Cooperative, Autonomous Anti-DDoS Network (A2D2V2)


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  ◆ Mitigation strategies
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  ◆ Cooperative Intrusion Response:
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◆ A2D2 Overview
Outline

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Motivation for A2D2V2

- DDoS and network security in general are still big areas of research
- Expand on initial A2D2 work
- No enterprise wide automated cooperative intrusion detection and response systems available
Goals for A2D2V2

- Expand on A2D2 ideas to provide cooperative defense against attacks
- To validate the enterprise effectiveness of the IDIP software implementation
- Show clients that are in non-IDIP enabled subnets reap benefits of enterprise network attack response cooperation
- Show that IDIP can provide a cooperative defense that efficiently notifies upstream routers of an attack
What is DoS/DDoS

- DoS – Denial of Service Attack
- DDoS Distributed Denial of Service Attack

Stacheldraht
Trinoo
Tribal Flood Network (TFN)
IDIP

- Intruder Detection and Isolation Protocol (IDIP)
  - Initially developed by DARPA, Boeing and NAI labs
  - Intended to be published, standard protocol. No longer open protocol.
  - Developed to support real-time tracking and containment of DDoS attacks that cross network boundaries. 2 stage response.
    - Initial response harsh and coarse grained, short lived
    - Subsequent response is more reasoned
  - Supports damage assessment and recovery in local environment
  - Provides network based response as well
IDIP

- IDIP guiding principles
  - Response to intrusions in real-time
  - Support of environments that span multiple administrative domains
  - Minimal impact on systems performance
  - Autonomous & continued operation even under attack
IDIP Protocols and Layering

- **IDIP Message Layer**
  - Reliable Delivery
  - Duplicate Removal
  - Multicast Support
  - Time Management
  - Message class
  - subscription

- **IDIP Backplane**
  - Neighborhood Management
  - Node status
  - IDIP Cryptographic Services
    - Authentication
    - Integrity
    - Privacy
  - Key Management

- **User Datagram Protocol**

- **Internet Protocol**
IDIP Enterprise Architecture

Community

Neighborhood 1
- Boundary Controller
- Discovery Coordinator

Neighborhood 2
- Boundary Controllers
- Intrusion Detection System

Neighborhood 3
- Boundary Controllers
- Intrusion Detection System
Cooperative Intrusion Detection Traceback Architecture, Common Intrusion Specification Language (CITRA and CISL)

- **CITRA**
  - Framework for integration of IDS, firewalls, routers, and other components in an IDIP system.
  - Allows for a global response via IDIP node cooperation.
  - Designed to facilitate low-cost integration of independently developed components.
  - IDIP defines the format of and information specification that CITRA enabled components exchange.

- **CISL**
  - Language developed to support CITRA.
  - Used to disseminate data among IDS and response systems.
DC - Discovery Coordinator (Management Console)
BC - Boundary Controller (Firewalls, Routers, etc.)
EBC - Edge Boundary Controller (e.g., Corporate Firewall)
Intrusion Detection Message Exchange Format (IDMEF)

- Purpose to define formats and exchange procedures for sharing information
- Intended to standardize data format that automated IDS's can use to report alerts
- Enables interoperability among commercial and opensource IDS's.
- OO representation of alert data
- Data model allows for natural differences
- Goal is to provide a standardization of alerts in an unambiguous manner
- Implemented in XML
Intrusion Detection and Exchange Protocol (IDXp)

- Another protocol to exchange data between IDS entities
- Supports mutual authentication, integrity and confidentiality
- Provides for exchange of IDMEF messages, unstructured data between IDS systems
- Open, published standard
Dynamic Tracing

- IP Link Level Headers and ARP
  - Parsing the IP Packet link level header for MAC address
  - Use arp/rarp for resolving this to real IP address
  - ARP and RARP limitations

- tcpdump
  - Allows for fined grained control of monitoring interfaces
  - Is promiscuous
Autonomous Anti-DDoS Network (A2D2)

**DMZ**
- RealServer
  - IP: 128.168.0.2
  - NM: 255.255.0.0
  - GW: 192.168.0.1

**Private Subnet 192.168.0**
- Pluto
  - eth0
  - IP: 128.198.61.12
  - NM: 255.255.255.128
  - GW: 128.198.61.1

**Public Network 128.198**
- Attack from 128.198.61.15 (Alpha)
- Attack from 128.198.61.17 (Gamma)

**Internet**
- 100Mbps Switch

**10 Mbps Hub**
- IDS
- RealServer Traffic
- IDS Alerts
- Multi-Level Rate Limiting

**Autonomous Anti-DDoS Network (A2D2)**

**Firewall (iptables)**
- Security Policy
- Class-Based Queuing (CBQ)

**Multi-Level Rate Limiting**
- IP: 128.198.61.12
- NM: 255.255.255.128
- GW: 128.198.61.1

**Class-Based Queuing (CBQ)**
- IP: 192.168.0.1
- NM: 255.255.0.0
- GW: 128.198.61.12

**100Mpbs Switch**
- **Master Client & Handler**
  - Saturn
    - 128.198.61.11
    - NM: 255.255.255.128
    - GW: 128.198.61.1

**DDoS Agent**
- Alpha
  - 128.198.61.15

**DDoS Agent**
- Beta
  - 128.198.61.16

**DDoS Agent**
- Delta
  - 128.198.61.18

**DDoS Agent**
- **Gamma**
  - 128.198.61.17

**DDoS Agent**
- **Client1**
  - 128.198.a.195

**DDoS Agent**
- **Client2**
  - 128.198.b.82

**DDoS Agent**
- **Client3**
  - 128.198.c.31

**DDoS Agent**
- **Real Player Client**
  - **Client1**
    - 128.198.a.195
  - **Client2**
    - 128.198.b.82
  - **Client3**
    - 128.198.c.31

**DDoS Agent**
- **Real Player Client**
  - **Gamma**
    - 128.198.61.17

**DDoS Agent**
- **Real Player Client**
  - **Beta**
    - 128.198.61.16

**DDoS Agent**
- **Real Player Client**
  - **Delta**
    - 128.198.61.18

**DDoS Agent**
- **Real Player Client**
  - **Alpha**
    - 128.198.61.15

**DDoS Agent**
- **Master Client & Handler**
  - **Saturn**
    - 128.198.61.11
    - NM: 255.255.255.128
    - GW: 128.198.61.1
A2D2V2 Features

- 7 key feature additions from A2D2
  - IDIP Additions to Snort IDS
    - report_idip and preprocessor changes
  - IDIP Enabled firewall/routers
    - idip_firewall_receiver
  - Earlier detection and pushback of attack via traffic monitoring
    - tcpdump.sh, dumper.sh awk scripts
  - Notification of upstream routers of attack
    - Static router configuration table
  - Notification to upstream routers of attack mitigation strategies taken by surrounding neighborhoods and subsequent response
    - Response policy is accept
A2D2V2 IDIP Communication and Neighborhoods Design

11.x subnet

Neighborhood 1

IDIP Messaging
IDIP Application (rate limiter)
IDIP Discovery Coordinator

BC

A2D2V2 Community

IDIP Messages

Neighborhood 2

BC
IDIP Messaging
IDIP Application (rate limiter)
IDIP Discovery Coordinator

IDIP Messages

13.x subnet

IDIP Messaging
IDIP Application (IDS)

16.x subnet

Neighborhood 3

BC
IDIP Messaging
IDIP Application (rate limiter)
IDIP Discovery Coordinator

IDIP Messages

15.x subnet
A2D2V2 IDIP Modifications

- IDIP Messaging Protocol
  - IDIP Neighborhood management via the DC
  - Message creation and formatting
  - Protocol initialization
  - Message forwarding
  - Socket communication pieces

- IDIP Application Protocol
  - Snort modifications for IDIP support
  - IDIP enabled firewall/router application
A2D2V2 IDIP Communication Flow

Snort IDS -> generates flood report when attack is detected
report_idip -> intercepts flood report message
report_idip-> creates three classes of IDIP messages:
  IDIP DO
  IDIP UNDO
  IDIP TRACE

report_idip-> forwards IDIP message to next immediate
  upstream firewall/router

idip_firewall_receiver-> receives IDIP message and processes
  according to request
A2D2V2 IDIP Communication Flow

idip_firewall_receiver -> either:
  performs trace using tcpdump
  performs do(applies rate limiting to itself)
  performs undo(undoes rate limiting as per request
  notifies upstream routers of mitigation action taken
Recommends same action to be taken by upstream routers
idip_firewall_receiver on upstream router applies recommended action of rate limiting
A2D2V2 Implementation

◆ Key software modules:
  ◆ firewall/routers:
    ◆ idip_firewall_receiver – IDIP Application and Message Subsystem
    ◆ tcpdump.sh, dumper.sh – IDIP Application
    ◆ trace_kill – IDIP Application
    ◆ topo.txt – DC Static configuration tables
  ◆ A2D2 class based queueing and rate limiter modules

◆ Server:
  ◆ Snort with spp_flood preprocessor
  ◆ report_idip – IDIP Application and Message subsystem
  ◆ tcp_snd

◆ Client:
  ◆ tcp_rcv
  ◆ A2D2 attack tool and packet counting modules
A2D2V2 Full Attack and Response Test Scenario

- Normal tcp_rcv traffic running on C1 and C2, tcp_snd running on S1 and S2 with non-stop TCP SYN flood attack on A1, A2 and A3 targeting both S1 and S2 for 3 ½ minutes. A2D2V2 IDIP enabled Snort running on S1, IDIP firewall/router software running on R97, R99, R102. Class based queueing and other QoS techniques as per A2D2 implementation are applied to firewall/routers.
A2D2V2 Full Attack and Response Results, C1
A2D2V2 Full Attack and Response Results, C2
# A2D2V2 Full Attack and Router Response Times

<table>
<thead>
<tr>
<th>Event</th>
<th>Time</th>
</tr>
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<tbody>
<tr>
<td>R99 Receives First Attack notification and starts tracing</td>
<td>0</td>
</tr>
<tr>
<td>R99 Sends out first attack notification to upstream router R102</td>
<td>$T + 6$ seconds</td>
</tr>
<tr>
<td>R102 Receives first attack notification from R99</td>
<td>$T + 9$ seconds</td>
</tr>
<tr>
<td>R97 Receives first attack notification from R99</td>
<td>$T + 62$ seconds</td>
</tr>
<tr>
<td>R99 Applies first attack rule to itself</td>
<td>$T + 65$ seconds</td>
</tr>
</tbody>
</table>
idip_firewall_receiver.c do_trace_request: UNDER ATTACK:

idip_firewall_receiver.c do_trace_request: from source 192.168.16.133

idip_firewall_receiver.c do_trace_request: on interface eth3

idip_firewall_receiver.c do_trace_request: number of packets 308

idip_firewall_receiver.c do_request: message received FLOOD DETECTED on r993 from 192.168.16.133 (THRESHOLD 50 connections exceeded in 10 seconds)

idip_firewall_receiver.c do_request: Connected to rate limiter

idip_firewall_receiver.c do_request: Sent msg FLOOD DETECTED on r993 from 192.168.16.133 (THRESHOLD 50 connections exceeded in 10 seconds) to rate limiter

idip_firewall_receiver.c do_trace_request: alertmsg sent to 192.168.14.102: FLOOD DETECTED on r993 from 192.168.16.133 (THRESHOLD 50 connections exceeded in 10 seconds)

idip_firewall_receiver.c do_trace_request: Checking for other upstream routers to notify

idip_firewall_receiver.c do_trace_request(): alertmsg sent to 192.168.12.97: FLOOD DETECTED on r993 from 192.168.16.133

idip_firewall_receiver.c do_trace_request(): alertmsg sent to other upstream router, 12.97
A2D2V2 Cooperative Defense Highlights

- Without cooperative defense of A2D2V2 C2 would starved out during the attack
- Local attack response of A2D2 in place doesn't stop this situation. A2D2V2 provides additional levels of attack detection and response.
- 16.x and 11.x subnets have no attack detection mechanism. Rely on notification from 13.x subnet attack detection to stop attack traffic
- IDS in 13.x had much less work to do since attack was pushed upstream, closer to source
- Multi-administrative domain(A2D2V2 neighborhoods) response is much faster than if human intervention is required
A2D2V2 Conclusions

- Cooperative, multi-network intrusion detection and response system
- A2D2V2 clients on IDIP enabled networks experience reasonable network throughput (packets per second measured for A2D2V2) during the attack
- A2D2V2 clients on Non-IDIP enabled networks experience benefits of IDIP cooperative detection and response in other networks during attack
- Allows victim networks to identify and stop attack at source
Lessons Learned

- So many...
  - How to setup an enterprise network test bed
  - How to setup static routing tables on routers for networks not within 1 link
  - Iptables with multiple input/output interfaces
  - IP forwarding and how it works
  - Linux firewall security
  - Linux
  - Remote management of test bed
  - Hardware setup and configuration
  - Stacheldraht attack tools quirks
  - SSH and X11 forwarding
Future work

- Correlation Engine
- IDIP Enhancements
- Redundant/cooperative discovery coordinators
- OpenSLP
- IDMEF, IDXP, CISL and IDIP
- CIDF
- Performance Enhancements
- Tracing and locating of other IDIP networks
Backup Slides
Pieces of IDIP Implementation for A2D2V2

IDIP Message Header:

```c
struct idip_header {
    uint18_t version;
    uint8_t flags;
    uint16_t length;
    uint8_t next_type;
    uint8_t pad;
    uint16_t checksum;
    uint32_t seq_num;
    uint32_t time_stamp;
    uint32_t priority;
    uint32_t dest_addr;
    uint32_t dest_proc_id;
    uint32_t dest_boot_time;
    uint32_t pad_extra;
};
```
Pieces of IDIP Implementation for A2D2V2

IDIP App Header:

```c
struct idip_app_msg_hdr {
    uint8_t                         version;
    uint8_t                         class_id;
    uint32_t                        length;
    uint32_t                        timestamp;
    uint32_t                        thread_id;
    struct idip_app_orig_addr       orig_addr;
    uint8_t                         flags;
    uint8_t                         pad[3];
};
```
IDIP vs. IDMEF

- IDMEF defines data formats and exchange procedures for sharing data from IDS system to other IDS systems and to mgt systems interacting with them.
- Two open source IDMEF libraries available for IDMEF, libidmef and a Java IDMEF classes.
- Both IDMEF and IDIP enable interoperability among opensource commercial and research IDS systems.
- IDMEF is XML based, makes it highly interoperable. IDIP uses a message protocol.
- IDIP requires additional software infrastructure on IDIP nodes. IDMEF only requires use of the lib/java class to generate the appropriate message.
IDIP vs. IDMEF

- IDIP and IDMEF require knowledgeable party to help correlate data
- IDMEF has some correlation protocol definitions
- IDIP relies on trace message data to determine appropriate responses
- IDMEF is an open, fully available protocol
- IDIP documentation is not fully available. The IDIP Key distribution and Cryptographic extensions are not available
Figure 5. A simplified version of the IDMEF model as of January 30, 2003 [7].
IDIP and CISL

- CISL is IDIP information specification language
- It is used in IDIP to communicate trace and report information
- CISL uses S-expression syntax to form sentences describing events and responses
- CISL provides reasonably rich vocabulary for the structure and instances of a set of events involving only networked computers.
- CISL has some limitations
Example CISL expression for a simple event:
Delete
  (When
    (Time '12:24 15 Mar 1999 UTC')
  )
(Initiator
  (UserName 'joe')
  (UserID 1234)
  (HostName 'foo.example.com')
)
(FileSource
  (FullPathName '/etc/passwd')
  (HostName 'foo.example.com')
)
IDIP and IDMEF

- CISL seems a bit cumbersome
- Using IDMEF(XML) to transfer data in a compatible way might be more lightweight
IDIP and CIDF

- Effort to develop protocols and application programming interfaces so that IDS research projects can share information and resources to enable sharing of IDS components
- Utilizes CISL for data format
- CIDF's primary goal is to represent intrusion detection data in a Global Intrusion Detection Object(GIDO) format
- Last substantial work done for CIDF in 1999
- CIDF is intended for use in conjunction with IDIP
IDXP is Intrusion Detection Exchange Protocol used for exchanging data between IDS entities.

- Supports mutual authentication, integrity and confidentiality over a connection-oriented protocol.
- Specified as a Blocks Extensible Exchange Protocol (BEEP).
- Provides for the exchange of IDMEF messages.
- IDXP is an open, published standard.
- IDIP protocol spec is only partially available.

Both allow for proxy of intermediate nodes to pass along data.

Both provide for a security protocol. IDIP's security protocol is not available at this time.
A2D2V2 Test Scenarios

1. Normal tcp_rcv traffic running on C1 and C2 and tcp_snd running on S2 with no attack. And, no CBQ applied to firewall/routers. This was used for baseline packet performance data.

2. Normal tcp_rcv traffic running on C1 and C2, tcp_snd running on S1 with the TCP SYN flood attack running on A1, A2 and A3 targeting S1, 192.168.13.1 and S2, 192.168.15.1. No IDIP or IDS software running nor class based queueing has been applied. This is to show the affect on the clients with no DDoS attack mitigation. Results shown are for C1 only. C2 exhibited exact symptoms as C1 in this test scenario, that is the near total loss of packet transmission.
A2D2V2 Test Scenarios

3. Normal tcp_rcv traffic running on C1 and tcp_snd running on S1 with a 3 1/2 minute non-stop TCP SYN attack running on A1 and A2 with R97 and R99 running IDIP enabled software, and S1 running IDIP enabled Snort IDS. Class based queueing and other QoS techniques have been applied to each participating router/firewall as discussed in Section 8.1.2. This scenario is intended to show the attack response within 2 LAN's only. Cooperation happens between the R97 and R99 firewall/routers.
A2D2V2 Test Scenarios

4. Normal tcp_rcv traffic running on C1 and C2, tcp_snd running on S1 and S2 with the non-stop TCP SYN flood attack running on A1, A2 and A3 targeting both S1 and S2 for 3 ½ minutes, along with the A2D2V2 IDIP enabled Snort running on S1, and IDIP firewall/router software running on R97, R99 and R102. Class based queueing and other QoS techniques have been applied to each participating A2D2V2 router/firewall as discussed in Section 8.1.2. This is to show the results of a full enterprise wide cooperative DDoS attack response and mitigation scenario. This test was run several times, with 2 graphs per client being displayed to show the consistency of response for each client.
Client C1 Baseline Packet Rate
Client C2 Baseline Packet Rate
Client C1 Test 2 data

Bandwidth Usage

"data.txt" using 1:2
Client C1 Test 3 data
A2D2V2 R99 iptables After Attack and Mitigation

Chain INPUT (policy DROP 25 packets, 3604 bytes)
pkts bytes target prot opt in out source destination
0 0 level3 all -- any any 192.168.11.72 anywhere
0 0 level3 all -- any any 192.168.11.48 anywhere
0 0 level3 all -- any any 192.168.11.114 anywhere
0 0 level3 all -- any any 192.168.11.51 anywhere
0 0 level3 all -- any any 192.168.11.18 anywhere
0 0 level3 all -- any any 192.168.11.134 anywhere
512K 134M ACCEPT all -- any any anywhere anywhere

Chain FORWARD (policy DROP 0 packets, 0 bytes)
pkts bytes target prot opt in out source destination
0 0 level3 all -- any any 192.168.11.72 anywhere
0 0 level3 all -- any any 192.168.11.48 anywhere
0 0 level3 all -- any any 192.168.11.114 anywhere
0 0 level3 all -- any any 192.168.11.51 anywhere
0 0 level3 all -- any any 192.168.11.18 anywhere
0 0 level3 all -- any any 192.168.11.134 anywhere
894K 170M ACCEPT all -- any any anywhere anywhere

Chain OUTPUT (policy DROP 1 packets, 52 bytes)
pkts bytes target prot opt in out source destination
286K 102M ACCEPT all -- any any anywhere anywhere
### A2D2V2 R99 iptables After Attack and Mitigation

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<th>prot</th>
<th>opt</th>
<th>in</th>
<th>out</th>
<th>source</th>
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<th>anywhere</th>
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<td></td>
<td>0</td>
<td>0</td>
<td>DROP</td>
<td>all</td>
<td>--</td>
<td>any</td>
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<td>anywhere</td>
<td>anywhere</td>
<td>anywhere</td>
<td>anywhere</td>
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<td>0</td>
<td>DROP</td>
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<td>--</td>
<td>any</td>
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<tr>
<td></td>
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<td>0</td>
<td>ACCEPT</td>
<td>all</td>
<td>--</td>
<td>any</td>
<td>any</td>
<td>anywhere</td>
<td>anywhere</td>
<td>anywhere</td>
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limit: avg 50/sec burst 5

<table>
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<td>any</td>
<td>anywhere</td>
<td>anywhere</td>
<td>anywhere</td>
<td>anywhere</td>
<td></td>
</tr>
</tbody>
</table>

limit: avg 151/sec burst 5

|                              | 0    | 0     | DROP   | all  | --  | any    | any    | anywhere | anywhere | anywhere | anywhere | anywhere |
## A2D2V2 R102 iptables After Attack and Mitigation

### Chain INPUT (policy DROP 0 packets, 0 bytes)

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<th>bytes</th>
<th>target</th>
<th>prot</th>
<th>opt</th>
<th>in</th>
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<td>any</td>
<td>any</td>
<td>192.168.11.72</td>
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<tr>
<td>0</td>
<td>0</td>
<td>level3</td>
<td>all</td>
<td>--</td>
<td>any</td>
<td>any</td>
<td>192.168.11.48</td>
<td>anywhere</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>level3</td>
<td>all</td>
<td>--</td>
<td>any</td>
<td>any</td>
<td>192.168.11.114</td>
<td>anywhere</td>
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<tr>
<td>0</td>
<td>0</td>
<td>level3</td>
<td>all</td>
<td>--</td>
<td>any</td>
<td>any</td>
<td>192.168.11.51</td>
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<tr>
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<td>all</td>
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<td>any</td>
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<td>192.168.11.18</td>
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<td>0</td>
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<td>level3</td>
<td>all</td>
<td>--</td>
<td>any</td>
<td>any</td>
<td>192.168.11.134</td>
<td>anywhere</td>
</tr>
<tr>
<td></td>
<td>3544</td>
<td>450K</td>
<td>ACCEPT</td>
<td>all</td>
<td>any</td>
<td>any</td>
<td>anywhere</td>
<td>anywhere</td>
</tr>
</tbody>
</table>

### Chain FORWARD (policy DROP 0 packets, 0 bytes)

<table>
<thead>
<tr>
<th>pkts</th>
<th>bytes</th>
<th>target</th>
<th>prot</th>
<th>opt</th>
<th>in</th>
<th>out</th>
<th>source</th>
<th>destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>level3</td>
<td>all</td>
<td>--</td>
<td>any</td>
<td>any</td>
<td>192.168.11.72</td>
<td>anywhere</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>level3</td>
<td>all</td>
<td>--</td>
<td>any</td>
<td>any</td>
<td>192.168.11.48</td>
<td>anywhere</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>level3</td>
<td>all</td>
<td>--</td>
<td>any</td>
<td>any</td>
<td>192.168.11.114</td>
<td>anywhere</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>level3</td>
<td>all</td>
<td>--</td>
<td>any</td>
<td>any</td>
<td>192.168.11.51</td>
<td>anywhere</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>level3</td>
<td>all</td>
<td>--</td>
<td>any</td>
<td>any</td>
<td>192.168.11.18</td>
<td>anywhere</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>level3</td>
<td>all</td>
<td>--</td>
<td>any</td>
<td>any</td>
<td>192.168.11.134</td>
<td>anywhere</td>
</tr>
<tr>
<td></td>
<td>1799K</td>
<td>253M</td>
<td>ACCEPT</td>
<td>all</td>
<td>any</td>
<td>any</td>
<td>anywhere</td>
<td>anywhere</td>
</tr>
</tbody>
</table>

### Chain OUTPUT (policy DROP 0 packets, 0 bytes)

<table>
<thead>
<tr>
<th>pkts</th>
<th>bytes</th>
<th>target</th>
<th>prot</th>
<th>opt</th>
<th>in</th>
<th>out</th>
<th>source</th>
<th>destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>3487</td>
<td>363K</td>
<td>ACCEPT</td>
<td>all</td>
<td>any</td>
<td>any</td>
<td>any</td>
<td>anywhere</td>
<td>anywhere</td>
</tr>
<tr>
<td></td>
<td>3487</td>
<td>363K</td>
<td>ACCEPT</td>
<td>all</td>
<td>any</td>
<td>any</td>
<td>anywhere</td>
<td>anywhere</td>
</tr>
</tbody>
</table>
A2D2V2 R102 *iptables After Attack and Mitigation*

Chain level0 (0 references)

```
pkts bytes target     prot opt in     out     source destination
0     0 DROP       all  --  any    any     anywhere   anywhere
```  

Chain level1 (0 references)

```
pkts bytes target     prot opt in     out     source destination
0     0 DROP       all  --  any    any     anywhere anywhere
```  

Chain level2 (0 references)

```
pkts bytes target     prot opt in     out     source destination
0     0 ACCEPT     all  --  any    any     anywhere anywhere
limit: avg 50/sec burst 5
0     0 DROP       all  --  any    any     anywhere anywhere
```  

Chain level3 (14 references)

```
pkts bytes target     prot opt in     out     source destination
1243 1861K ACCEPT     all  --  any    any     anywhere anywhere
limit: avg 151/sec burst 5
500 749K DROP
```
A2D2V2 iptraf Data From S2 During Attack Run

Wed Jul  5 14:13:05 2006; ******** Detailed interface statistics started ********

*** Detailed statistics for interface eth0, generated Wed Jul  5 14:18:52 2006

Total:  1565701 packets, 210432861 bytes
    (incoming: 716189 packets, 45786214 bytes; outgoing: 849512 packets, 164646647 bytes)
IP:    1565701 packets, 186996595 bytes
    (incoming: 716189 packets, 34243116 bytes; outgoing: 849512 packets, 152753479 bytes)
TCP:   1565433 packets, 186978371 bytes
    (incoming: 715921 packets, 34224892 bytes; outgoing: 849512 packets, 152753479 bytes)
UDP:   0 packets, 0 bytes
    (incoming: 0 packets, 0 bytes; outgoing: 0 packets, 0 bytes)
ICMP:  268 packets, 18224 bytes
    (incoming: 268 packets, 18224 bytes; outgoing: 0 packets, 0 bytes)
Other IP: 0 packets, 0 bytes
    (incoming: 0 packets, 0 bytes; outgoing: 0 packets, 0 bytes)
Non-IP: 0 packets, 0 bytes
    (incoming: 0 packets, 0 bytes; outgoing: 0 packets, 0 bytes)
Broadcast: 0 packets, 0 bytes
A2D2V2 *iptraf* Data From S2 During Attack Run

Average rates:
- **Total:** 4851.48 kbits/s, 4512.11 packets/s
- **Incoming:** 1055.59 kbits/s, 2063.95 packets/s
- **Outgoing:** 3795.89 kbits/s, 2448.16 packets/s

Peak total activity: 7028.49 kbits/s, 8184.80 packets/s
- **Peak incoming rate:** 2118.14 kbits/s, 4075.20 packets/s
- **Peak outgoing rate:** 5706.25 kbits/s, 4901.00 packets/s
- **IP checksum errors:** 0

**Running time:** 347 seconds
**Week Jul  5 14:18:52 2006; ******** Detailed interface statistics stopped**
A2D2V2 idip_firewall_receiver

main()

/*
 * The backplane listens on a socket and determines the type of request
 * being sent to it. From there it invokes the appropriate processing.
 */

void main() {

    int length;
    int n;
    idip_message_t i_message;
    struct sockaddr_in toaddr;

    /* Set up our listening socket */
    if ((gen_mbx = socket(AF_INET, SOCK_DGRAM, 0)) < 0) {
        fprintf(stderr, "Unable to set up receiver socket.\n");
        perror(strerror(errno));
        return;
    } * Listen for messages from any host, on the IDIP_APP_PORT */
    (void) memset(&gen_from, 0, sizeof (gen_from));
    gen_from.sin_family = AF_INET;
    gen_from.sin_addr.s_addr = INADDR_ANY;
A2D2V2 idip_firewall_receiver
main()

Gen_from.sin_port = htons(IDIP_APP_PORT);

if (bind(gen_mbx, (struct sockaddr *) &gen_from,
    sizeof (struct sockaddr_in)) < 0) {
    fprintf(stderr, "Could not bind to port\n");
    perror(strerror(errno));
}

length = sizeof (gen_from);

if (getsockname(gen_mbx, (struct sockaddr *) &gen_from,
    &length)) {
    perror("getting socket name");
    exit(1);
}
while (1) {
    n = recvfrom(gen_mbx, &i_message,
        sizeof (idip_message_t),
        0, (struct sockaddr *)&gen_from, &length);
    if (n < 0) {
        perror("receiving datagram messages");
        continue;
    }
A2D2V2 idip_firewall_receiver
main()

/*
 * Process this message. It is possible that there has
 * been a transmission problem or data is garbled.
 * Move on
 * if this is the case.
 */
if (process_idip_message(&i_message) != 0) {
    perror("error processing idip message");
    continue;
}

/*NOTREACHED*/
A2D2V2 tcpdump.sh

# set time limit based on what caller specified. Exec script that will send
# SIGTERM to tcpdump to force this script to run the END block. Background
# this so it doesn't interrupt gawk processing below.

# Invoke tcpdump with options and pipe through gawk to gather data. The
# running of tcpdump is limited to the time specified by the caller. I
# am only interested in the ip protocol packets. I will get the source
# and destination addresses with the 'ip' specifier at $3 and $5 respectively.
# Do not track outgoing packets from this host as part of tracing data. This is
# achieved by the 'src host not loghost' qualifier.

# I need to dump on every interface I find on system. so, call ifconfig -a
# first, to get interface name. Call tcpdump on these.

INTERFACES=`/sbin/ifconfig | gawk ' { 
    # Get the interface name
    x = split($1, ifname)
    newif[i]=ifname[1]
    if (match(newif[i], "eth") && newif[i] != "lo") {
        printf("%s ", newif[i])
    } 
}'`

# get惜 drops

for i in `echo $INTERFACES` 
  do

        # set time limit based on what caller specified. Exec script that will send
        # SIGTERM to tcpdump to force this script to run the END block. Background
        # this so it doesn't interrupt gawk processing below.

        # Invoke tcpdump with options and pipe through gawk to gather data. The
        # running of tcpdump is limited to the time specified by the caller. I
        # am only interested in the ip protocol packets. I will get the source
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        # achieved by the 'src host not loghost' qualifier.

        # I need to dump on every interface I find on system. so, call ifconfig -a
        # first, to get interface name. Call tcpdump on these.

        INTERFACES=`/sbin/ifconfig | gawk ' { 
            # Get the interface name
            x = split($1, ifname)
            newif[i]=ifname[1]
            if (match(newif[i], "eth") && newif[i] != "lo") {
                printf("%s ", newif[i])
            } 
}'`

        # get惜 drops
# I need to dump on every interface I find on system. so, call ifconfig -a
# first, to get interface name. Call tcpdump on these.

INTERFACES=`/sbin/ifconfig | gawk ' {
    # Get the interface name
    x = split($1, ifname)
    newif[i]=ifname[1]
    if (match(newif[i], "eth") && newif[i] != "lo") {
        printf("%s ", newif[i])
    }
    i = i + 1
} '``

for i in $INTERFACES
do
  # for each interface check number of packets , if over threshold, report
  ./dumper.sh $i $1 > /tmp/o_$i &
done

# kill this process in $1 amount of time
./trace_kill $2
sleep 3
/bin/cat /tmp/o_*