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APT Splunking

Searching for adversaries with quadrants (and other methods)

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Who Are We?

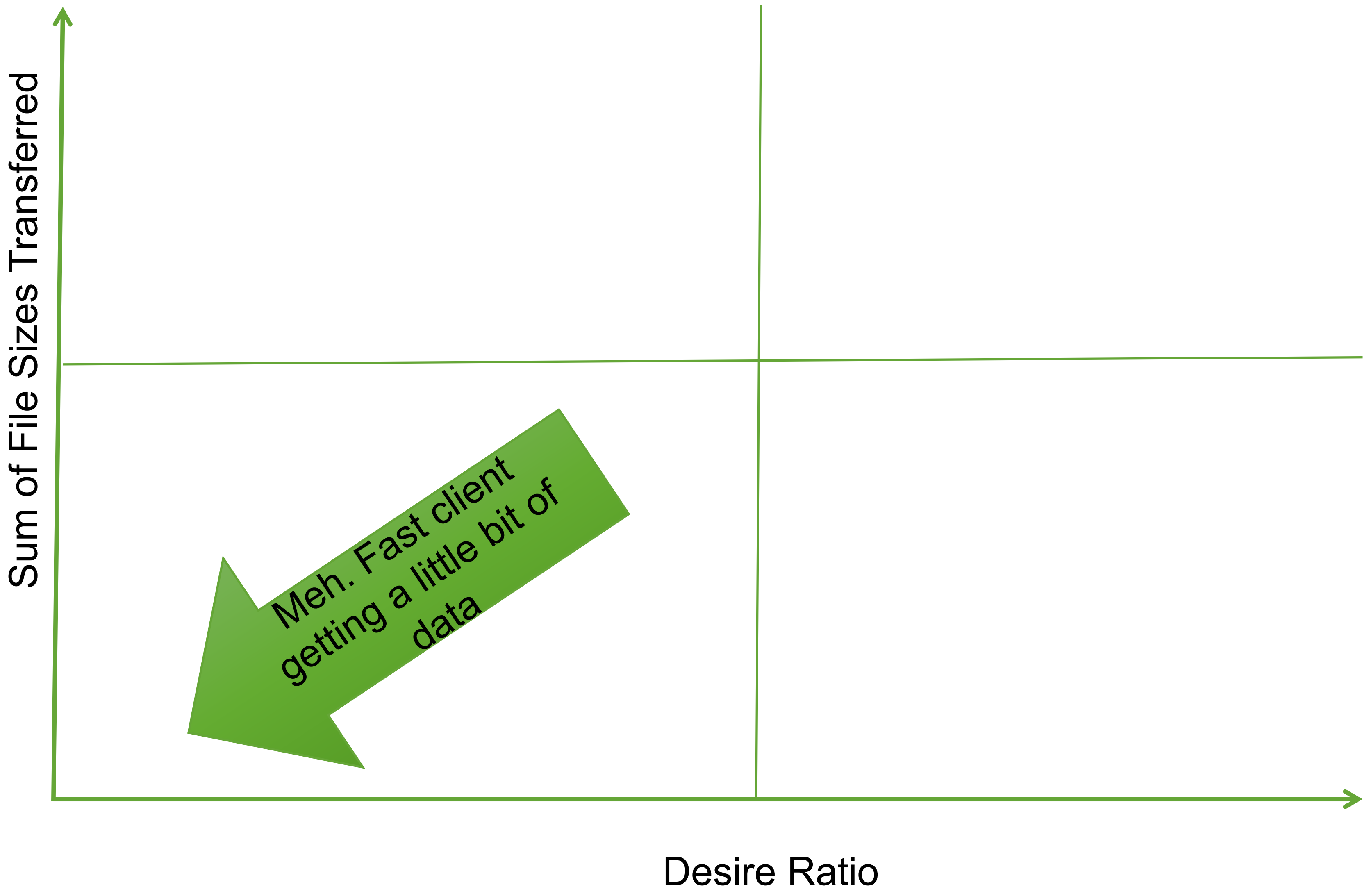
And why should you care?

- David Doyle
  - Bechtel CIRT Analyst
    - Splunk Administration
    - Viz Building
    - Incident Response
    - Plugging Visibility Gaps
    - Making it Look Easy
- Andrew Hunt
  - Bechtel Malware & Threat Intel Team Lead
    - Behavior analytics
    - Threat Intelligence
    - Math
    - Malware Analysis
    - IoT / DCS

Quadrant Analysis for Dummies

OR, a brief reintroduction to that thing you already know

How Quadrant Analysis Works



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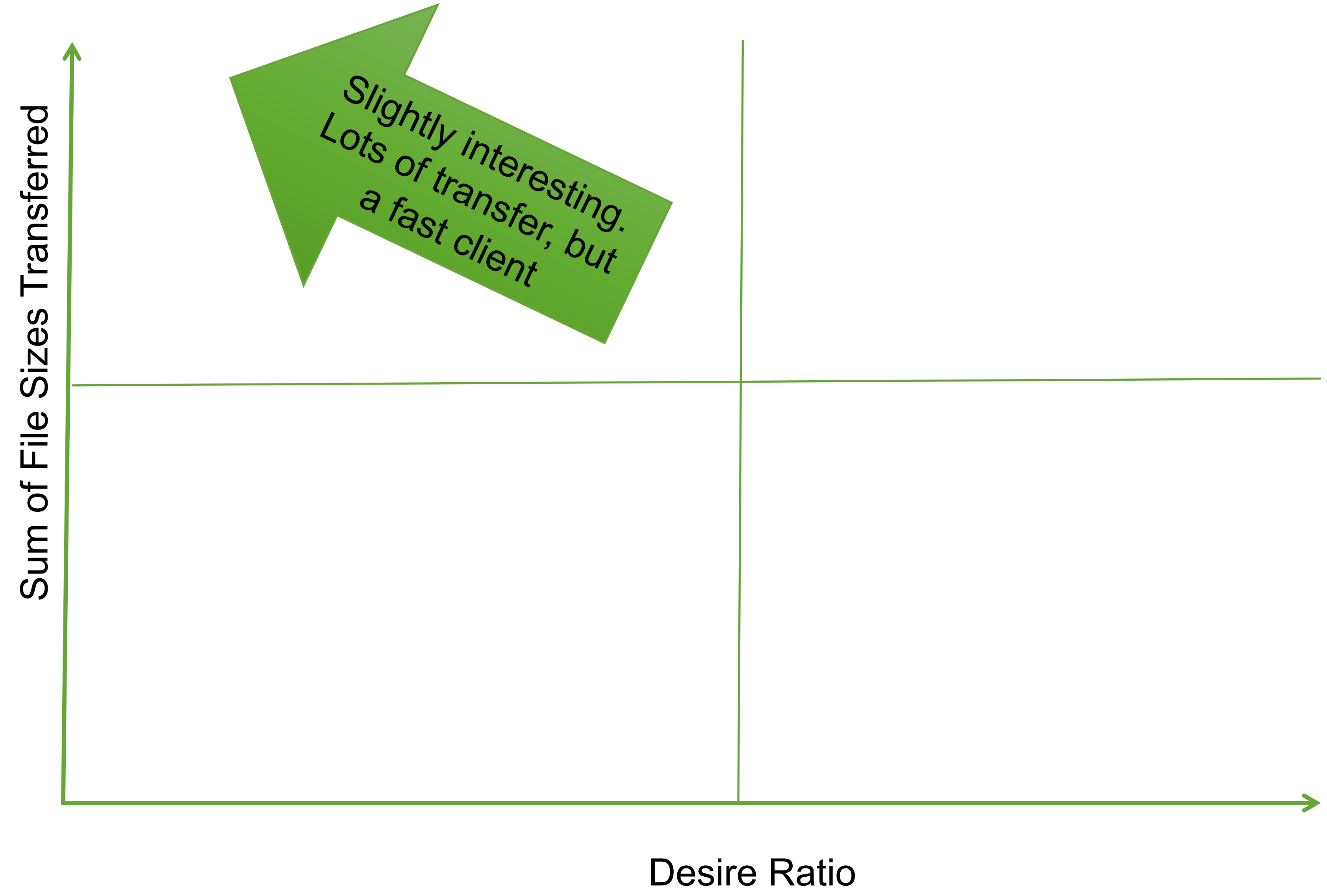

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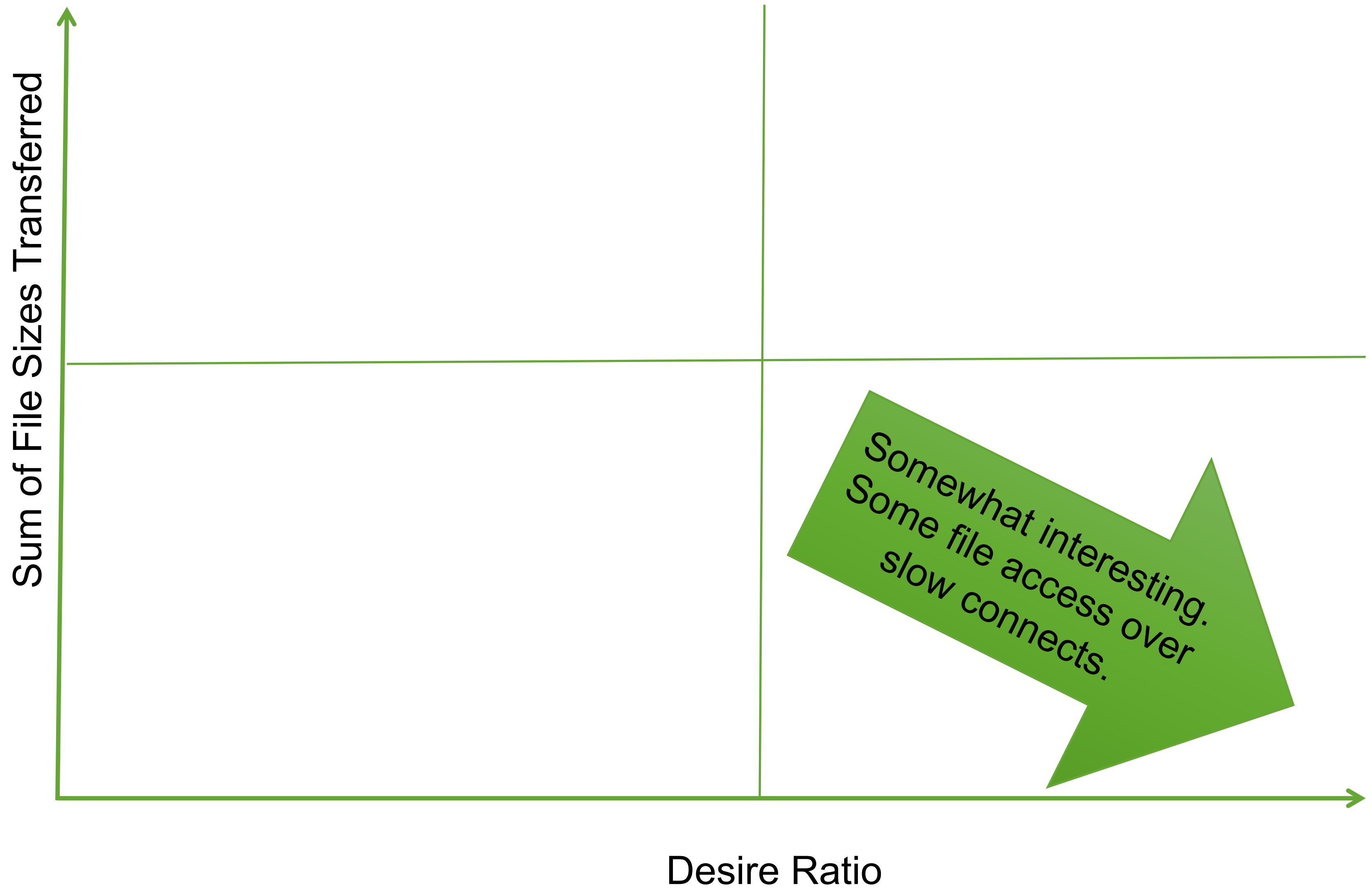

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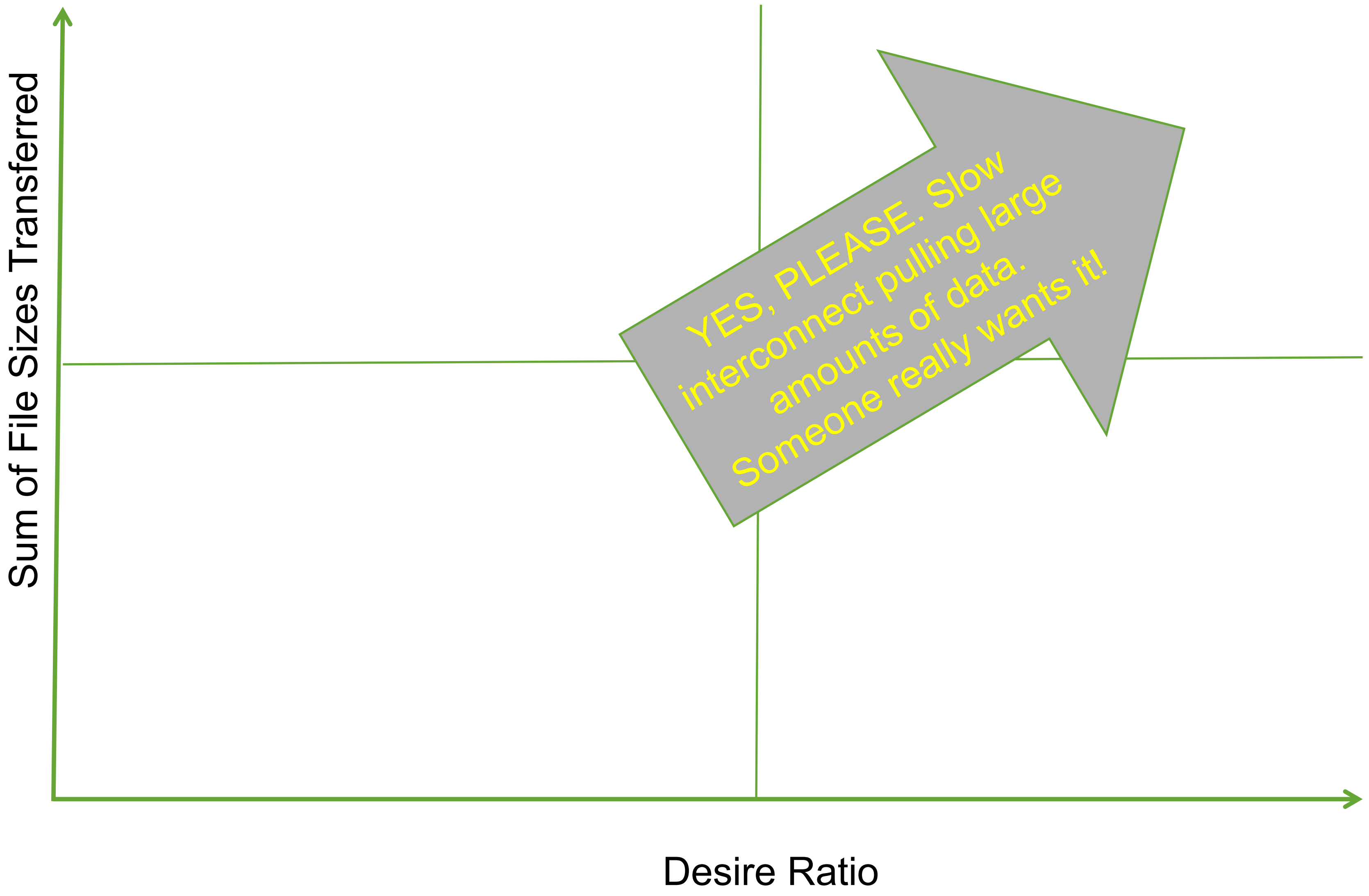

Using Quadrants to Winnow the Field of Knowns

OR, Knowing What You Know

Use Case 1: Dicing Quadrants

- FTP server exfiltration pivot
- Application logs contain artifacts about file transfers
  - File size
  - File transfer time
  - Connected IP address
- Provides introspection on several features
  - Overall size transferred to each client (scale)
  - Velocity can be calculated for each connection (speed)
    - velocity = file size / transfer time

Cracking Addicts With Speed

- Why do we care about transaction velocity?
  - We can make hypotheses based on assumptions
- Assumed
  - Faster clients are closer
  - Faster clients are more legit when pulling large amounts of data
  - Aggressors will tunnel, which introduces latency, thus a slower session
  - Aggressors are geographically far away, which increases the time cost of the interconnect
  - Aggressors want to pull lots of data
  - Aggressors are not Bechtel IPs (RFC 1918, 147.1/16)

Reading the Tea Leaves

- Hypothesis based on previous assumptions
  - Some bad actors can be identified by their velocity characteristics
  - Clients that have fast transfer velocity are less suspicious
  - Clients that have slower transfer velocity are more suspicious
  - Clients that have slow transfer velocity that pull large amounts of data are highly suspicious

It’s a Quadrant!

- Four mathematical assumptions
- Two gradients (size vs. velocity)
- Linked by client address….

It’s a Quadrant!

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We can graph that!

Stalking Desire

- Invert velocity to create a ‘desire ratio’
  - desire_ratio = 1 / velocity
  - Should provide a value between 0 and 1
  - Low numbers indicate low desire
    - high velocity, low effort
  - High numbers indicate high desire
    - low velocity, high effort

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That's an understandable value!

Some Quick Adjustments

- Some transfers were reported as extremely slow
  - In the sub bps
  - Infinitesimal rate blew out the scale on desire ratio.
    - Probably an error
    - Can’t transfer in sub-bytes
  - Made adjustments to present a reasonable scale to analyze the rest of the data
    - 0.0001 < desire_ratio < 1
    - Beyond 1 is an error
    - Below 0.0001 is just too small to care about

Some Quick Adjustments

- There are a lot of small transfers
  - Clutter the bottom of the graph
  - Drag the filesize scale out of analyzable range
- Assumed that we are interested in transfer greater than 5MB
  - filesize > 5000000 bytes

The Query

```
host=LOC* index=ftp_from_host
| spath
| rex field=cliconnaddr "^(?<cliconnaddr_ip>\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}):"
| rex field=lstnconnaddr "^(?<lstnconnaddr_ip>\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}):"
| eval transfer_rate=filesize/transtime
| fillnull value='-' filesize transtime
| search NOT (cliconnaddr_ip=0.0.0.0/8 OR cliconnaddr_ip=0.0.0.0/12 OR
[more of your internal networks here, you get the idea]
OR transtime='-' OR filesize='-')
| eval desire_ratio=1/transfer_rate
| stats avg(desire_ratio) as a_desire_ratio, sum(filesize) as s_filesize by
cliconnaddr_ip
| where s_filesize>5000000 AND a_desire_ratio>.00001 AND a_desire_ratio<1
```

The Breakdown

```
server=ash* index=ftp_from_host
| spath
| rex field=cliconnaddr "^(?<cliconnaddr_ip>\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}):"
```

- Spath
  - Splunk's built-in structured path parser
  - Automatically parses and extracts self-tagged key-value data
  - XML, JSON
- If spath is the Easy Button, why the REX?
  - cliconnaddr includes the IP address AND the port
  - Multiple sessions probably have different ports
  - Want to link by IP address only, not port
  - Need to extract the IP address from cliconnaddr

The Breakdown

```
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[more of your internal networks here, you get the idea]
OR transtime='-' OR filesize='-')
```

- Transfer rate is calculated with ‘eval’
- Eliminate useless events
  - Irrelevant events that report to this host/index combo
  - Don’t have file size or transfer data, but screw with calculated results
  - ‘fillnull’ followed by ‘search NOT’ filters these events out of the data set
  - Also get rid of IP ranges assumed not to be suspicious

The Breakdown

```
| eval desire_ratio=1/transfer_rate
| stats avg(desire_ratio) as a_desire_ratio, sum(filesize) as s_filesize by cliconnaddr_ip
```

- Calculate the ‘desire ratio’ as the inverse of velocity
  - Codifies the hypothesis that pulling data over slow connections means you want it more
- Calculate the average desire ratio and sum of data transferred by the client IP address
  - Averaging the desire ratio smooths bumps that might occur over time
  - Summing file sizes provides a measure over the query time horizon, aggregating the time dispersion of low-and-slow data pulls

The Breakdown

| where s_filesize>5000000 AND a_desire_ratio>.00001 AND a_desire_ratio<1

- Implement filters to apply whitelisting assumptions
  - Only care about data transfers in excess of 5MB
    - YMMV. Adjust as needed.
  - Only care about a ‘desire ratio’ between 1/100000 and 1
    - It seems stupid, but it cuts a lot of high-bandwidth, legit transfers from the graph

But Are We Ever Going To Plot It?

- Run the query
- Engage the visualization engine
  - Format as a scatter plot
  - Adjust X- and Y- axes to logarithmic scales

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AND NOW…

Shotgunning: Scatter Plot

- Lots of noise
  - But, separate!
  - And expected!
  - And all but filtered out on its own!

Shotgunning: Scatter Plot

- Up + Right = Interesting
  - X axis: desire_ratio
    - Rightward = slower
  - Y axis: filesize
    - Upward = larger
- So, up and to the right = slow and determined

Psychoanalysis Session

- Hovering over an interesting dot tells you the IP address
- Check out some quick features
  - DNS resolution
  - WHOIS
  - AS netblock ownership
  - Quick search for malice
- Does it smell bad?

What Did We Accomplish?

- Based on available data, math, and assumptions about demonstrated behavior
- Provided a method to filter down the amount of client IP addresses that need to be analyzed as a cold-call
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Hard indicators always win out!

Quadrant Analysis on Undefined Traffic Data

OR, The “or other methods” part

Use Case 2: Undiscovered Country

- Looked at artifacts from logs for a known activity
  - Discovery had already occurred
- What can we find with Quadrant Graphing on large, unknown datasets?

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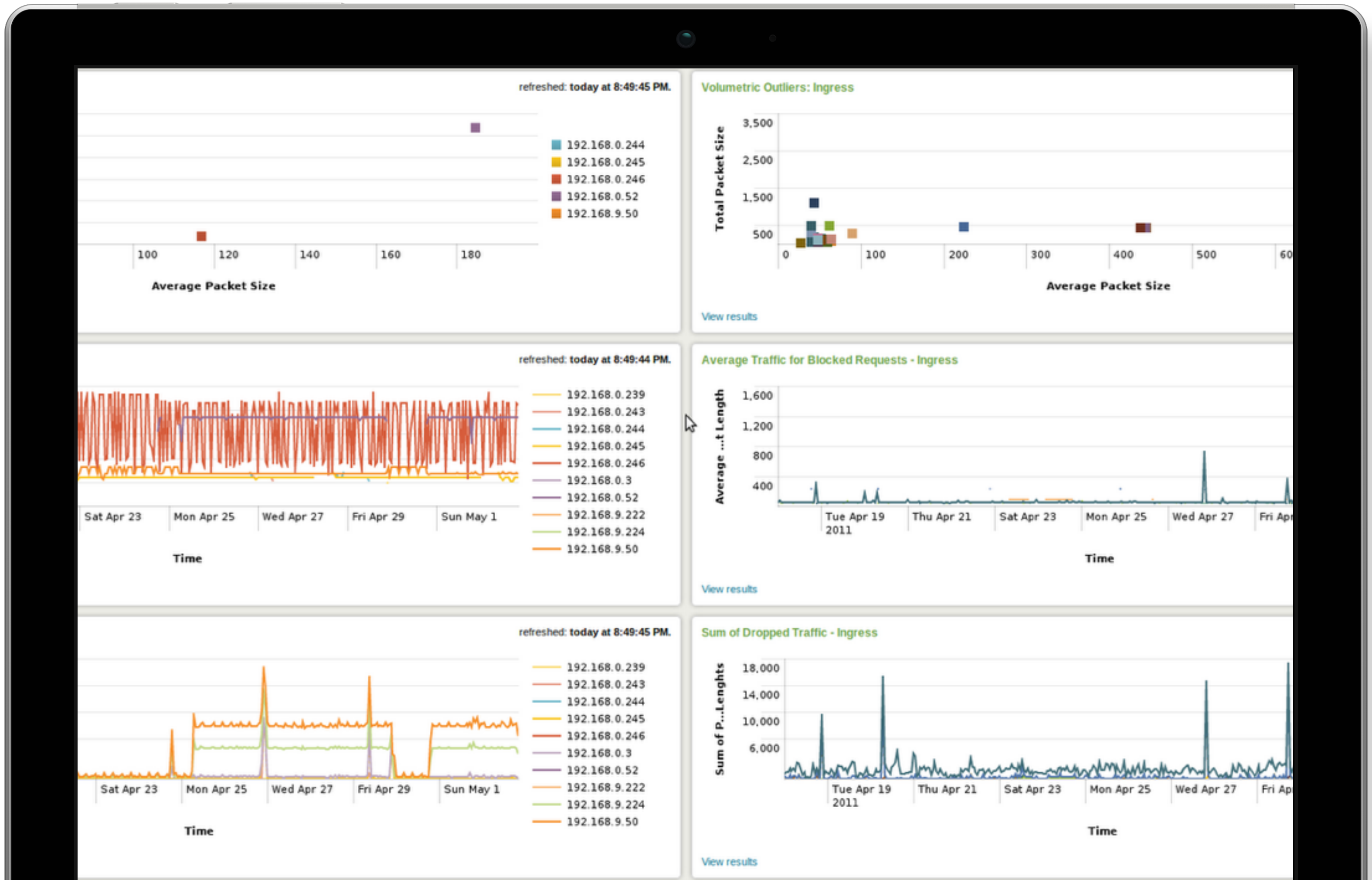
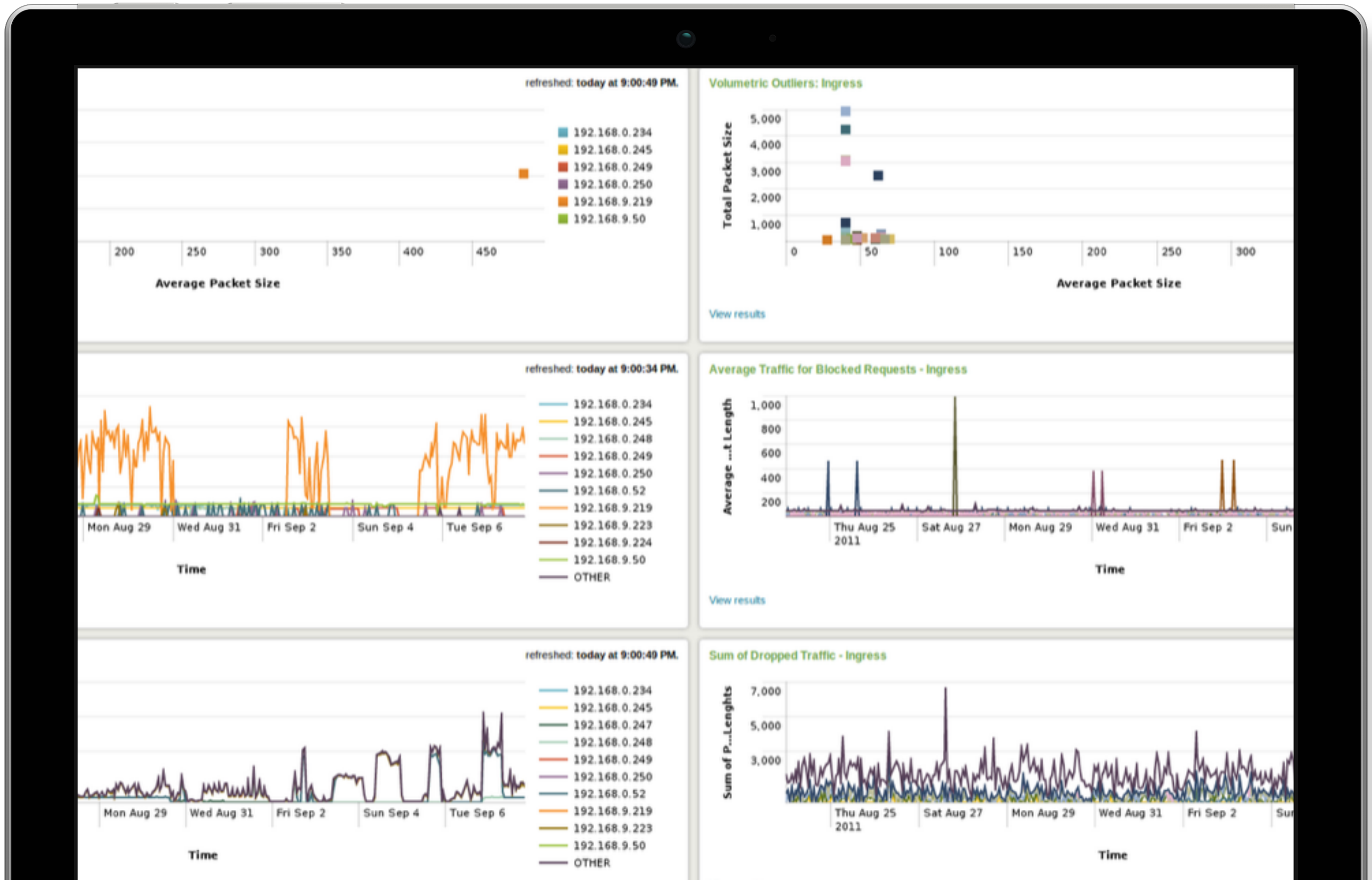
I'm so glad you asked!

Typical Heads-Up Dashboard



- These are all normal
  - …or at least expected
  - Don't worry about it

The Next Day…



- Things look very different, don't they?
  - Averages are normal, but steady, higher than expected baseline
  - Summation of dropped packets much higher than "normal"
  - Scatter plot shows several hosts w/small transactions

What's Different?

- Latter graph is more active, 'noisier'
- Ingress has less diverse drops
- Average vs Summation of packets reveals a clean ratio in the top 10

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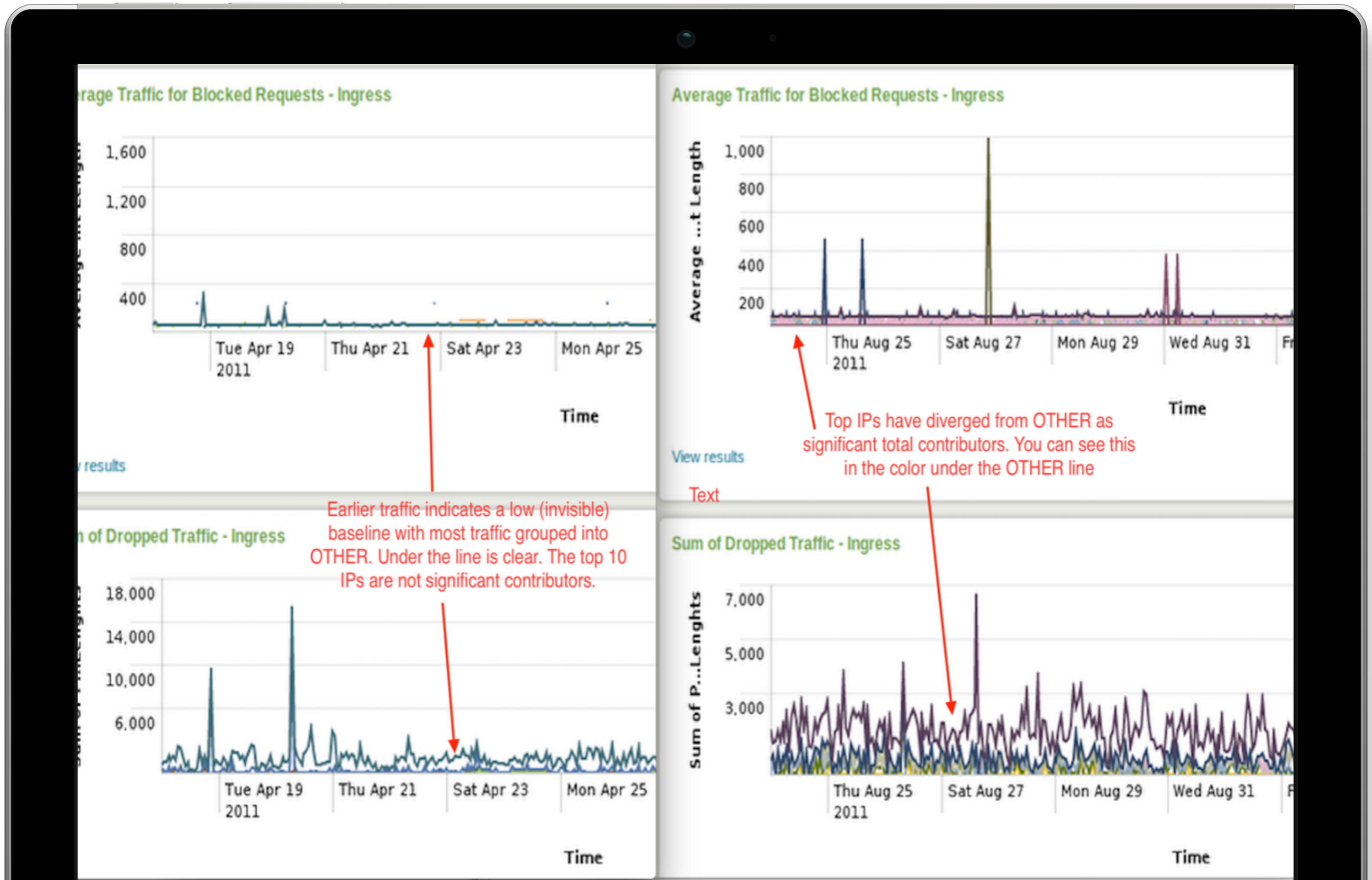
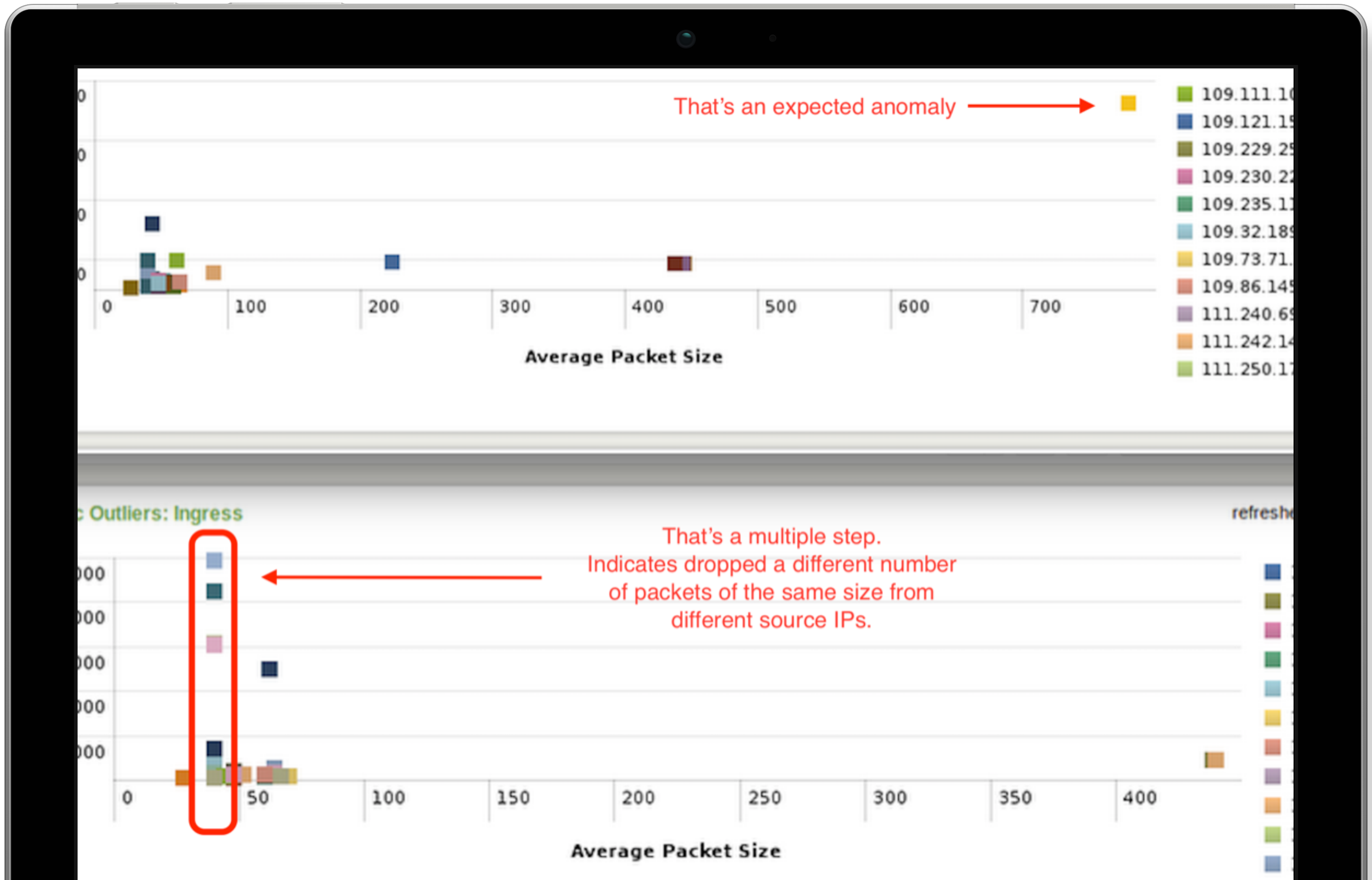
That's weird!

Less Diverse Drops



- Spikes in average blocked requests
- Lots of noise in sum of dropped traffic
- But, what is it?

The Stars Align



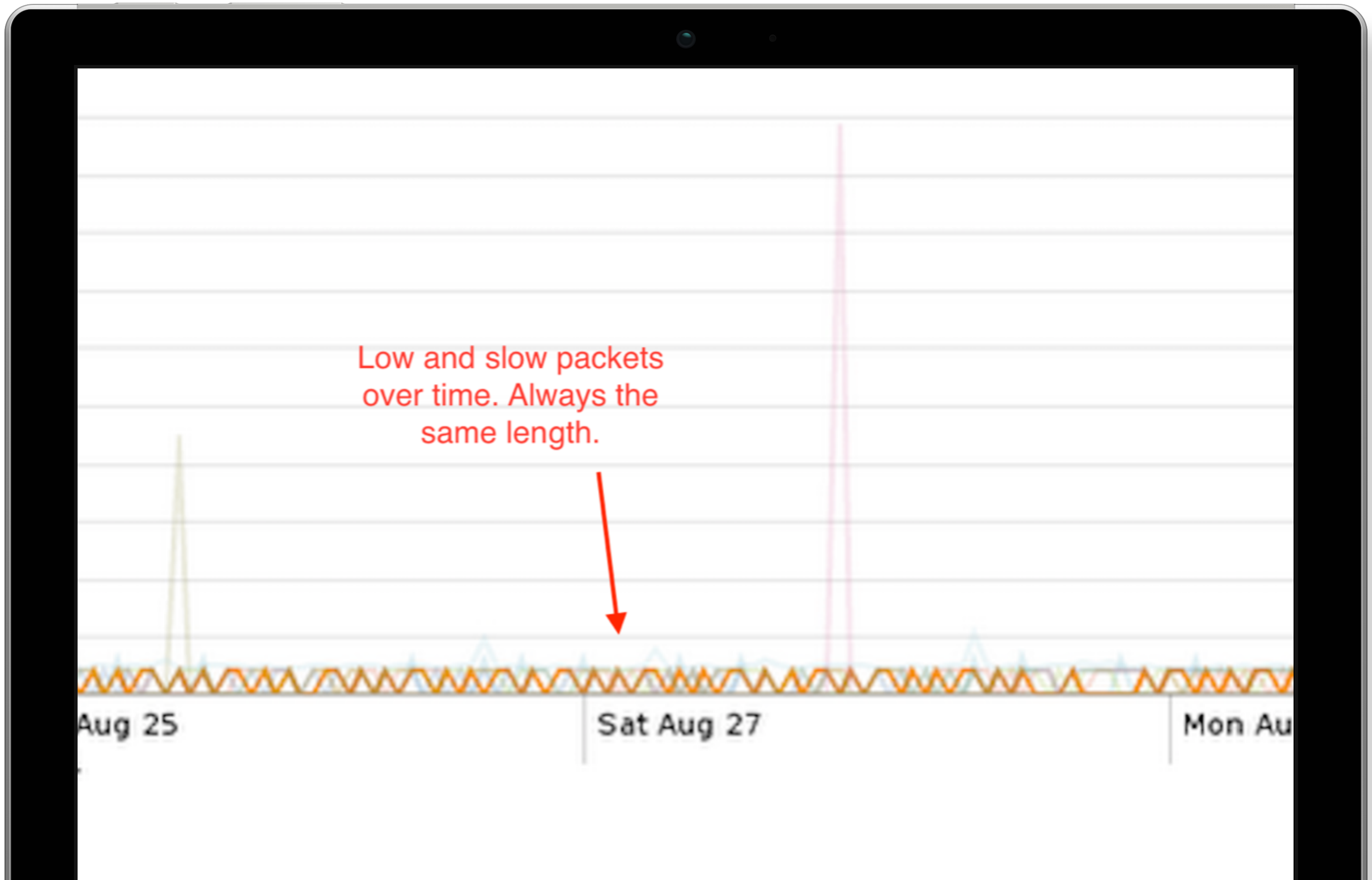
- Those pesky quadrants again
  - Nothing really jumps out for yesterday
  - But today's another story - what's up with that column?

So, Here's Another Query

```
sourcetype=firewall decision=b AND NOT
(s_ip=192.168.* OR s_ip=169.254.1.* OR s_port=80 OR s_port=443)
| fields s_ip, pkt_len
| timechart limit=0 span=1h sum(pkt_len) by s_ip
```

- Looking at firewall drops
  - Filter out local address space and known garbage
  - Filter out huge streams like HTTP[s] that tunnel everything. Not enough context at this level of analysis
- Limit to just the fields you want. Speeds search. The optimizer can reduce the number of fields it needs to parse.
- Sum packet lengths by source IP and display in a visual timechart

Shh! I'm Hunting Wabbits….



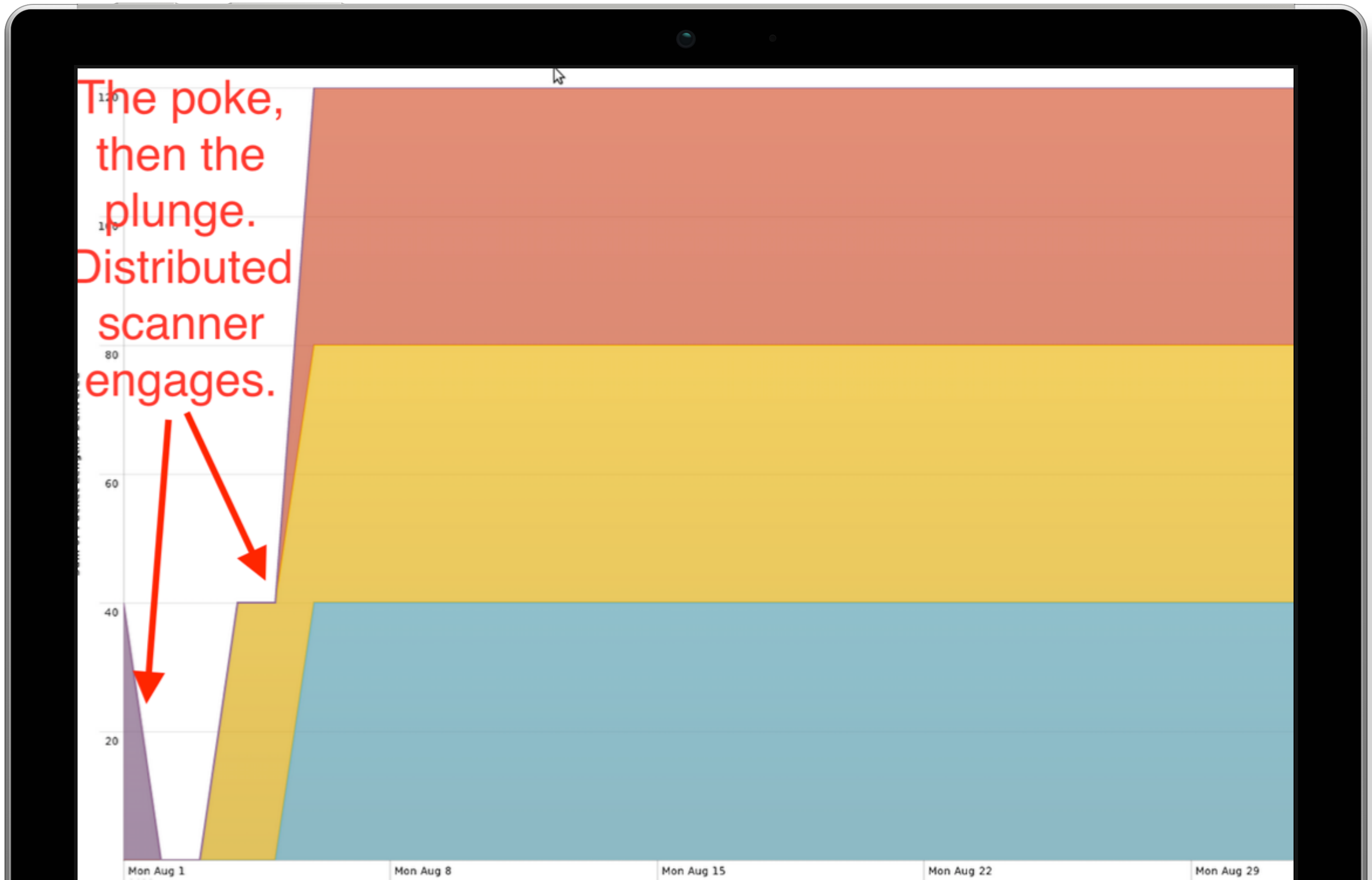
- Further hunting
  - Treat null values as 0
- One block ended up showing low and slow activity
- Time to investigate further….

More Hunting Means More Queries

```
sourcetype=firewall decision=b 58.218.199
| fields s_ip, pkt_len
| timechart limit=0 span=1d avg(pkt_len) by s_ip
```

- Search firewall events for specific network
  - Full text indexer parses on punctuation and spacing
  - Designed for IP addresses and domains!
  - CIDR field match notation also available
- Limit fields
- Chart in time by the average packet length for the subnet

Wabbit Season, Meet Duck Season



- Stacked area chart
  - Treat null values as 0 (again)
- Distribution even between scanners
  - Single host used as a preliminary sniffer

Fudging Fudd

- We have discovered a distributed scanner
- Have a fair idea of some of the infrastructure
- What is it looking for?
- Intent?

Fudging Fudd

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- Have a fair idea of some of the infrastructure
- What is it looking for?
- Intent?

What hunting season is it?

Wow, Much Query, Very Splunk

```
sourcetype=firewall decision=b 58.218.199
| fields s_ip, d_port
| dedup s_ip, d_port
| stats count as source_scanners by d_port
| sort -source_scanners
| lookup portServices port as d_port OUTPUT service as service
| table d_port, service, source_scanners
```

- Search prior subnet with field filters for s_ip, d_port
- Dedup source IP/dest port since only interested in counting the number of services hit
- Count and sort. This orders the numbers for the visualization
- We built a quick lookup table. You can, too!

It's Open-Proxy Season!

	d_port	service	source_scanners
1	1080	socks	3
2	2301	compaqdiag	3
3	2479	ssm-els	3
4	27977	TDSS open proxy	3
5	3246	Kademlia P2P (mlnet)	3
6	5390	Bosch Video Management System Software-open proxy	3
7	6588	AnalogX-proxy	3
8	7212	GhostSurf open proxy	3
9	73	netrjs-3	3
10	80	www	3
11	8000	iRDMI	3
12	8008	http-alt	3
13	8080	http-alt	3
14	8085	OKOGATE open proxies	3
15	8088	omniorb	3
16	8090	http-alt-alt	3
17	8118	privoxy	3
18	8123	polipo proxy	3
19	9000	CSlistener	3

- Proxys upon proxies
  - Upon proxies
- Each one shows up with three scanners
  - Look familiar?

Playing Favorites?

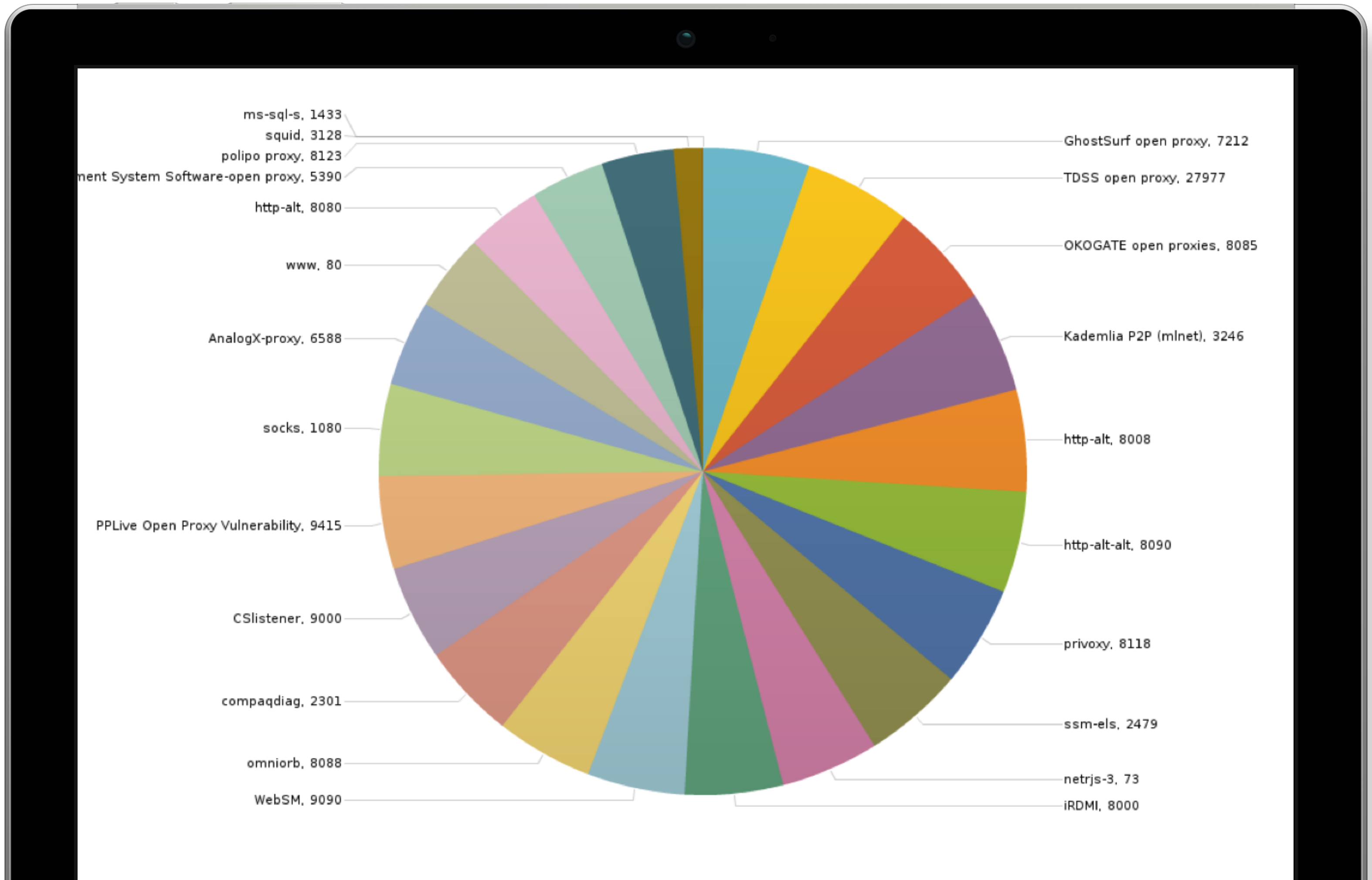
- Scanners appear to hit each service in the individual node runs
- REVERSE PERSPECTIVE
  - Sometimes this reveals other anomalies
  - Does the cluster favor certain services?
  - Does it look for one thing more than the others?

Revising That Last One

```
sourcetype=firewall decision=b 58.218.199
| fields s_ip, d_port
| lookup portServices port as d_port OUTPUT service as service
| strcat service ", " d_port label
| stats count as source_scanners by label
| sort -source_scanners
```

- Same base search
- Augment data with port descriptions
- Concatenate the text data into a label
  - Pie chart only accepts a text column and a number
- Count the hits
- Sort to make visualization nicer

EEO Compliant Proxy Hunter



- Pie chart, names and ports
- Hope you're not colorblind
  - (David is. Don't ask him to count wedges.)

What Did We Learn?

- Found a distributed scanner
- Linked the scanning nodes simply by packet size, time proximity, and math
- Looking for open proxies from poorly configured services and leftover malware
- Scanner is pretty static. Same packets
- Scanner looks evenly for proxy ports, no favoritism

Thank You

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