Defending Computer Networks
Lecture 14: More NIDS

Stuart Staniford

Adjunct Professor of Computer Science

Logistics

- HW3.
  - Only actually got it out yesterday.
    - Apologies for delay!
  - Will be due Tuesday October 22nd.
- Guest lecture Nov 5th – Tim Dawson, JPMC
- Quiz 2 will be Nov 7th
- Guest lecture Dec 3rd – Darien Kindlund, FEYE
- Quiz 3 will be Dec 5th (last class)

Assigned Reading

- Ptacek and Newsham, *Insertion, Evasion, and Denial of Service: Eluding Network Intrusion Detection*
  - https://sparrow.ece.cmu.edu/group/731-s08/readings/ptacek-newsham.pdf

Latest News

India to manufacture hardware for cybersecurity: Sibal

ANI | Oct 15, 2013, 03.18 PM IST

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Admitting that India's imported computer hardware is a security threat, the Union Minister for Communications and Information Technology Kapil Sibal said that the government has decided to set up manufacture of semi-conductors and computer chips.

NEW DELHI: Admitting that India's imported computer hardware is a security threat, the Union Minister for Communications and Information Technology Kapil Sibal on Monday said that the government has decided to set up manufacture of semi-conductors and computer chips.

Delivering the inaugural address at a two-day India Conference on Cyber Security and Cyber Governance, organised by Observer Research Foundation (ORF) and FICCI at New Delhi, Sibal said the government has already approved two projects to build semi-conductors and letters of intent have been issued already.

Sibal hoped that manufacture of chips in India in design with the Indian software companies will go a long way in improving cyber security, though it is easier said than done.

He said the government is also planning to train 5,00,000 people in the next five years in using and governing cyber space.

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More News

16 Breach at PR Newswire Tied to Adobe Hack

OCT 13

Earlier this year, hackers broke into the networks of marketing and press release distribution service **PR Newswire**, making off with usernames and encrypted passwords that customers use to access the company's service and upload news releases, KrebsOnSecurity has learned.

The stolen data was found on the same Internet servers that housed huge troves of source code recently stolen from Adobe Systems. Inc., suggesting the same attackers may have been responsible for both breaches. Date and time stamps on the stolen files indicate that breach at PR Newswire occurred on or after March 8, 2013.

Presented with a copy of the purloined data, PR Newswire confirmed ownership of the information. The company said that later today it will begin the process of alerting affected customers and asking them to change their account passwords. The company says its investigation is ongoing, but that the data appears to be related to a subset of its customers from Europe, the Middle East, Africa and India.

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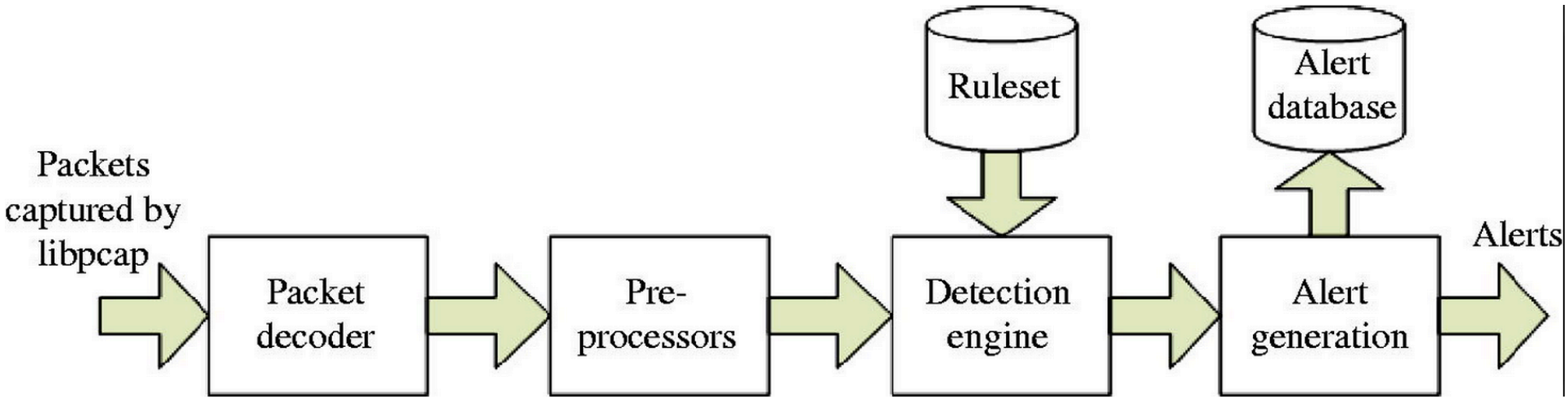
Breach at PR N
Adobe Hack

Main Goals for Today

- More Network Intrusion Detection

Overall Snort Architecture



Snort Detection Engine Data Structure

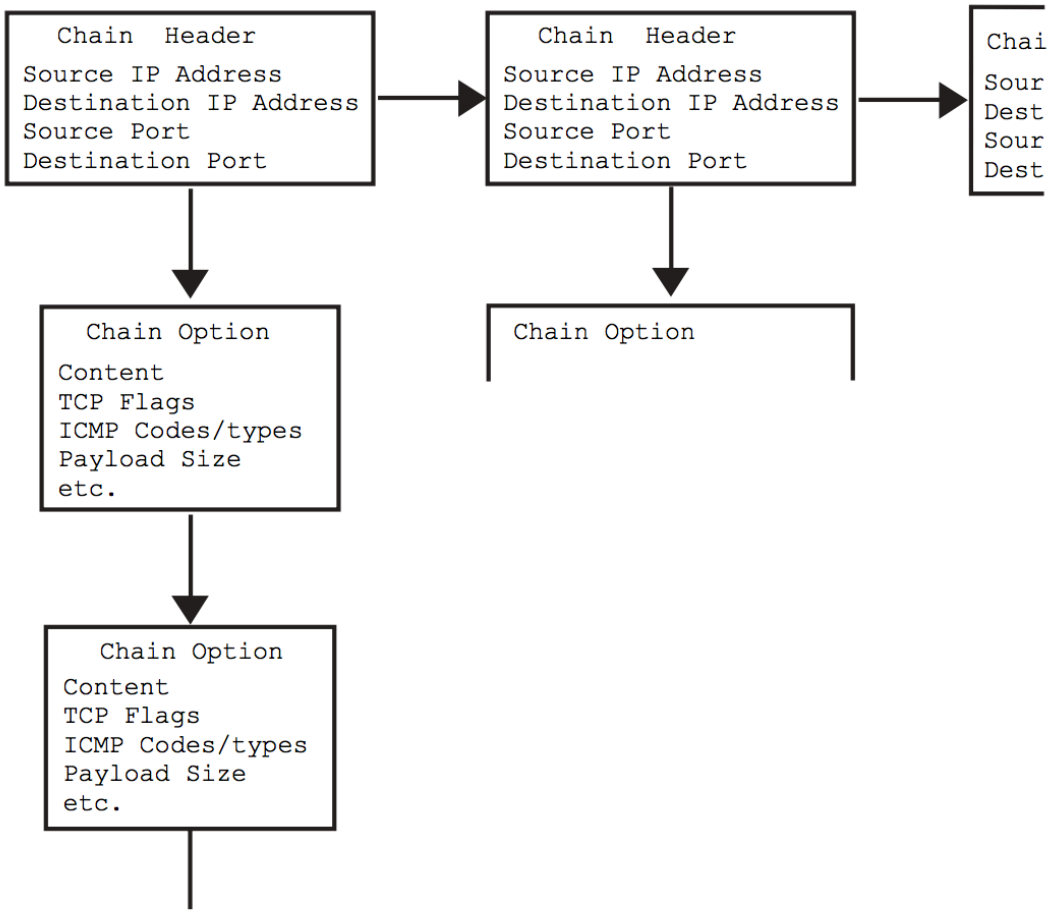


Figure 3: Rule Chain logical structure.

Snort Rule Example 1

alert tcp $EXTERNAL_NET any -> $HTTP_SERVERS $HTTP_PORTS (msg:"SERVER-WEBAPP HyperSeek hsx.cgi directory traversal attempt"; flow:to_server,established; content:"/hsx.cgi"; http_uri; content:"../../"; http_raw_uri; content:"%00"; distance:1; http_raw_uri; metadata:ruleset community, service http; reference:bugtraq,2314; reference:cve,2001-0253; reference:nessus,10602; classtype:web-application-attack; sid:803; rev:21;)

Snort Rule Example 2

alert tcp **$EXTERNAL_NET $HTTP_PORTS -> $HOME_NET** any (msg:"*EXPLOIT-KIT Multiple exploit kit Payload detection - readme.exe*"**; flow:to_client,established**; content:"**filename=";** http_header; content:**"readme.exe"**; within:12; fast_pattern; http_header; **content:"|0D 0A|"**; within:4; http_header; metadata:policy balanced-ips drop, policy security-ips drop, service http; reference:cve,2006-0003; reference:cve,2007-5659; reference:cve,2008-0655; reference:cve,2008-2992; reference:cve,2009-0927; reference:cve,2010-1885; reference:cve,2011-0559; reference:cve,2011-2110; reference:cve,2011-3544; reference:cve,2012-0188; reference:cve,2012-0507; reference:cve,2012-1723; reference:cve,2012-1889; reference:cve,2012-4681; reference:url,blog.webroot.com/2011/10/31/outdated-operating-system-this-blackhole-exploit-kit-has-you-in-its-sights/; classtype:trojan-activity; sid:25387; rev:3;)

Snort Rule Example 3

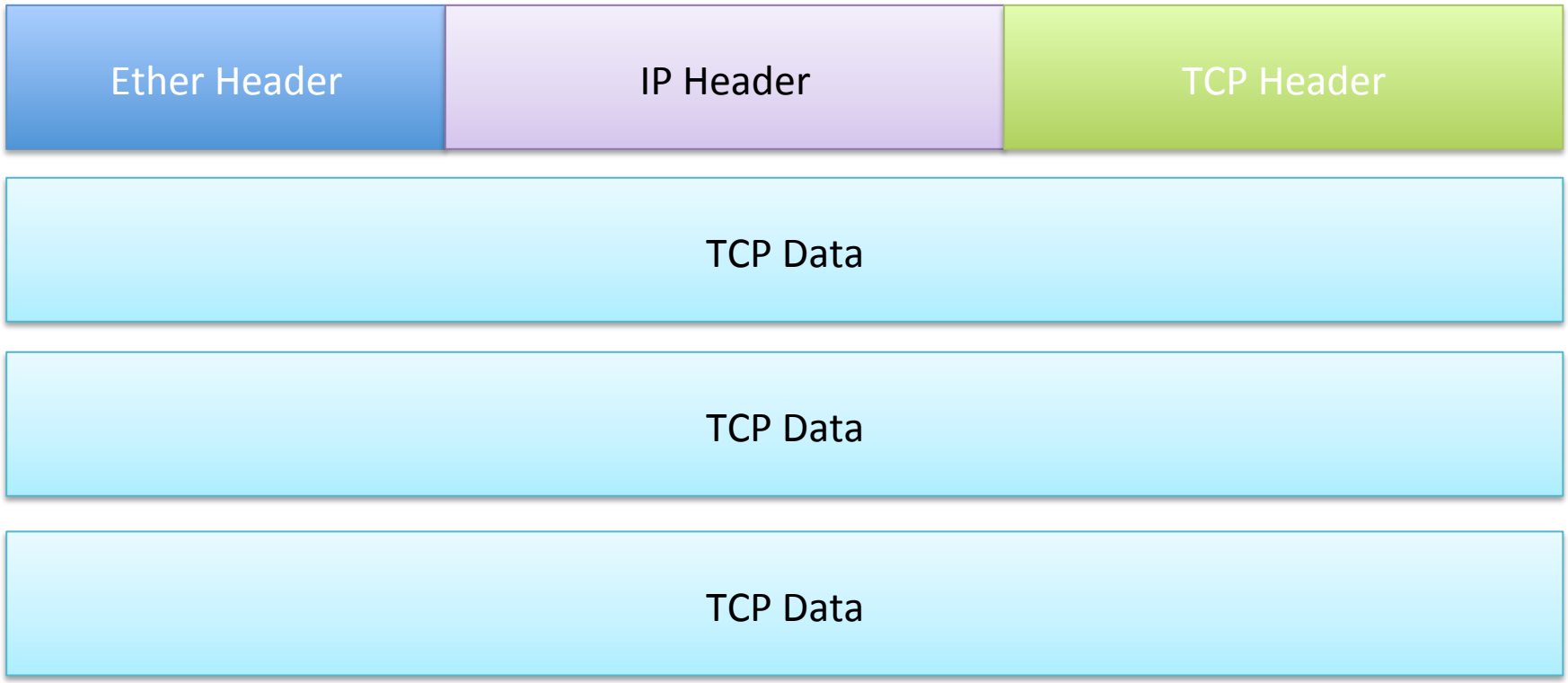
alert tcp **$EXTERNAL_NET $HTTP_PORTS -> $HOME_NET any**
(msg:"*BROWSER-IE IE5 compatibility mode use after free attempt*";
flow:to_client,established; file_data; content:**"meta http-equiv=|22|X-UA-Compatible|22| content=|22|IE=5|22|"**; fast_pattern:only;
content:**".runtimeStyle.setExpression"**;
content:**"document.body.innerHTML"**; metadata:policy balanced-ips drop, policy security-ips drop, service http; reference:cve,2013-3121;
reference:url,technet.microsoft.com/en-us/security/bulletin/MS13-047;
classtype:attempted-user; sid:26851; rev:3;)

Background on Example 3

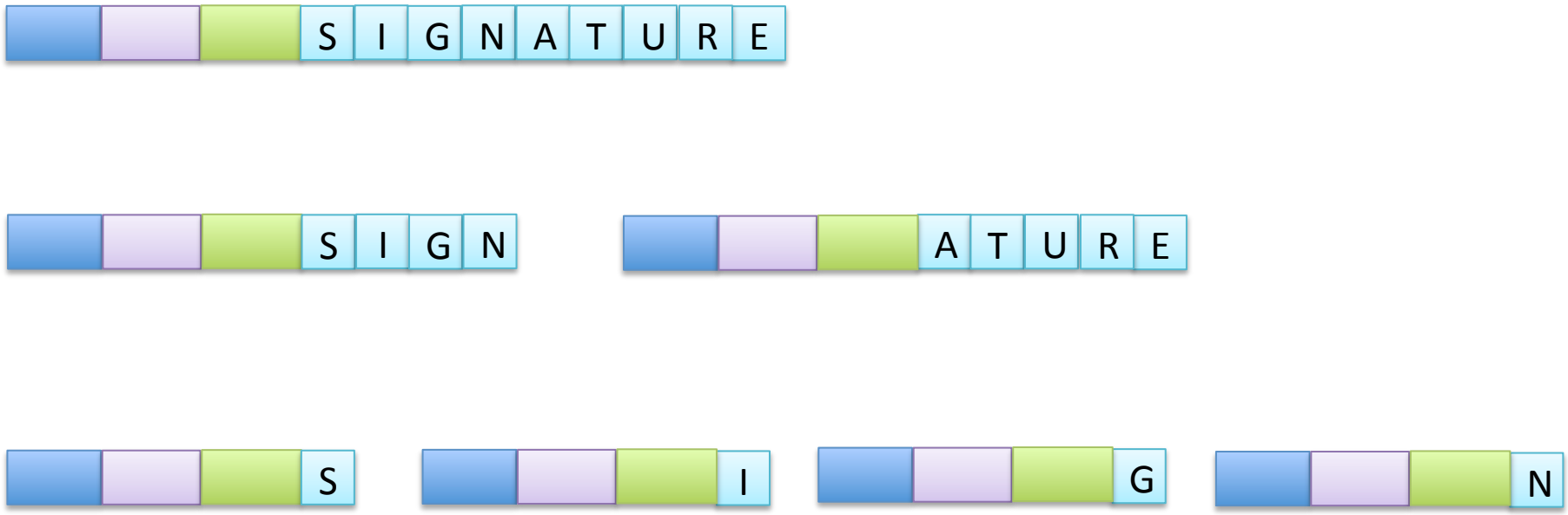
- http://www.cve.mitre.org/cgi-bin/cvename.cgi?name=CVE-2013-3121
- http://www.securityfocus.com/bid/60390
- http://technet.microsoft.com/en-us/security/bulletin/ms13-047

A remote code execution vulnerability exists when Internet Explorer improperly processes script while debugging a webpage. The vulnerability may corrupt memory in a way that could allow an attacker to execute arbitrary code in the context of the current user within Internet Explorer. An attacker could host a specially crafted website that is designed to exploit this vulnerability through Internet Explorer and then convince a user to view the website.

Evading NIDS: TCP

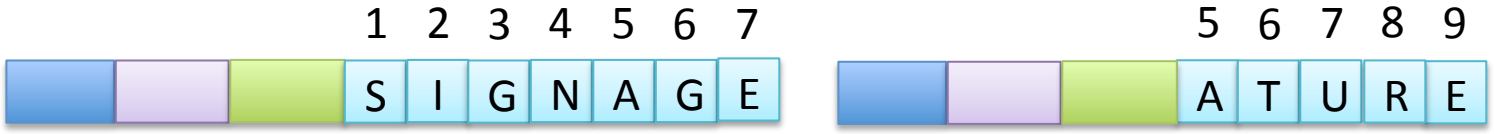


Variants



Clearly we have to reassemble TCP before looking for “SIGNATURE”

But what about this case?



In Snort

- Stream5 preprocessor
  - Buffers packets and reassembles stream
  - Passes onto detection engine
  - Target based
    - changes behavior according to target OS
    - Static configuration
  - Can detect reassembly anomalies
    - But off by default
    - Probably too many fps

`policy <policy_id>`	The Operating System policy for the target OS. The policy_id can be one of the following:

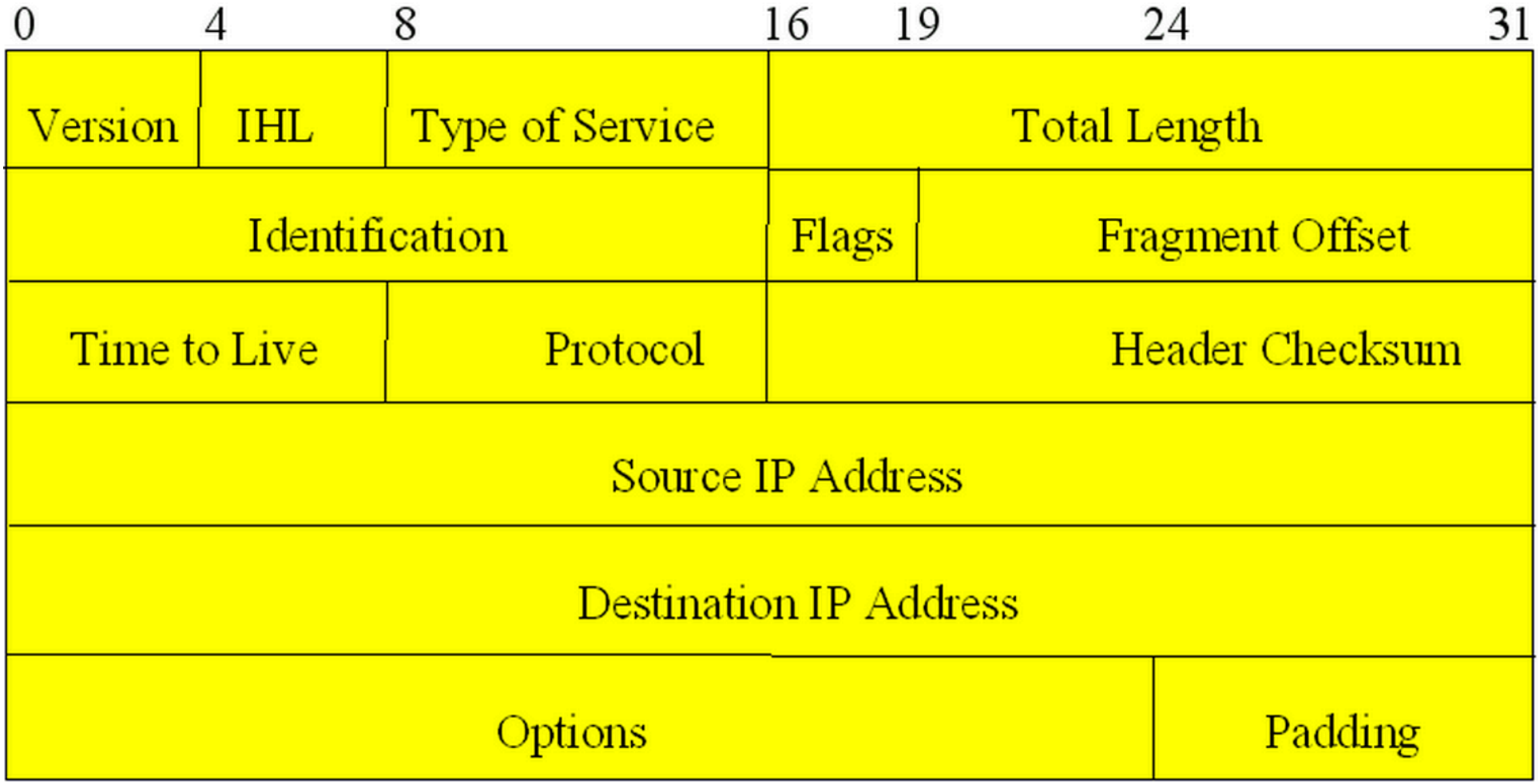
Policy Name	Operating Systems.
`first`	Favor first overlapped segment.
`last`	Favor first overlapped segment.
`bsd`	FresBSD 4.x and newer, NetBSD 2.x and newer, OpenBSD 3.x and newer
`linux`	Linux 2.4 and newer
`old-linux`	Linux 2.2 and earlier
`windows`	Windows 2000, Windows XP, Windows 95/98/ME
`win2003`	Windows 2003 Server
`vista`	Windows Vista
`solaris`	Solaris 9.x and newer
`hpux`	HPUX 11 and newer
`hpux10`	HPUX 10
`irix`	IRIX 6 and newer
`macos`	MacOS 10.3 and newer

Snort flow sub-keywords

Option	Description
`to_client`	Trigger on server responses from A to B
`to_server`	Trigger on client requests from A to B
`from_client`	Trigger on client requests from A to B
`from_server`	Trigger on server responses from A to B
`established`	Trigger only on established TCP connections
`not_established`	Trigger only when no TCP connection is established
`stateless`	Trigger regardless of the state of the stream processor (useful for packets that are designed to cause machines to crash)
`no_stream`	Do not trigger on rebuilt stream packets (useful for dsize and stream5)
`only_stream`	Only trigger on rebuilt stream packets
`no_frag`	Do not trigger on rebuilt frag packets
`only_frag`	Only trigger on rebuilt frag packets

http://manual.snort.org/node33.html#SECTION00469000000000000000

Evading NIDS: Fragmentation



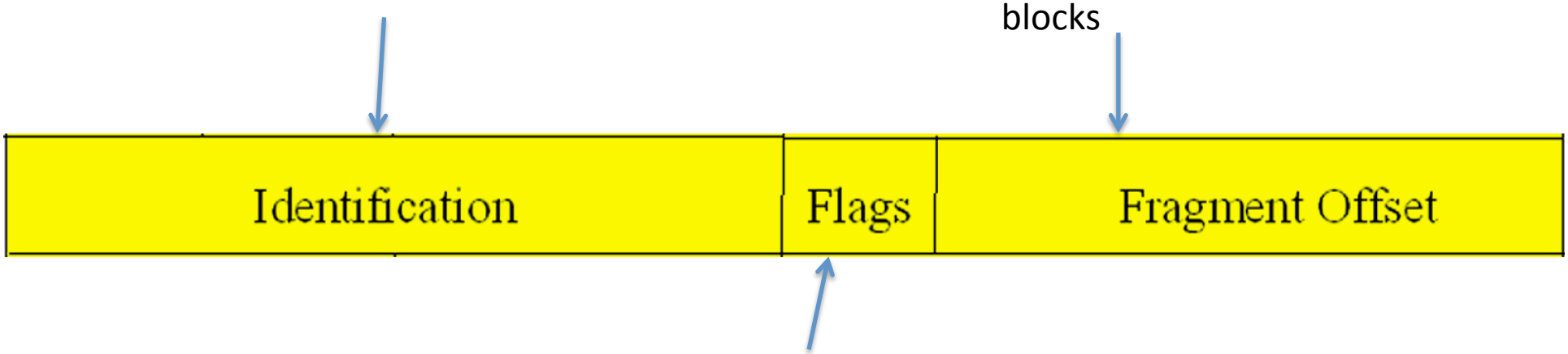
Reason for Fragmentation

- 2 byte length: 64kB IP packet
  - Actually more through special jumbo options
- Physical layers generally smaller
- Historically endpoints would not know MTU size in middle
  - "MTU discovery" nowadays.
- So if a packet too big for physical network arrives at router
  - Need to split it into pieces

How Fragmentation Works

All fragments of a given packet have same id

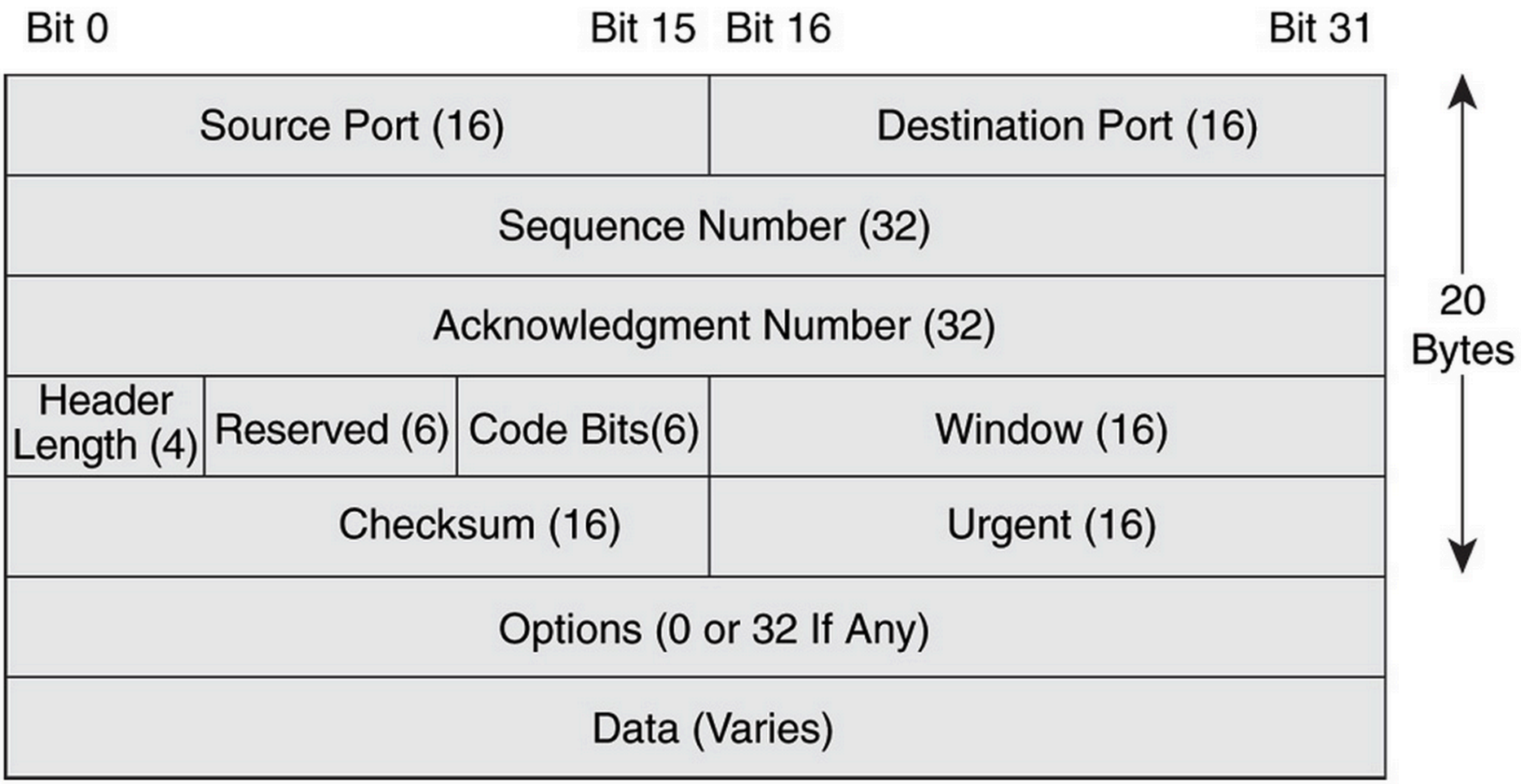
Offset of this segment in the original ip data, in eight byte blocks



MF flag bit says whether to expect any more packets

Note that fragmentation can be used to break up the TCP header, not just the TCP data

TCP Header in Fragmentation



5 Minute Break

Using Fragmentation for Evasion

- IDS must reassemble fragments before doing TCP processing
  - Can look for signs of abusive fragmentation
- Overlapping fragments are host dependent
  - Possibility of evasion
- Hosts will timeout partial fragment streams
  - IDS must match host timeout behavior

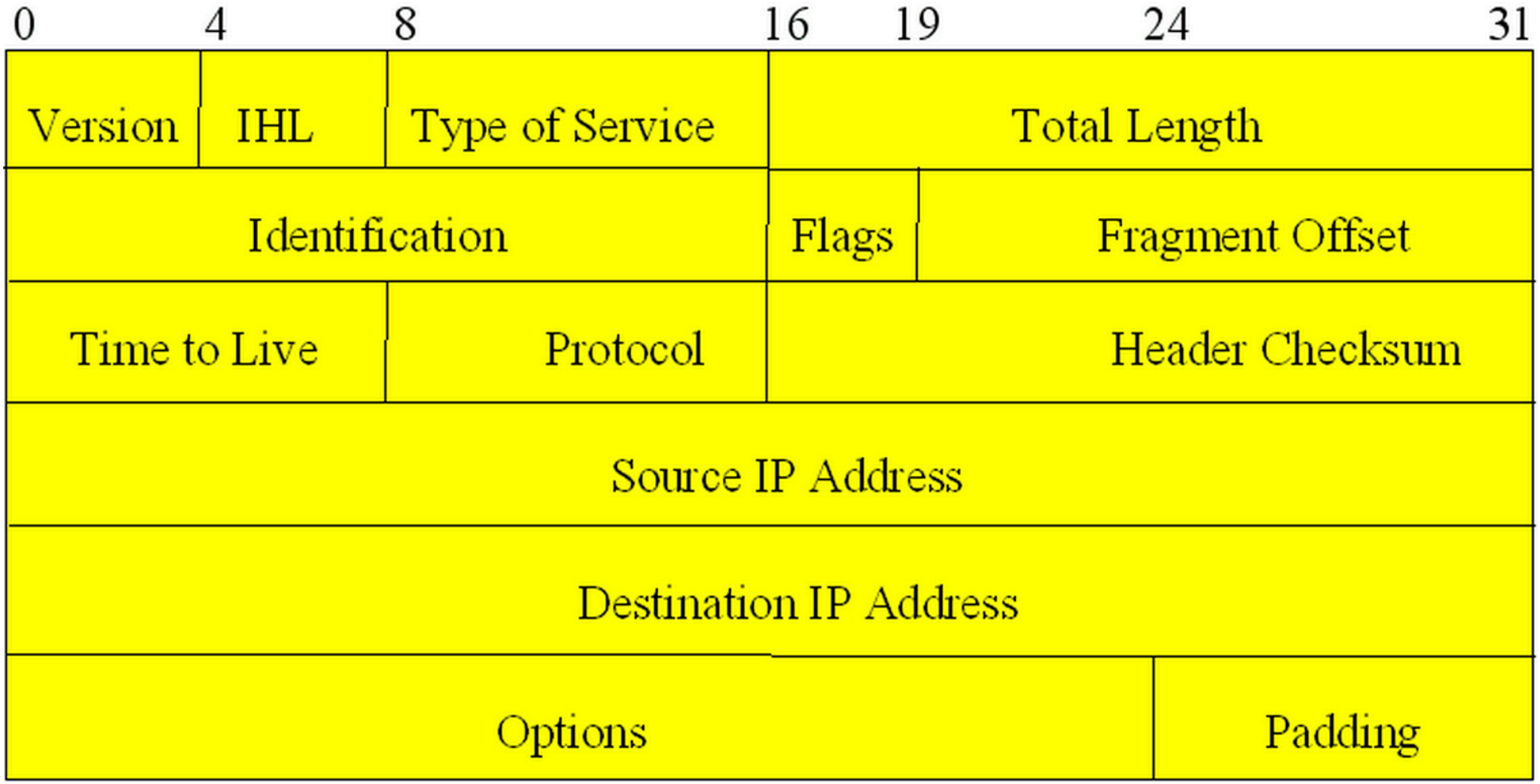
Snort solution

- Frag3 reassembly preprocessor
  - Buffer and reassemble fragments
  - Has to come before TCP reassembly
    - Since cannot even reliably infer tcp header until defragging is done
  - Target based
    - Again, based on a static policy
  - Can alert on anomalies

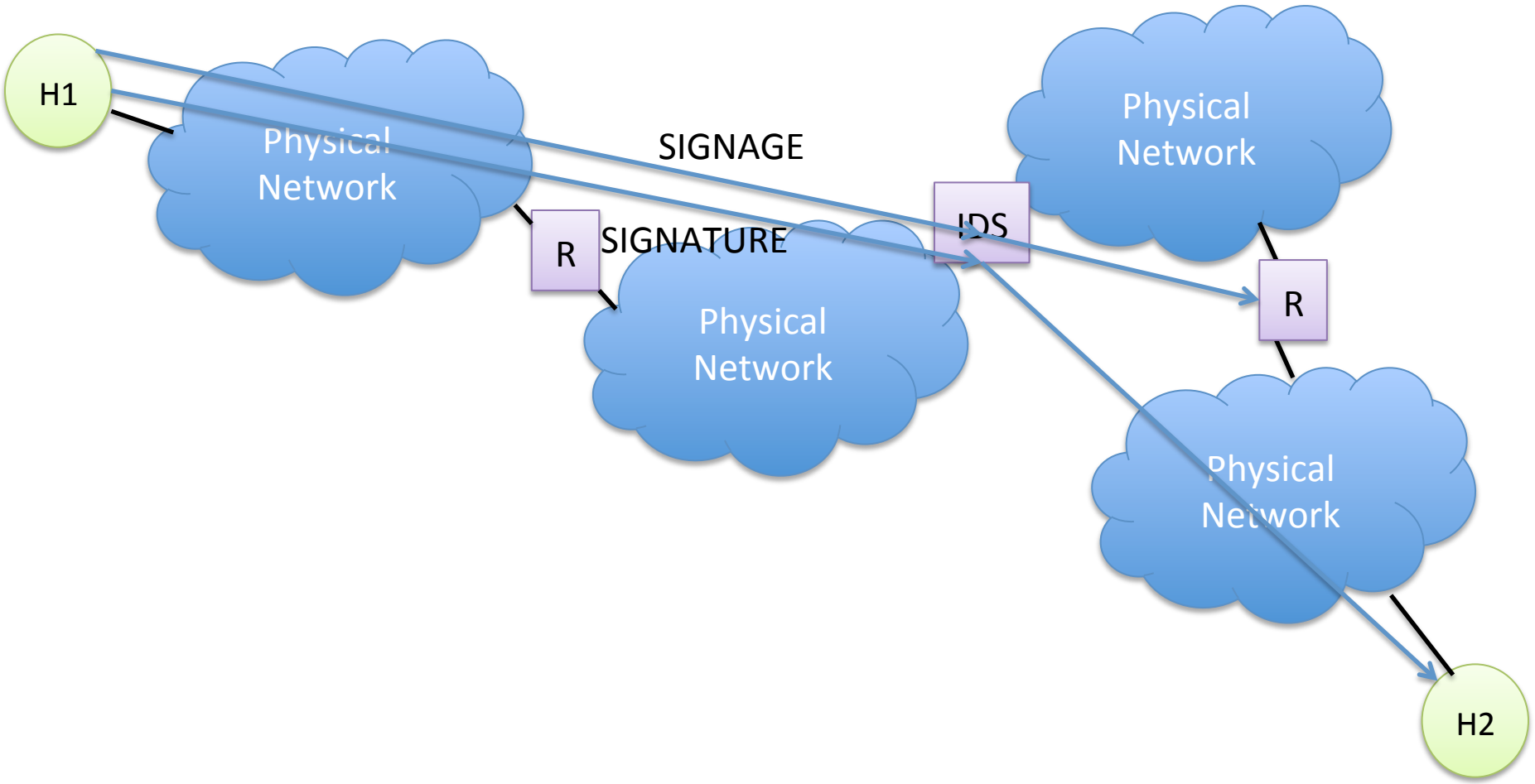
Evading NIDS: Mac address

- Only works if on same L2 network as NIDS
- Add extra packets directed to bad Mac address
  - But with correct destination IP
  - If IDS is not careful, it will process promiscuously
    - Where end-client won't
- Note there are possible legit reasons for Mac address to change during a connection
  - Eg route flapping
  - So just looking for a changing Mac will have some FPs.

Evading NIDS: TTL



Evading NIDS: TTL Field

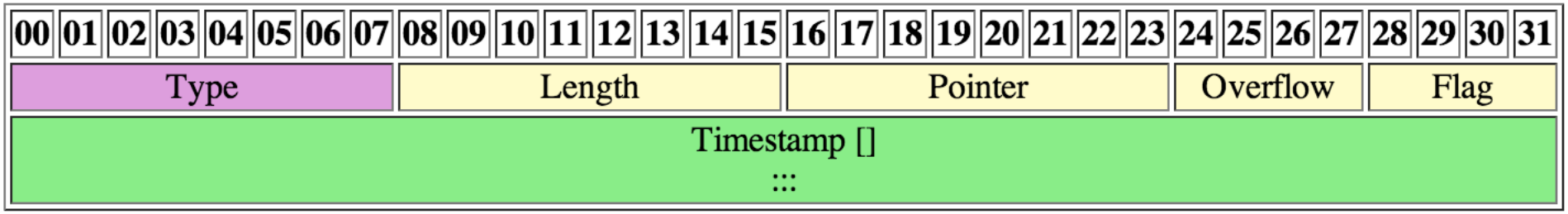


Fragmentation Variant Strategy

- Similar to TTL
- There is a DF bit in “Flags” field in IP header
- Means “Don’t Fragment”
- On certain packets, set this then set packet size greater than MTU at some part of route
- Routers will drop those packets, not deliver
- Can be used as an evasion strategy

IP Timestamp Option Evasion

- IP Options allow additional fields to be added to IP packet header
  - For special purposes
  - IHL field > 5 signals presence of options
- Timestamp recording (RFC 781)
- Packet will be dropped if timestamp option malformed



Effects of Evasions

- Force the IDS to know a great deal about the network
  - Distance to end points (TTL)
  - MTUs in physical networks (DF bit)
  - Nature of end-client (reassembly algorithms)
- OTOH
  - Many of these strategies are themselves somewhat suspicious
  - IDS can use them as evidence
    - maybe, care needed on FPs

Strategies for Defeating Evasions

- Target based
  - IDS needs to figure out nature of all machines on network
    - Active fingerprinting (integration with vuln scanner)
    - Passive fingerprinting
    - Manual, static
      - not scalable unless network pretty homogeneous
  - Do TCP, Frag, etc reassembly however appropriate
    - IDS implementors have a lot of work to do

Strategies for Evasions (2)

- Normalization
  - If IDS is inline (IPS = Intrusion Prevention System)
  - Then IPS can rewrite packet stream to make it unambiguous
  - Solves problem pretty well in principle
  - Places different set of demands on IPS
    - Better not break anything in rewriting those packets!
    - Latency
    - Reliability – MTF
      - Disks on box
    - Typically customers start in non-inline mode, and then move to inline as they gain confidence