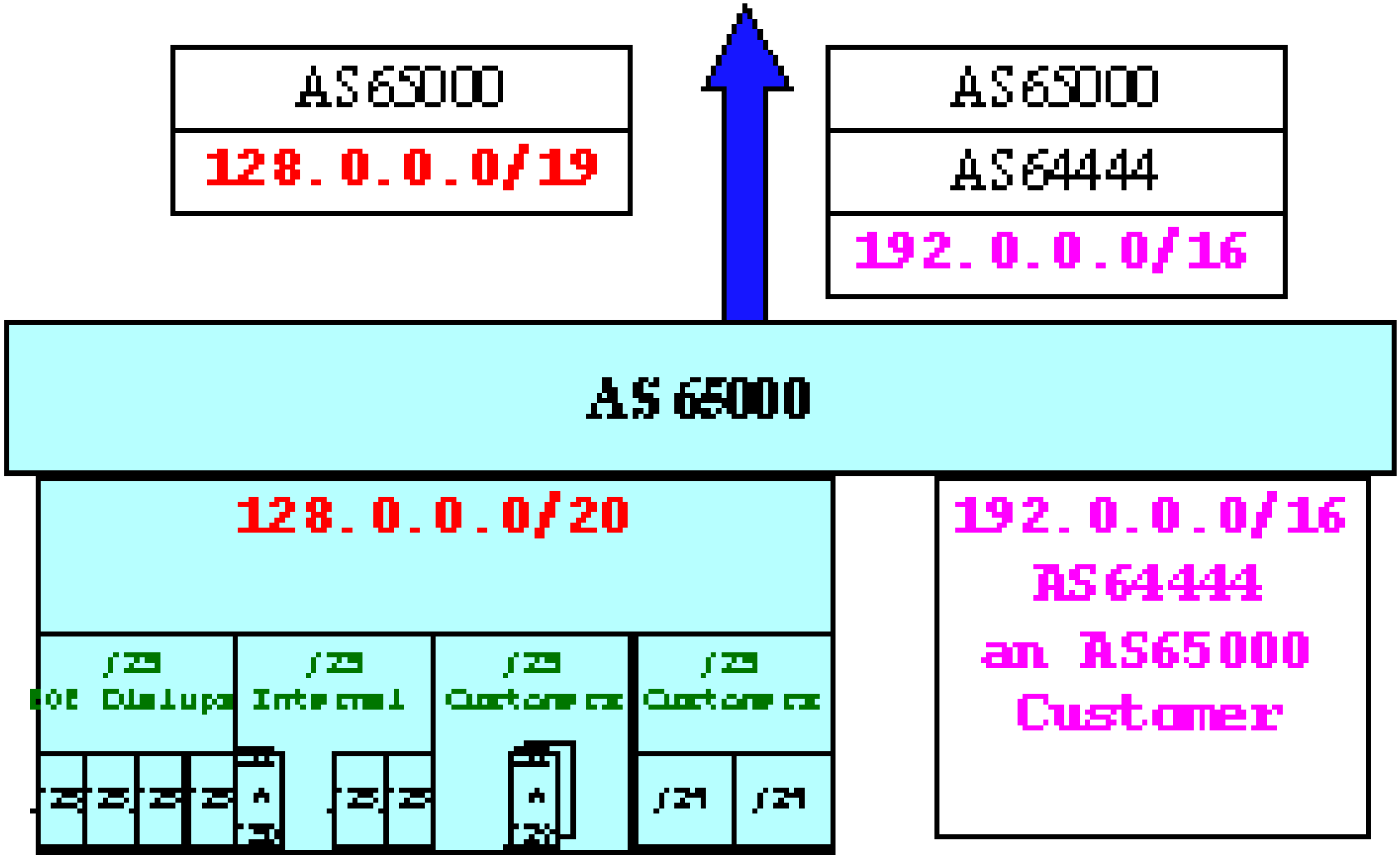
- Keep current report of allocations, assignment, and utilization
- Include dated log to show trends

"I am Kim of Borg.
Resistance is Futile.
You will be Aggregated."

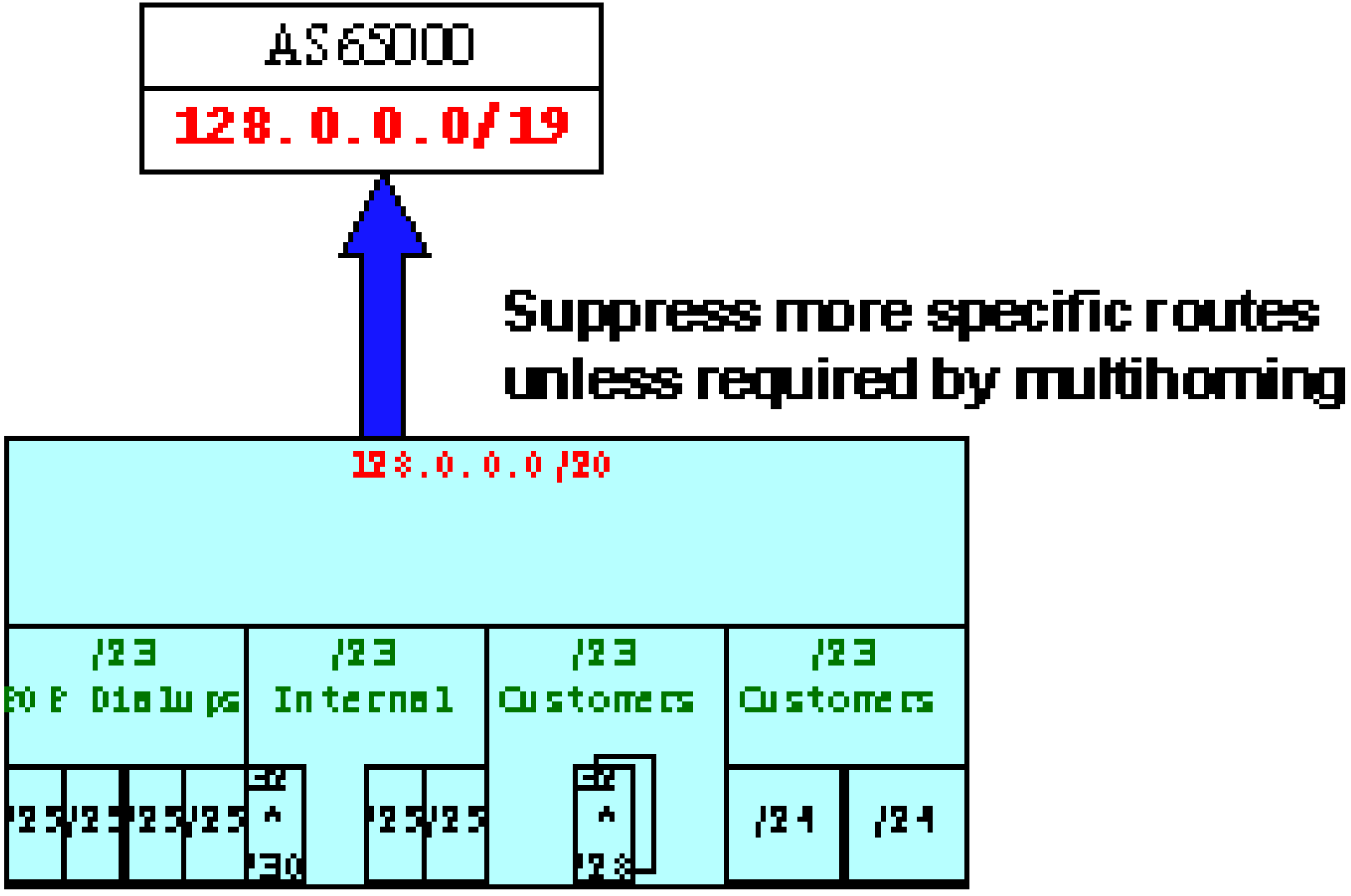
Aggregation is better than Aggravation

- **Blackhole routes for your blocks**
  - Avoid more-specifics
  - Use NO-EXPORT when controlling load to upstream
- **Encourage customers to aggregate**
  - Proxy aggregation hard to administer
- **Understand which blocks you can advertise**
  - And do ingress/egress filtering

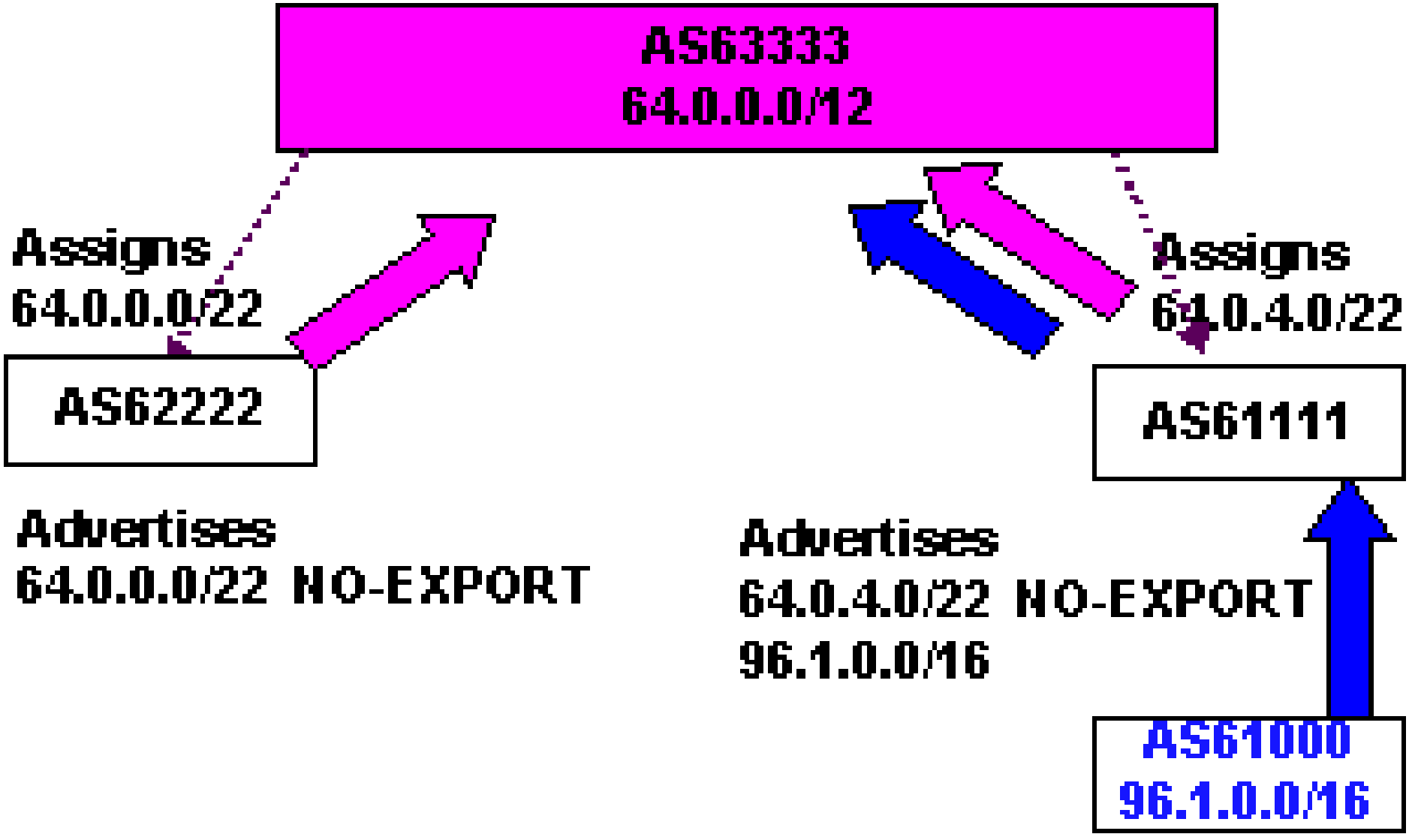
Origination vs. Advertising



Aggregating your Own Traffic



Advertising with NO-EXPORT



Planning for Renumbering

The Good of the Many
Outweighs the Good of the One

Mr. Spock

Renumbering is Inevitable

- Build networks to be renumbering friendly
- See RFC2071 & RFC2072
- NAT techniques help but are not a panacea
- An attraction of IPv6 is its renumbering capability, not that it gives "more addresses"

Renumbering 1

- **Database/Inventory**
  - closely tied to DNS
- **Host Plan**
  - Naming
  - Addressing
    - Well-disciplined server assignment
      - Own address
      - Server & router addresses
  - Find hidden IP addresses
    - Data bases and transaction servers
    - Software license managers
    - Network management tools

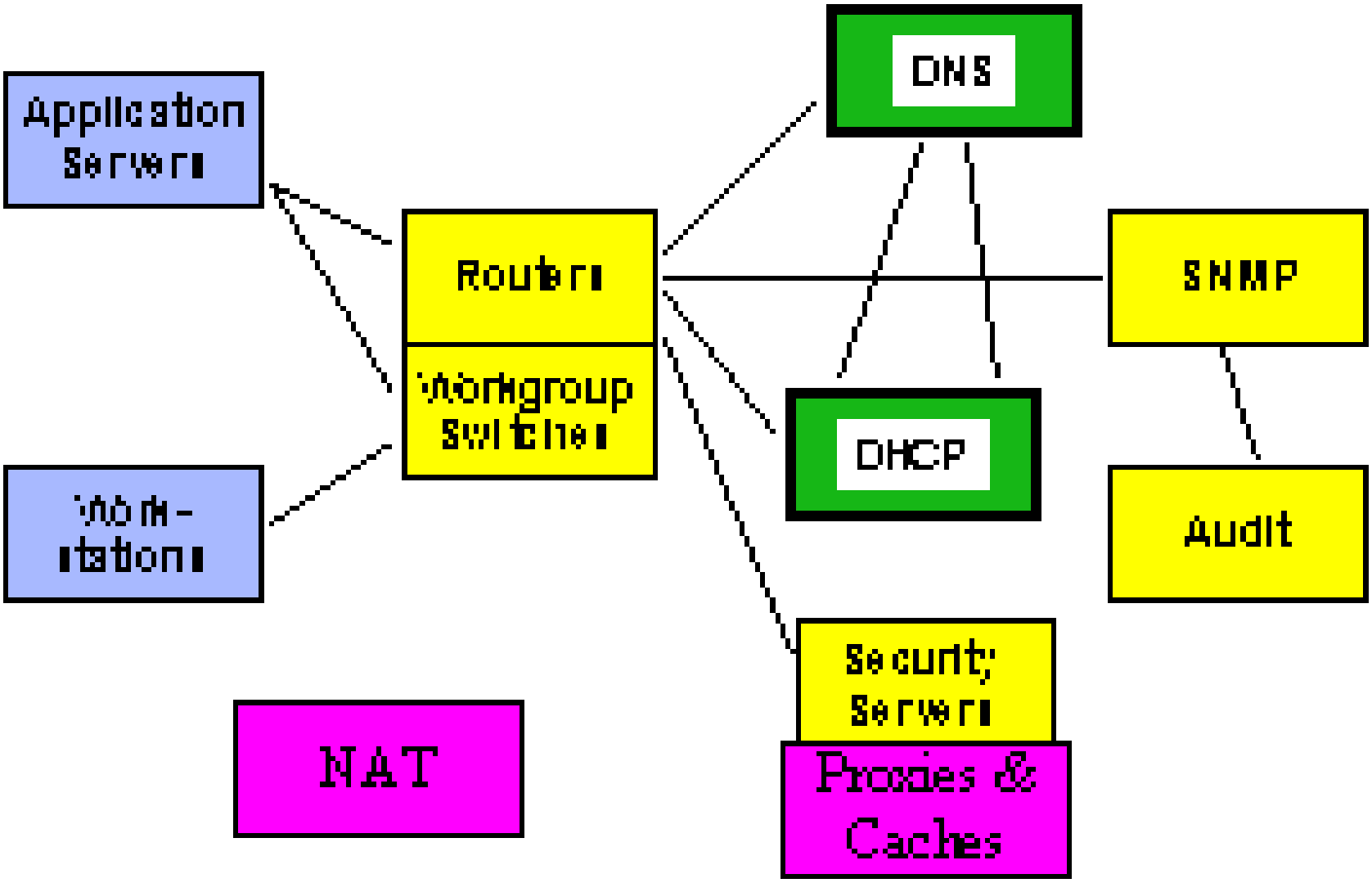
Renumbering 2

- **Addressing and Relaying Plan**
  - External connectivity
  - Efficient use of address space
- **Dynamic Addressing**
  - DHCP for LANs and Proxied WANs
    - Static mode preferred for maintainability
    - Dynamic addressing may reduce address space requirement
  - PPP/IPCP for Dialups

Domain Name Service

- Key to renumbering
- Replace hard-coded IP references with DNS references
- Useful to define DNS names for router interfaces

Interactions



Further Information

- **Shameless Plug**
- ***Designing Addressing Architectures for Routing and Switching***
  - Howard C. Berkowitz
  - Macmillan Technical Publishing, December 1998