Security Considerations for IPv6 Networks

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Ημερίδα Ενημέρωσης Χρηστών για την Τεχνολογία IPv6 - Αθήνα, 25 Μαίου 2011

Agenda

- Introduction – Major Features in IPv6
- IPv6 more secure than IPv4?
- IPSec
- IPv4 vs IPv6: a Threat Comparison
- ND revisited
- ND-related Threats: an Overview
- Security Risks During IPv4→IPv6 Transition
- Home IPv6 Network
- References
- Appendix I

Major Features in IPv6

- Extended Address Space
- Autoconfiguration
- Header Structure / Extension Headers
- Mandatory IPSec Support
- QoS
- Route Aggregation
- Efficient Transmission

IPv6 more secure than IPv4?

Lets agree that IPv6 is (will) not inherently be more or less secure than IPv4

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In many cases, IPv4 security practices and policies can be replicated for IPv6

IPv6 more secure than IPv4?

- Fairly new and undiscovered territory
- Uncalculated Factors: tunneling and all 6to/in4
- Lack of understanding
- Vulnerabilities unknown

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What about IPSec??

IPSec

- Authenticate and (optionally) encrypt IP packets end-to-end
- Mandatory implementation in IPv6

but...

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but...

- Use of IPSec not required
- Will IPSec be used more frequently in IPv6? Probably not!
- Complexity Issues (key management, configuration complexity etc)

IPv4 vs IPv6: a Threat Comparison

- Reconnaissance Attacks harder to achieve with IPv6 (but still possible)
- ARP (IPv4) attacks replaced by ND-related (IPv6) attacks
- Lack of Broadcast in IPv6 means no more amplification attacks (maybe)
- Unauthorized access to IPv6 networks could be more widespread (at first)
- No significant change in Application-level attacks (after a slow start)

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IPv4 vs IPv6: a Threat Comparison - Mitigation

- Efficient use of different types of addressing
- Increase difficulty in network scanning (random subnets, random interface IDs)
- Use IPSec for authentication
- Devise a proper ICMPv6 filtering policy *(see Appendix I)*
- Secure tunnelled environments (complicated)

IPv4 vs IPv6: a Threat Comparison - Mitigation

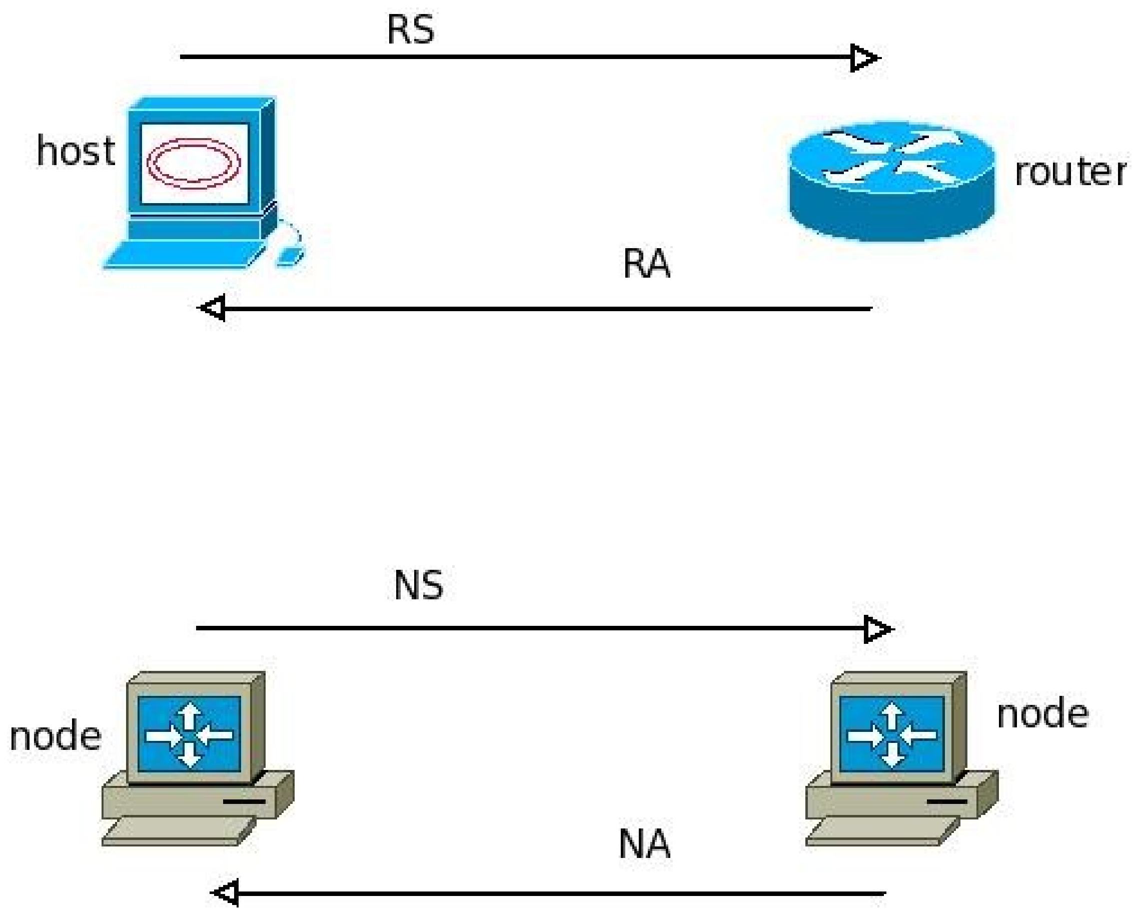
- Default DENY is still considered best practice

- Block IPv6 traffic on IPv4-only networks and vice-versa

ND Revisited

- IPv6 Address Autoconfiguration
- Determine Network Prefixes (and other configuration info)
- Duplicate Address Detection (DAD)
- Neighbor Unreachability Detection (NUD)
- Detect changes in link-layer addresses

ND Revisited



ND-Related Threats: an Overview

- Rogue RAs: rogue routers inserted on LAN
- Rogue RAs: rogue RAs from “legitimate” nodes
- Spoofed responses to DAD messages = DOS attack
- Spoofed NS/NA messages can cause redirect attacks

SeND (Secure ND) addresses some of the issues

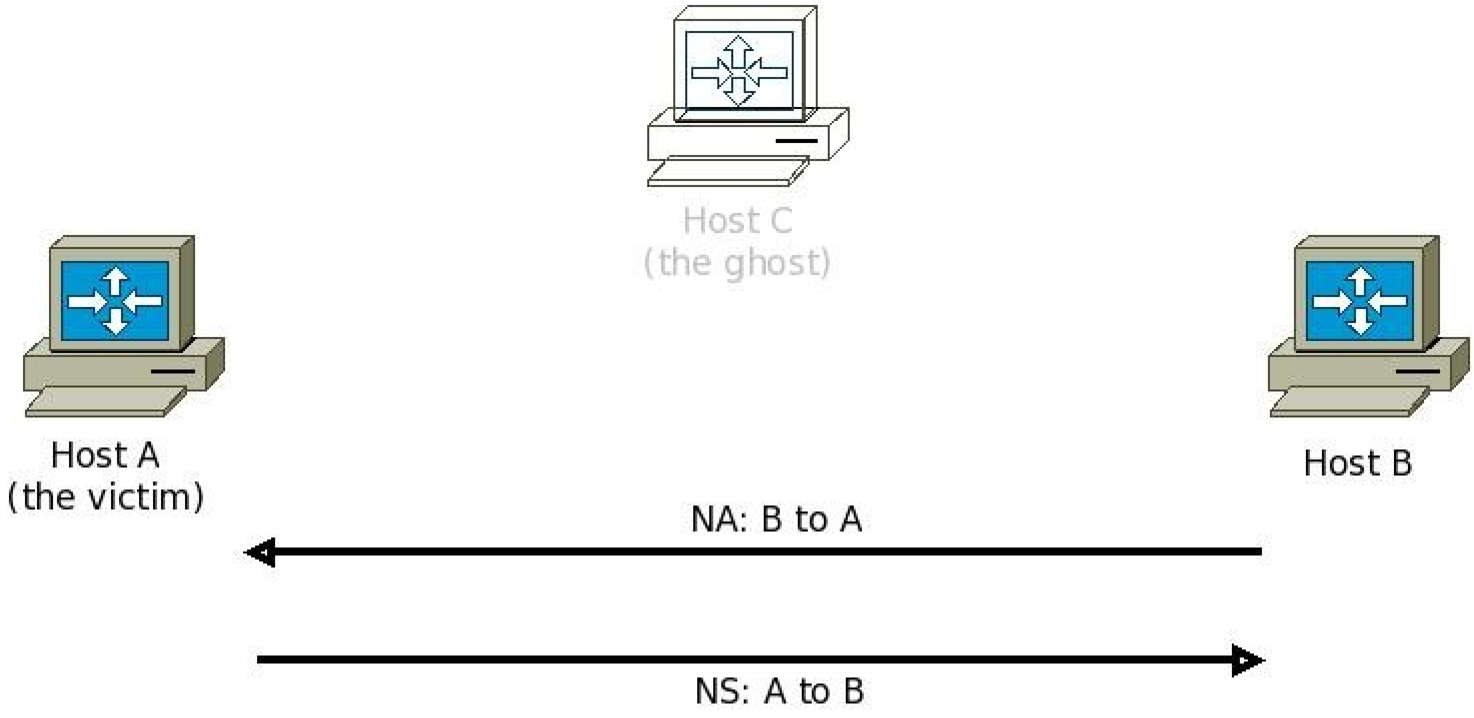
ND-Related Threats: a Case Study

Neighbor Solicitation/Advertisement Spoofing

- Host A (AKA “the victim”) sends Neighbor Solicitation (NS) to Host B
- Host C (AKA “the attacker”) replies with Neighbor Advertisement (NA) instead of the real host B to gracious Neighbor Solicitation (NS) message by host A.
- Host A updates its NDP cache binding the link-layer address of the attacker to the legitimate IP address of host B.
- The victim will send packets to the attacker instead of legitimate Host B.

ND-Related Threats: a Case Study

Neighbor Solicitation/Advertisement Spoofing



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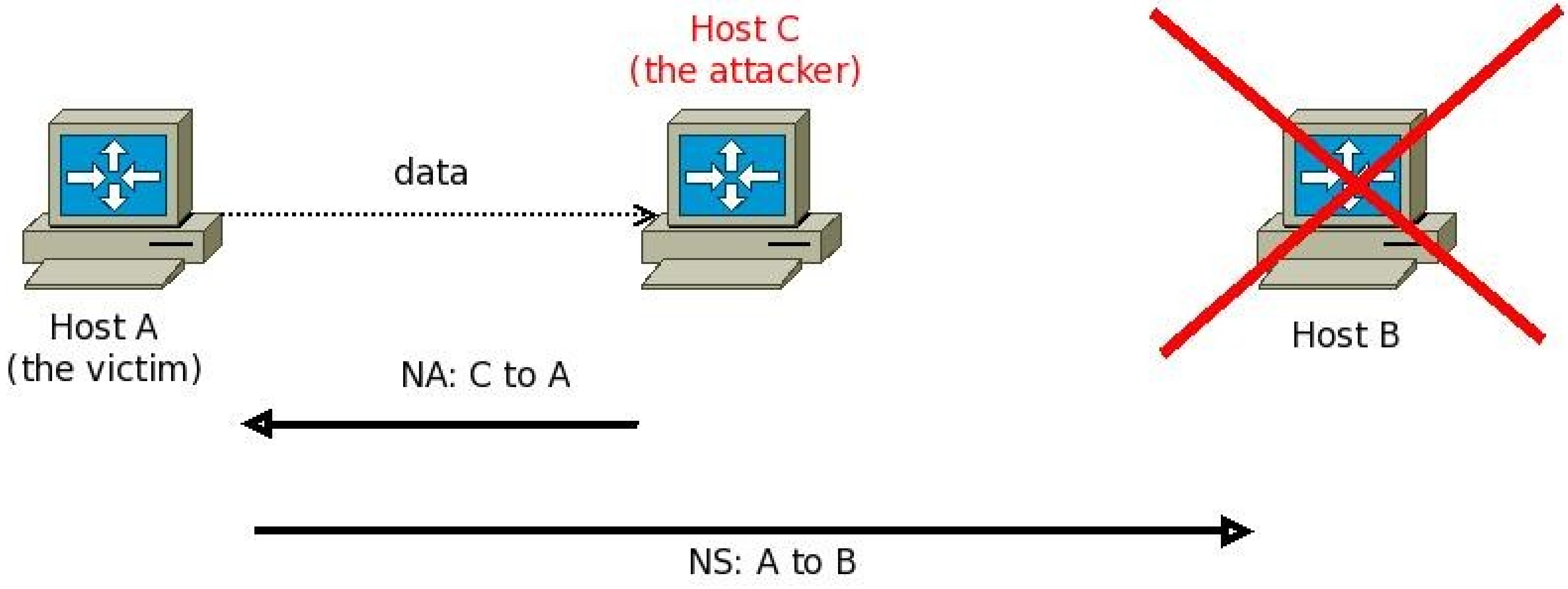

Security Risks During IPv4 to IPv6 Transition

- Added Complexity by dual stack operations
- Immaturity (or even lack) of IPv6 security products / lack of vendor support
- Unauthorized/unknown IPv6 clients
- Use of IPv6 by the “attacker” community
- Vulnerabilities in IPv6

Security Risks During IPv4 to IPv6 Transition

- **Added Complexity by dual stack operations**
  - 2 x configurations = 2 x things that can go wrong
  - Security infrastructure possibly not aware of dual environment
  - IPv4 still supported for legacy systems
- Immaturity (or lack) of IPv6 security products / lack of vendor support
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Security Risks During IPv4 to IPv6 Transition

- Added Complexity by dual stack operations
- **Immaturity (or lack) of IPv6 security products / lack of vendor support**
    - Security vendors are waiting for customer demand
    - Various levels of IPv6 “support” offered
    - Lack of standardization of IPv6 support
- Unauthorized/unknown IPv6 clients
- Use of IPv6 by the “attacker” community
- Vulnerabilities in IPv6

Security Risks During IPv4 to IPv6 Transition

- Added Complexity by dual stack operations
- Immaturity (or even lack) of IPv6 security products / lack of vendor support
- **Unauthorized/unknown IPv6 clients**
  - IPv6 support is often enabled by default
  - Active 6to4 interfaces
- Use of IPv6 by the “attacker” community
- Vulnerabilities in IPv6

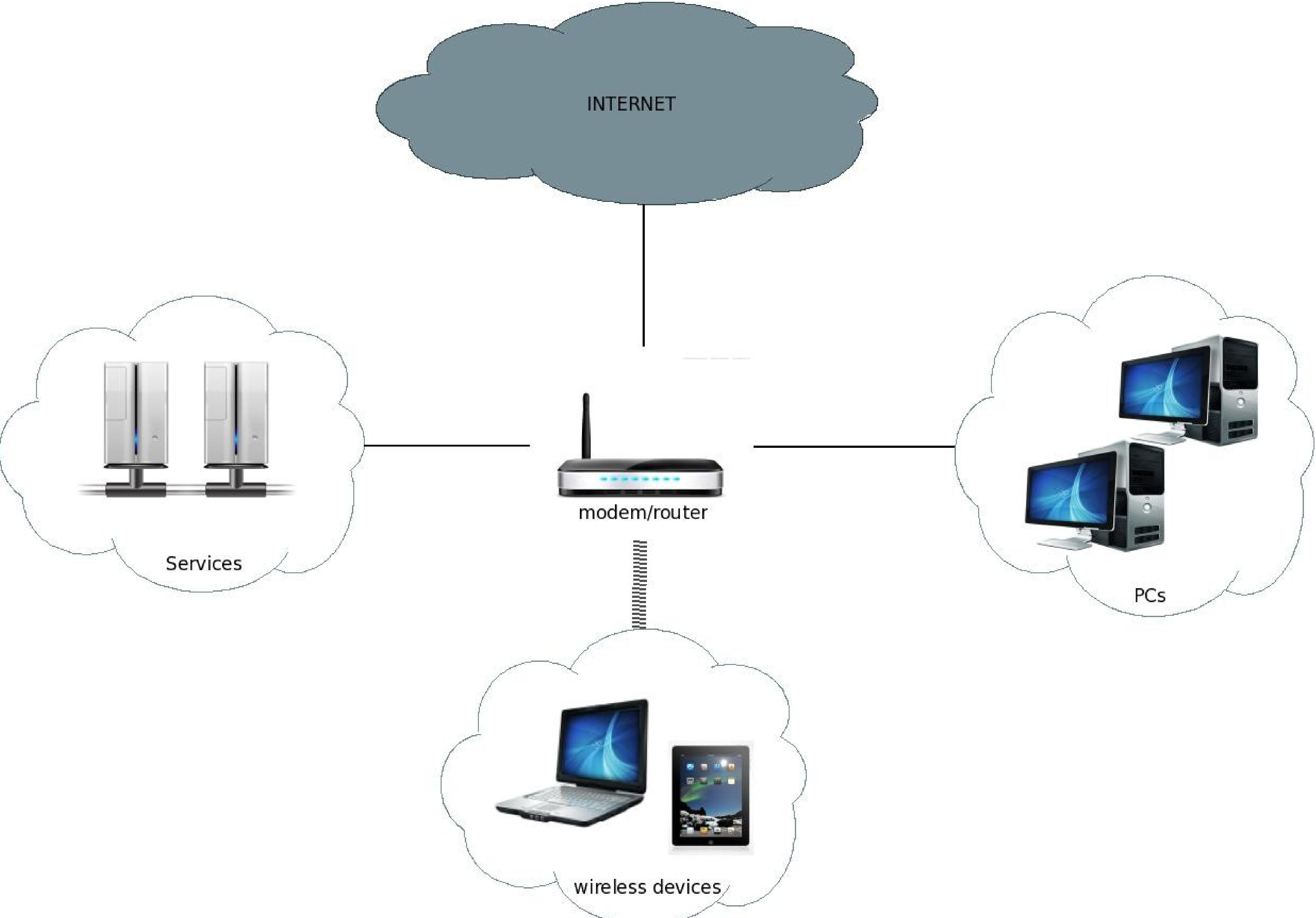
Security Risks During IPv4 to IPv6 Transition

- Added Complexity by dual stack operations
- Immaturity (or even lack) of IPv6 security products / lack of vendor support
- Unauthorized/unknown IPv6 clients
- **Use of IPv6 by the “attacker” community**
  - Firewalls often ignore IPv6 traffic
  - Attackers enabling IPv6 on compromised systems
  - IPv6 traffic usually not monitored
- Vulnerabilities in IPv6

Security Risks During IPv4 to IPv6 Transition

- Added Complexity by dual stack operations
- Immaturity (or even lack) of IPv6 security products / lack of vendor support
- Unauthorized/unknown IPv6 clients
- Use of IPv6 by the "attacker" community
- **Vulnerabilities in Ipv6**
  - ND-related (as discussed)
  - 0-day exploits

Home IPv6 Network



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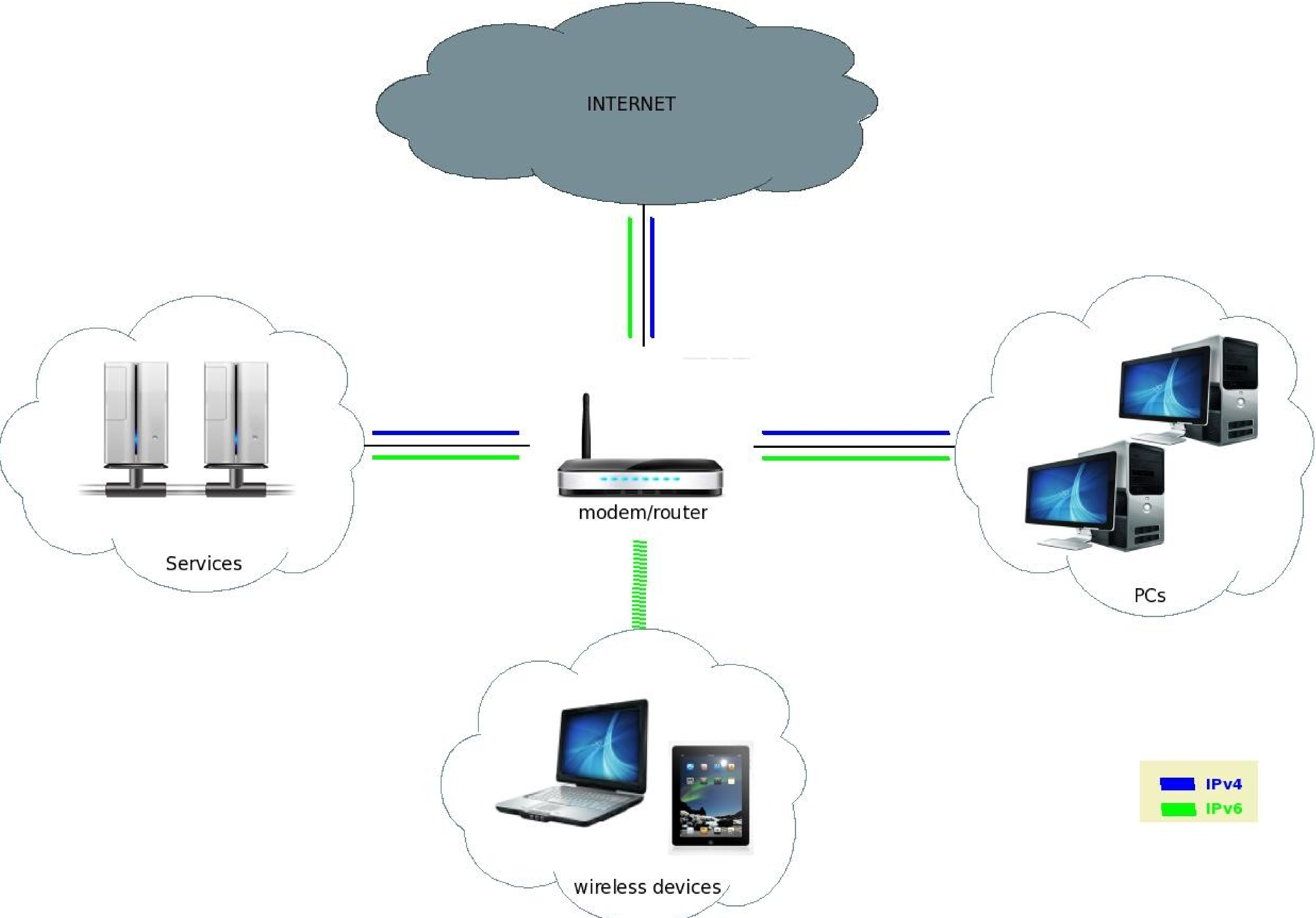
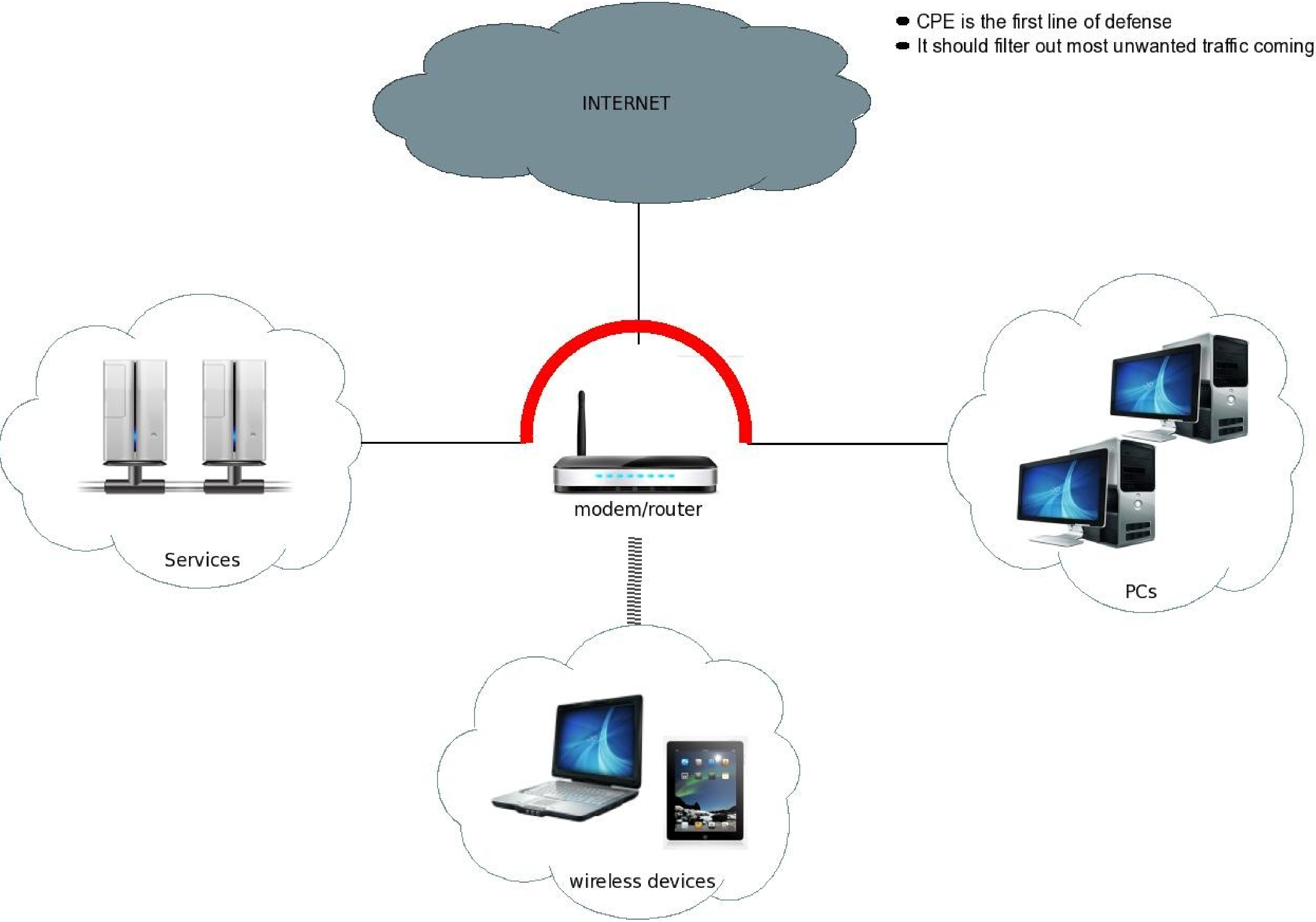


Home IPv6 Network - CPE

Layered Approach: CPE is the first layer

Home IPv6 Network - CPE

- CPE is the first line of defense
- It should filter out most unwanted traffic coming in



Home IPv6 Network - CPE

- Use Network Filters (stateless)to block unwanted traffic (spoofed, Martians etc)
- Use stateful firewalls for fine grained access
- ICMPv6 Filtering (as discussed)
- Management Interfaces should not be offered via WAN
- Use SeND (if available)

- When in bridged mode, beware of router vulnerabilities

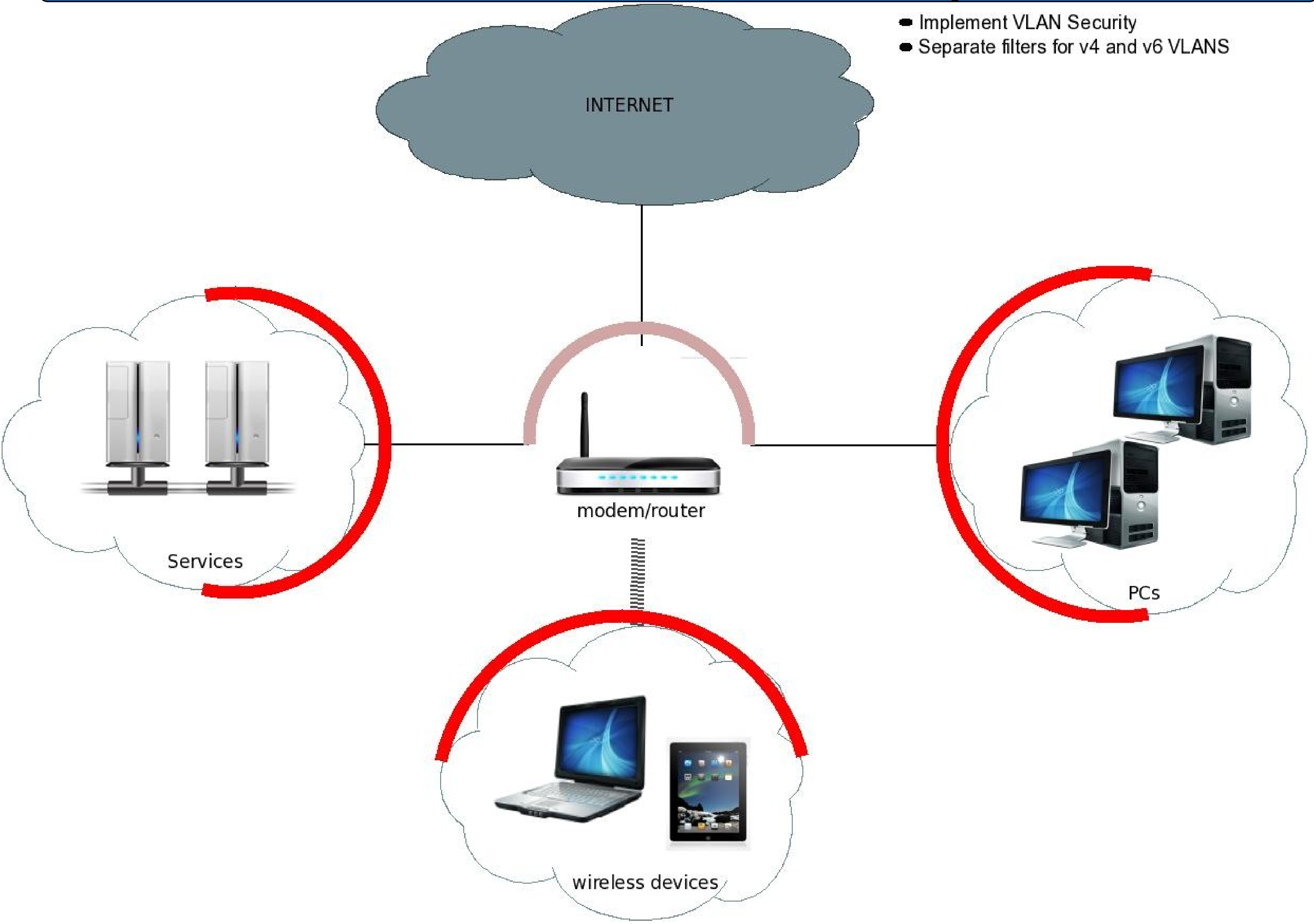
(e.g. linux with no firewall turned on)

Home IPv6 Network – CPE: VLAN protection

Layered Approach: Protect your VLANS

Home IPv6 Network – CPE: VLAN protection

- Implement VLAN Security
- Separate filters for v4 and v6 VLANS

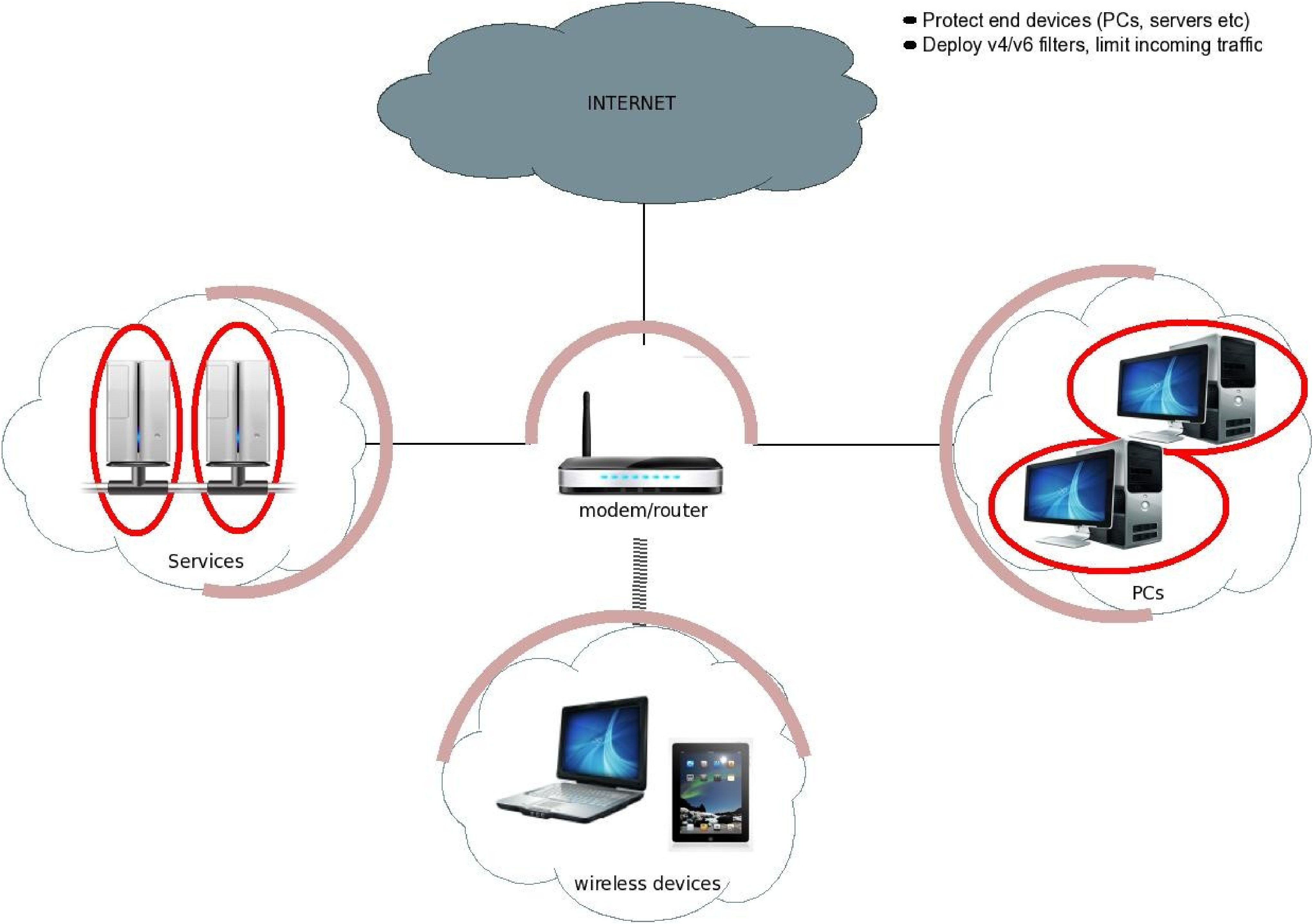


Home IPv6 Network - LAN

Layered Approach: End Devices

Home IPv6 Network - LAN

- Protect end devices (PCs, servers etc)
- Deploy v4/v6 filters, limit incoming traffic



Home IPv6 Network - LAN

- Deploy packet filters (iptables, pf etc)
- Use RA guards (if applicable)
- No “hiding” behind NAT anymore! Use privacy extensions
- Avoid Man In The Middle (MITM) attacks : use IPSec

Home IPv6 Network - LAN

Semi-Paranoid:

Exposed MAC addresses due to SLAAC (eui-64) may result to specific h/w flaw

Paranoid:

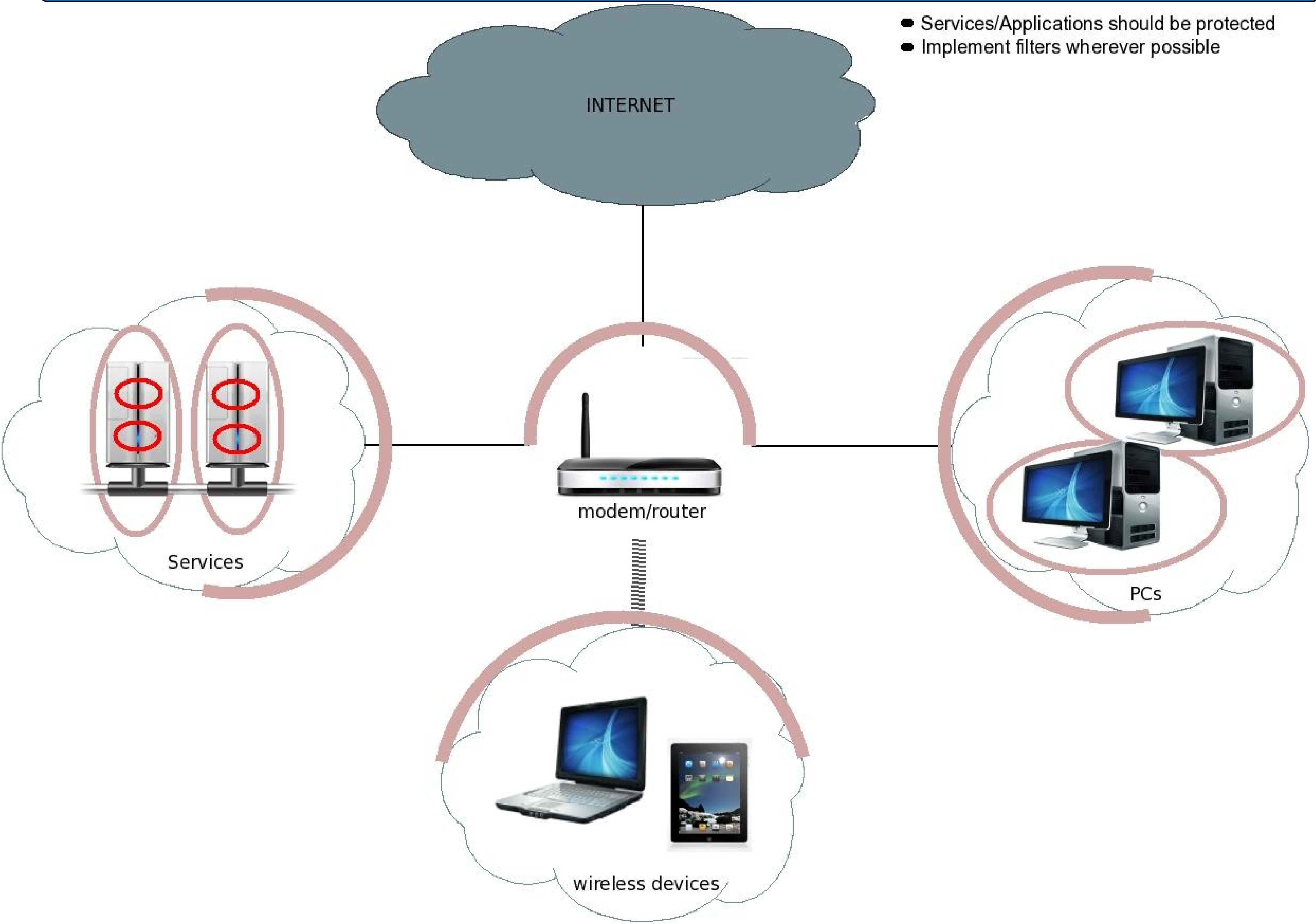
Interface can be tracked when moving around (from static interface ID)

Home IPv6 Network - Services

Layered Approach: Services Protection

Home IPv6 Network - Services

- Services/Applications should be protected
- Implement filters wherever possible



Home IPv6 Network - Summary

As mentioned, lessons learned from IPv4, can be re-used

➔Defense in depth

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- ➔Defense in depth
- ➔Patching

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- Defense in depth
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- Sane Configuration Management

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- ➔Defense in depth
- ➔Patching
- ➔Sane Configuration Management
- ➔Access Control

Home IPv6 Network - Summary

As mentioned, lessons learned from IPv4, can be re-used

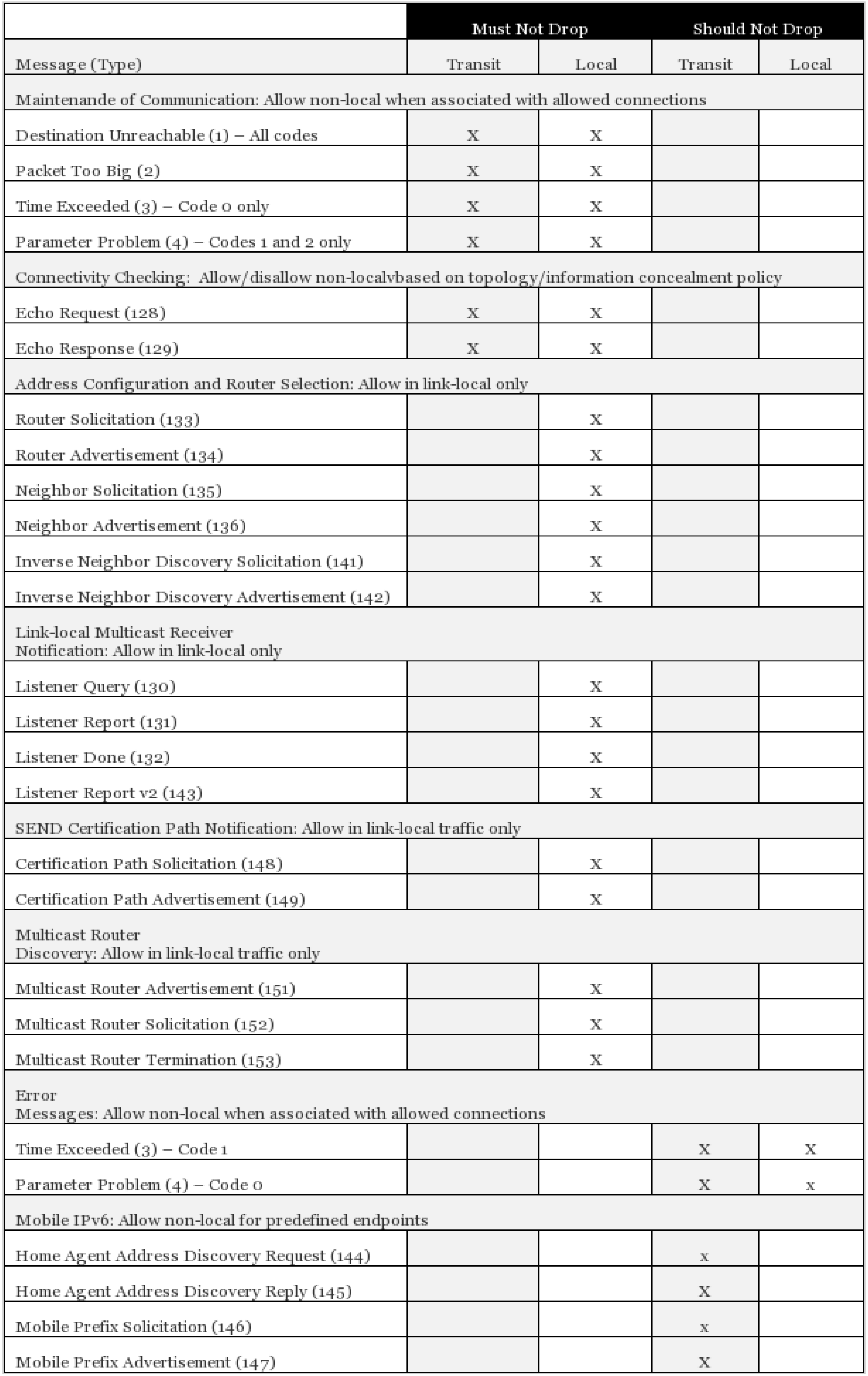
- Defense in depth
- Patching
- Sane Configuration Management
- Access Control
- Frequent revision of security policies

References / Further Reading

- IPv6 Security (Theory vs Practice) – Merike Kaeo www.doubleshotsecurity.com
- IPv6 Routing Header Security - Philippe Biondi, Arnaud Ebalard
- Guidelines for the Secure Deployment of IPv6 – NIST Special Publication 800-119
- SeND - http://tools.ietf.org/html/rfc3971
- Rogue RAs - http://tools.ietf.org/html/rfc6104
- RA Guard - http://tools.ietf.org/html/rfc6105
- Simple Security for IPv6 CPEs - http://tools.ietf.org/html/rfc6092
- Privacy Extensions for SLAAC in IPv6 - http://tools.ietf.org/html/rfc4941
- IPv6 Implications for Network Scanning - http://tools.ietf.org/html/rfc5157
- Filtering ICMPv6 in Firewalls - http://tools.ietf.org/html/rfc4890
- Routing Loop Attack w/ auto Ipv6 Tunnels -

  http://tools.ietf.org/search/draft-ietf-v6ops-tunnel-loops-07

Appendix I – ICMPv6 Filtering



	Must Not Drop		Should Not Drop	
Message (Type)	Transit	Local	Transit	Local
Maintenande of Communication: Allow non-local when associated with allowed connections				
Destination Unreachable (1) – All codes	X	X		
Packet Too Big (2)	X	X		
Time Exceeded (3) – Code 0 only	X	X		
Parameter Problem (4) – Codes 1 and 2 only	X	X		
Connectivity Checking: Allow/disallow non-localvbased on topology/information concealment policy				
Echo Request (128)	X	X		
Echo Response (129)	X	X		
Address Configuration and Router Selection: Allow in link-local only				
Router Solicitation (133)		X		
Router Advertisement (134)		X		
Neighbor Solicitation (135)		X		
Neighbor Advertisement (136)		X		
Inverse Neighbor Discovery Solicitation (141)		X		
Inverse Neighbor Discovery Advertisement (142)		X		
Link-local Multicast Receiver Notification: Allow in link-local only				
Listener Query (130)		X		
Listener Report (131)		X		
Listener Done (132)		X		
Listener Report v2 (143)		X		
SEND Certification Path Notification: Allow in link-local traffic only				
Certification Path Solicitation (148)		X		
Certification Path Advertisement (149)		X		
Multicast Router Discovery: Allow in link-local traffic only				
Multicast Router Advertisement (151)		X		
Multicast Router Solicitation (152)		X		
Multicast Router Termination (153)		X		
Error Messages: Allow non-local when associated with allowed connections				
Time Exceeded (3) – Code 1			X	X
Parameter Problem (4) – Code 0			X	x
Mobile IPv6: Allow non-local for predefined endpoints				
Home Agent Address Discovery Request (144)			x	
Home Agent Address Discovery Reply (145)			X	
Mobile Prefix Solicitation (146)			x	
Mobile Prefix Advertisement (147)			X	

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