Incorporating dynamic list structures into YAF

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Agenda

IPFIX limitations

IPFIX extensions

List Structure Details

New in YAF

Mediators

yInspector

Limitations & Future Work

IPFIX Limitations

Fixed structured templates

- Templates contain a fixed set of information elements
- Unable to change elements depending on the data
- Unable to handle multiple occurrences of the same element
- Difficult to maintain relationships of hierarchical data
- Creating “single-use” templates is inefficient

Weak capabilities for lists

- Lists could be embedded in a variable length field
- Collector needs a priori knowledge to parse

New Requirements

Full Packet Capture

Maintain/Analyze Relationships

Security

Monitoring

Maintenance

Why IPFIX?

Template Mechanism

- As long as the Information Element is defined in the Information Model with a TLV {type, length, value}, it can be encoded

New IPFIX Capabilities

Basic List

- List of zero or more instances of an Information Element

Sub Template List

- List of zero or more instances of a structured data type defined by a template

Sub Template Multi List

- List of zero or more instances of a structured data type defined by different template definitions

Templates

Templates are sent before data is exported

When templates are defined, there is no concept of nested templates

- IPFIX Collector does not know what you intend to transport in lists

They are sent across the wire as equals

A template can contain a BL, STL, and/or STML

- Lists can be nested – necessary for maintaining relationships
- Some nested hierarchies are better than others
  - STL of 1 element = BL

Data Variability

The structure of the listed data is not chosen until the data is encoded and transmitted

How does this help?

- Data Specific Templates
- Variable Length Lists
- Model Hierarchical Relationships
- Nest Lists within Lists
- Multiple Occurrences of Data Types

YAF uses this flexibility to create data records that only contain elements it has data for

- Reduces null elements
- Relieves template management problem

New YAF Features

Deep Packet Inspection

SSL Certificate Capture

p0f

Tunneling Protocols

DNS

YAF Application Labeling & DPI

Application Labeling

- HTTP, SSH, SMTP, Gnutella, YMSG, DNS, FTP, SSL/ TLS, SLP, IMAP, IRC, RTSP, SIP, RSYNC, PPTP, NNTP, TFTP, Teredo, POP3, DHCP, SMB, SNMP, AIM, SOCKS
- Compare flow's payload against configurable regular expressions and protocol decoding plug-ins
- Label 80 regex HTTP/\d\.\d/b

Deep Packet Inspection

- Based on Application Labeling
- If labeling succeeds, dive in further and pull out interesting strings

YAF IPFIX Templates

Before

0	1 - 15	16 - 31
Set ID = 2		Length = FFF
Template ID		Field Count
0	flowStartMilliseconds 152	Field Length = 8
0	flowEndMilliseconds 153	Field Length = 8
0	octetTotalCount 85	Field Length = 8
1	octetTotalCount 85	Field Length = 8
Reverse PEN		29305
0	packetTotalCount 86	Field Length = 8
1	packetTotalCount 86	Field Length = 8
Reverse PEN		29305
0	sourceIPv4Address 8	Field Length = 4
0	destinationIPv4Address 12	Field Length = 4
0	sourceTransportPort 7	Field Length = 2
0	destinationTransportPort 11	Field Length = 2
0	protocolIdentifier 4	Field Length = 1
0	flowEndReason 136	Field Length = 1
1	silkAppLabel 33	Field Length = 2
CERT PEN		6817
0	tcpSequenceNumber 184	Field Length = 4
1	tcpSequenceNumber 184	Field Length = 4
Reverse PEN		29305
1	initialTCPFlags 14	Field Length = 1
CERT PEN		6817
1	unionTCPFlags 15	Field Length = 1
CERT PEN		6817
1	reverseInitialTCPFlags 16398	Field Length = 1
CERT PEN		6817
1	reverseUnionTCPFlags 16399	Field Length = 1
CERT PEN		6817
0	vlanId 58	Field Length = 2
1	payload 18	Variable Length
CERT PEN		6817
1	reversePayload	Variable Length
CERT PEN		6817

After

0	1 - 15	16 - 31
Set ID = 2		Length = FFF
Template ID		Field Count
0	flowStartMilliseconds 152	Field Length = 8
0	flowEndMilliseconds 153	Field Length = 8
0	octetTotalCount 85	Field Length = 8
1	octetTotalCount 85	Field Length = 8
Reverse PEN		29305
0	packetTotalCount 86	Field Length = 8
1	packetTotalCount 86	Field Length = 8
Reverse PEN		29305
0	sourceIPv4Address	Field Length = 4
0	destinationIPv4Address 12	Field Length = 4
0	sourceTransportPort 7	Field Length = 2
0	destinationTransportPort 11	Field Length = 2
0	protocolIdentifier 4	Field Length = 1
0	flowEndReason 136	Field Length = 1
1	silkAppLabel 33	Field Length = 2
CERT PEN		6817
0	vlanId 58	Field Length = 2
0	subTemplateMultiList	Variable Length

0	1 - 15	16 - 31
Set ID = 2		Length = 12
Template ID		Field Count
0	tcpSequenceNumber 184	Field Length = 4
1	tcpSequenceNumber 184	Field Length = 4
Reverse PEN		29305
1	initialTCPFlags 14	Field Length = 1
CERT PEN		6817
1	unionTCPFlags 15	Field Length = 1
CERT PEN		6817
1	reverseInitialTCPFlags 16398	Field Length = 1
CERT PEN		6817
1	reverseUnionTCPFlags 16399	Field Length = 1
CERT PEN		6817

0	1 - 15	16 - 31
Set ID = 2		Length = FFF
Template ID		Field Count
1	payload 18	Variable Length
CERT PEN		6817
1	reversePayload	Variable Length
CERT PEN		6817

Fixbuf API

```
fbSubTemplateMultiList_t *stml = NULL;

fbSubTemplateMultiListInit(&(rec.subTemplateMultiList), 0, 2);

stml = fbSubTemplateMultiListGetNextEntry(&(rec.subTemplateMultiList), stml);

fbSubTemplateMultiListEntryInit(stml, YAF_TCP_FLOW_TID, tcpTemplate, 1);

/* Fill with data*/

stml = fbSubTemplateMultiListGetNextEntry(&(rec.subTemplateMultiList), stml);

fbSubTemplateMultiListEntryInit(stml, YAF_PAYLOAD_TID, payloadTemplate, 1);

/* Fill with data*/
```

STML is initialized
Get first entry in STML
Initialize entry
Fill with data
Get Next Entry
Initialize Entry
Fill with data
…

Protocol Specific Templates

YAF DNS Example

0	1 - 15	16 - 31
Set ID = 2		Length = 64
Template ID		Field Count
1	subTemplateList	Variable Length

YAF DNS Template

Resource Record Template

0	1 - 15	16 - 31
Set ID = 2		Length = FFF
Template ID		Field Count
0	subTemplateList	Variable Length
1	dnsTTL	Field Length = 4
CERT PEN		6817
1	dnsQueryType	Field Length = 2
CERT PEN		6817
1	dnsQueryResponse	Field Length = 1
CERT PEN		6817
1	dnsAuthoritative	Field Length = 1
CERT PEN		6817
1	dnsNXDomain	Field Length = 1
CERT PEN		6817
1	dnsRRSection	Field Length = 1
CERT PEN		6817
1	dnsQueryName	Variable Length
CERT PEN		6817

A Record

0	1 - 15	16 - 31
Set ID = 2		Length = 4
Template ID		Field Count
0	sourceIPv4Address	Field Length = 4

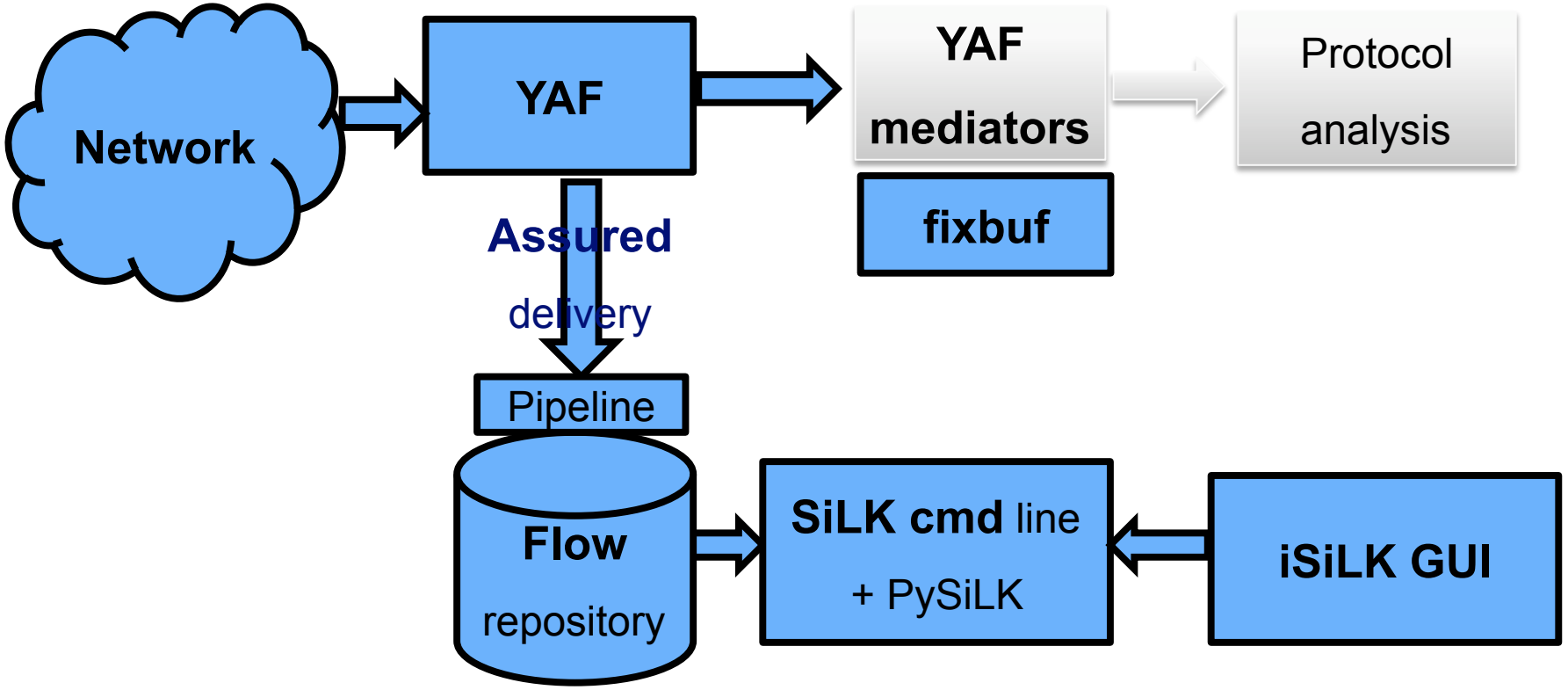
MX Record

0	1 - 15	16 - 31
Set ID = 2		Length = FFF
Template ID		Field Count
1	dnsMXPreference	Field Length = 2
CERT PEN		6817
1	dnsMXExchange	Variable Length
CERT PEN		6817

NS Record

0	1 - 15	16 - 31
Set ID = 2		Length = FFF
Template ID		Field Count
1	dnsNSdname	Variable Length
CERT PEN		6817

YAF Mediators



Spread Mediators

What is Spread?

- Spread is an open source toolkit that provides a publish/ subscribe messaging service

Templates are managed per group

Messages can be multicast or sent to 1 or more subscribed groups

Collectors can subscribe to 1 or more groups

Spread groups can be leveraged to collect data specific records from YAF

YAF MySQL Mediator

a.k.a. yInspector

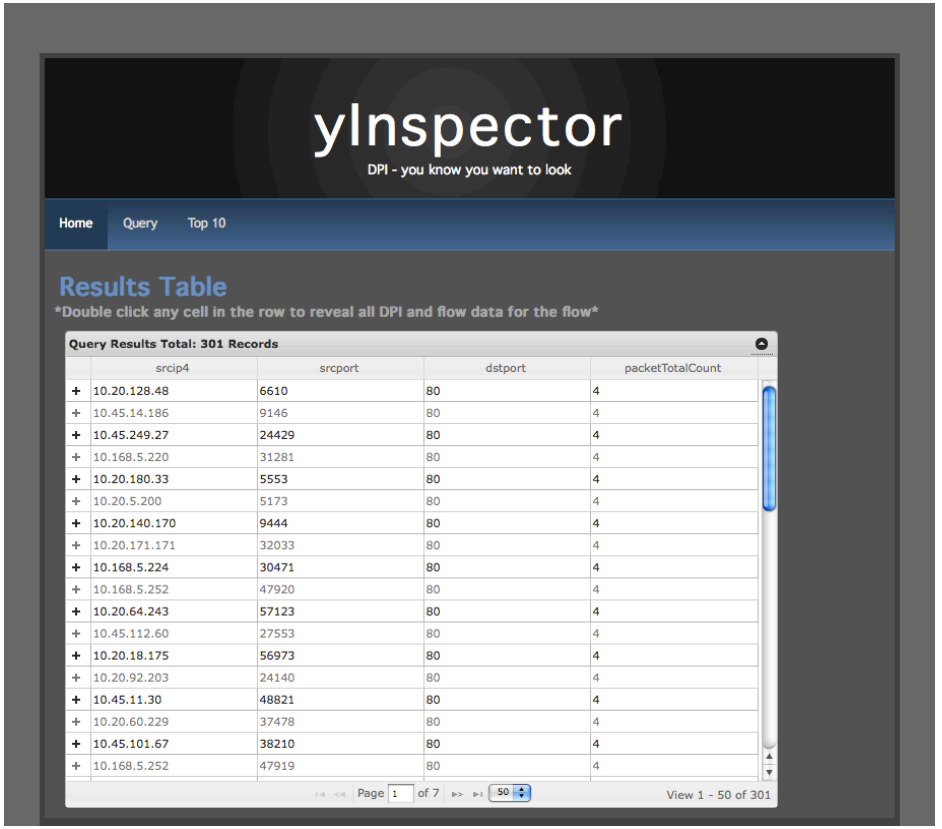
Listens for connections from YAF via the network

Parses Flow and DPI Data and inserts into a MySQL Database

A web front end was created to query the database

yInspector


yInspector
DPI - you know you want to look
Home
Query
Top 10
Select Options
Source IP Address
Source Port
Flow Start Time
Vlan
Packet Count
Octet Count
flowEndReason
Initial TCP Flags
Destination IP Address
Destination Port
Flow End Time
silkAppLabel
Reverse Packet Count
Reverse Octet Count
Protocol
Union TCP Flags
Where Options
Source IPv4 Address
Destination IPv4 Address
Source Port
Destination Port
Protocol
ALL TCP UDP
Vlan
flowStartTime
6/27/2010
flowEndTime
12/28/2010
silkAppLabel
80 53 21 110
25 143 69 554
194 427 22 5060 443
Protocol Specific Options
User Agent
HTTP Get
HTTP Server String
Search
Protocol Specific Field Names
FTP
IMAP
RTSP
SIP
SMTP
SSH
Links
SEI
CERT
NETSA
NETSA TOOLS
YAF
More Info


yInspector
DPI - you know you want to look
Home
Query
Top 10
Results Table
Double click any cell in the row to reveal all DPI and flow data for the flow
Query Results Total: 301 Records
srcip4 srcport dstport packetTotalCount
10.20.128.48 6610 80 4
10.45.14.186 9146 80 4
10.45.249.27 24429 80 4
10.168.5.220 31281 80 4
10.20.180.33 5553 80 4
10.20.5.200 5173 80 4
10.20.140.170 9444 80 4
10.20.171.171 32033 80 4
10.168.5.224 30471 80 4
10.168.5.252 47920 80 4
10.20.64.243 57123 80 4
10.45.112.60 27553 80 4
10.20.18.175 56973 80 4
10.20.92.203 24140 80 4
10.45.11.30 48821 80 4
10.20.60.229 37478 80 4
10.45.101.67 38210 80 4
10.168.5.252 47919 80 4
Page 1 of 7
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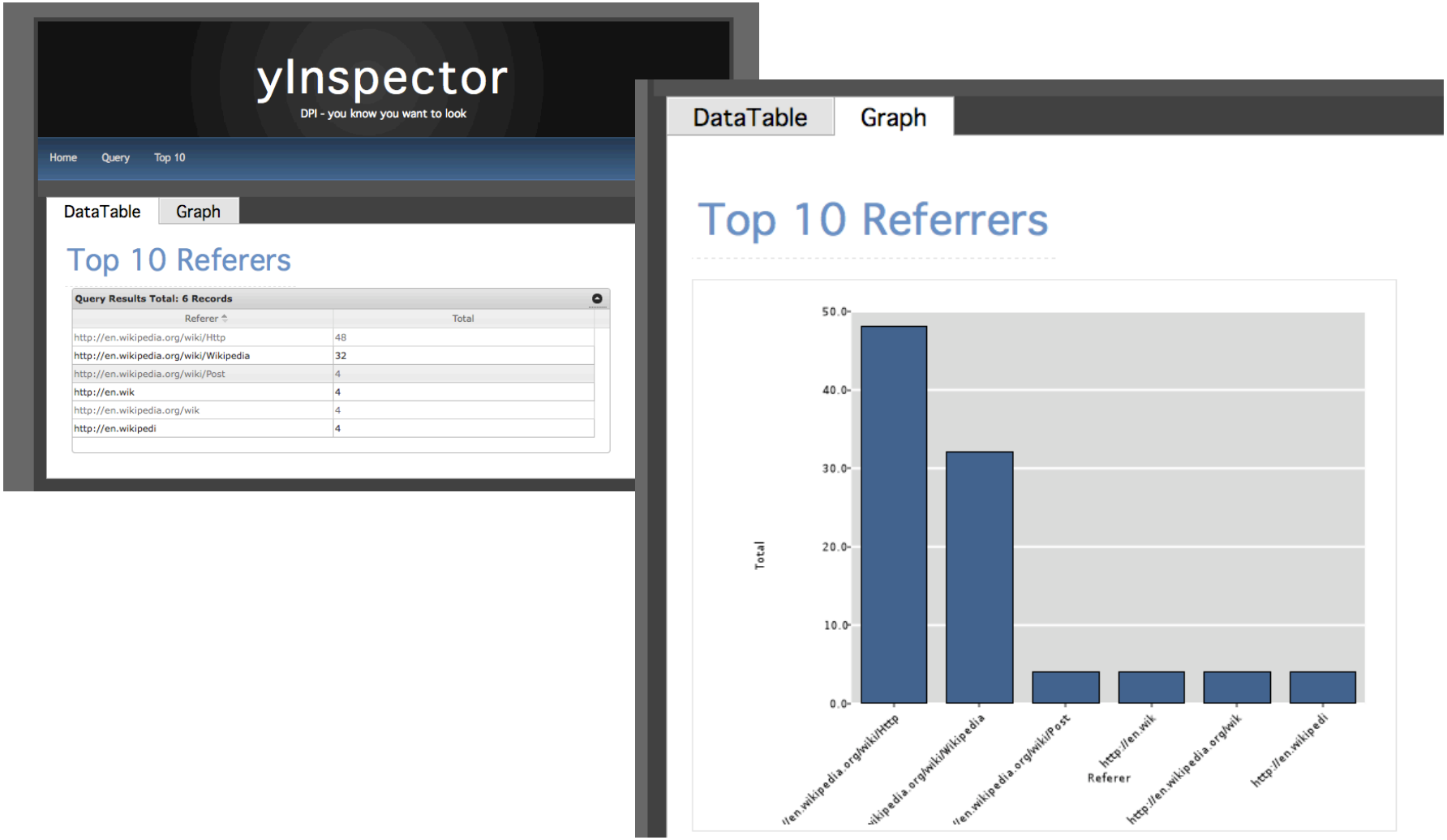
View 1 - 50 of 301

ylnspector


ylnspector
DPI - you know you want to look
Home
Query
Top 10
DataTable
Graph
Top 10 Referers
Query Results Total: 6 Records
Referer
Total
http://en.wikipedia.org/wiki/Http 48
http://en.wikipedia.org/wiki/Wikipedia 32
http://en.wikipedia.org/wiki/Post 4
http://en.wik 4
http://en.wikipedia.org/wik 4
http://en.wikipedi 4
DataTable
Graph
Top 10 Referrers
Total
50.0
40.0
30.0
20.0
10.0
0.0
Referer
http://en.wik
http://en.wikipedia.org/wik
http://en.wikipedi

Limitations

IPFIX Collectors still need to be aware of what is coming

Internal Templates are handled differently with lists

More responsibility on user to manage memory

Future Work

Deep Packet Inspection Enhancements

Machine Learning Capability for Protocol Recognition

Testing

Visualization Enhancements

Questions?

YAF available for download:

www.tools.netsa.cert.org

netsa-help@cert.org

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