Next Generation Flow Measurement for Application Monitoring

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May 30, 2014
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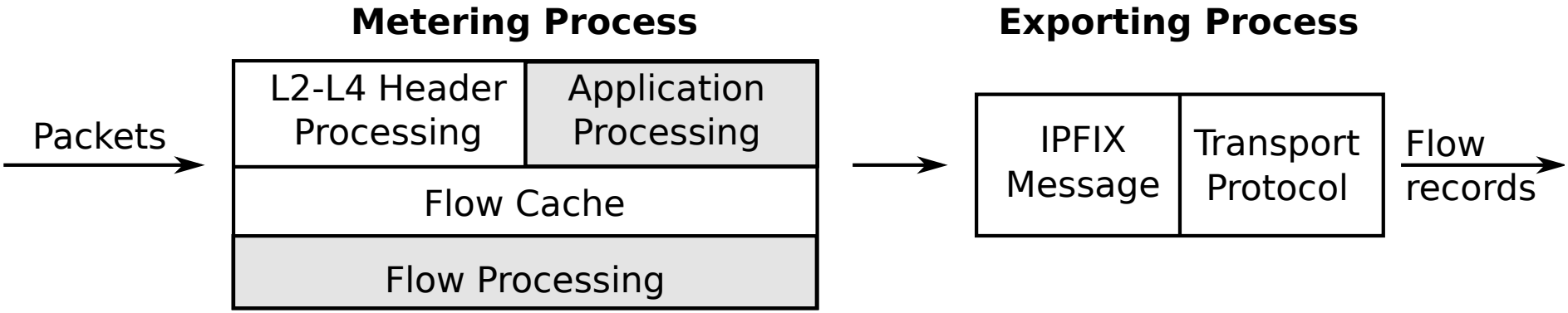
Application Flow Monitoring

- Passive network monitoring
- IP flow monitoring + application protocol information
- More accurate traffic classification
- Threat detection on application level
  - Phishing
  - Invalid X.509 certificates
  - ...
- Emerging trend in network monitoring
- More work in implementation than research

Application Flow Monitoring



IP flow example

Flow start	Duration	Proto	Src IP Addr:Port		Dst IP Addr:Port	Flags	Packets	Bytes
09:41:21.763	0.101	TCP	172.16.96.48:15094	->	209.85.135.147:80	.AP.SF	4	715
09:41:21.893	0.031	TCP	209.85.135.147:80	->	172.16.96.48:15094	.AP.SF	4	1594

Application flow extension example

HTTP RT	HTTP Host	HTTP Path	HTTP Code	HTTP Type
GET	www.seznam.cz	/favicons/019/194-DBrJCJ.png	-	-
HTTP	-	-	200 OK	image/x-icon

Application Flow Impacts

- R.Q. (1): **What are the impacts of application protocol measurement on flow exporters?**
  - CPU intensive processing
  - Flow cache memory requirements
  - Increasing bandwidth requirements
- Results
  - Design and Evaluation of HTTP Protocol Parsers for IPFIX Measurement[1]
  - FlowMon - Plugins for HTTP Monitoring (2012)
- Future work
  - Quantify the impacts
  - Propose solution for flow cache size
  - Specific compression of flow data stream

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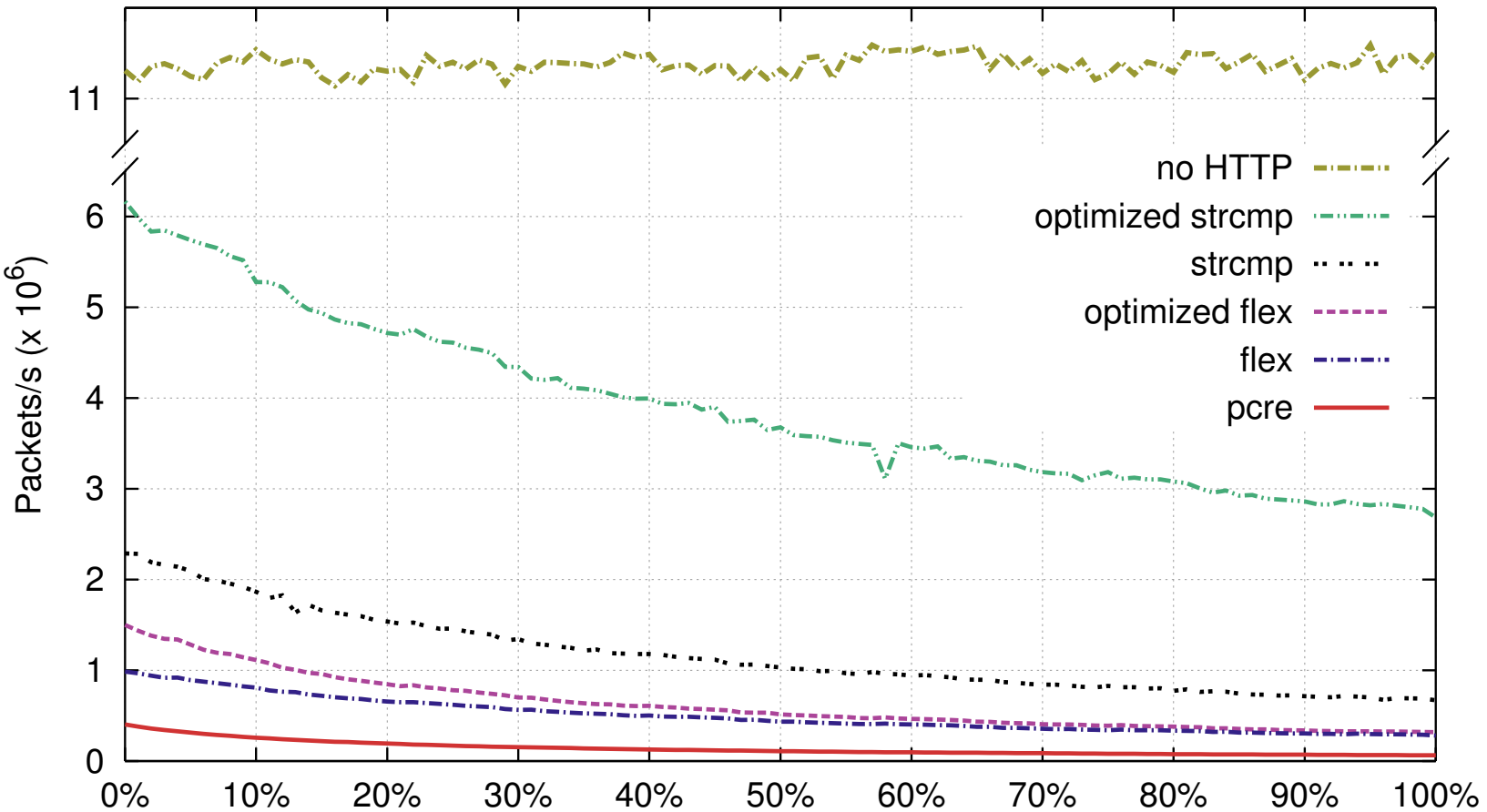
[1] Petr Velan, Tomáš Jirsík and Pavel Čeleda. **Design and Evaluation of HTTP Protocol Parsers for IPFIX Measurement.** In *Lecture Notes in Computer Science, Vol. 8115*, pages 136-147, Chemnitz, Germany, 2013.

HTTP Parsers Performance Decline



Portion of HTTP traffic in the mix (0 % - no HTTP, 100 % - only HTTP headers)

Application Flow Performance

- R.Q. (2): **What are the limits of application protocol measurement on high-speed networks?**
  - IP flow is capable of monitoring 40/100 Gbps
  - Application flow causes significant performance decline
  - No framework for performance comparison of flow measurement
  - Different results on different data sets

- Future Work
  - Create a methodology for comparison of flow measurement performance
  - Create data sets for testing application protocol parsers

Application Flow Benefits

- R.Q. (3): **How can application protocol information be used to improve flow measurement quality?**
  - Use application information to improve flow measurement
  - Better flow aggregation
- Results
  - Large-Scale Geolocation for NetFlow[1]
  - An Investigation Into Teredo and 6to4 Transition Mechanisms: Traffic Analysis[2]
- Future Work
  - Split flows based on application
  - Application protocol specific timeouts

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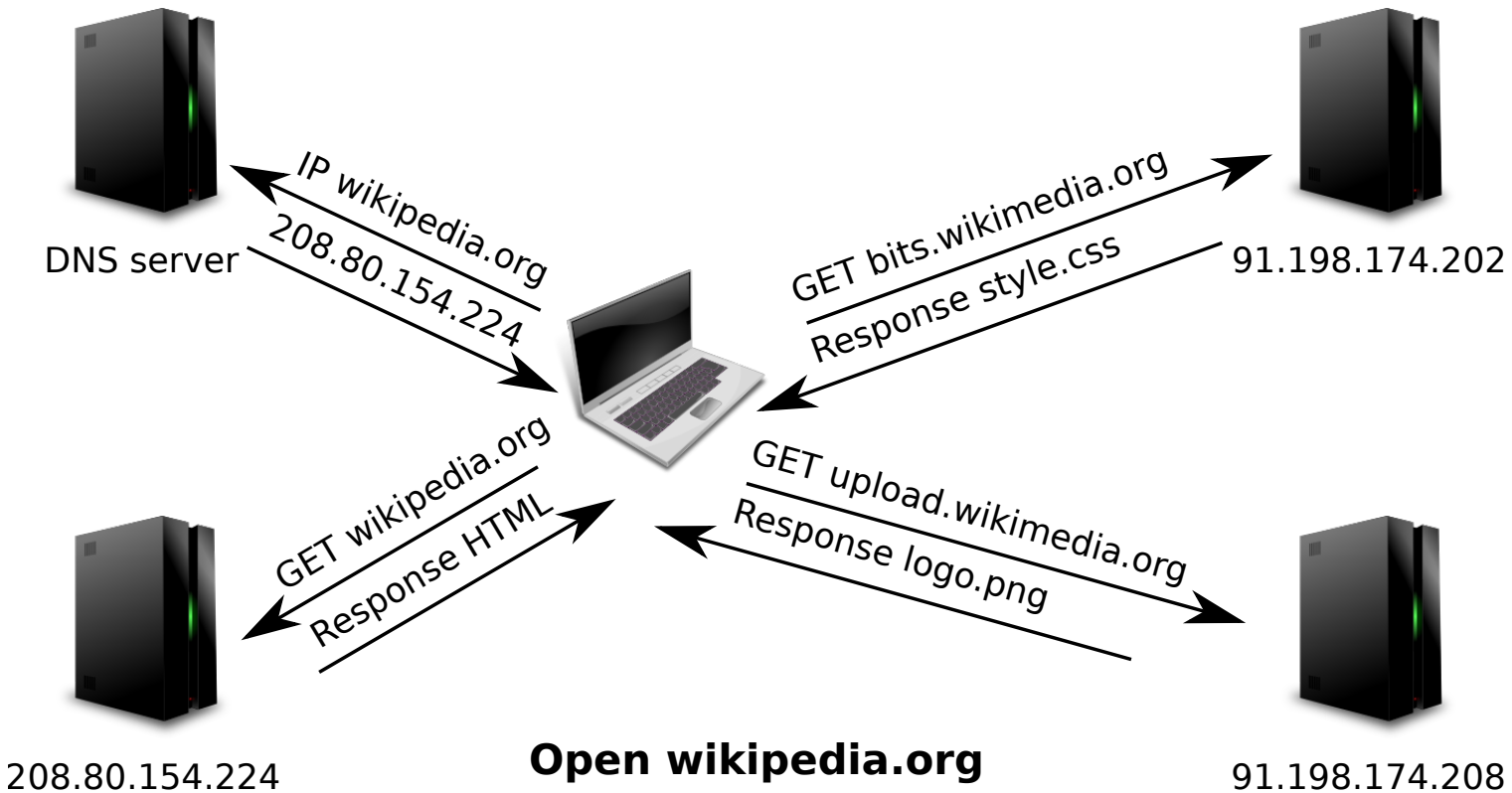
[1] Pavel Čeleda, Petr Velan, Martin Rábek, Rick Hofstede and Aiko Pras. **Large-Scale Geolocation for NetFlow.** In *IFIP/IEEE International Symposium on Integrated Network Management (IM 2013)*, pages 1015-1020, Ghent, Belgium, 2013.

[2] Martin Elich, Petr Velan, Tomáš Jirsík and Pavel Čeleda. **An Investigation Into Teredo and 6to4 Transition Mechanisms: Traffic Analysis.** In *38th Annual IEEE Conference on Local Computer Networks (LCN 2013)*, pages 1046-1052, Sydney, Australia, 2013.

Next Generation Flow

- R.Q. (4): **How can information from multiple packet streams be aggregated to single application event and how can we utilize application events to design the next generation flow monitoring?**



Plan of Work

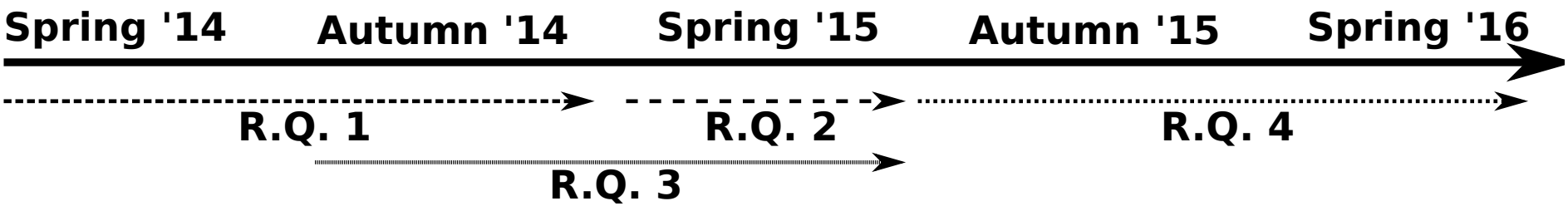
Research Questions

(1) Application Flow Impacts

(2) Application Flow Performance

(3) Application Flow Benefits

(4) Next Generation Flow



Thank You For Your Attention!

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Achieved Results in Application Flow Monitoring

Papers:

- Pavel Čeleda, Petr Velan, Martin Rábek, Rick Hofstede and Aiko Pras.
  Large-Scale Geolocation for NetFlow.
  In *IFIP/IEEE International Symposium on Integrated Network Management (IM 2013)*, pages 1015-1020, Ghent, Belgium, 2013.
- Petr Velan, Tomáš Jirsík and Pavel Čeleda.
  Design and Evaluation of HTTP Protocol Parsers for IPFIX Measurement.
  In *Lecture Notes in Computer Science, Vol. 8115*, pages 136-147, Chemnitz, Germany, 2013.
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  In *38th Annual IEEE Conference on Local Computer Networks (LCN 2013)*, pages 1046-1052, Sydney, Australia, 2013.

Software:

- FlowMon - Plugins for HTTP Monitoring (2012)

Other results

Papers:

- Petr Velan and Radek Krejčí.
  Flow Information Storage Assessment Using IPFIXcol.
  In *Lecture Notes in Computer Science 7279*, pages 155-158, Heidelberg, 2012.
- Petr Velan.
  Practical experience with IPFIX flow collectors.
  In Filip De Turck, Yixin Diao, Choong Se on Hong, Deep Medhi, Ramin Sadre. IFIP/IEEE International Symposium on Integrated Network Management (IM 2013). Ghent, Belgium, 2013.

Software:

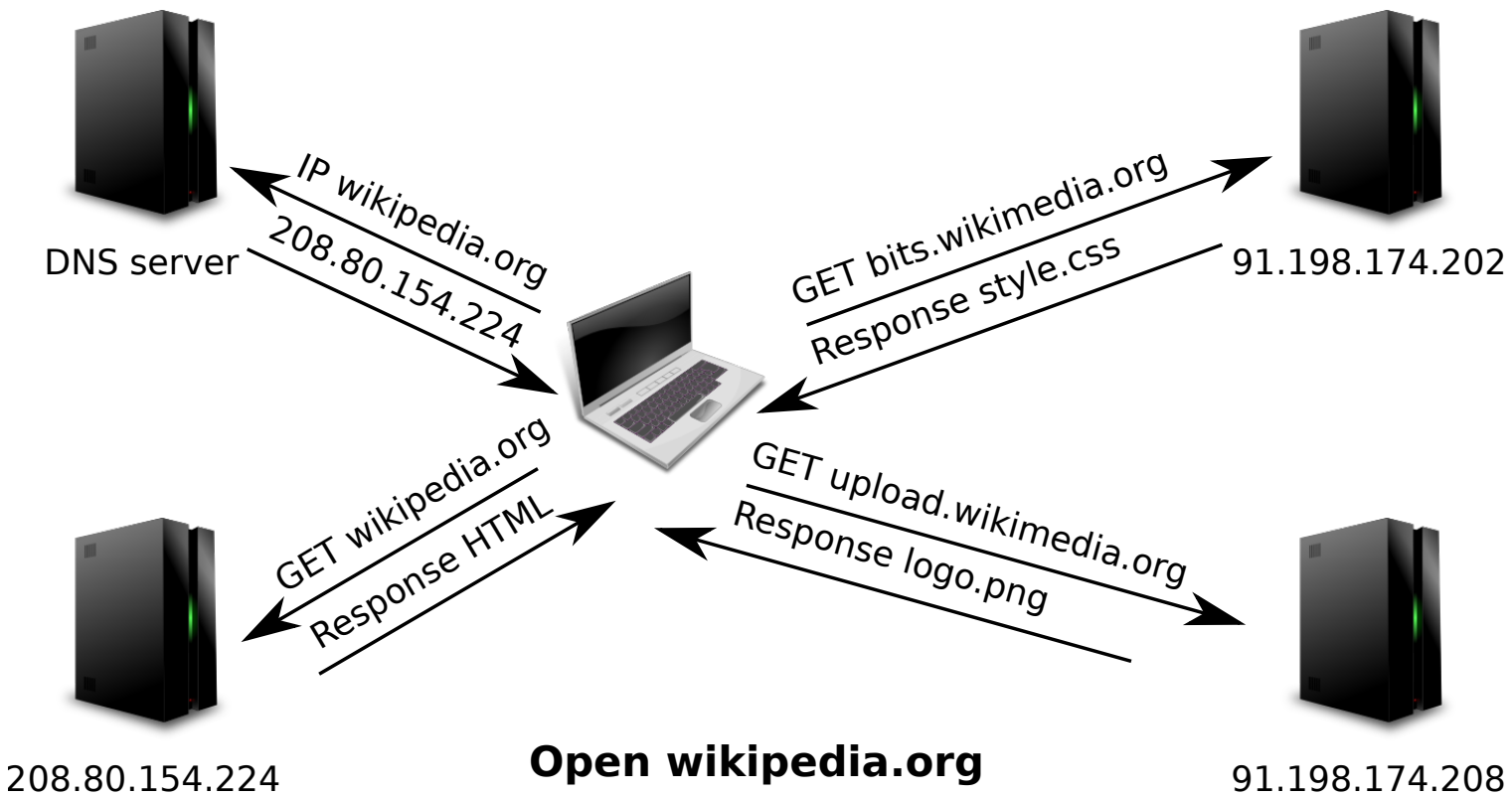
- FlowMon - IPFIX Export Plugin (2012)
- IPFIX collector (2013)
  - An implementation of IPFIX flow collector.

Current NIDS Throughput

- Flow monitoring has about 10 - 40 times the throughput of deep packet inspection
- IDS throughput depends heavily on provided features
- IDS utilize often distributed processing for speeds > 1 Gbps
- Flows allow for efficient data storage and processing of historical data

Next Generation Flow Measurement

- Prototype implementation for HTTP and DNS
- Add **Event ID** to flow records
- Group flow records by **Event ID** on collector



Amount of Processed Data

- Sampling significantly affects flow quality
- Advantage of flows is in data aggregation
- The first few packets often carry the most important information
- Amount of necessary data depends on specific protocol and analysis depth

Data Source

- Local network traffic for development
- Data from The Cybernetic Proving Ground[1]
  - Real world data
  - Experiment repeatability
- Encryption is not end-to-end, e.g. in data centers
- Privacy issues are being elevated

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[1] http://www.muni.cz/ics/research/projects/23884/web/?lang=en