Flow Visualization Using MS-Excel

Visualization for the Common Man

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US-CERT Analysts
Einstein Program

Background

- US-CERT Mission
- Einstein Program
  - > Large volumes of traffic
  - > Architecture limitations
- Proactive vs. Reactive analysis
- Slow application certification process

Pro's and Con's

- Pro's:
  - Visualization allows for rapid analysis
  - Patterns are easy to identify
  - Flexibility in analysis
  - Most enterprises have MS Office (Excel)
- Con's:
  - Excel plotting engine is limited
  - Max of 65K records (recommend <= 50K)
  - Data must be imported and formatted
  - Memory management is an issue

Data Preparation Steps

- Data Pull
- Data Reduction
- Importing Data
- Data Formatting
- Sample analysis slides

Data Pull

Analysts have several options when trying to pull interesting datasets. Several methods we find useful are:

- Collecting data during non-business hours
  - Reduces traffic from users; helps expose automated sessions
- Search for outbound traffic only
  - Reduces noise from scanning, etc.
- Filtering for packets with the PSH/ACK flags set in the initial flags field
  - Focuses the traffic on sessions where data is actually transferred
- Filtering for packets with the SYN flag set in the initial flags field
  - Focuses on sessions initiated by your organization
- Limit traffic to records under 5K bytes
  - Most cyclical sessions (beaconing) happen in this range

Traffic should be refined to provide the best possible dataset for analysts to work with.

Data Reduction

To further enhance the concentration of suspicious data, analysts should:

- Remove replies from servers (responses to inbound server requests)
  - Looking for genuine outbound traffic
- Remove loud, common talkers (instant messenger, web crawlers, etc)
  - Reduces the noise, especially in web traffic
- “Whitelists” and “blacklists” are helpful for filtering

This is an iterative approach – Analyze, Research, Remove.

Importing Data

Data is imported from a pipe delimited text file

sIP	dIP	sPort	dPort	pro	packets	bytes	flags	sTime	dur	eT
10.147.82.96	10.130.166.158	80	5516	6	11	8258	FS PA	2007/10/29T15:07:38.807	0.290	2007/10/29T15:07:39.
10.140.165.218	10.54.98.176	80	5705	6	86	120321	FS PA	2007/10/29T15:07:40.875	0.552	2007/10/29T15:07:41.
10.95.46.146	10.34.134.191	80	5705	6	1	40	A	2007/10/29T15:07:42.473	0.000	2007/10/29T15:07:42.
10.94.132.147	10.168.141.231	80	49094	6	10	7348	FS PA	2007/10/29T15:16:19.666	0.825	2007/10/29T15:16:20.
10.226.143.219	10.162.254.83	80	49297	6	33	43588	FS PA	2007/10/29T15:16:23.020	0.498	2007/10/29T15:16:23.
172.25.4.165	10.161.142.75	80	47356	6	10	7047	FS PA	2007/10/29T15:28:21.421	0.859	2007/10/29T15:28:22.
10.120.9.241	10.36.140.83	80	47489	6	7	1839	FS PA	2007/10/29T15:28:23.285	0.326	2007/10/29T15:28:23.
10.192.192.130	10.124.26.9	5516	80	6	9	945	FS PA	2007/10/29T15:07:38.771	0.292	2007/10/29T15:07:39.
10.8.58.141	10.254.147.27	5705	80	6	55	3589	FS PA	2007/10/29T15:07:40.843	1.591	2007/10/29T15:07:42.
10.215.49.170	10.30.5.168	49094	80	6	8	969	FS PA	2007/10/29T15:16:19.638	0.825	2007/10/29T15:16:20.
10.207.158.173	10.15.150.60	49297	80	6	22	1666	FS PA	2007/10/29T15:16:23.004	0.488	2007/10/29T15:16:23.
192.168.45.69	10.88.159.210	47356	80	6	9	1796	FS PA	2007/10/29T15:28:21.381	0.874	2007/10/29T15:28:22.
10.227.193.146	10.237.117.172	47489	80	6	7	888	FS PA	2007/10/29T15:28:23.261	0.313	2007/10/29T15:28:23.
10.115.234.230	10.144.241.122	80	24503	6	10	6735	FS PA	2007/10/29T16:01:28.698	0.220	2007/10/29T16:01:28.
10.52.224.171	10.232.170.176	80	24601	6	7	1475	FS PA	2007/10/29T16:01:29.421	0.236	2007/10/29T16:01:29.
10.144.199.78	10.208.138.229	80	64021	6	10	6437	FS PA	2007/10/29T16:09:08.791	0.161	2007/10/29T16:09:08.
10.9.152.19	10.233.152.178	80	64124	6	7	1310	FS PA	2007/10/29T16:09:09.883	0.247	2007/10/29T16:09:10.
10.116.235.116	10.27.192.234	80	64021	6	1	40	A	2007/10/29T16:09:08.951	0.000	2007/10/29T16:09:08.
10.0.158.212	10.131.10.198	80	40079	6	11	6378	FS PA	2007/10/29T16:16:40.586	0.247	2007/10/29T16:16:40.
10.40.145.167	10.229.195.82	80	40167	6	15	15095	FS PA	2007/10/29T16:16:41.718	0.317	2007/10/29T16:16:42.
10.40.157.25	10.12.36.164	80	18275	6	10	6242	FS PA	2007/10/29T16:24:32.546	0.235	2007/10/29T16:24:32.
10.33.232.60	10.224.241.212	80	18385	6	21	21877	FS PA	2007/10/29T16:24:34.100	0.409	2007/10/29T16:24:34.
10.75.204.191	10.52.57.127	24503	80	6	8	1439	FS PA	2007/10/29T16:01:28.654	0.223	2007/10/29T16:01:28.
10.6.83.30	10.218.84.41	24601	80	6	7	888	FS PA	2007/10/29T16:01:29.393	0.225	2007/10/29T16:01:29.
10.123.207.187	10.211.245.126	64021	80	6	9	2544	FS PA	2007/10/29T16:09:08.762	0.153	2007/10/29T16:09:08.
10.239.204.27	10.140.242.63	64021	80	6	1	40	R	2007/10/29T16:09:08.951	0.000	2007/10/29T16:09:08.

Data Formatting

Columns within the spreadsheet should be aligned to each field of the flows, Einstein data is formatted to encompass:

- Source IP
- Destination IP
- Source Port
- Destination Port
- Protocol
- Packets
- Bytes
- Flags
- Start Time
- Duration
- End Time
- Sensor
- Type
- Initial Flags

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	sIP	dIP	sPort	dPort	pro	packets	bytes	flags	sTime	dur	eTime	sensor	type	initialFlag
2	x.x.x.x	y.y.y.y	52611	22	6	2569	3385741	FS PA	2007/10/17T00:10:40.722	9.5	2007/10/17T00:10:50.222	X	out	S
3	x.x.x.x	y.y.y.y	7774	22	6	136	10750	PA	2007/10/17T00:08:28.293	1795.691	2007/10/17T00:38:23.984	X	out	A
4	x.x.x.x	y.y.y.y	7774	22	6	106	9046	PA	2007/10/17T00:38:36.714	1800.05	2007/10/17T01:08:36.764	X	out	PA
5	x.x.x.x	y.y.y.y	1688	22	6	1	41	A	2007/10/17T00:01:18.787	0	2007/10/17T00:01:18.787	X	out	A
6	x.x.x.x	y.y.y.y	1688	22	6	1	41	A	2007/10/17T00:06:18.690	0	2007/10/17T00:06:18.690	X	out	A
7	x.x.x.x	y.y.y.y	1688	22	6	1	41	A	2007/10/17T00:11:18.598	0	2007/10/17T00:11:18.598	X	out	A
8	x.x.x.x	y.y.y.y	1688	22	6	1	41	A	2007/10/17T00:16:18.514	0	2007/10/17T00:16:18.514	X	out	A
9	x.x.x.x	y.y.y.y	1688	22	6	1	41	A	2007/10/17T00:21:18.433	0	2007/10/17T00:21:18.433	X	out	A
10	x.x.x.x	y.y.y.y	1688	22	6	1	41	A	2007/10/17T00:26:18.349	0	2007/10/17T00:26:18.349	X	out	A
11	x.x.x.x	y.y.y.y	1688	22	6	1	41	A	2007/10/17T00:31:18.257	0	2007/10/17T00:31:18.257	X	out	A
12	x.x.x.x	y.y.y.y	1688	22	6	1	41	A	2007/10/17T00:36:18.164	0	2007/10/17T00:36:18.164	X	out	A
13	x.x.x.x	y.y.y.y	1281	22	6	956	40630	PA	2007/10/17T00:09:32.281	1798.994	2007/10/17T00:39:31.275	X	out	A
14	x.x.x.x	y.y.y.y	1688	22	6	1	41	A	2007/10/17T00:41:18.068	0	2007/10/17T00:41:18.068	X	out	A
15	x.x.x.x	y.y.y.y	1688	22	6	1	41	A	2007/10/17T00:46:17.971	0	2007/10/17T00:46:17.971	X	out	A

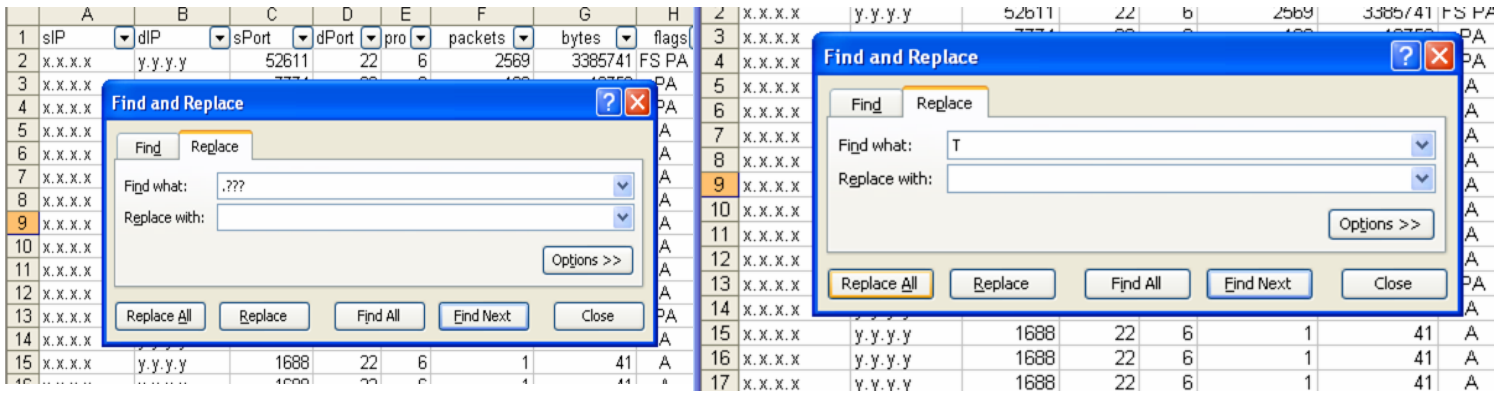
Data Formatting Cont.

US-CERT analysts use two methods to format the Einstein time fields into a format that is able to be plotted:

A: Use the - - legacy-timestamps switch to place the time in a

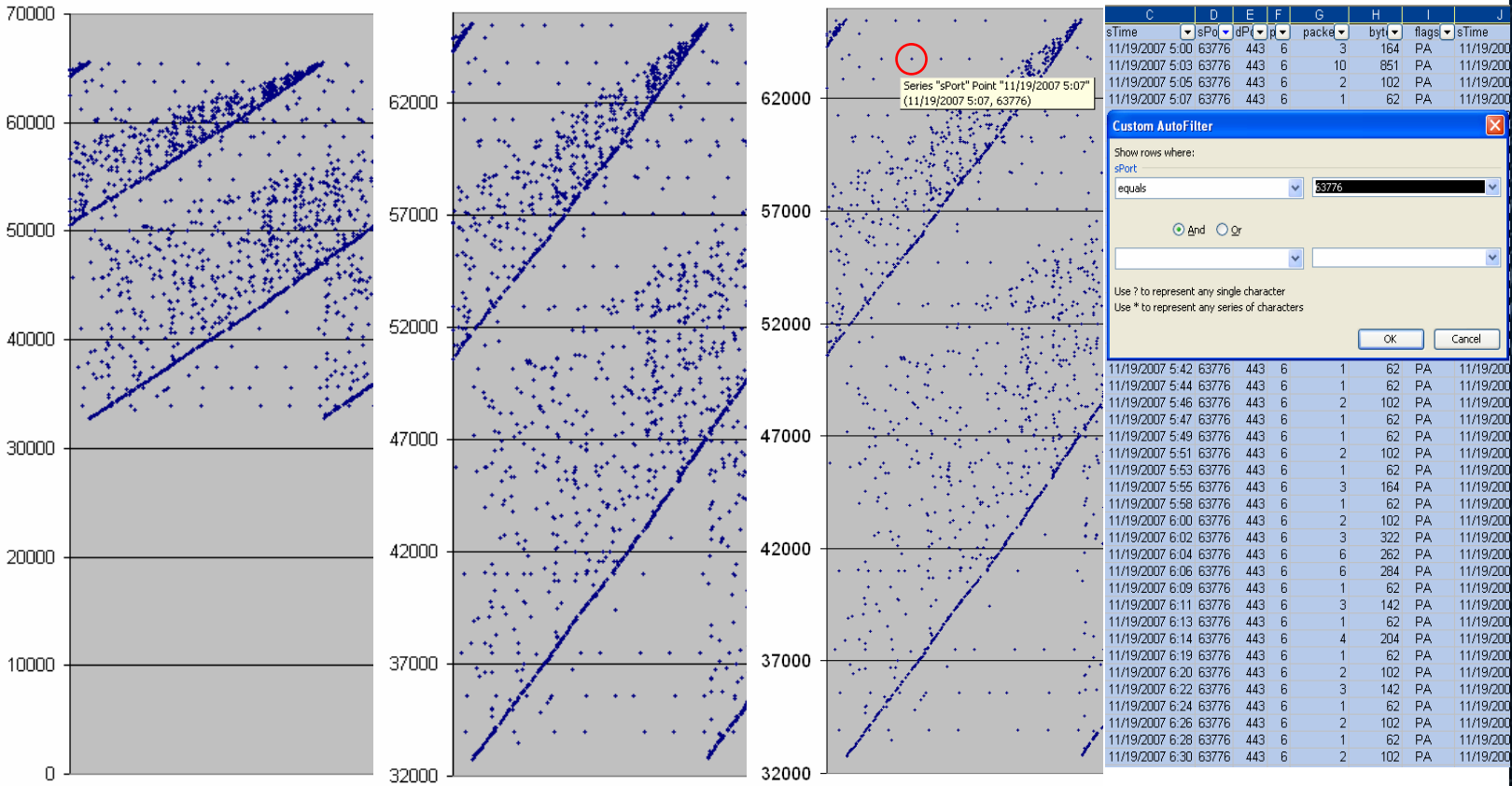
MM/DD/YYYY HH:MM:SS format from the default MM/DD/YYYYTHH:MM:SS.MMM

B: Utilize the replace function in excel to remove the milliseconds from the time and replace the T placeholder with a space:



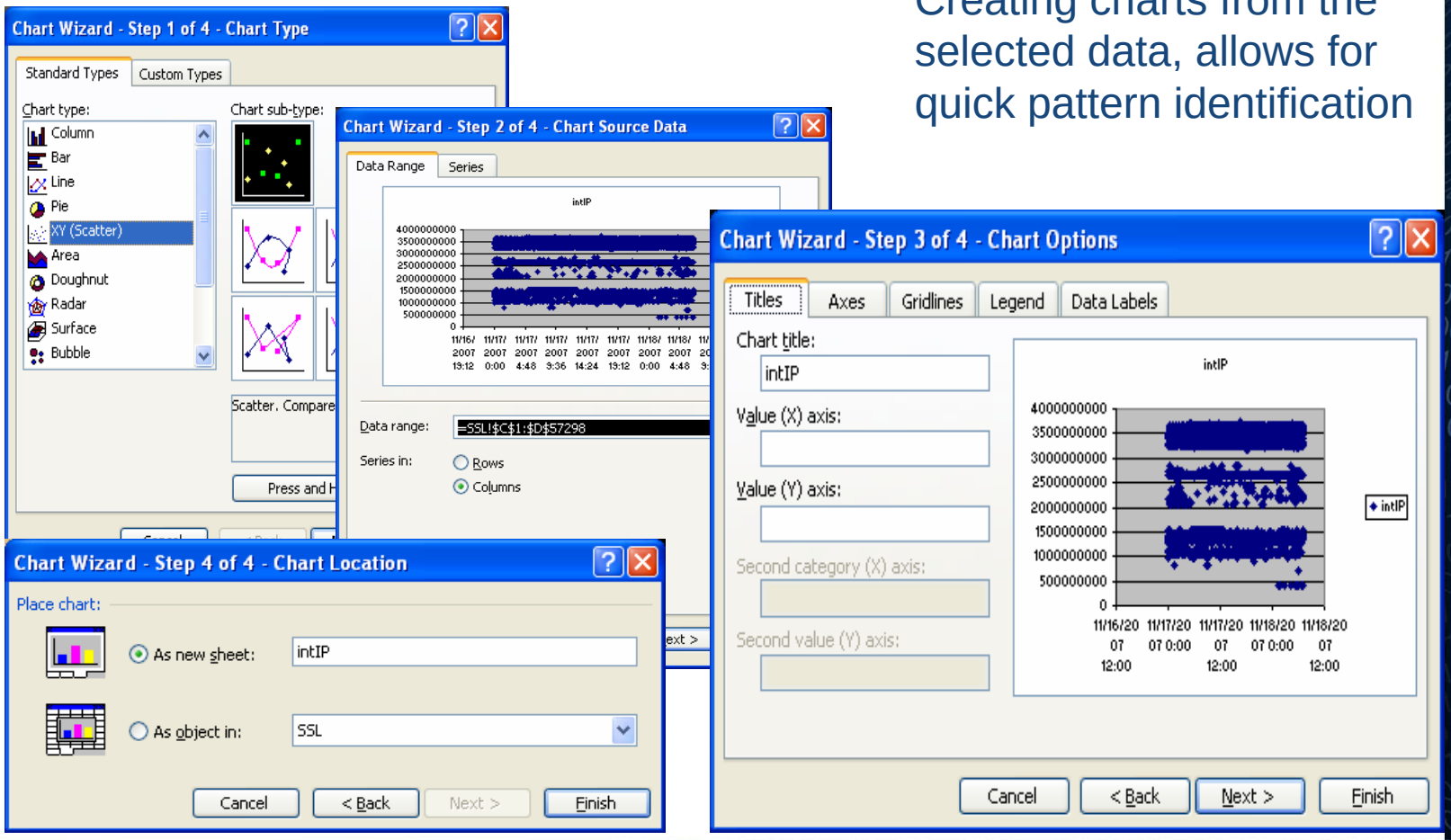
Analysis Workflow

Plot Zoom Highlight AutoFilter



Plot

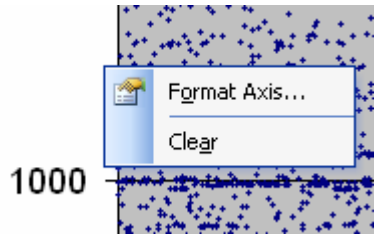
Creating charts from the selected data, allows for quick pattern identification

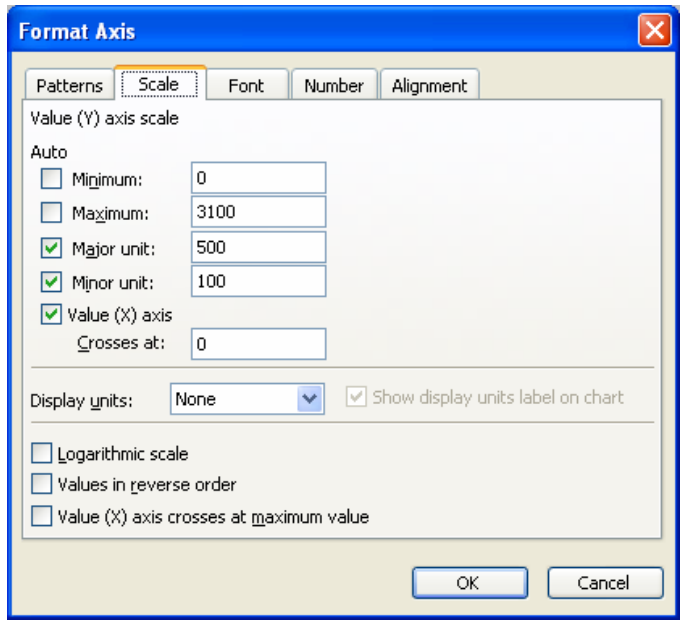


Zoom

You can “zoom” in to specific data points, by changing the scale of the axis

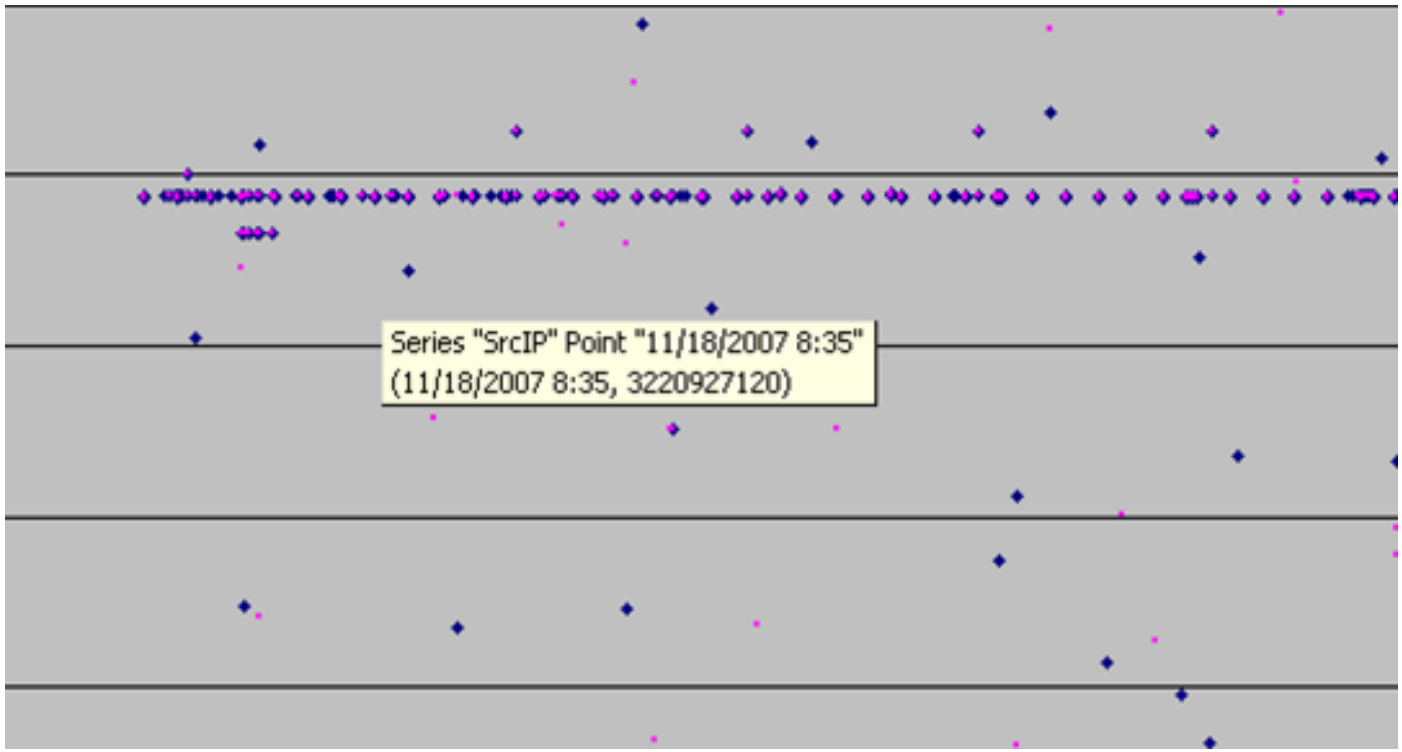
- Right click on the axis
- Select “Format Axis”
- Click on the “Scale” tab
- Adjust scale as desired
- Works for both axis
- Remember to remove





Highlight

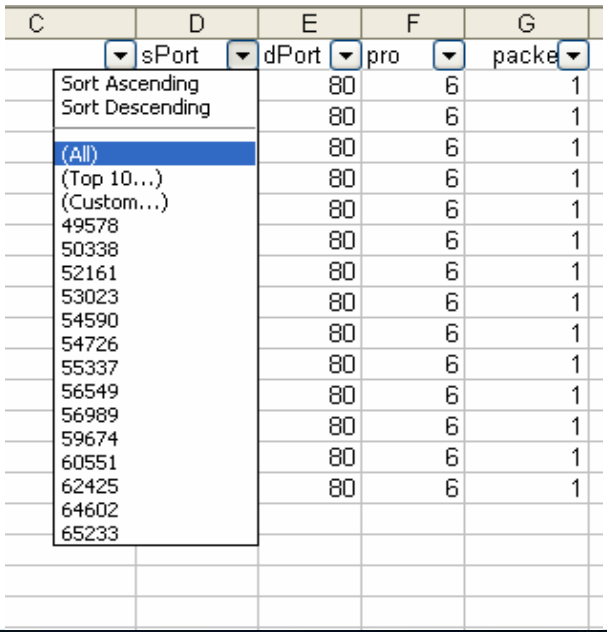
By hovering over a data point in the series an analyst can locate the point in the rest of the records by filtering for the displayed information



AutoFilter

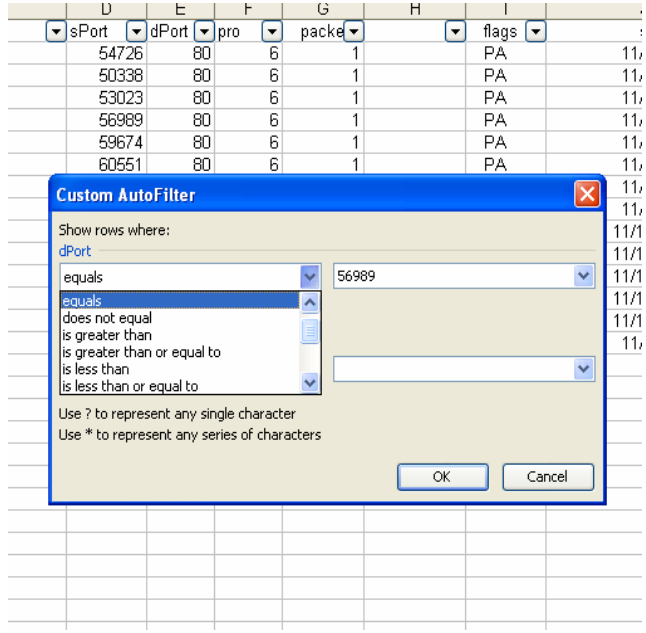
Method A – Drop down list:

Select the desired value from the drop down list



Method B – Custom Filter:

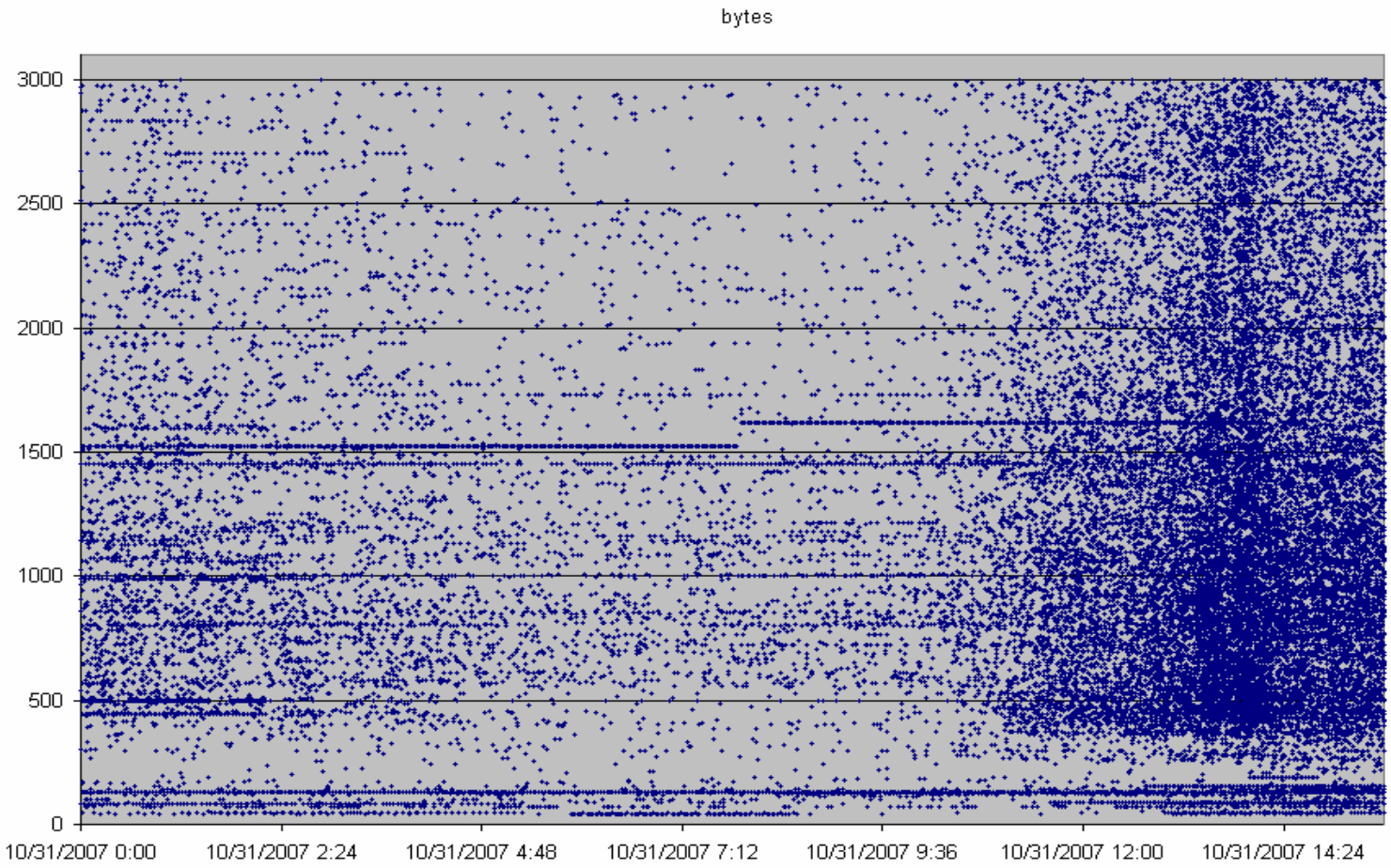
Select data by using Excel's built in boolean logic search functions



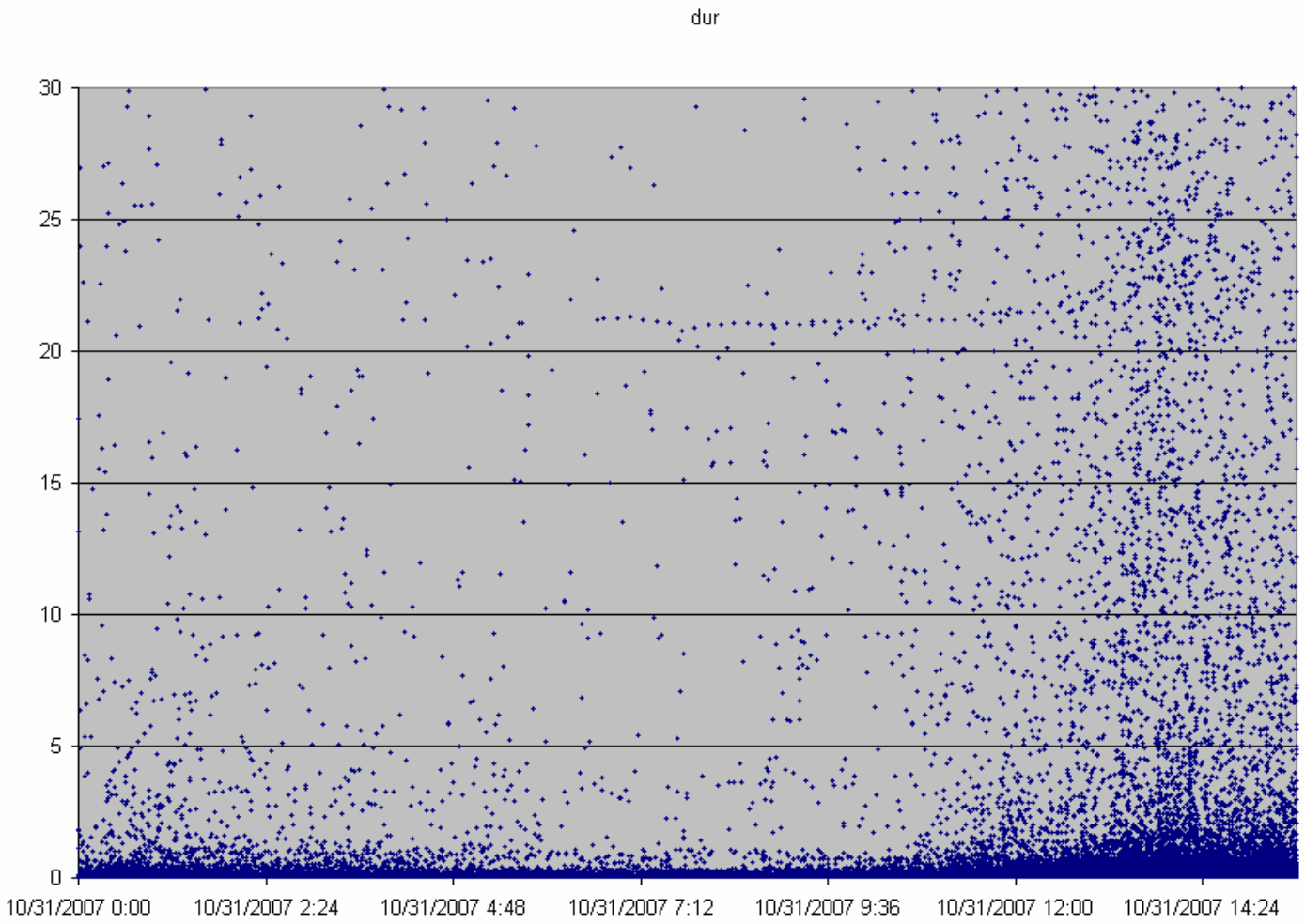
Sample Analysis Slides

- Scatter Plot Analysis
  - Byte Based Patterns
  - Duration Based Patterns
  - sPort vs. dPort Patterns
  - IP Based Patterns
  - Application Pattern

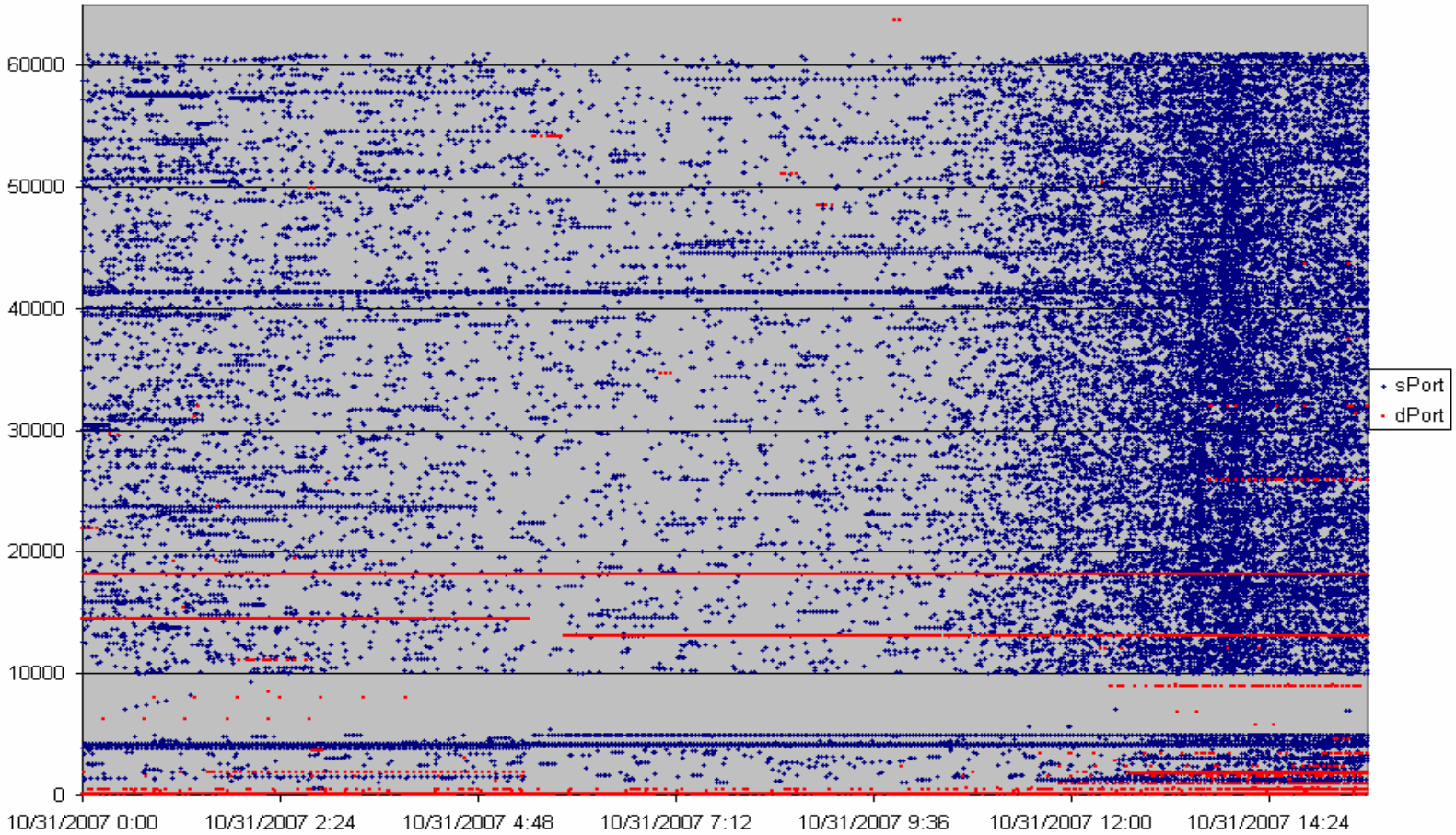
Byte Based Patterns



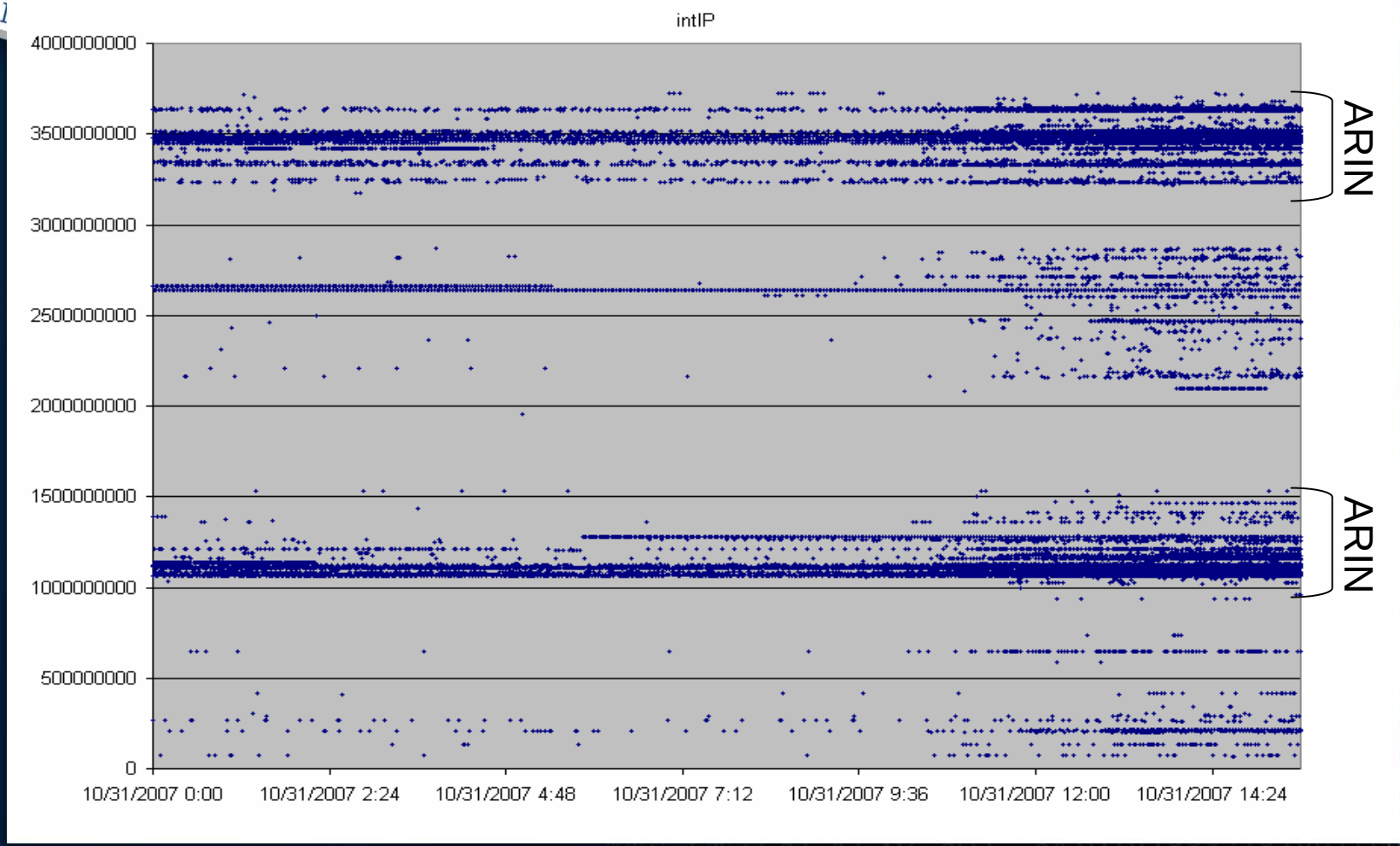
Duration Based Patterns



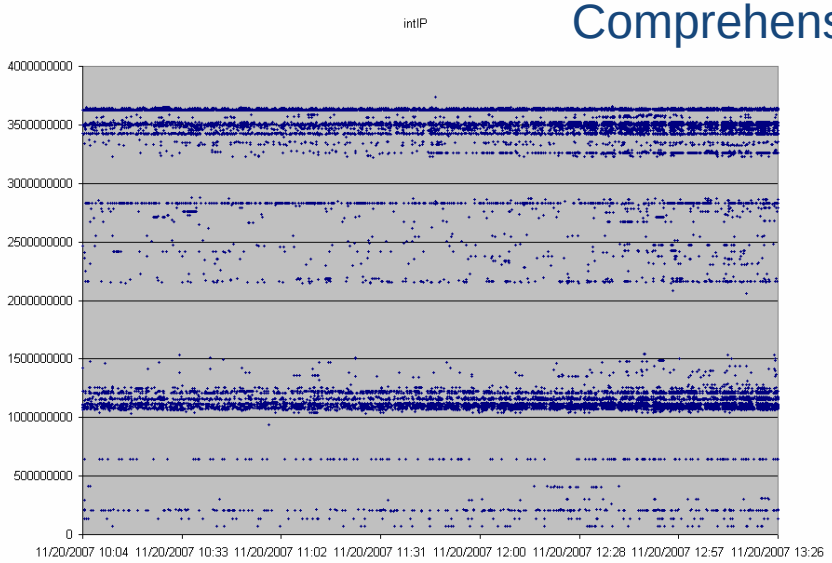
sPort vs. dPort

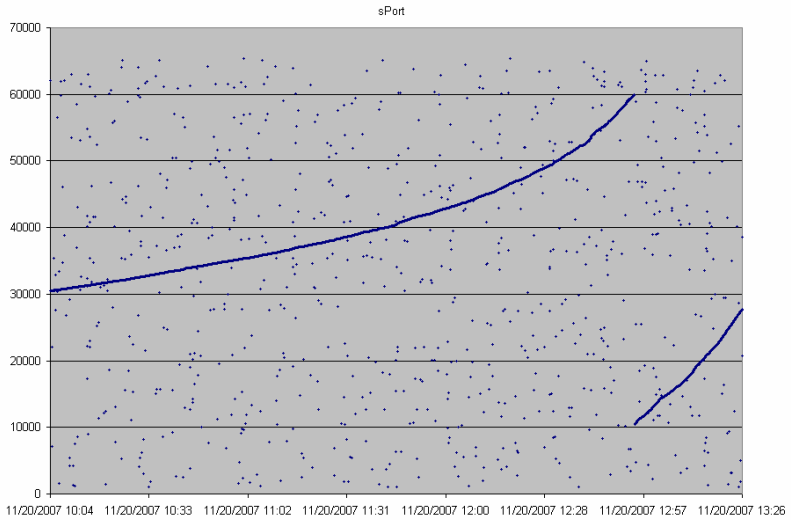


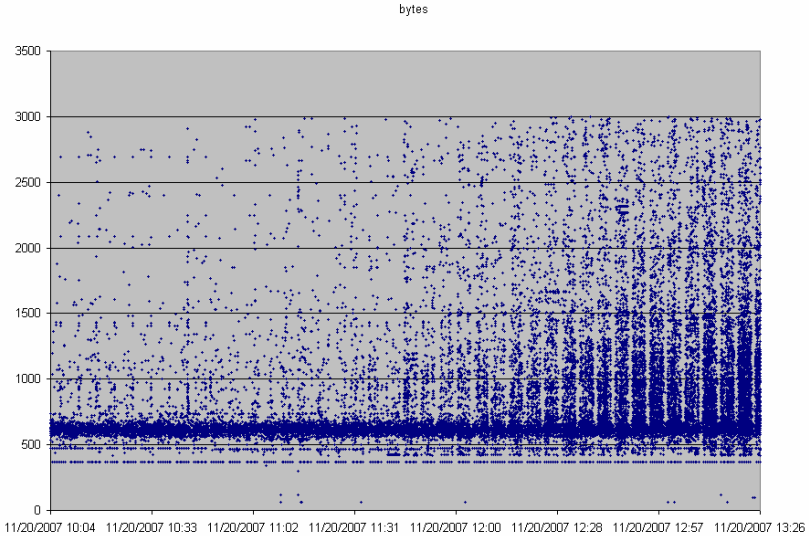
IP Integer Patterns

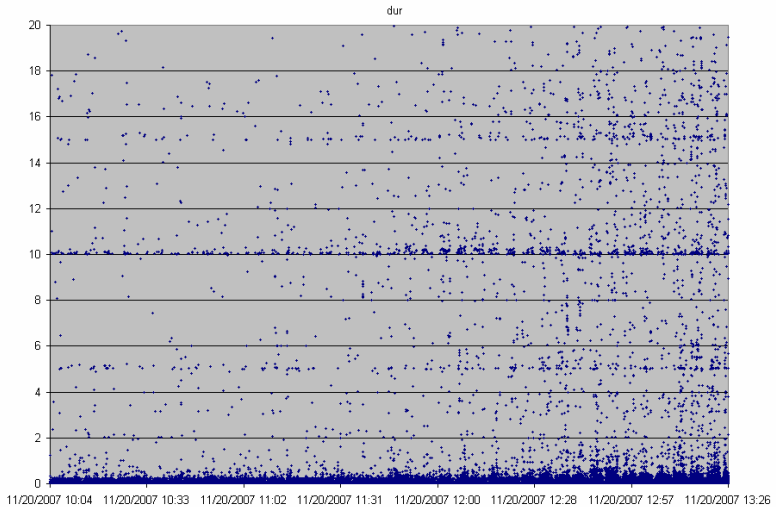


Comprehensive View

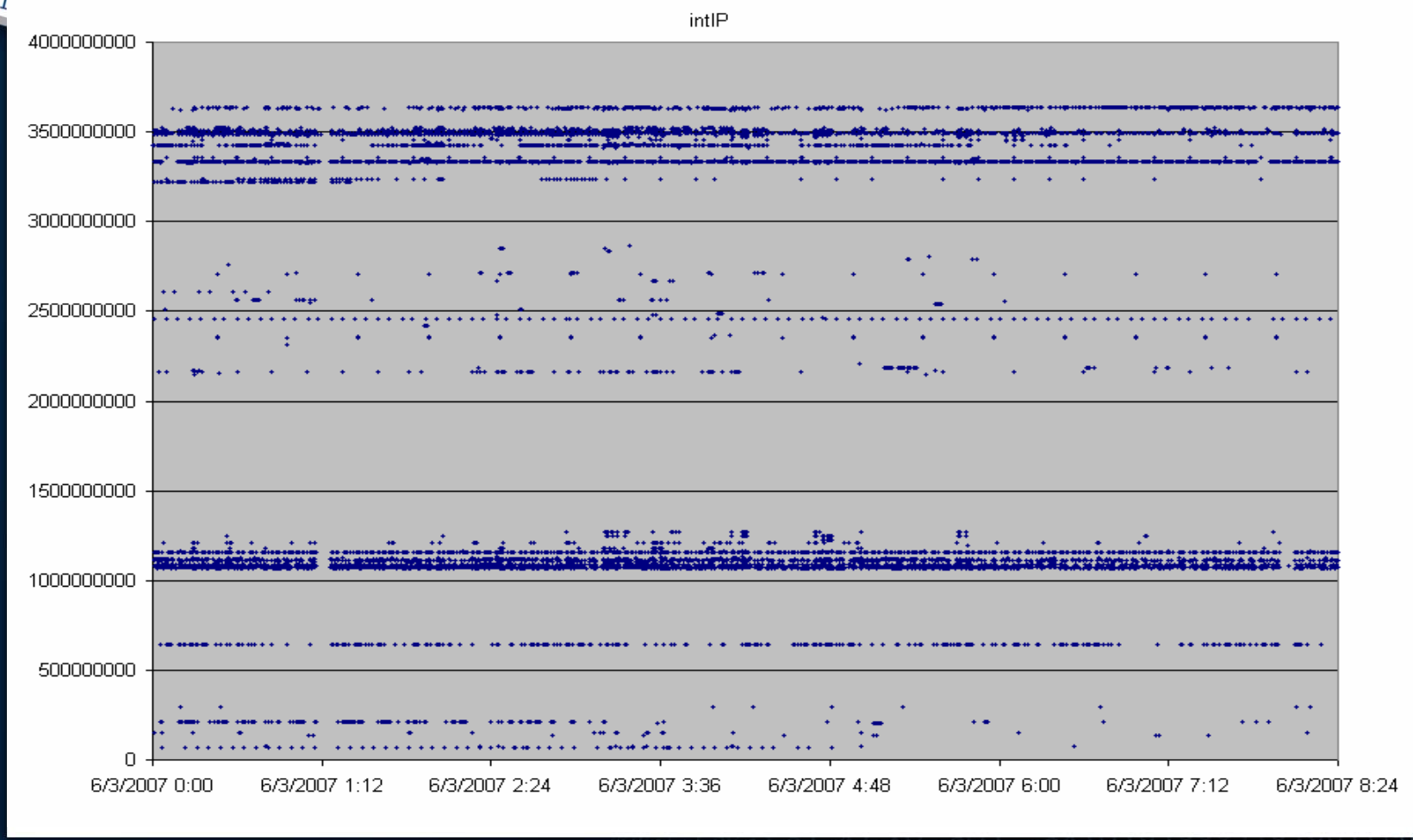




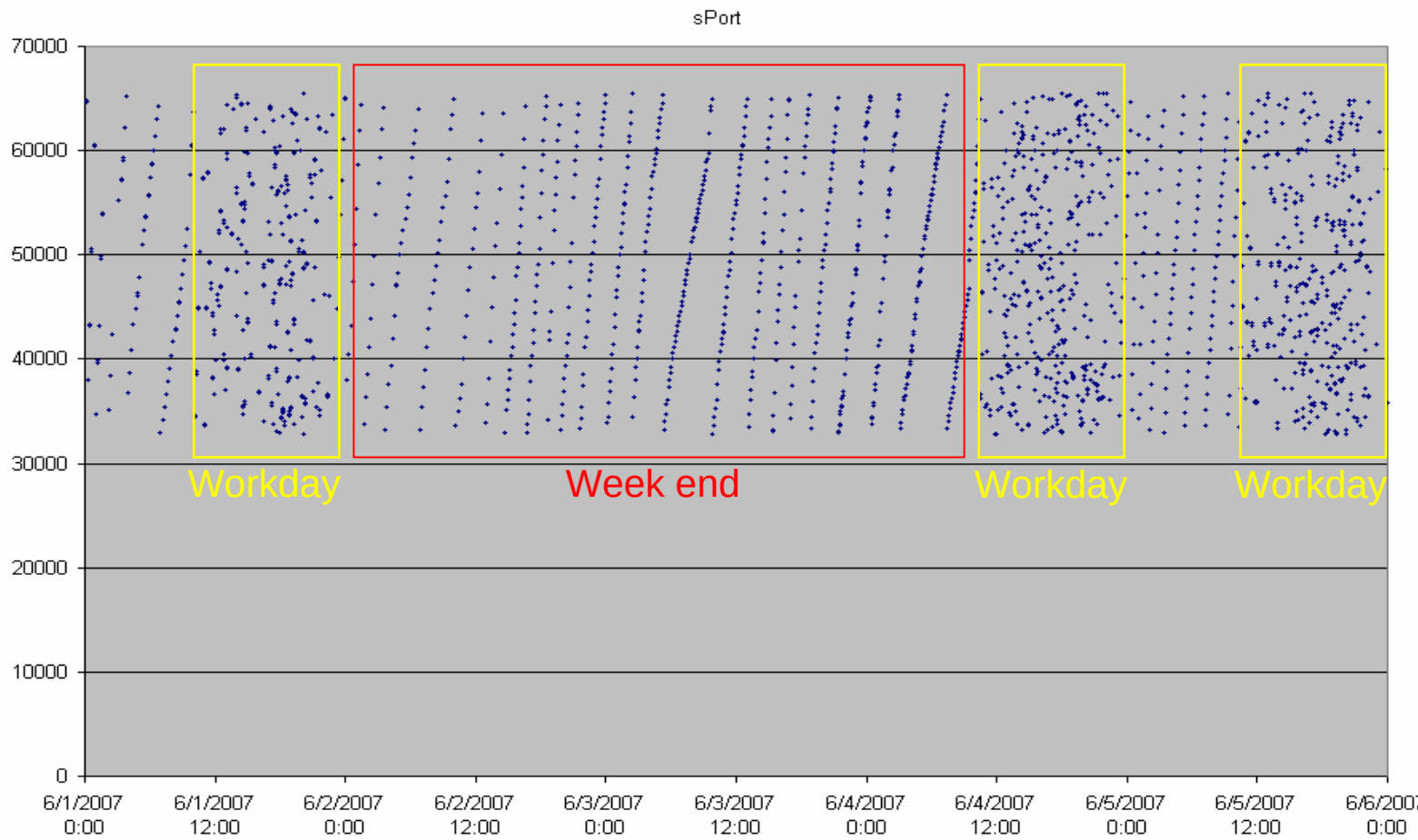




Case Study


intIP
4000000000
3500000000
3000000000
2500000000
2000000000
1500000000
1000000000
500000000
0
6/3/2007 0:00
6/3/2007 1:12
6/3/2007 2:24
6/3/2007 3:36
6/3/2007 4:48
6/3/2007 6:00
6/3/2007 7:12
6/3/2007 8:24

Multi-day View



Case Study Conclusion

After notifying the agency in question, the machines that were generating this traffic were found and forensically examined. The malware turned out to be a keystroke logger that posted data to a specific website and retrieved commands embedded on the same site. Prior to this incident, there was no malware associated with this site.

Additional Analysis

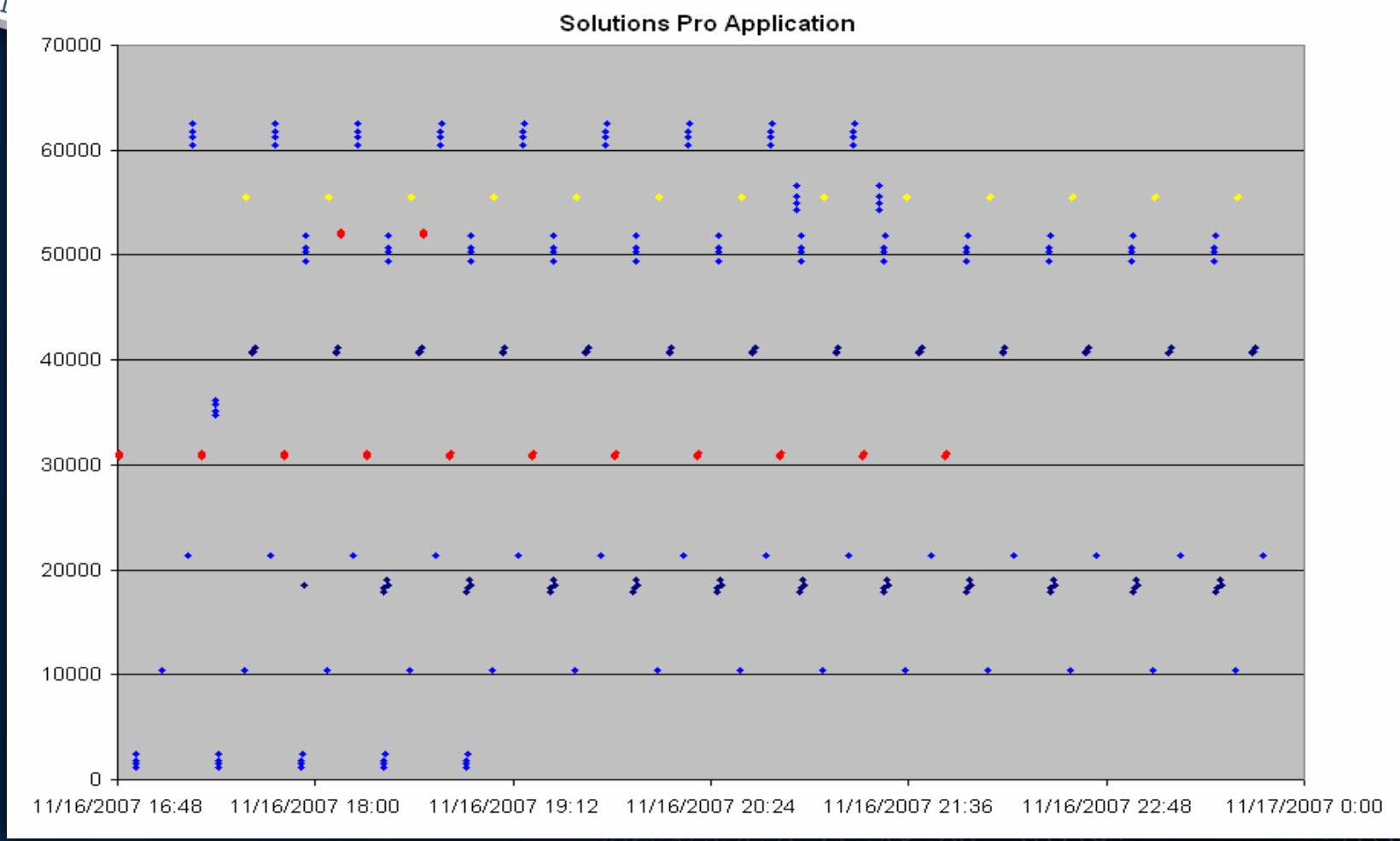
Determining application patterns

- Identifying specific applications

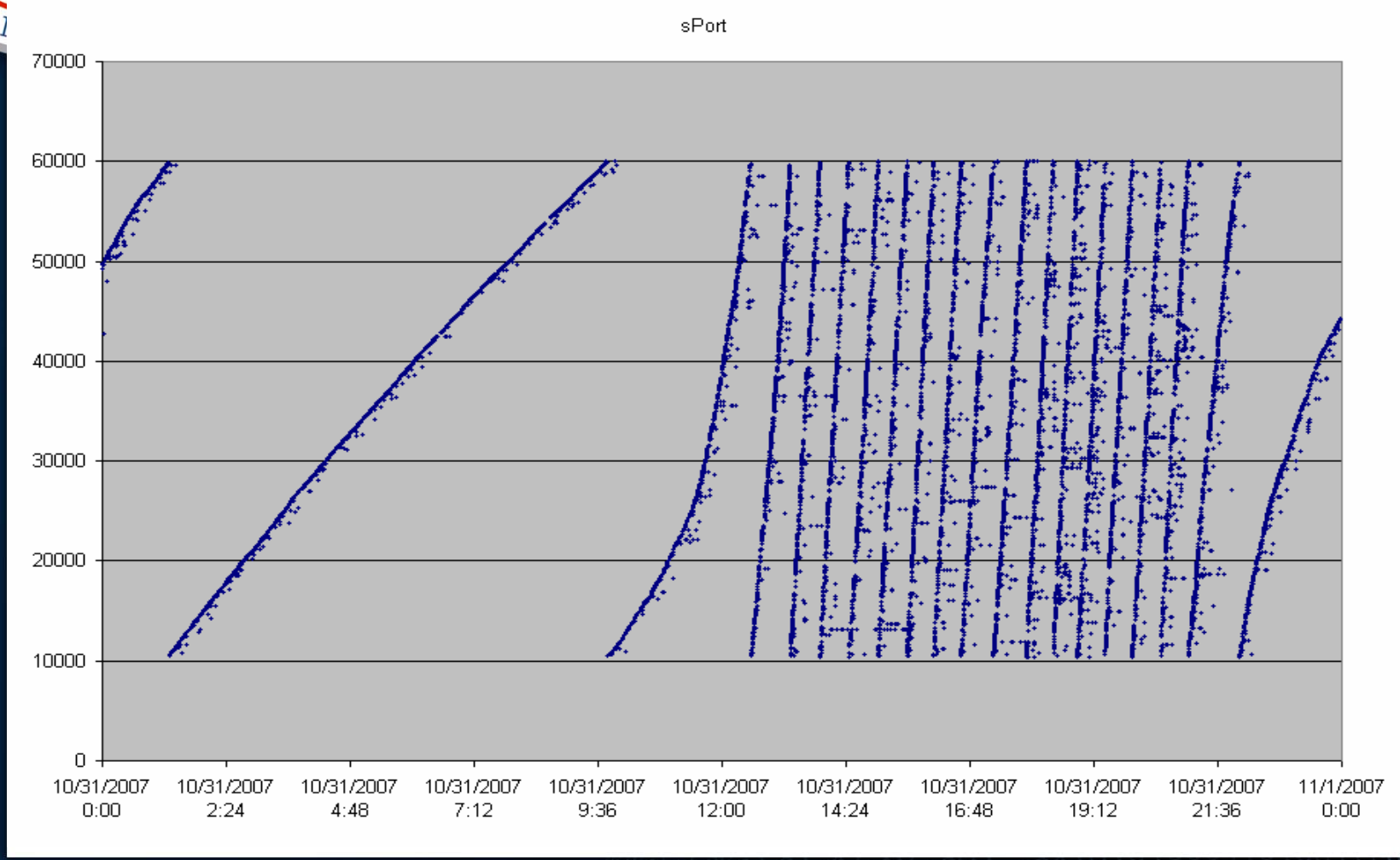
Working with gateway traffic

- Structured gateway
- Proxy gateway
- Gateway mannerisms

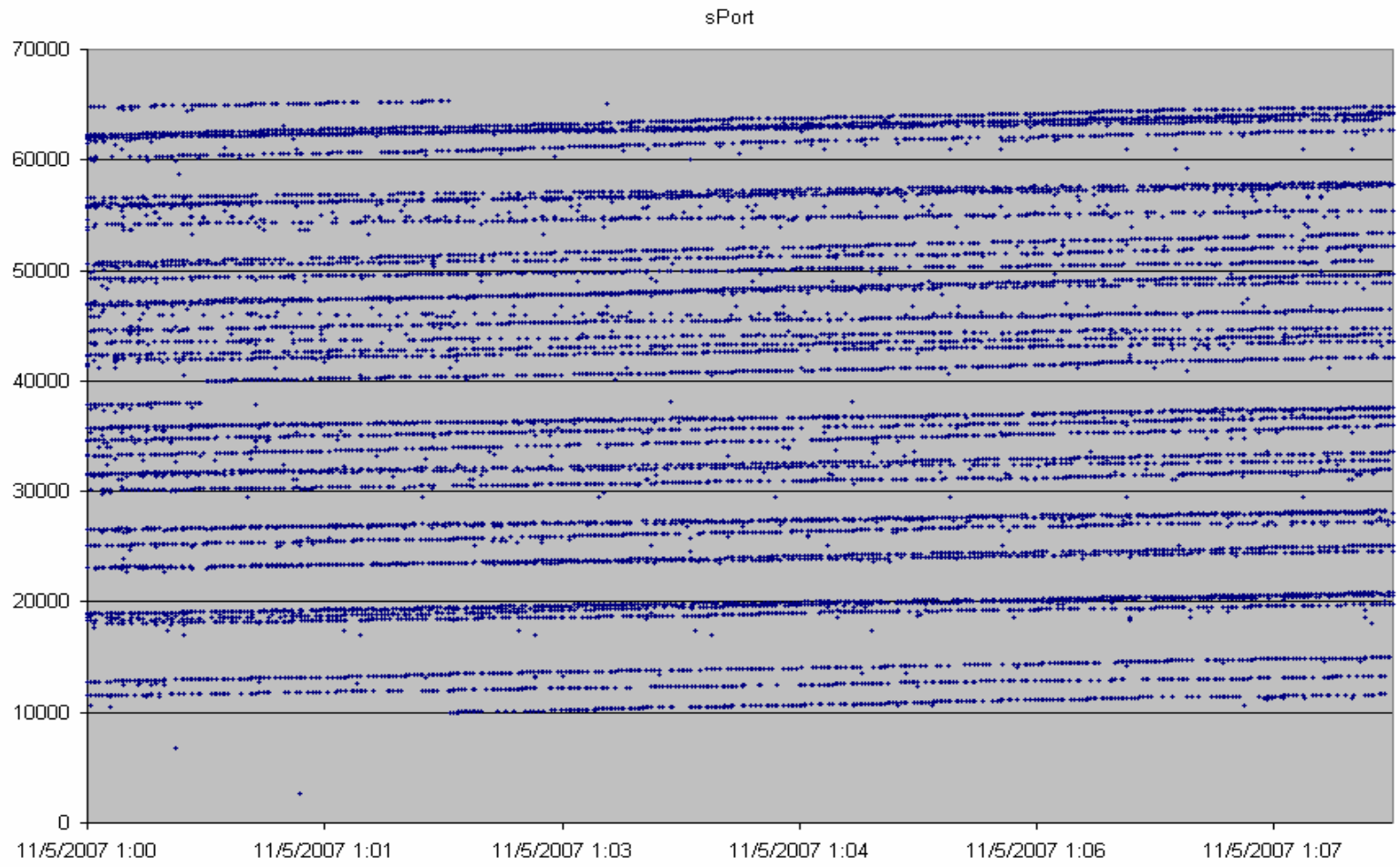
Application Patterns



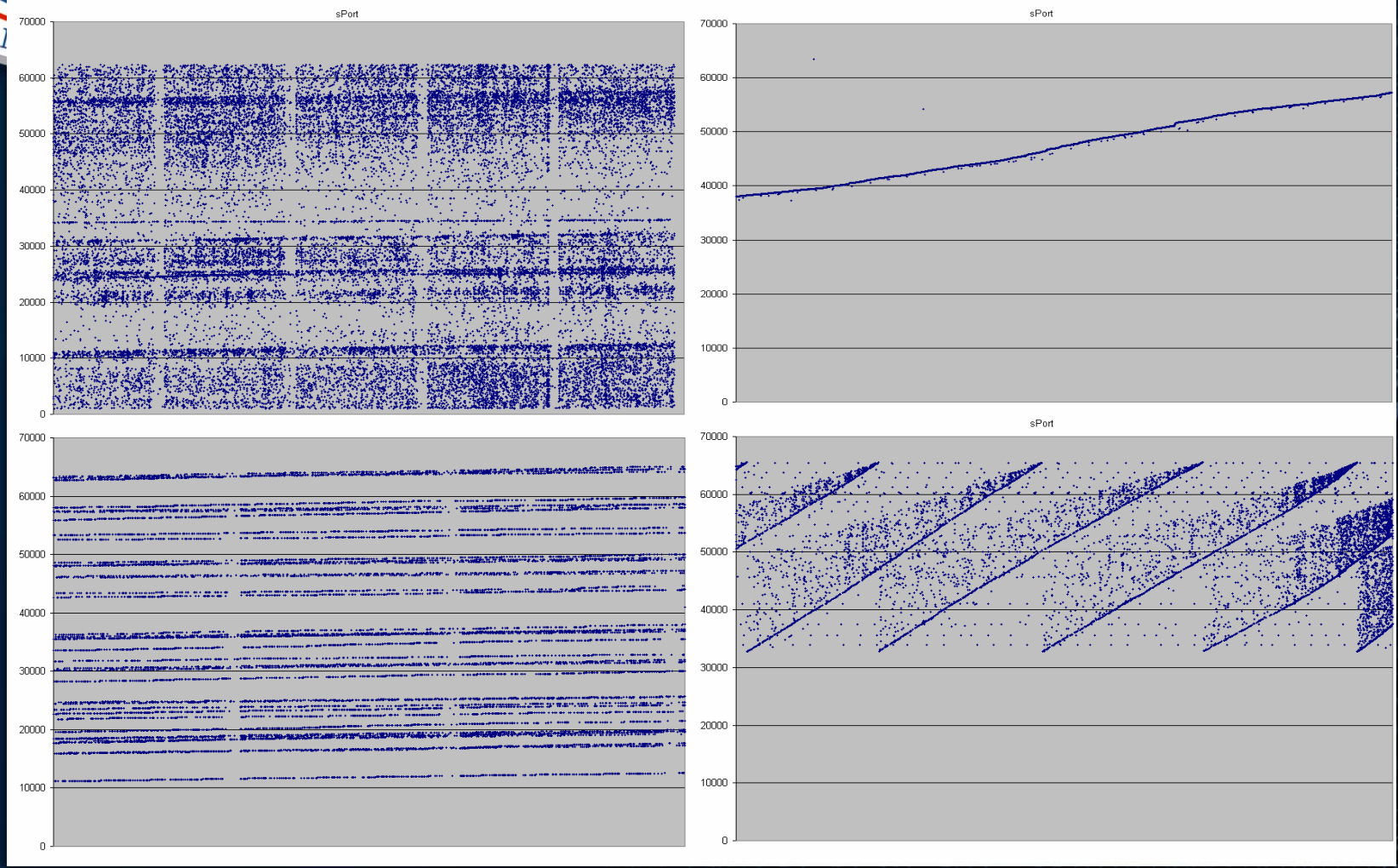
Structured Gateway



Proxy Gateway



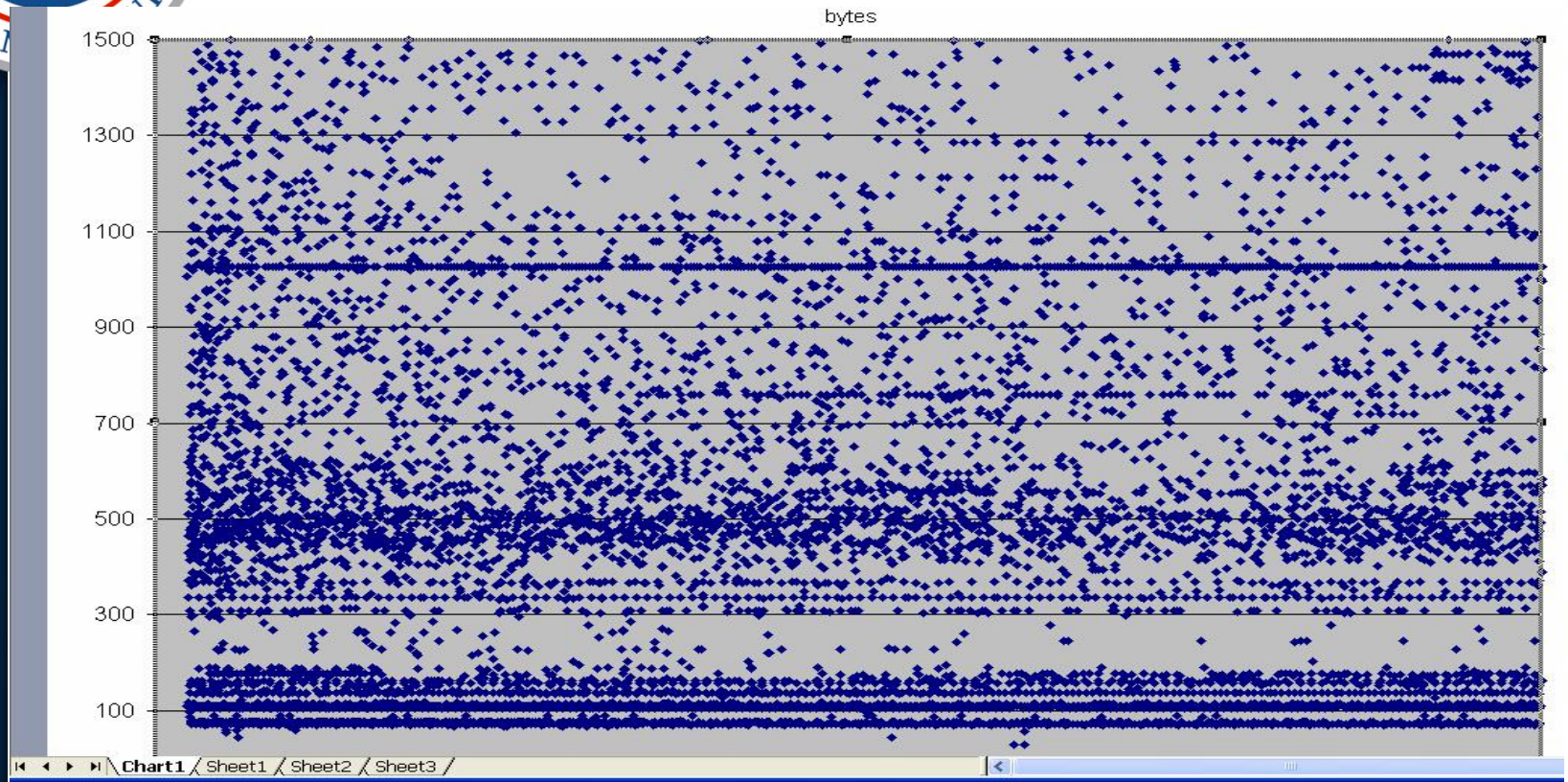
Gateway Mannerisms



Future Directions

- Split view analysis
- Coloring data
- Application coloring
- sPort colored by app
- Gateway coloring to IP

Split View

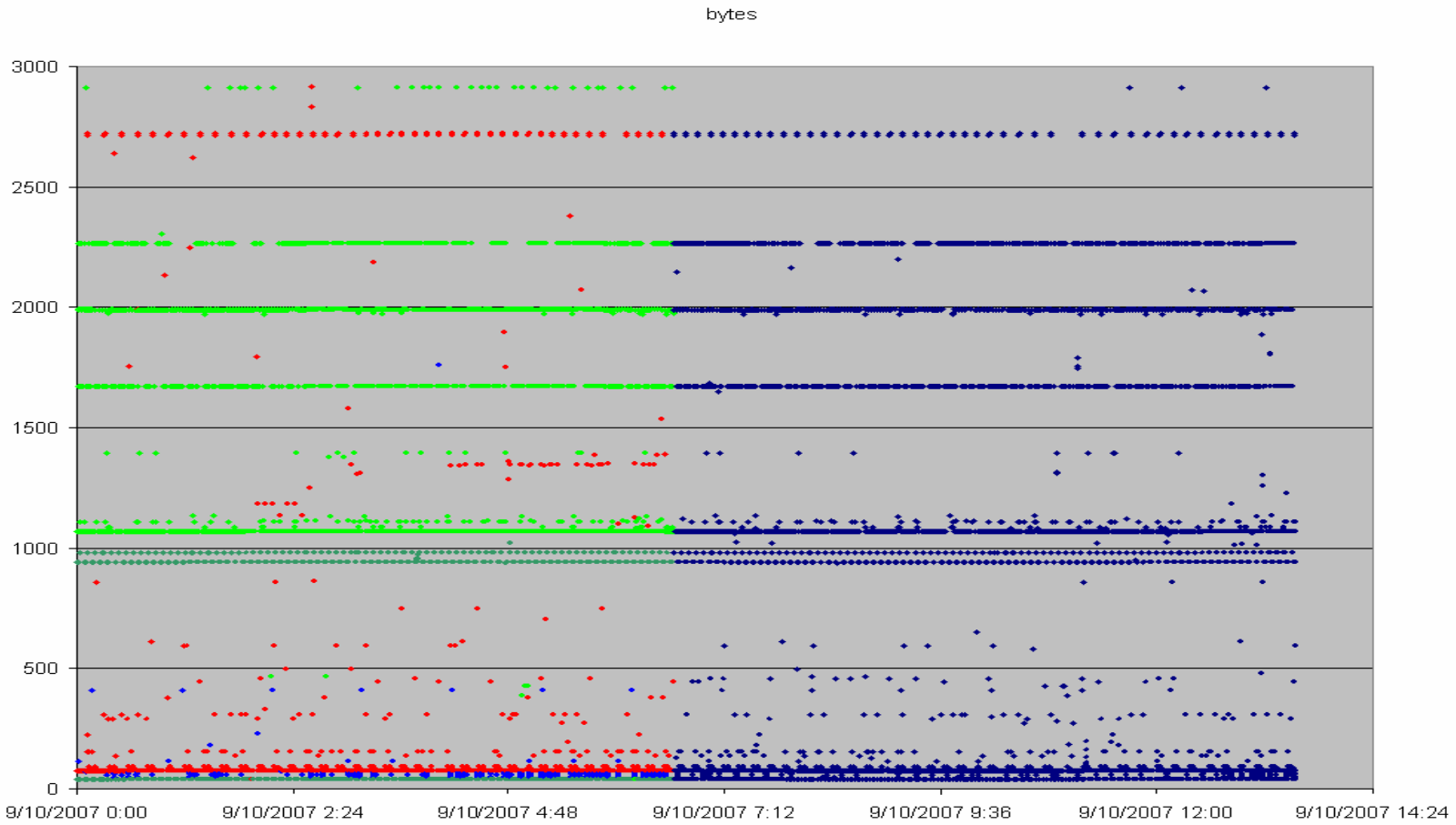


Book1

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	sIP	dIP	sTime	bytes	eTime	sPo	dPo		type	initial					
187	xxx.xxx.219.191		9/19/2007 0:01	86	9/19/2007 0:01	4313	21		out	PA					
188	xxx.xxx.180.1		9/19/2007 0:00	108	9/19/2007 0:00	10023	45365		out	PA					
189	xxx.xxx.180.1		9/19/2007 0:00	108	9/19/2007 0:00	10023	1143		out	PA					
190	xxx.xxx.180.1		9/19/2007 0:00	108	9/19/2007 0:00	10023	63549		out	PA					
191	xxx.xxx.208.97		9/19/2007 0:00	116	9/19/2007 0:00	1352	51191		out	PA					

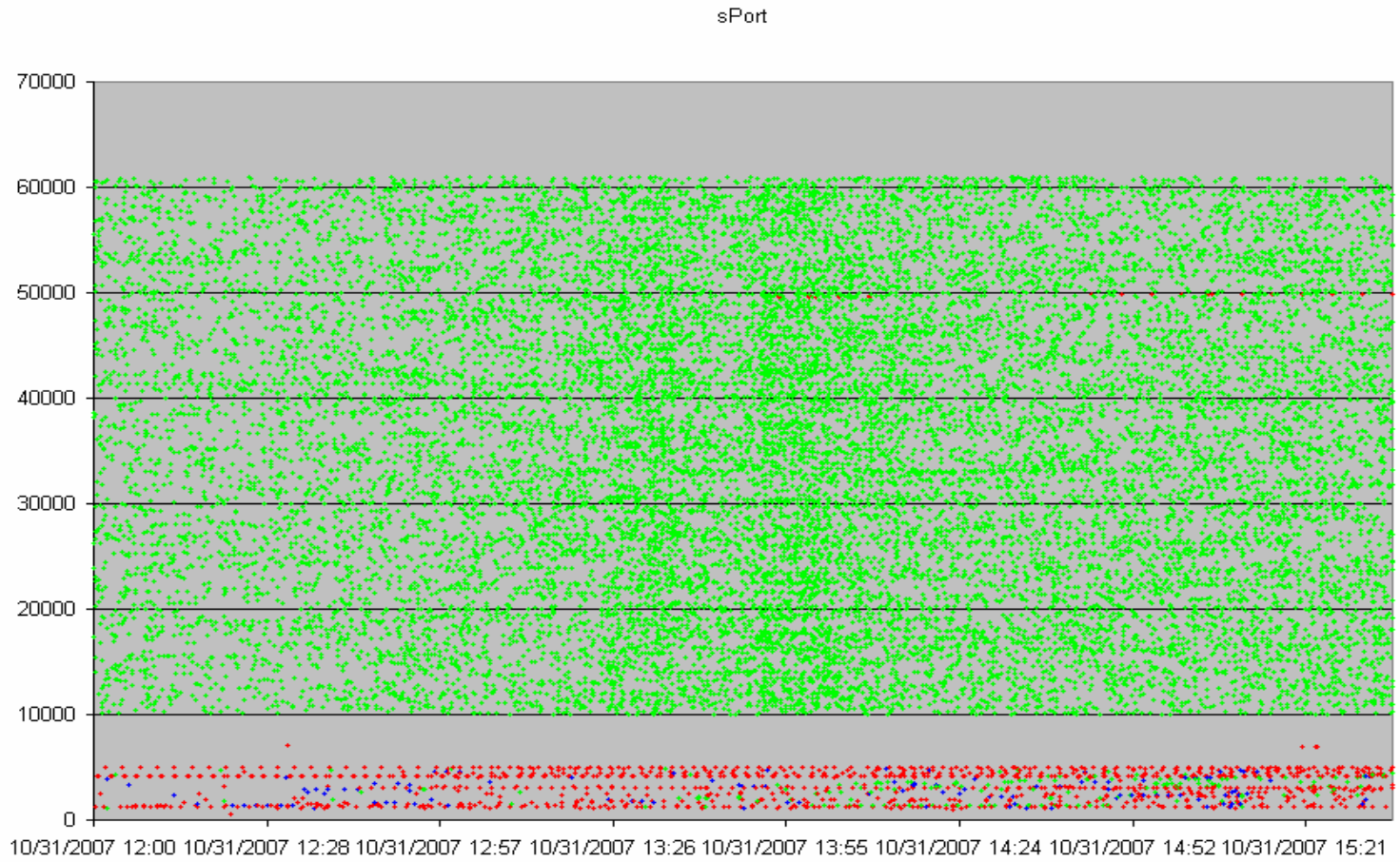
Coloring Example

Green = HTTP, Dark Green = HTTPS, Blue = DNS, Red = Other

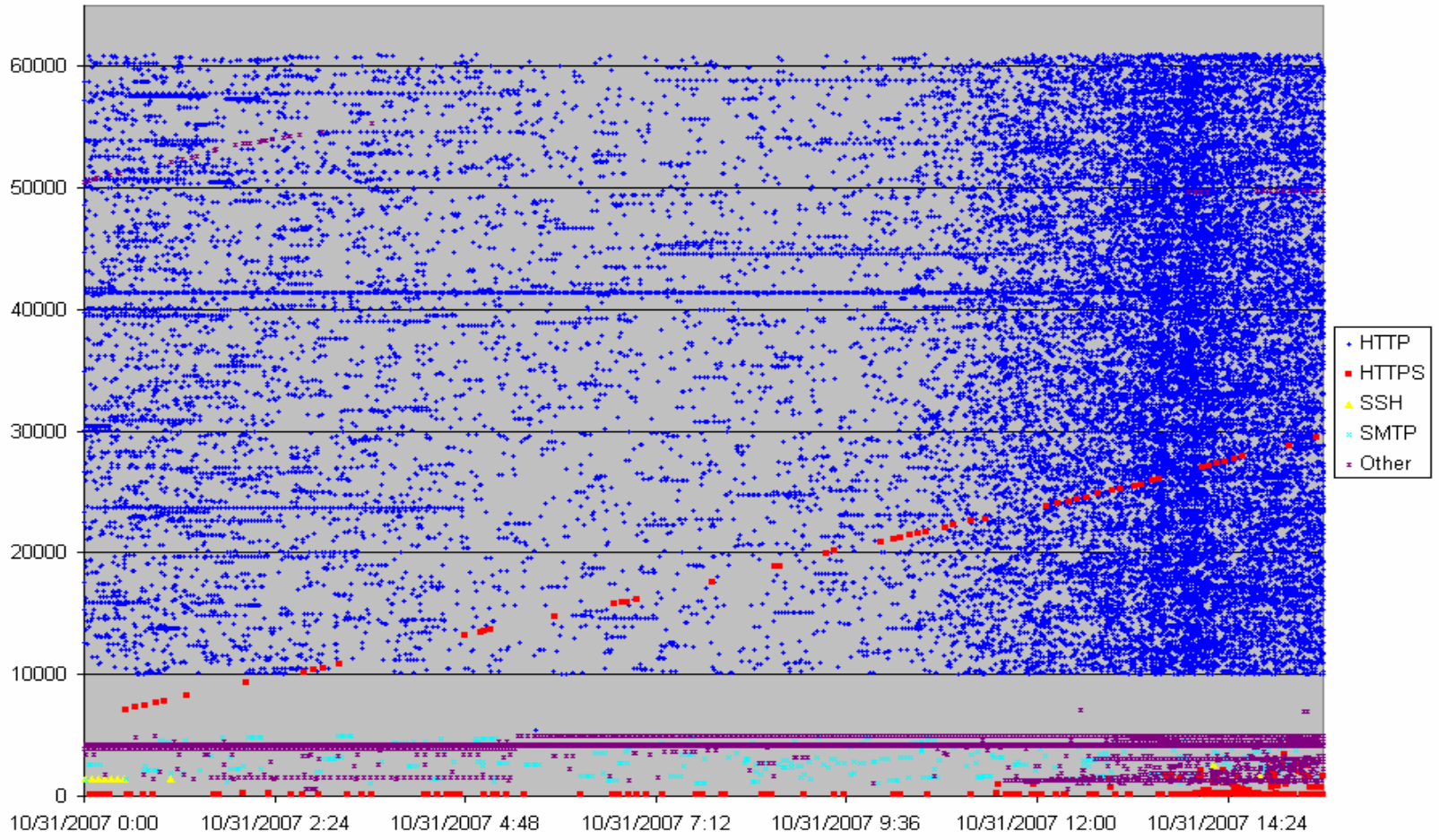


Application Coloring

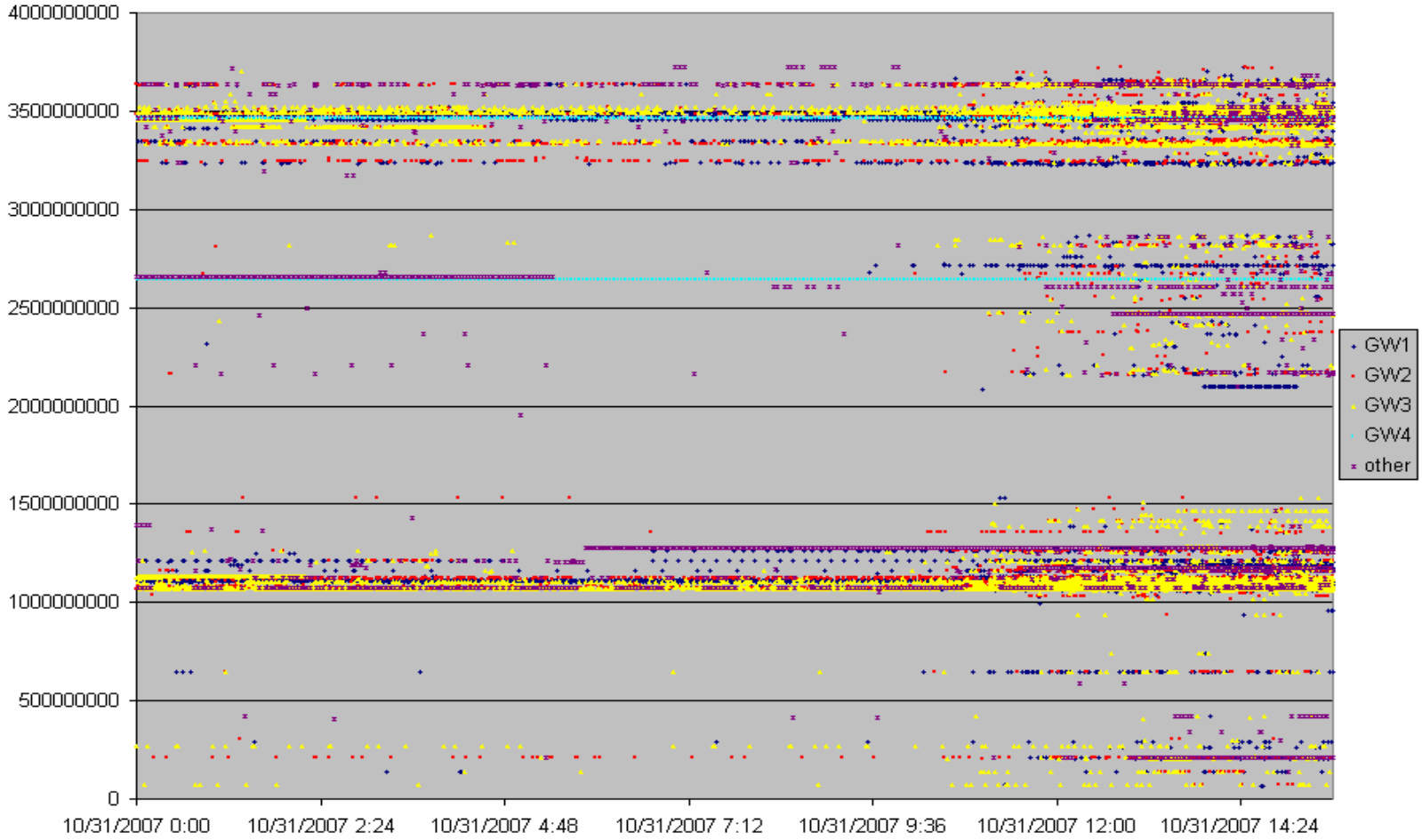
Green = HTTP, Blue = DNS, Red = Other



Color sPort vs Application



Colorization Example – GW2IP



Contact Info

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  - Phone: +1 202-282-8010
- **General questions or suggestions**
  - US-CERT Information Request
  - Email: info@us-cert.gov
  - Phone: +1 703-235-5111
- **For more information, visit** http://www.us-cert.gov

Questions?