Transparent Network Security  
Policy Enforcement

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Overview

- OpenBSD bridge
- Transparent firewall
- Layer-2 filtering
- LAN extension (IPsec bridge)

Other uses...
- Bump-in-the-wire
- Distributed firewalls
## Bridge Implementation

- **What is a bridge?**
  - Address cache
  - Learning
  - Discovery

- **OpenBSD bridge**
  - Implemented as a virtual interface
  - Member interfaces as ports
  - Multiple independent bridged networks per host
Input Processing

Ethernet

Ethernet Driver

ether_input()

Layer-3 Protocols

all frames

broadcast and
local frames

bridge_input()

broadcast and
non-local frames

Frame queued,
soft interrupt
scheduled
Output Processing

bridgeintr()

Record MAC source address

Drop same segment frames

Multicast handling

Non-IP handling

Individual Frame

Ethernet

Queued on Interface 1

Layer-2 filtering (output)

Layer-3 (IP) filtering

Layer-2 filtering (input)

Ethernet

Queued on Interface 2

Layer-2 filtering (output)

... Ethernet

... Queued on Interface N

... Layer-2 filtering (output)

... Layer-2 filtering (output)
Layer-2 Filtering

- Prevent ethernet address spoofing
- Static address cache entries
- Tunable MAC discovery
- Tunable MAC address learning
- Tunable multicast/broadcast handling
- IPF-like rules for Layer-2 MAC addresses
Layer-3 Filtering

☑ Uses standard packet filter mechanism (IPF) for Layer-3 filtering
  ○ Code and knowledge reuse
☑ Divert frames that pass Layer-2 filters to Layer-3
  ○ Some packet-cooking necessary
☑ Frames are forwarded iff they pass both filtering mechanisms
Result: Invisible firewall

Problems this solves
- Firewalls themselves can be subject to attack since they are exposed
- Sometimes at the wrong layer
- Minimizes topology changes
- No changes necessary to the protected hosts
- "Personal firewalls"
  - Plug-n-play
  - Useful in home-networking
**LAN extension**

- **Extend LAN over WAN**
  - Nice for telecommuters
  - No routing/addressing voodoo needed

- **Needed pieces**
  - Mechanism to capture all frames -- Bridge
  - Encapsulation mechanism -- IPsec
LAN extension implementation

- encapsulation (enc) interface
  - Virtual interface with IPsec Security Association (SA) attached
  - Originally used just for debugging

- Bridge Changes
  - Allow "enc" interfaces as members
  - Changes to allow member interfaces without MAC addresses

- Do Ethernet-in-IP over IPsec
Modified Input Processing

- Ethernet
  - Ethernet Driver
    - ether_input()
      - Layer-3 Protocols
      - broadcast and local frames
    - bridge_input()
      - broadcast and non-local frames
  - IPsec (enc)
    - etherip_input()
      - IPsec extensions
      - Frame queued, soft interrupt scheduled

Diagram:
- Ethernet to Ethernet Driver
- Ether_input() to Layer-3 Protocols (broadcast and local frames)
- Ether_input() to bridge_input()
- Bridge_input() to Frame queued, soft interrupt scheduled
Future/Current Work

- Desirable to have IPsec everywhere
  - Not possible to add to all systems
- Interim solution: bump-in-the-wire
  - Separate box (bridge) does IPsec on behalf of end-host
  - Pretends to be end-host when negotiating SAs
  - isakmpd changes needed
Conclusion

Where to find the code:
OpenBSD 2.7 - http://www.openbsd.org/

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Disclaimer
OpenBSD is based in Calgary, Canada. All individuals doing cryptography related work do so outside countries that have limiting laws.