IPv6
What Works…What Doesn't

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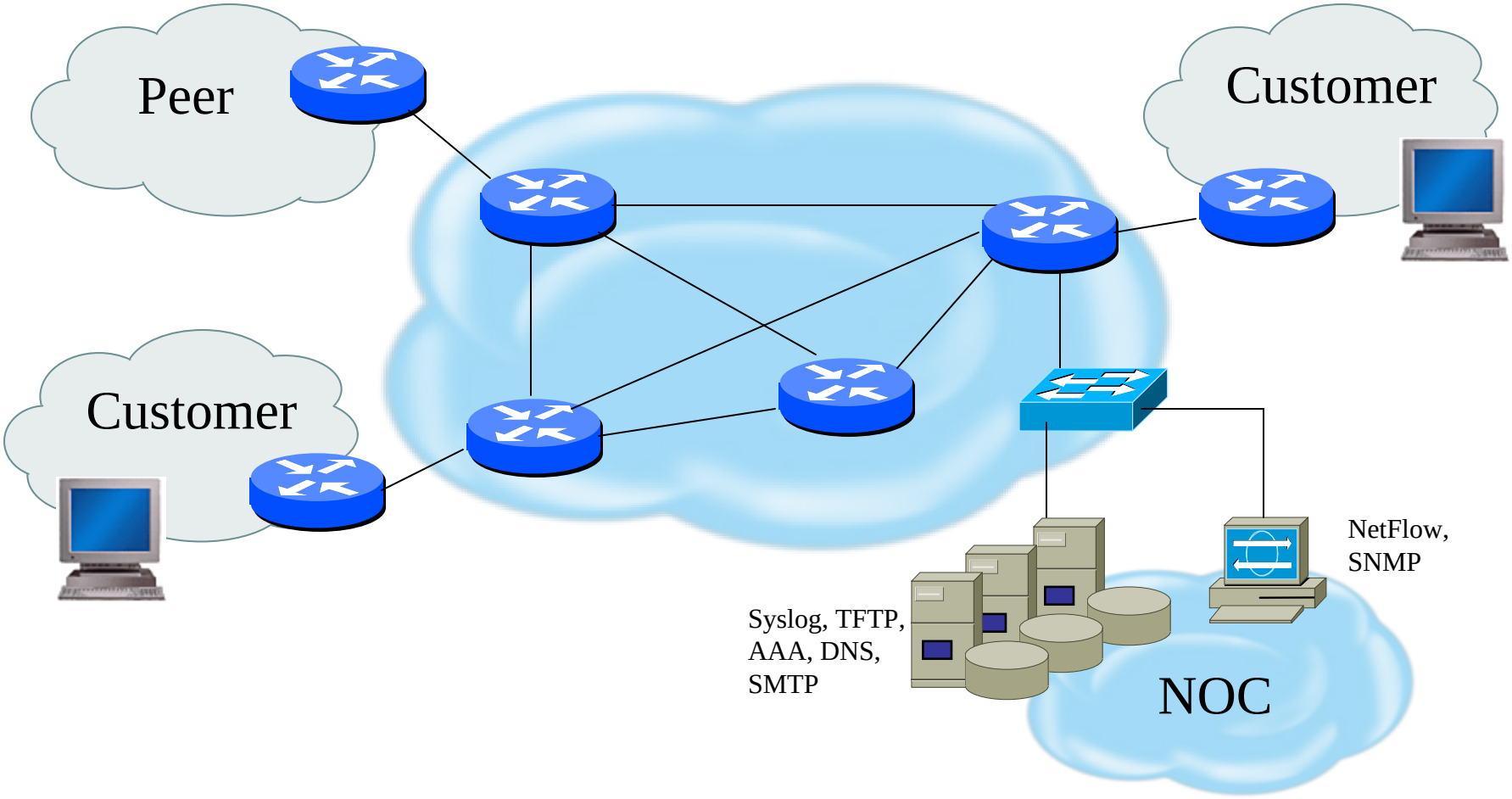
Agenda

- Architecture Considerations…….I have an IPv6 address block…..now what?
- Functional Considerations
- My Deployment Experience
- Where Do I Go From Here….

Architecture Considerations

- Addressing / Naming
  - What subnet boundaries make sense
    - your own network infrastructure
  - No universal BCP for pt-pt addressing
    - rfc3627 offers guidelines but who follows it?
  - Endpoint Identifier management
    - address automation vs obscurity vs auditability
  - DNS Naming Considerations
- Native Routing vs Tunnels
- Management
- Security [what does ‘built-in’ really mean]

Infrastructure Components



Functional Considerations

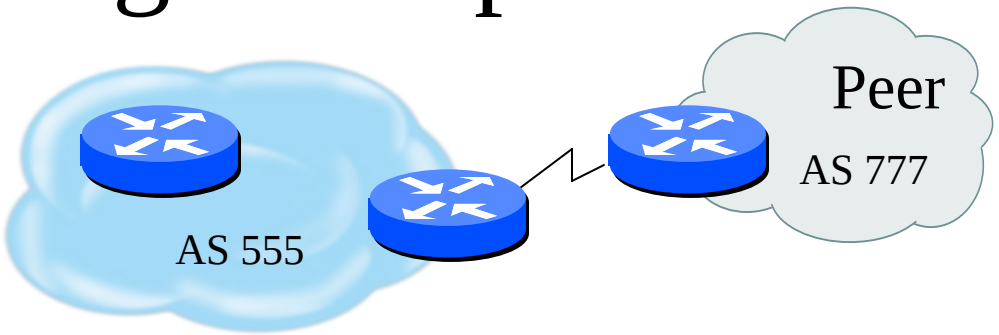
- Routing Control Plane
- Data Path
- Device Management
  - In-Band / OOB
- Software Upgrade
- Configuration Integrity
- Network Services
  - DNS, Syslog, NTP, SNMP, Netflow

- Logging
- Filtering
- DoS Tracking /Tracing
  - Sink Hole Routing
  - Black-Hole Triggered Routing
  - Unicast Reverse Path Forwarding (uRPF)
  - Rate Limiting

Routing Control Plane

- Easy to configure and it just works
  - Route filters limit what routes are believed from a valid peer
  - Packet filters limit which systems can appear as a valid peer
  - Limiting propagation of invalid routing information
    - Prefix filters
    - AS-PATH filters
- MD-5 authentication vs IPsec
  - IPsec is not always available…..
- Not yet possible to validate whether legitimate peer has authority to send routing update (v4 or v6)

BGP Routing Example




```
router bgp AS 555
 bgp router-id 10.10.66.9
 no bgp default ipv4-unicast
 neighbor 10.10.66.65 remote-as 555
 neighbor 10.10.66.65 update-source Loopback0
 neighbor 2001:DB8:ACD7:FEE::65 remote-as 555
 neighbor 2001:DB8:ACD7:FEE::65 update-source Loopback0
 neighbor 192.168.66.100 remote-as 777
 neighbor 192.168.66.100 password 7 AA2F787A599D551243050B
 neighbor 2001:DB8:CCC:F000::97 remote-as 777
 neighbor 2001:DB8:CCC:F000::97 password 7 C919268878067A2E752634
 !
```

Note: Imagine using IPsec with neighbor 2001:db8:ccc:f000::97 pre-share 'secret'

BGP Routing Example Cont.

```
address-family ipv6
 neighbor 2001:DB8:CCC:F000::97 activate
 neighbor 2001:DB8:CCC:F000::97 prefix-list Public6_Only out
 neighbor 2001:DB8:CCC:F000::97 filter-list 1 out
 neighbor 2001:DB8:ACD7:FEE::65 activate
 neighbor 2001:DB8:ACD7:FEE::65 next-hop-self
 neighbor 2001:DB8:ACD7:FEE::65 filter-list 1 out
 network 2001:DB8:ACD7::/48
 no synchronization
 exit-address-family
!
ip as-path access-list 1 permit ^$
!
ipv6 prefix-list Public6_Only seq 10 permit 2001:DB8:ACD7::/48
```

What Needs Improvement in IPv6 Routing

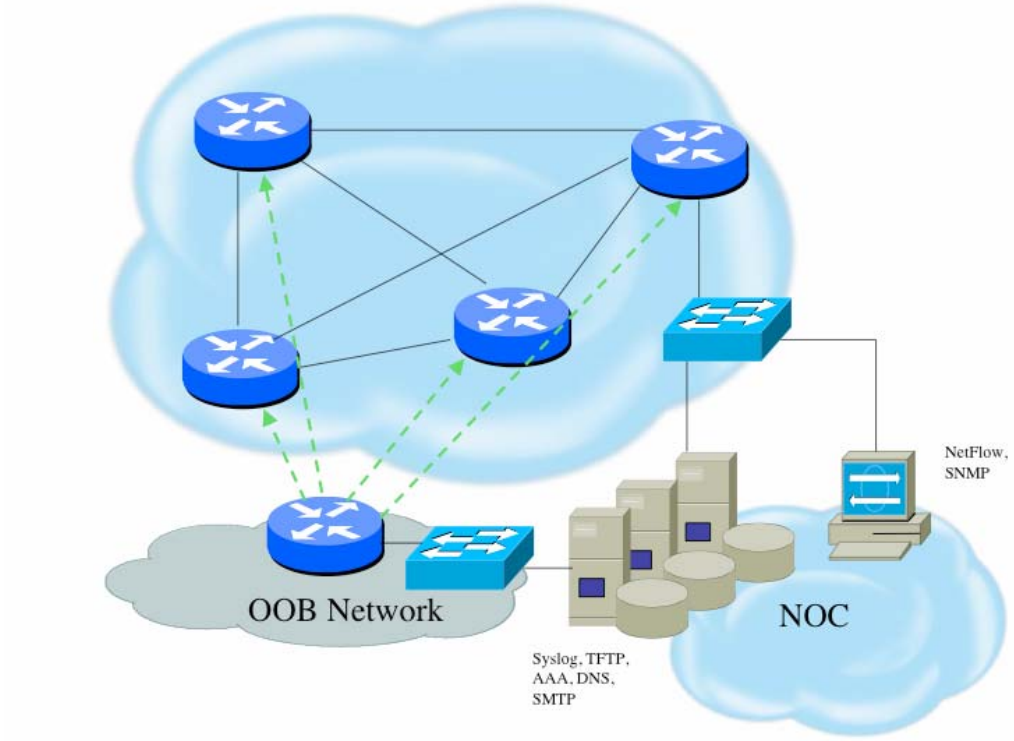
- Not all products that support IPv4 routing will support all IPv6 routing protocols the same way
  - Firewalls that support OSPF but not OSPFv3
  - Static IPv6 routing is NOT fun…..
- A product supports OSPFv3 - is lack of IPsec support a problem? (I think so….)

Data Path

- Filtering and rate limiting are primary security risk mitigation techniques in IPv4
  - Configurable for v6
  - Logging needs improvement (!!)
- Netflow is primary method used for tracking traffic flows in IPv6 (mostly v4 transport)
- uRPF is usually available for IPv6

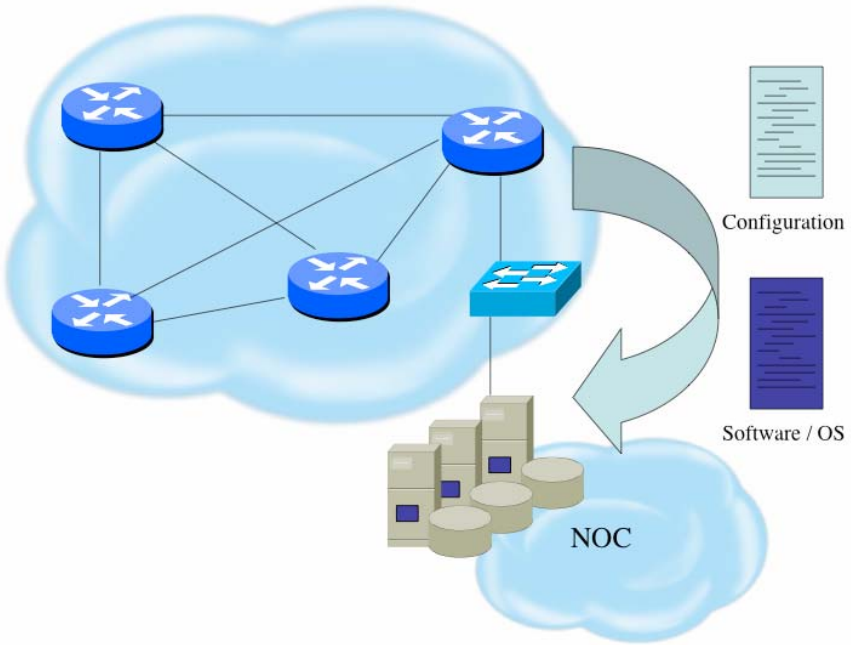
What if customers start using more end-to-end encryption?

Device In-Band/OOB Management



- SSH / Telnet available using v6 transport
- SNMP, NTP, RADIUS, TACACS+ , SYSLOG uses mostly v4 transport

Software Upgrade / Integrity



IPv4 transport is used

- All access to the systems storing images and configs are authenticated and audited
- Configuration files are polled and compared on an hourly basis
- Filters limit uploading / downloading of files to specific systems
- Many system binaries use MD-5 checks for integrity

General Observations

- IPv6 is being used and deployed in many ISPs and the plumbing pieces work fairly well (routing, tunnels)
- Majority of the issues come from network services, management and security
  - NOT a reason to avoid IPv6
    - DNS worked fine although need better automation
    - Management works OK over v4 transport
    - Security is no worse than with v4
    - Monitoring / auditing tools need improvement
  - NEED to get vendors to make appropriate priority decisions for their roadmaps

General Observations (Cont.)

- New products need clue
  - "Why is NTP useful?"
  - Basic filtering configurable but cannot log
  - No IPsec support (is this IPv6 standards compliant?)
  - Lack of debugging tools….
  - Basic security principles
    - No clear-text passwords in configurations
    - SSHv2 device access for both v4 and v6
    - Log access-list violations (v4 and v6)
    - Timestamps must use NTP
    - IPsec for authentication and integrity using IKEv2
    - Provide secure download of OS and config files

Operator Issue(s)

- I want commands to have same look and feel as in v4…..but is this really a problem?
  - Examples:
    - “access-list foo” vs “ipv6 filter-list foo”
    - “ip access-group v4_list in” vs “ipv6 traffic-filter v4_list in”
    - ipv6 vty access-lists that cannot simply specify allowable src addresses
  - Scripts need to be modified anyhow so it’s just annoying because I am used to the ‘old’ way

How many IOS-like CLI’s have you used?!?
IPv6 is just another iteration…….

IPv6 Standards Fun

- OSPFv3 - all vendors ‘IF’ they implemented IPsec used AH….latest standard to describe how to use IPsec says MUST use ESP w/null encryption and MAY use AH
- Why did NAT-PT ever become a standard?
- IPsec IKE vs IKEv2…..require implementation of IKEv2 for IPv6 and avoid future issues….

Regarding IPv6 Security

- Design security into IPv6 networks that do not blindly mimic the current IPv4 architectures
  - Don’t break working v4 infrastructure
  - Don’t re-architect current mess
- Requires some thought to policy
  - Where are you vulnerable today ?
  - *IF* IPsec was easy to configure and worked without performance hit, would you use it ?
    - think authentication and integrity, not encryption (Syslog, TFTP, SNMP, NTP)

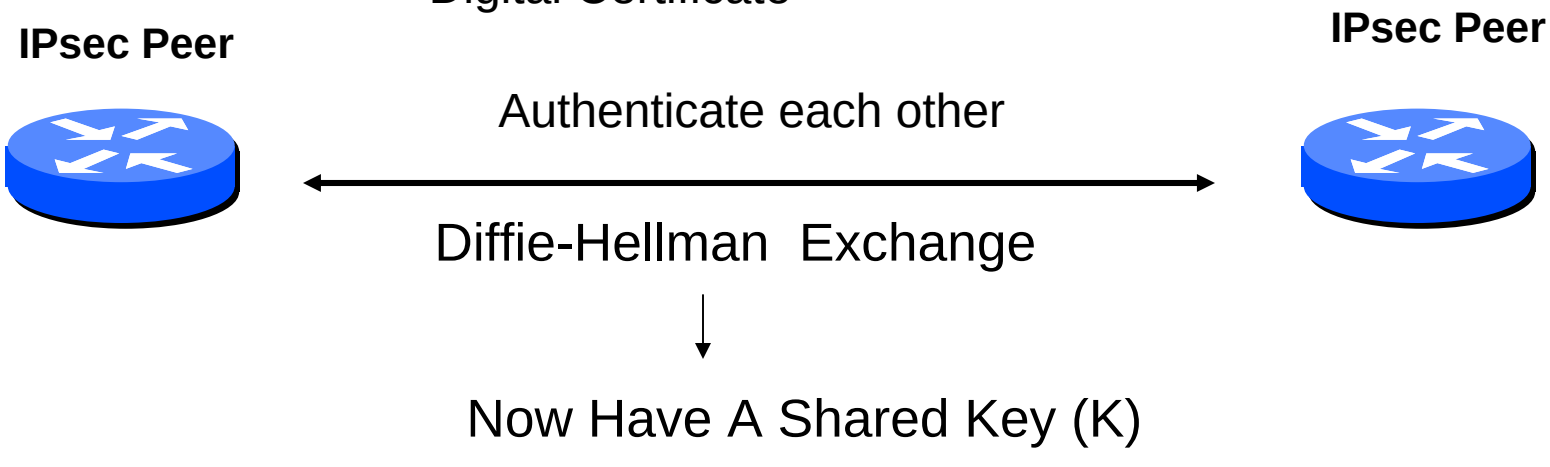
Minimal IPv6 Security

- IPsec ESP w/ null encryption…..***products need to support operational IPsec***
  - Data origin authentication
  - Data integrity
- Filters at edges for sanity checks….***products need to support IPv6 filtering***
- Auditing tools to see what traffic is traversing the net….***products need to support logging of IPv6 traffic***

IPsec vs MD-5 Authentication

Peers Authenticate using:

- **Pre-shared key (thisisapassword)**
- Digital Certificate



K is used to ***derive*** authentication key

Authentication Keys get periodically re-created !!

IPsec Issues
We Need To FIX This

- Vendors still have complex configurations
  - Consistent defaults will go a long way
  - Customers need to ask/push/plead for this!!
- Too many hypothetical problems
  - Doesn't work for routing protocols
  - Too difficult to configure
  - Why do I need encryption?
    - IPsec does NOT have to use encryption

Imagine ‘SIMPLE’ IPsec Commands

Sample future configurations (maybe?):

Syslog server <ipv6-address>
    authenticate esp-null sha1 pre-share ‘secret4syslog’
TFTP server <ipv6-address>
    authenticate esp-null aes128 pre-share ‘secret4tftp’
BGP peer 2001:db8:3:66::2 authenticate esp-null aes128
        pre-share ‘secret4AS#XXX’

(default lifetimes, DH groups, PFS, etc can be modified if needed)

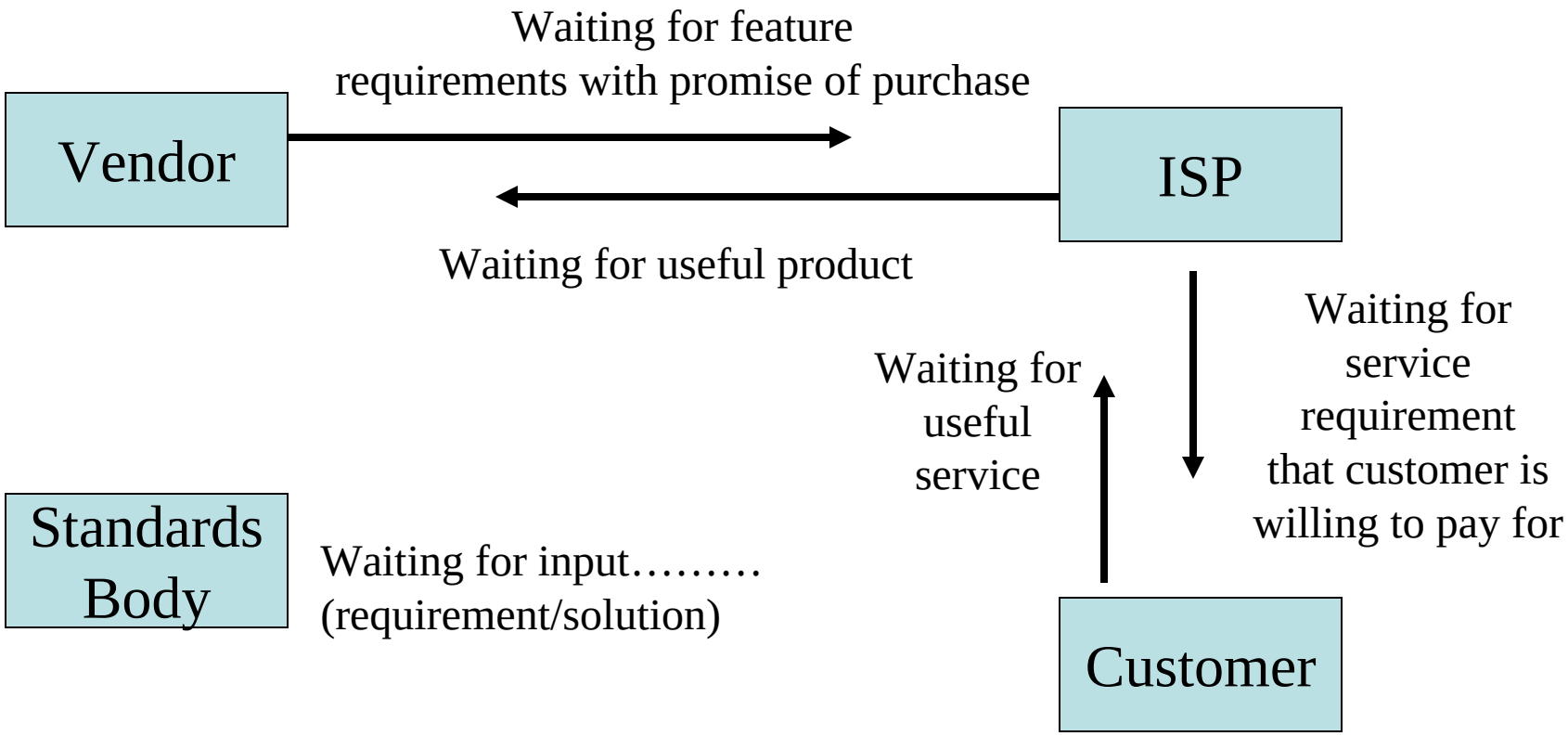
Realistic Deployment Now

- Provide IPv6 capability that will have appropriate cost/operational impact for you
  - Tunneling solution OK for minimal support but recognize lack of management and greater security risk
- Incremental transition to more native functionality as cost opportunities become better defined
  - Newest sw usually requires hw upgrade
  - Operational costs to run dual-stack environment
    - Note that lack of tools and some lack of functionality in vendor products (management & security) adds to the cost
  - Training costs to understand IPv6

Critical For IPv6 Deployments (Stuff That Needs Improvement)

- Monitoring filtering violations
- Configuring NTP (v4 or v6)
- IPv6 tunnel broker devices need to be more operationally aware instead of just providing quick fix to get an IPv6 address
- Auditing tools to specifically understand and see IPv6 traffic patterns
- Address management tools
- Where is easily configurable IPsec? [if you don't require it, vendors won't spend resources on it]

The Catch-22



Who makes the first move?

Questions ?