Exploring research collaborations between University of Puerto Rico and Brazil

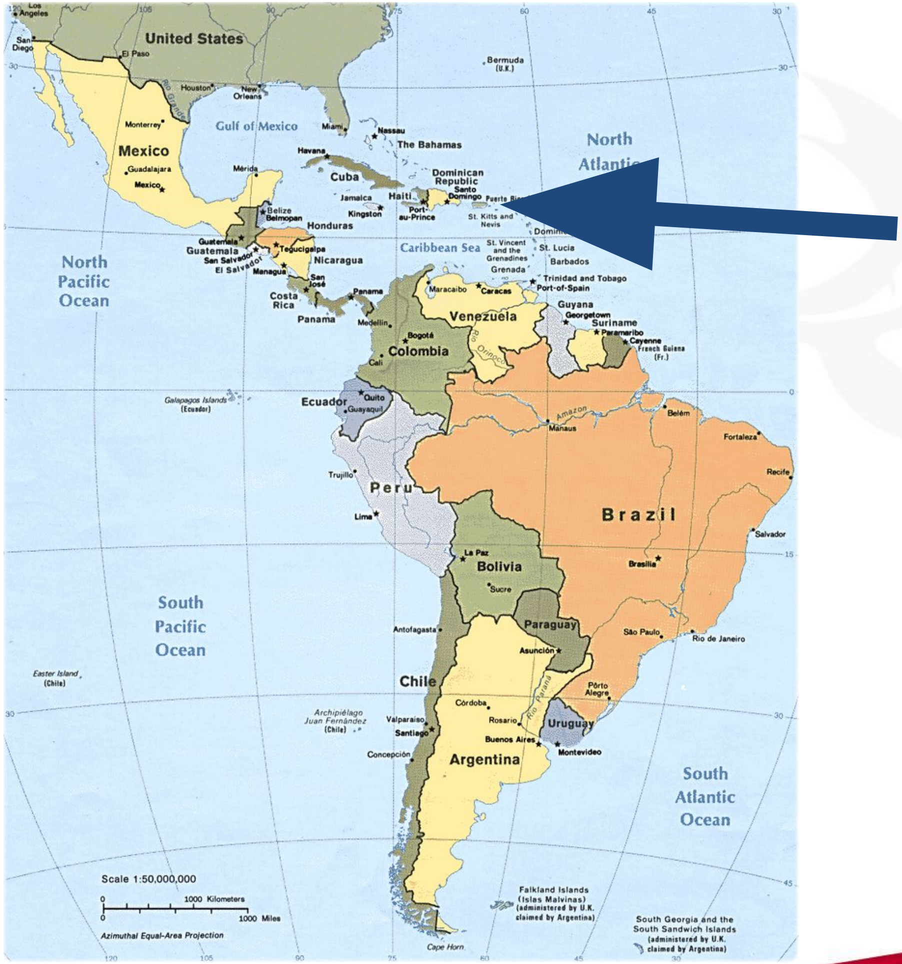
José R. Ortiz-Ubarri

Computer Science Department

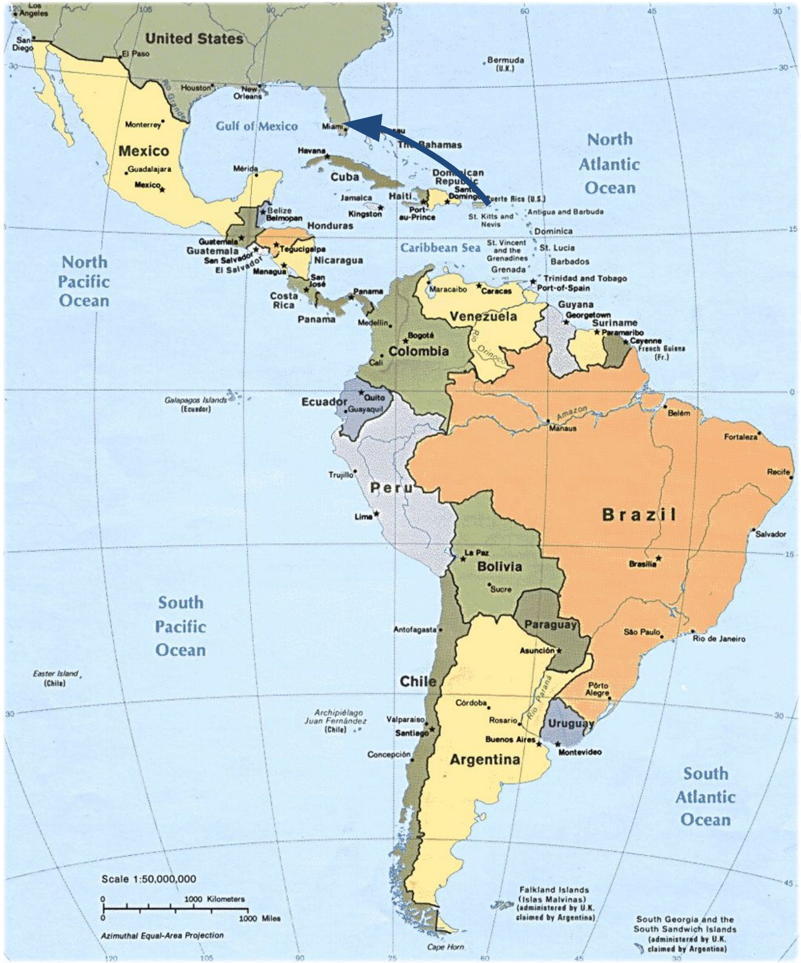
University of Puerto Rico

Collaborators: Edusmildo Orozco, Rafael Arce, Humberto Ortiz, Francis Castro, CSLab students

SwitchOn Workshop 2015

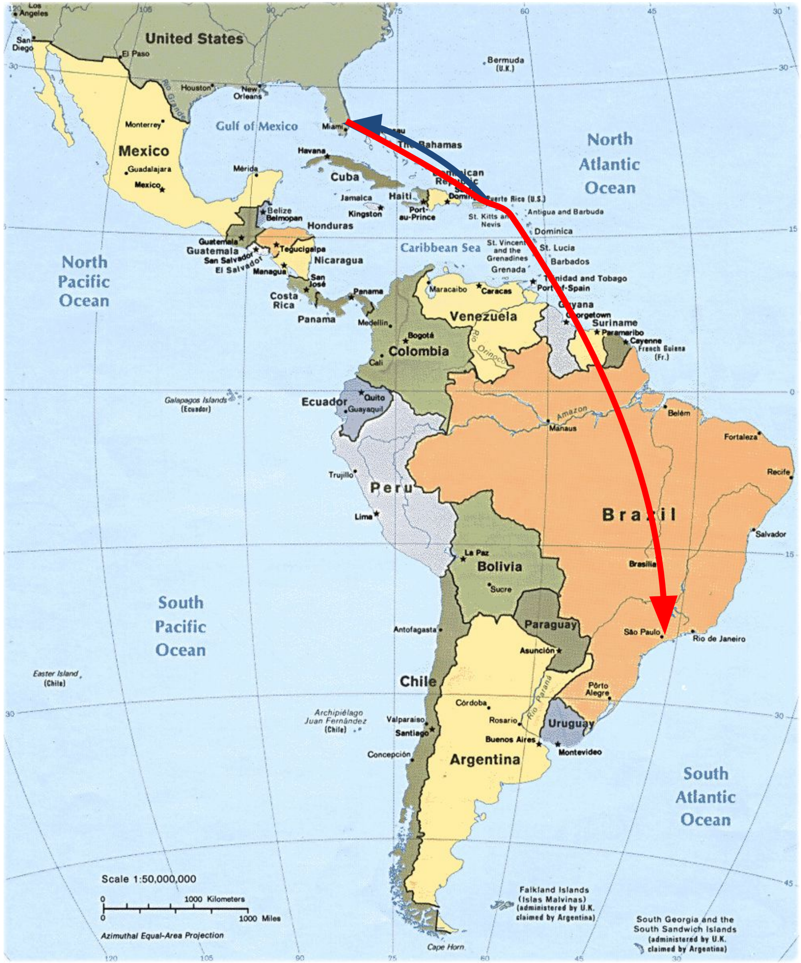


Puerto Rico is right here!



My path to Sao Paulo!!!

🟦 from SJU to MIA



My path to Sao Paulo!!!

🟦 from SJU to MIA

🟥 from MIA to GRU

University of Puerto Rico

Rio Piedras Campus

Computer Science Department

- 9 full time professors
- Undergraduate program
- Working on a graduate program

Our work

- Educational projects to improve CS curriculum and the way computer science is taught at the University of Puerto Rico

- Application of High Performance Computing to solve computationally intensive scientific problems

- Computer and Network security

Educational work

- Educational projects to improve CS curriculum and the way computer science is taught at the University of Puerto Rico
  - E. Orozco, R. Arce-Nazario, J. Ortiz-Ubarri and H. Ortiz-Zuazaga. **A Curricular Experience With Parallel Computational Thinking: A Four Years Journey**. In Proceedings of EduPDHPC, Denver, Colorado, USA, 2013.
  - J. Ortiz-Ubarri, R. Arce-Nazario, I. Rubio. **Development of engaging and readily transferable laboratory experiences for the introductory programming course.** National Science Foundation under Grant No. DUE-1245744.
  - J. Ortiz-Ubarri, H. Ortiz-Zuazaga, R. Arce-Nazario, P. Ordoñez. **Academics and Training for the Advancement of Cybersecurity Knowledge in Puerto Rico (ATACK-PR)**. National Science Foundation under Grant No. DUE-1438838.

Application of HPC

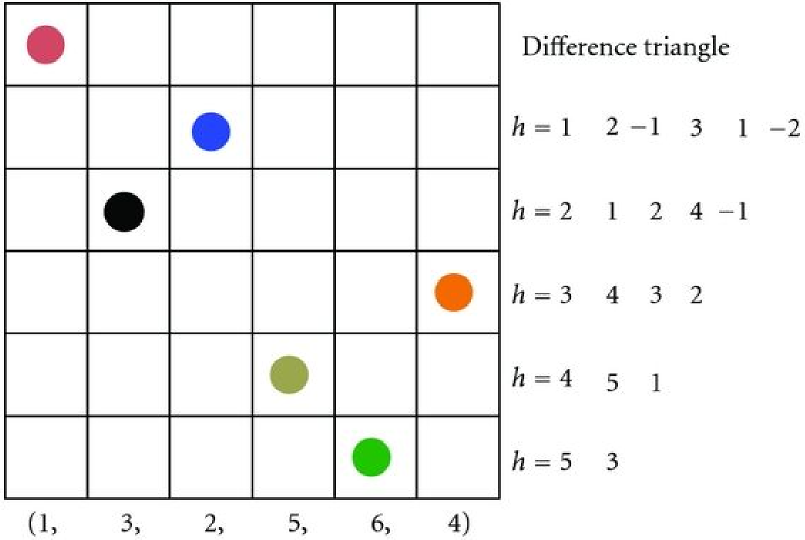
- Application of High Performance Computing to solve computationally intensive scientific problems
    - Periodic Arrays for application in multiple target recognition, optical orthogonal codes, and digital watermarking
    - Enumeration of permutation polynomials for applications in cryptography
    - Scientific data analysis and visualization

Costas problem example

- The enumeration of two-dimensional Costas arrays is a problem with factorial time complexity and has been solved for sizes up to 29 using computer clusters.

- Costas arrays of higher dimensionality have recently been proposed and their properties are beginning to be understood.

- We presented the first implementations for enumerating these **multidimensional** arrays in GPUs and FPGAs, as well as the first discussion of techniques to prune the search space and reduce enumeration run time.



Difference triangle

$h = 1$ 2 −1 3 1 −2

$h = 2$ 1 2 4 −1

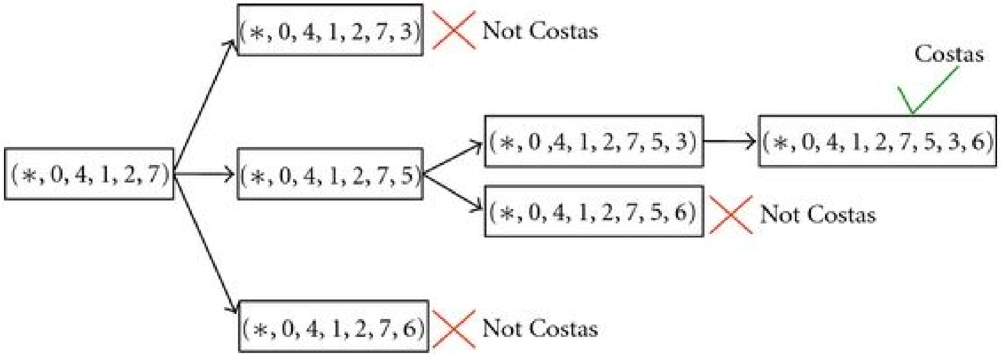
$h = 3$ 4 3 2

$h = 4$ 5 1

$h = 5$ 3

(1, 3, 2, 5, 6, 4)

Costas problem example



- Both GPU and FPGA implementations rely on Costas array symmetries to reduce the search space and perform concurrent explorations over the remaining candidate solutions.

Computer and Network security

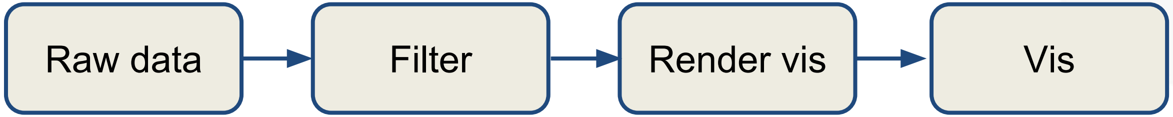
- With our undergraduates we have been working in applications for network monitoring for situational awareness and computer and network forensics
    - Tools to monitor our Science DMZ
        - J. Ortiz-Ubarri, H. Ortiz-Zuazaga, R. Arce-Nazario. Perimeter Network to Expedite the Transmission of Science (PR-NETS). National Science Foundation under Grant No. ACI-1340959.
    - Web based network visualizations
        - Toa, a web based application for network situational awareness
    - Computer forensics tools

Toa features

- Web implementation based on bootstrap.
    - main web interface fits nicely in tablets and smartphones
- Interactive charts capable of listening to events.
    - used to connect charts to plugins
- Query the sensor data in the database and generate graphs.
- Parallel implementation of the parser and the grapher.

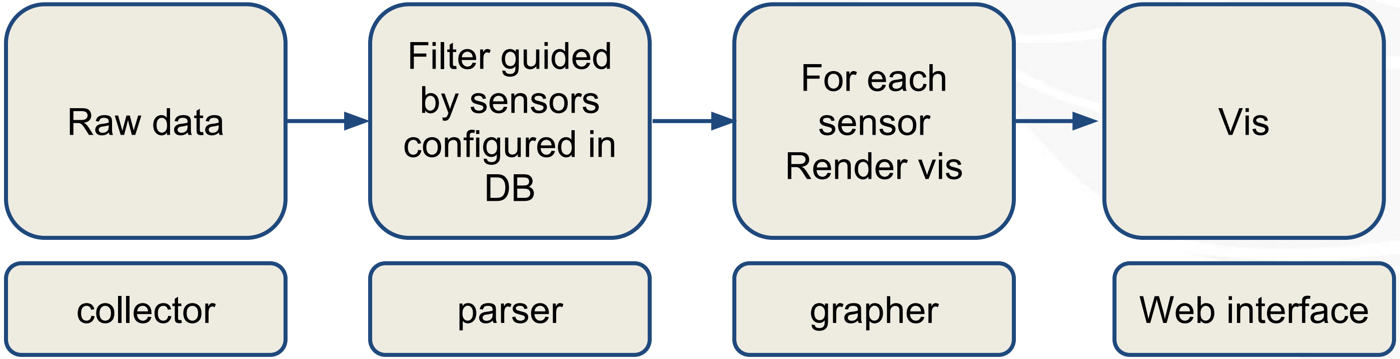
Generic data preparation process

For each sensor:

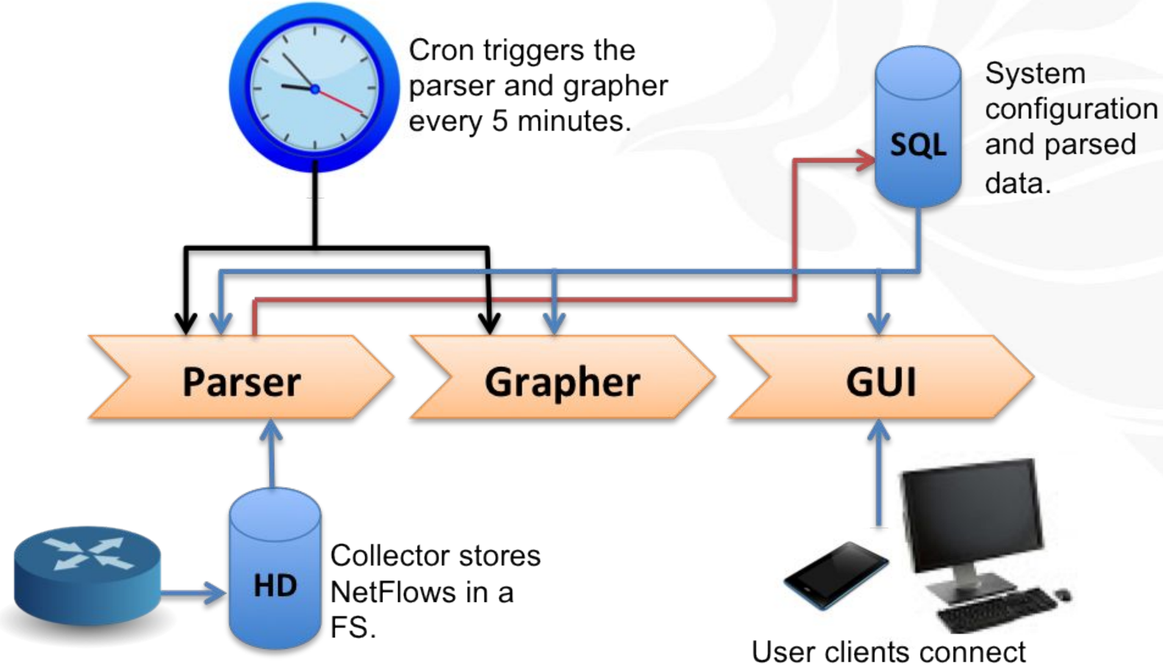


Reference: Paul Krystosek, Visualization of Network Flow Data, FloCon 2014.
http://resources.sei.cmu.edu/asset_files/Poster/2014_020_001_300460.pdf

Toa data preparation process


Raw data
Filter guided by sensors configured in DB
For each sensor Render vis
Vis
collector
parser
grapher
Web interface

Toa: Overview



Cron triggers the parser and grapher every 5 minutes.

System configuration and parsed data.

Collector stores NetFlows in a FS.

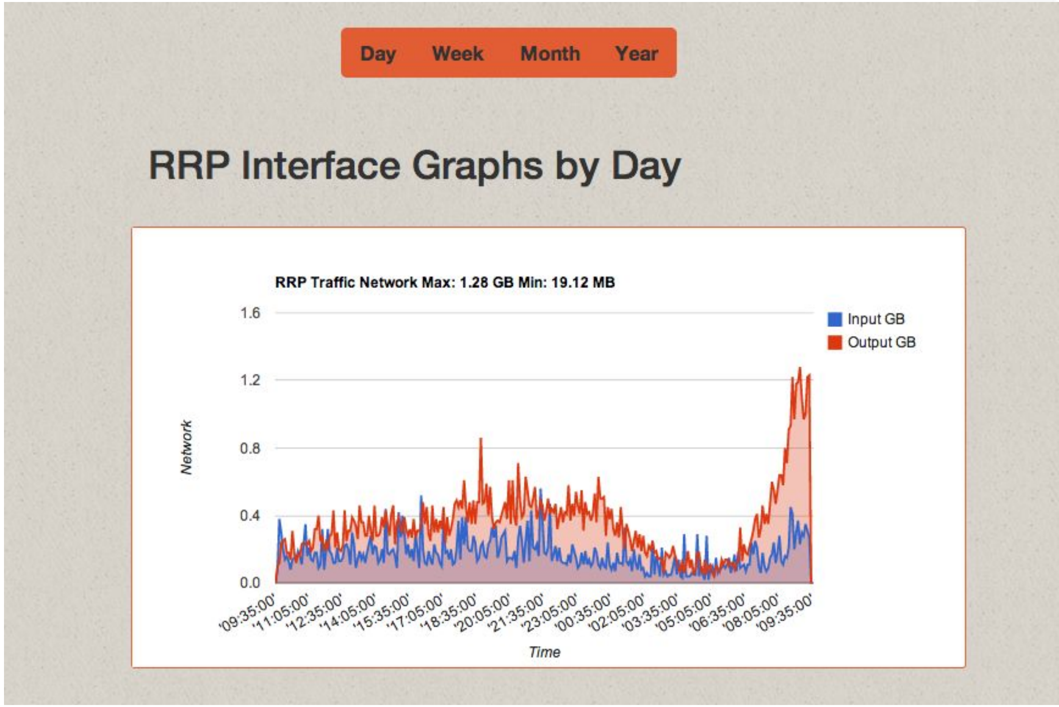
User clients connect to the TOA web service.

Toa

The web GUI presents users with the following network traffic visualization options:

- per network (interface, Autonomous System [AS], or network block (CIDR)) traffic,
- per-port traffic for each network,
- network to network traffic.

By Network: RRP

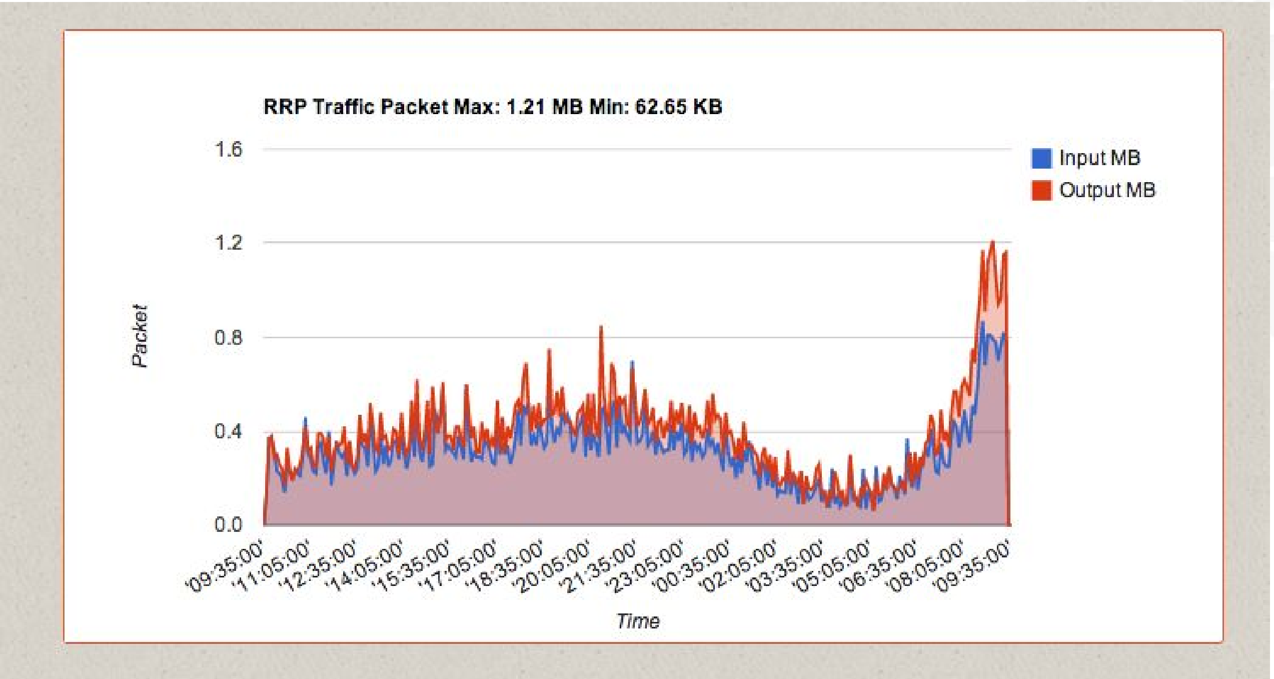


RRP Interface Graphs by Day

RRP Traffic Network Max: 1.28 GB Min: 19.12 MB

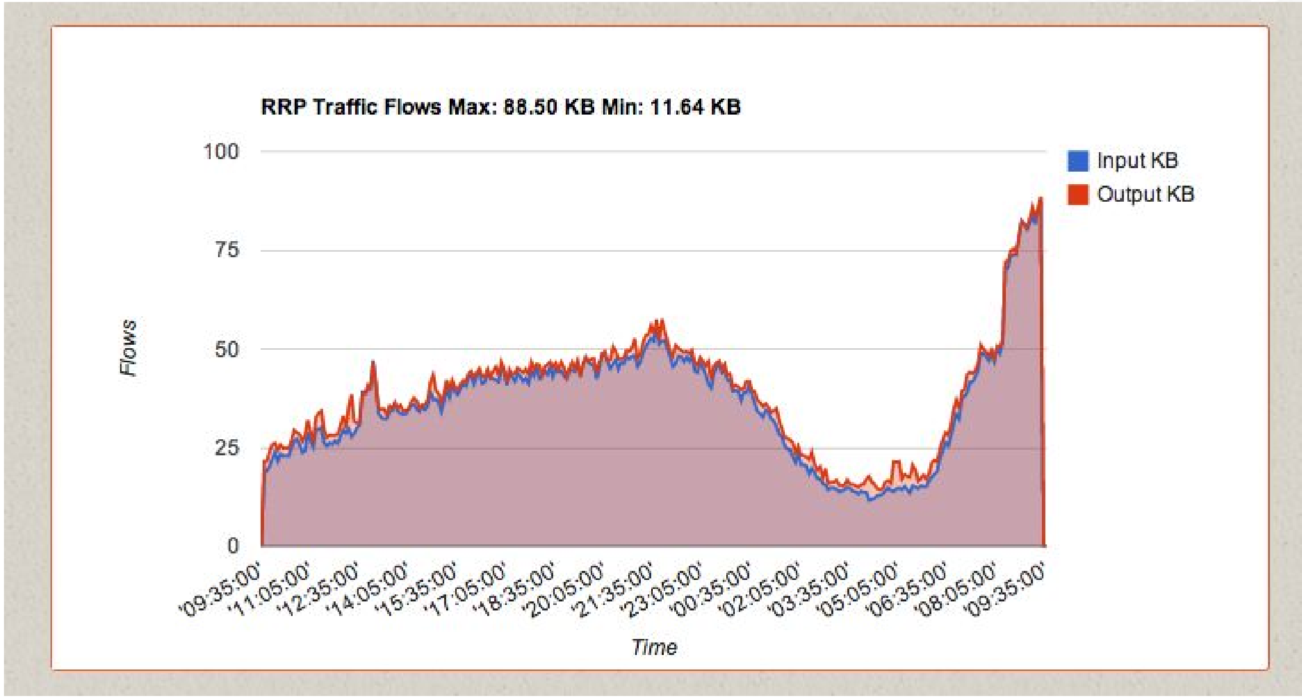
- Octets

By Network: RRP



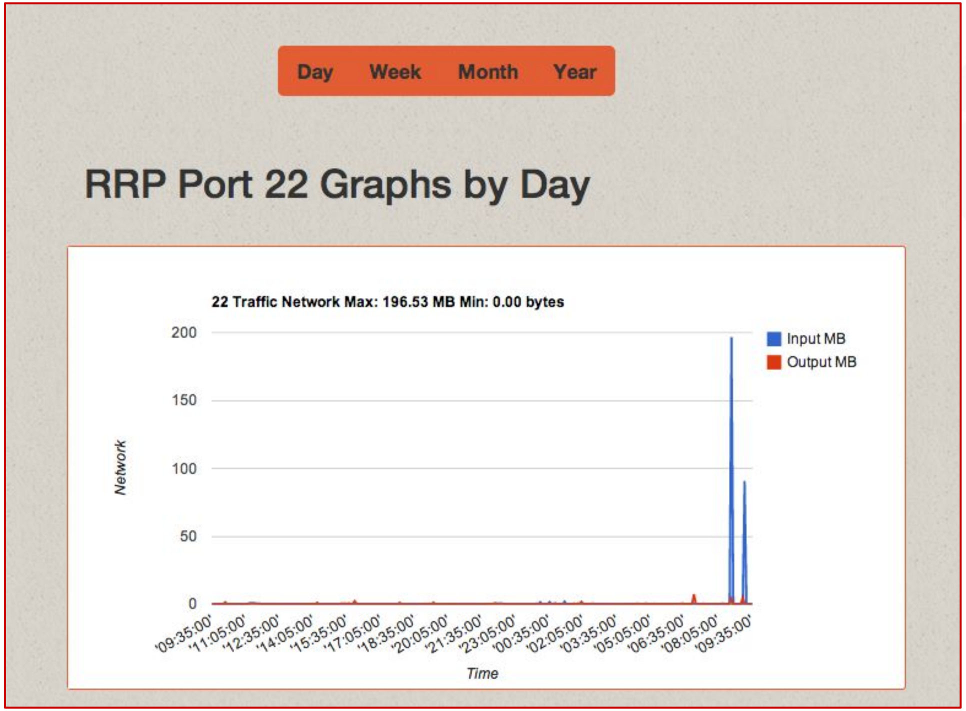
- Octets
- Packets

By Network: RRP



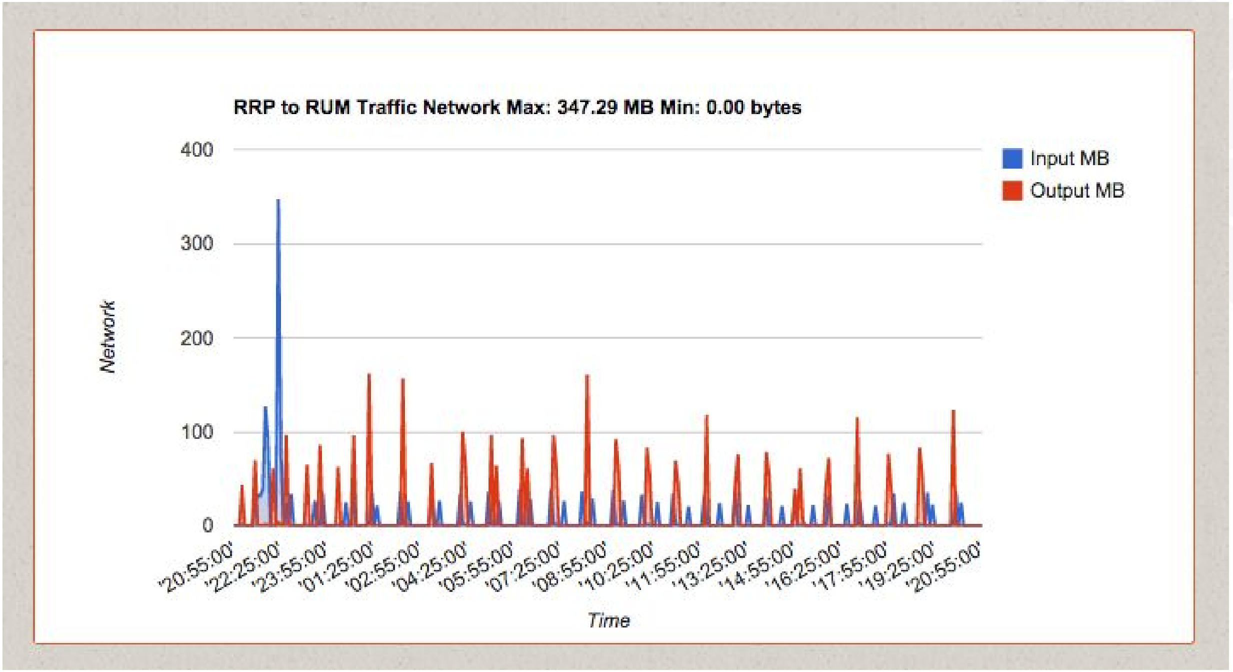
- Octets
- Packets
- Flows

By Network: RRP, port 22 (ssh)



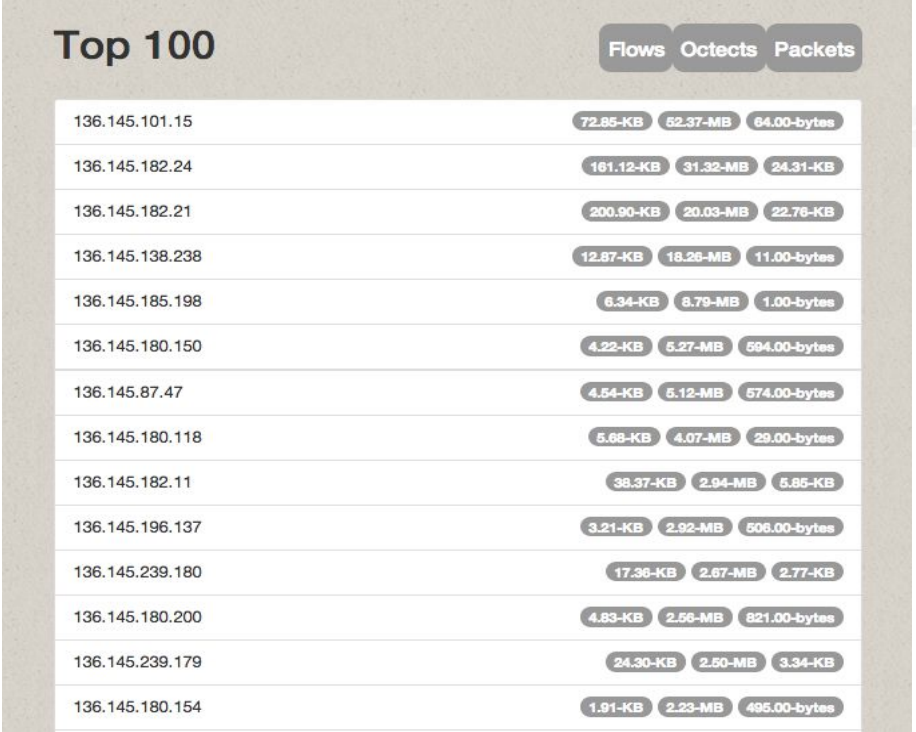
- Octets
- Packets
- Flows
- Combined

From Network 2 Network



- Octets
- Packets
- Flows
- Combined

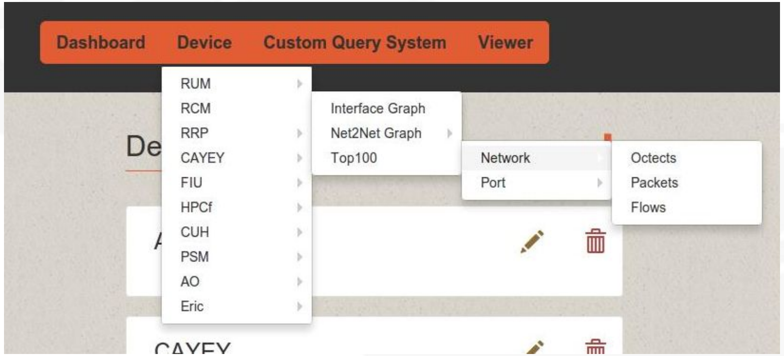
Top 100



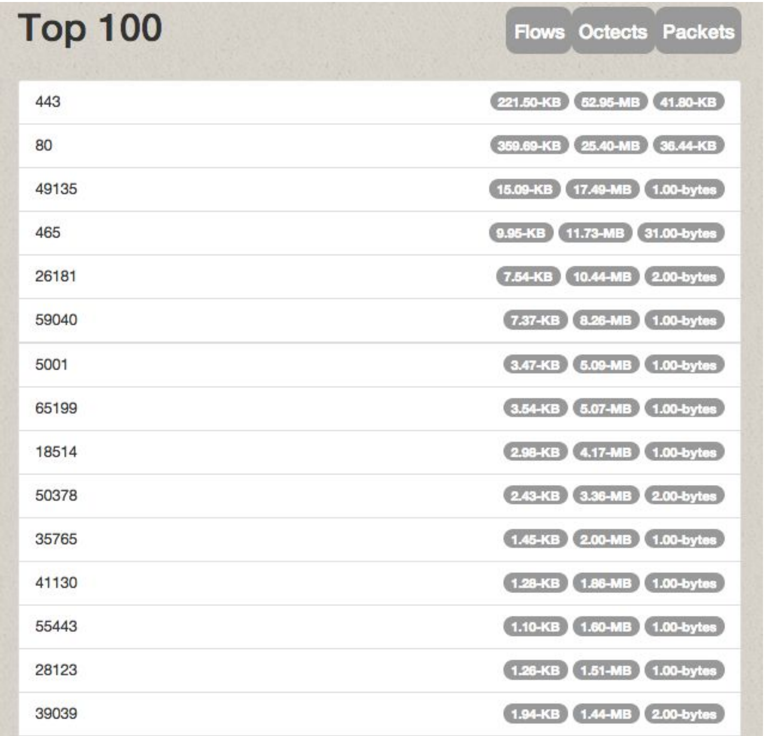
Top 100

Flows Octects Packets

136.145.101.15	72.85-KB	52.37-MB	64.00-bytes
136.145.182.24	161.12-KB	31.32-MB	24.31-KB
136.145.182.21	200.90-KB	20.03-MB	22.76-KB
136.145.138.238	12.87-KB	18.26-MB	11.00-bytes
136.145.185.198	6.34-KB	8.79-MB	1.00-bytes
136.145.180.150	4.22-KB	5.27-MB	594.00-bytes
136.145.87.47	4.54-KB	5.12-MB	574.00-bytes
136.145.180.118	5.68-KB	4.07-MB	29.00-bytes
136.145.182.11	38.37-KB	2.94-MB	5.85-KB
136.145.196.137	3.21-KB	2.92-MB	506.00-bytes
136.145.239.180	17.36-KB	2.67-MB	2.77-KB
136.145.180.200	4.83-KB	2.56-MB	821.00-bytes
136.145.239.179	24.30-KB	2.50-MB	3.34-KB
136.145.180.154	1.91-KB	2.23-MB	495.00-bytes

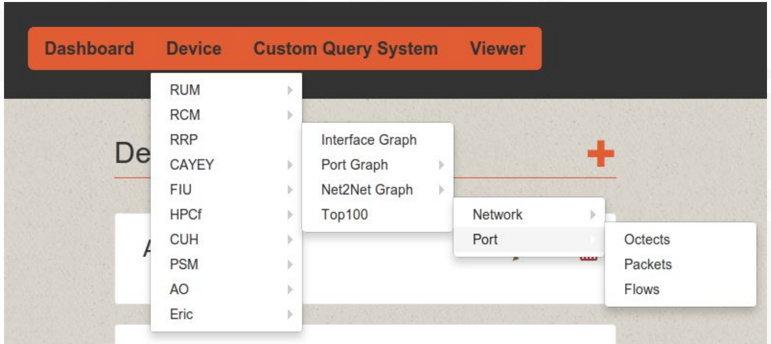


Top 100 ports

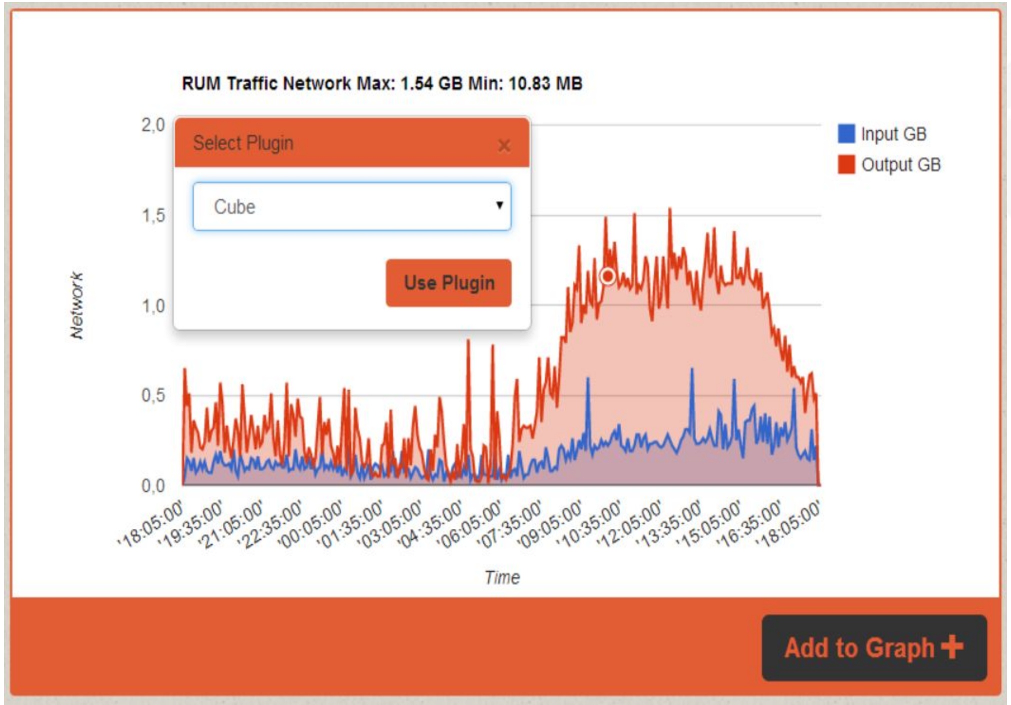


Top 100

	Flows	Octects	Packets
443	221.50-KB	52.95-MB	41.80-KB
80	359.69-KB	25.40-MB	36.44-KB
49135	15.09-KB	17.49-MB	1.00-bytes
465	9.95-KB	11.73-MB	31.00-bytes
26181	7.54-KB	10.44-MB	2.00-bytes
59040	7.37-KB	8.26-MB	1.00-bytes
5001	3.47-KB	5.09-MB	1.00-bytes
65199	3.54-KB	5.07-MB	1.00-bytes
18514	2.98-KB	4.17-MB	1.00-bytes
50378	2.43-KB	3.36-MB	2.00-bytes
35765	1.45-KB	2.00-MB	1.00-bytes
41130	1.28-KB	1.86-MB	1.00-bytes
55443	1.10-KB	1.60-MB	1.00-bytes
28123	1.26-KB	1.51-MB	1.00-bytes
39039	1.94-KB	1.44-MB	2.00-bytes

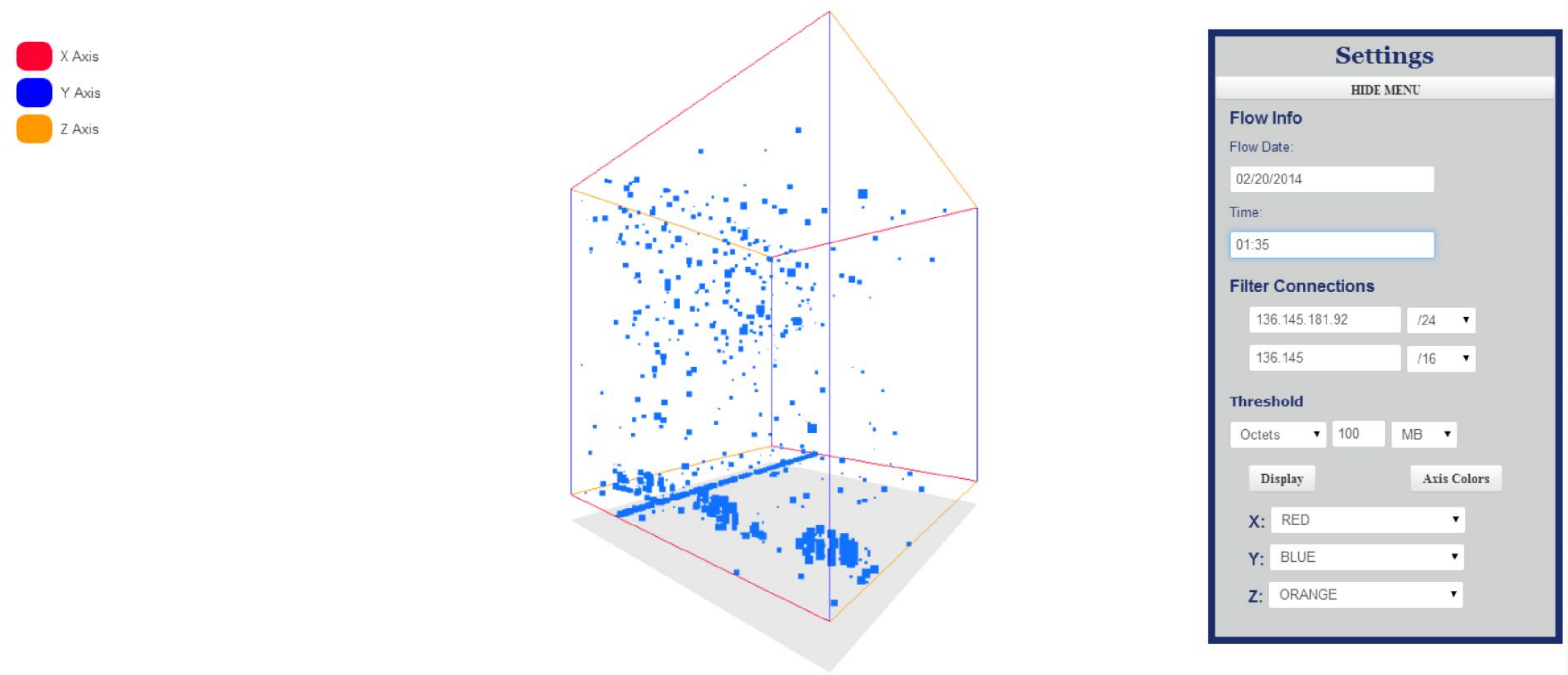


Graph Events



- A dialog generated when the user clicks a time point.

Cube Example



Flow Info

Flow Date: 02/20/2014

Time: 01:35

Filter Connections

136.145.181.92 /24

136.145 /16

Threshold

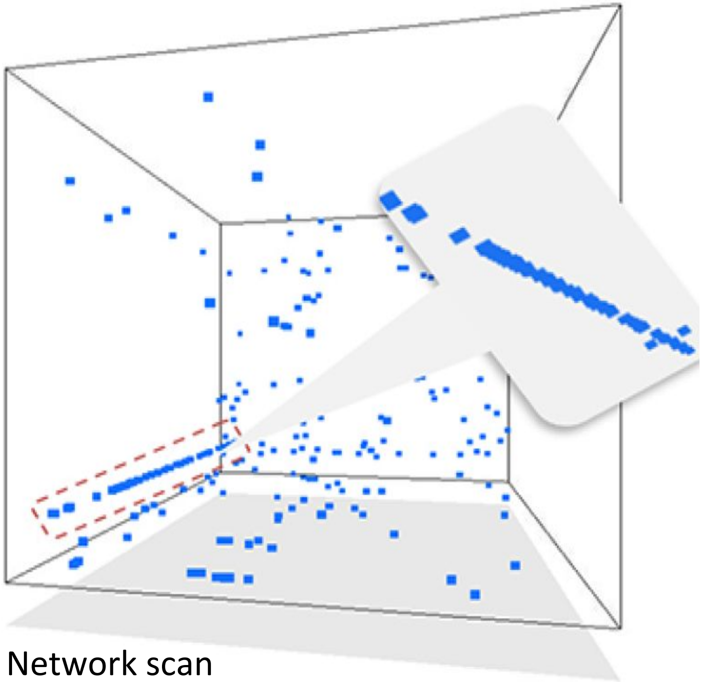
Octets 100 MB

X: RED

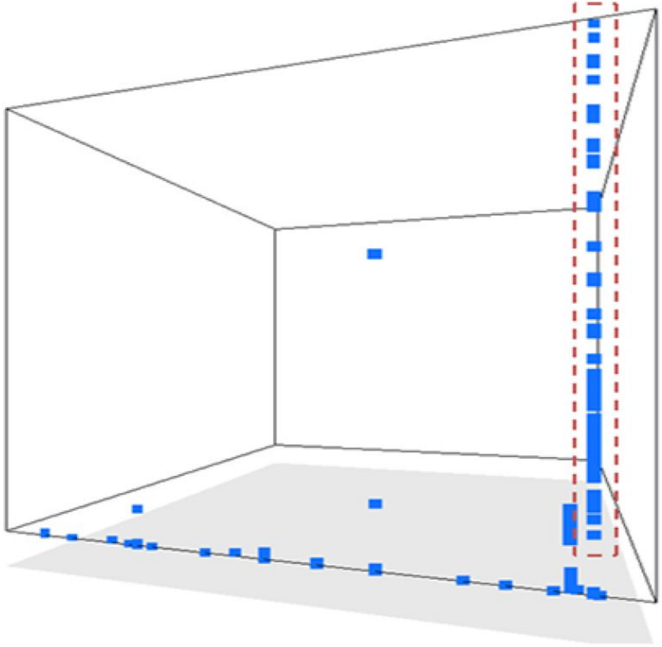
Y: BLUE

Z: ORANGE

Example of Possible Threats

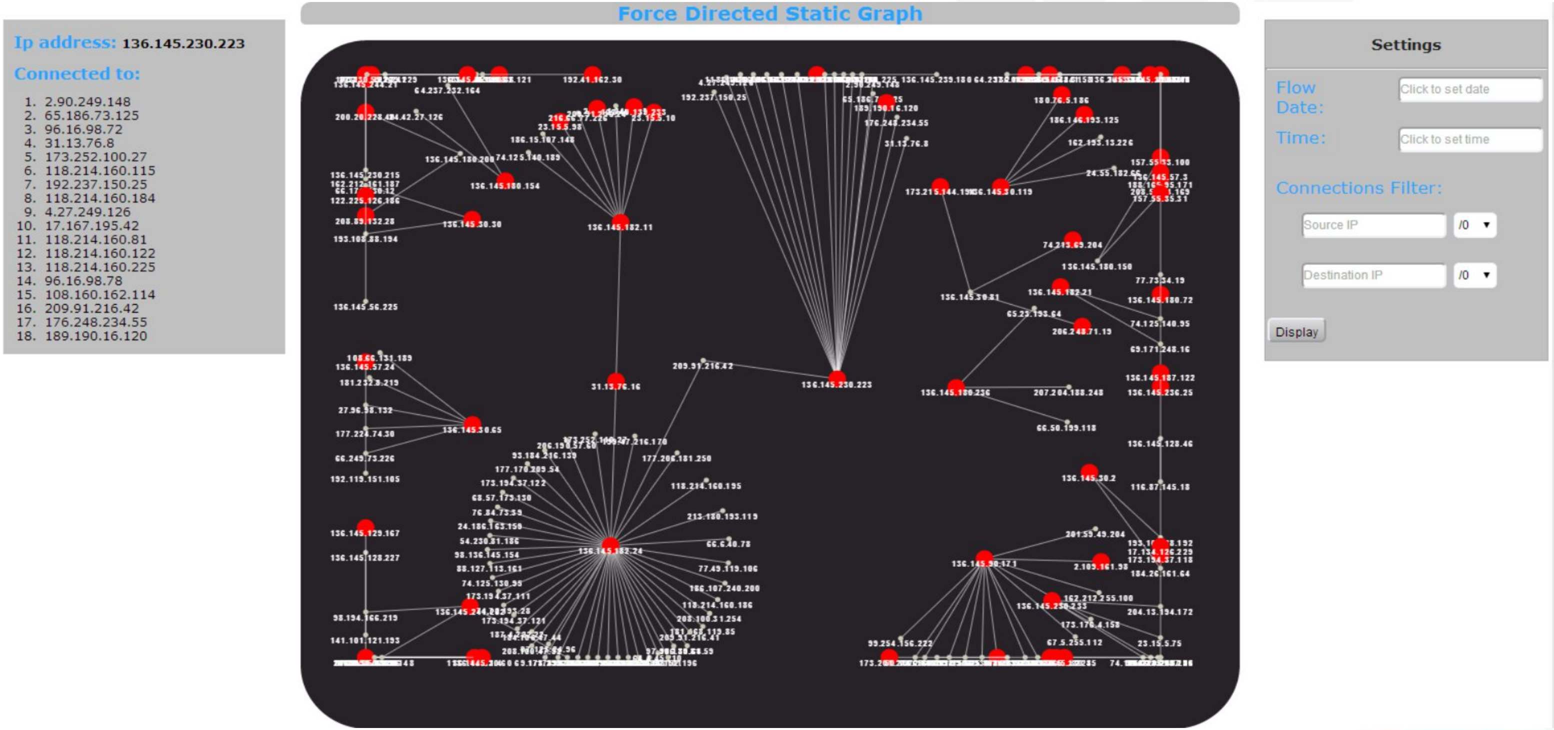


Network scan



Port scan

Graph Example



Force Directed Static Graph

Ip address: 136.145.230.223

Connected to:

1. 2.90.249.148
2. 65.186.73.125
3. 96.16.98.72
4. 31.13.76.8
5. 173.252.100.27
6. 118.214.160.115
7. 192.237.150.25
8. 118.214.160.184
9. 4.27.249.126
10. 17.167.195.42
11. 118.214.160.81
12. 118.214.160.122
13. 118.214.160.225
14. 96.16.98.78
15. 108.160.162.114
16. 209.91.216.42
17. 176.248.234.55
18. 189.190.16.120

Settings

Flow Date: Click to set date

Time: Click to set time

Connections Filter:

Source IP /0 ▼

Destination IP /0 ▼

References:

- [1] E. Orozco, R. Arce-Nazario, J. Ortiz-Ubarri and H. Ortiz-Zuazaga. A Curricular Experience With Parallel Computational Thinking: A Four Years Journey. In Proceedings of EduPDHPC, Denver, Colorado, USA, 2013.
- [2] J. Ortiz-Ubarri. New families of asymptotically optimal doubly periodic arrays with ideal correlation constraints. Cryptography and Communications(2015): 1-12.
  [3] R. Arce-Nazario, J. Ortiz-Ubarri. Multidimensional Costas arrays and their enumeration using GPUs and FPGAs. International Journal of Reconfigurable Computing (2012).
- [4] J. Ortiz-Ubarri, H. Ortiz-Zuazaga, A. Maldonado, E. Santos, J. Grullón. Toa: A Web-Based NetFlow Data Network Monitoring System at Scale. Proceedings of the IEEE Big Data Congress, New York, USA, 2015
- [5] J. Ortiz-Ubarri, H. Ortiz-Zuazaga, A. Maldonado, E. Santos, J. Grullón. Toa: A Web-Based NetFlow Data Network Monitoring System. In Proceedings FloCon 2015, Portland Oregon. January 2015.

Thanks!

jose.ortiz23@uprrp.edu