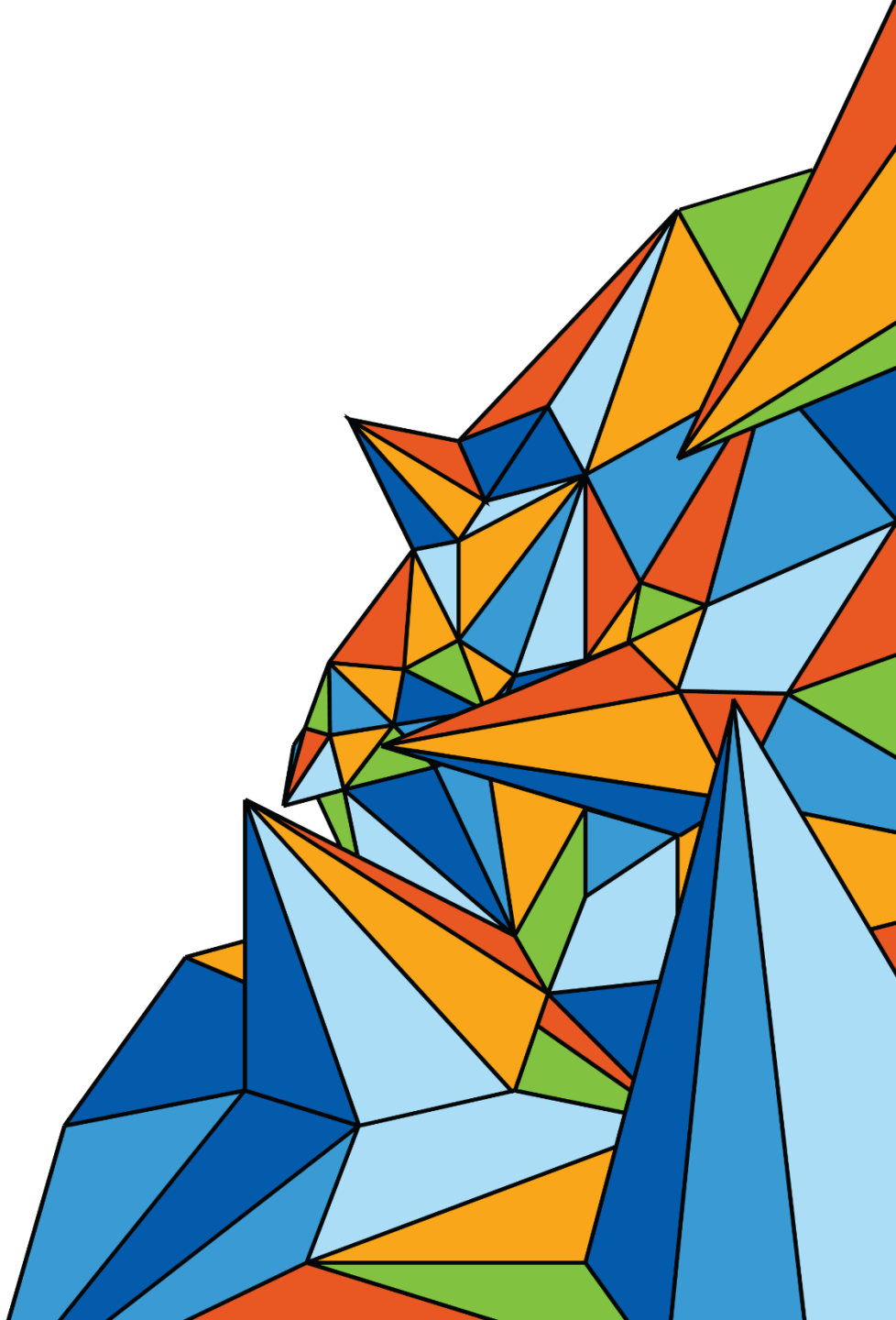
2015 UNITED
RAPID7 SECURITY SUMMIT

RAPID7 RESEARCH

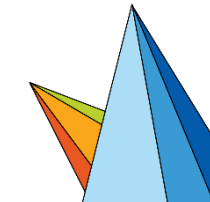
PROJECT SONAR

HD Moore



Agenda

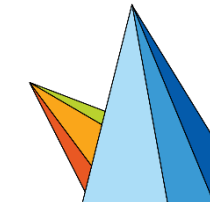
- Internet Scanning
- Global Overview
- Exposure Trends



What this talk is NOT about

- Making fun of technology users due to product flaws
- Image galleries of open industrial systems
- Snapshots of baby monitor cameras
- Shaming product vendors
- ShellHeartPoodleBleed
- Pew Pew Attack Maps

Internet Scanning



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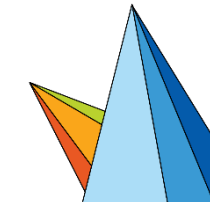
Why Scan the Internet?

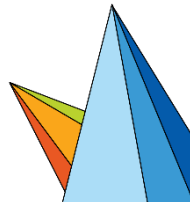
- Improve security decision making with real-world data
- Fix endemic security flaws before they get exploited
- Prioritize vulnerability research according to impact
- Improve open source security tools
- Hold vendors accountable
- Make the Internet safer
- The kids are doing it



Why You Shouldn’t Scan the Internet

- Network administrators see scans as attacks
- Scanning the internet is resource-intensive
- Lots of complaints (legal & physical)
- IP addresses constantly shuffle
- Processing can be difficult

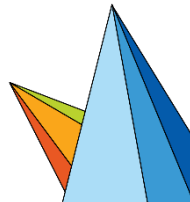
- **Skip all of this and use publicly available data!**



Internet Scanning with Project Sonar

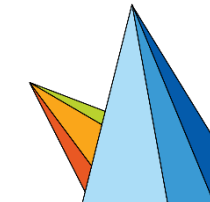
- Focused entirely on IPv4 and public DNS records
  - 1.0.0.0 to 223.255.255.255
  - Exclude reserved & private ranges
  - Exclude our opt-out list
- Scan about 3.7 billion IPv4 addresses
  - Scans run sequentially, from a single server
  - Typically span Monday - Friday

* Unless you opted out, see https://sonar.labs.rapid7.com/



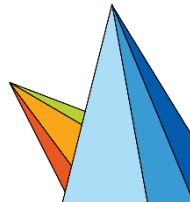
TCP & UDP Scanning

- Use Zmap to scan all of IPv4, except for opt-out ranges
- UDP scans are throttled to 180,000 pps on average
- TCP scans only send the SYN packet
- AWS nodes used to grab banners
- Data is deduplicated & decoded
- Uploaded to https://scans.io/



Project Sonar TCP & UDP Services

UDP	UDP	SSL	TCP
53	1900	25	22*
111	5060	143	80*
123	5351	443	445*
137	5353	993	
623	17185	995	
1434	47808		



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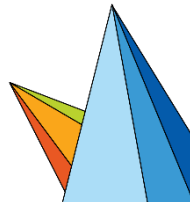
Reverse DNS Enumeration

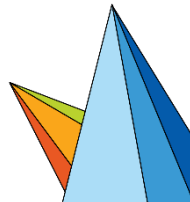
- Reverse DNS lookup of 0.0.0.0/0 every two weeks
  - Use dozens of cloud nodes to balance the load
  - Accidentally melted a few Tier-1 ISPs*
- 1.2 billion PTR records on average



Forward DNS Enumeration

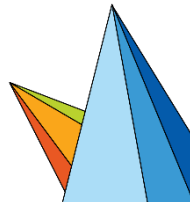
- Forward DNS is driven by a giant list of hostnames
  - Pulled from TLD/gTLD zone files
  - Extracted form SSL certificates (SAN/CN)
  - Extracted from HTTP scan HTML references
  - Extracted from PTR records

- 1.4 billion records on average



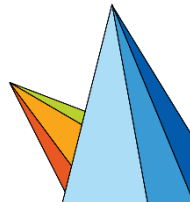
Data, Tools, and Documentation

- Public Datasets
  - https://scans.io/
- Open Source Tools
  - https://zmap.io/
  - https://nmap.org/
  - https://github.com/rapid7/dap/ && https://github.com/rapid7/recog/
- Documentation
  - https://github.com/rapid7/sonar/wiki

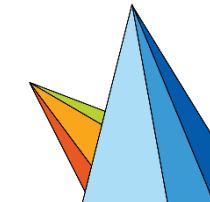


Other Projects & Data Sources

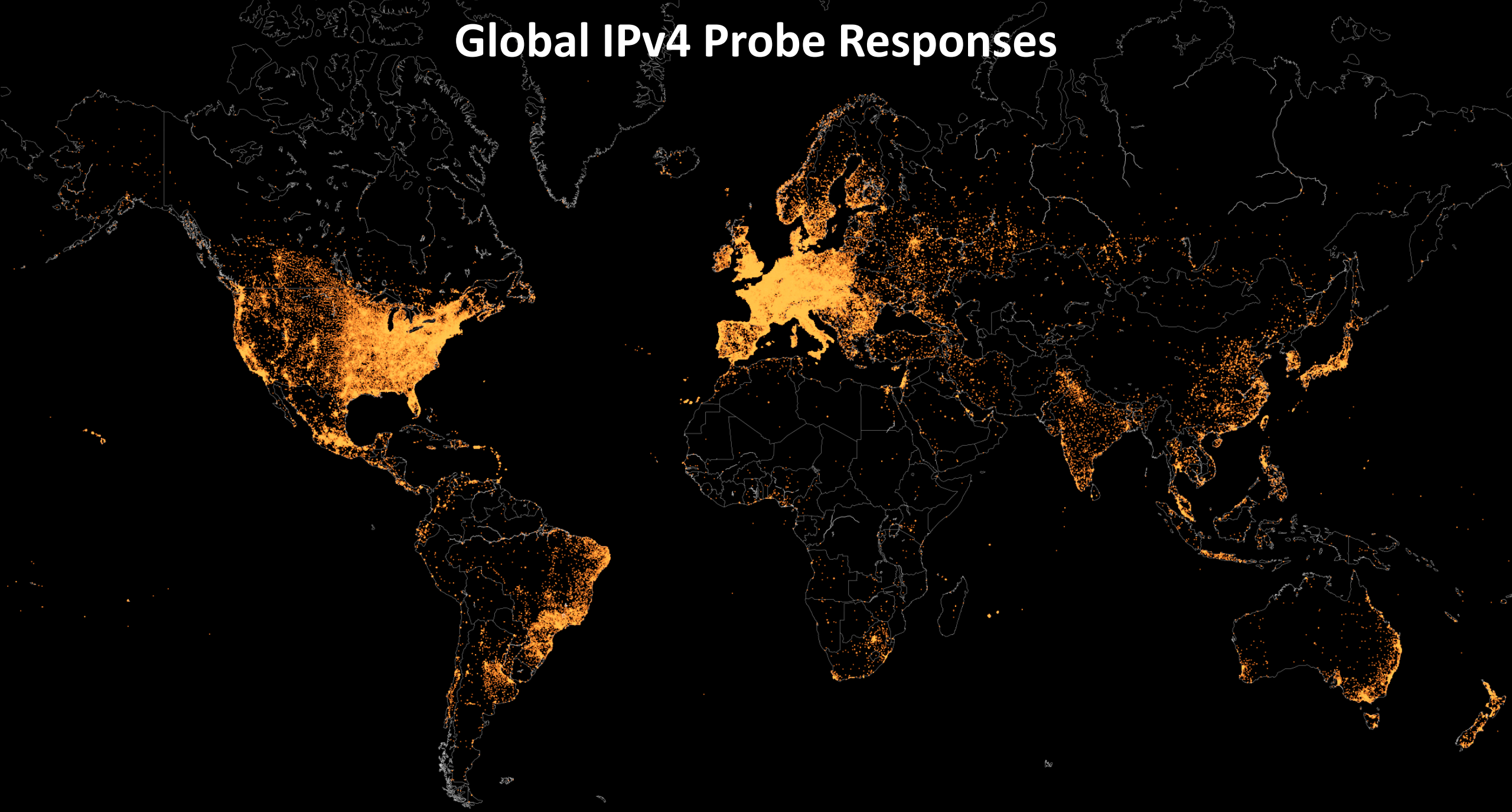
- Active scanning projects with public data
  - University of Michigan: https://scans.io/
  - Shodan: https://shodan.io/
- Older scanning projects with public data
  - http://internetcensus2012.bitbucket.org/ (2012)
- Previous scanning projects
  - Critical.IO (2012-2013)
  - PTCoreSec (2012+)
  - Metlstorm: “Low Hanging Kiwi Fruit” (2009+)
  - Nmap: Scanning the Internet (2008)
  - BASS (1998)



Global Overview

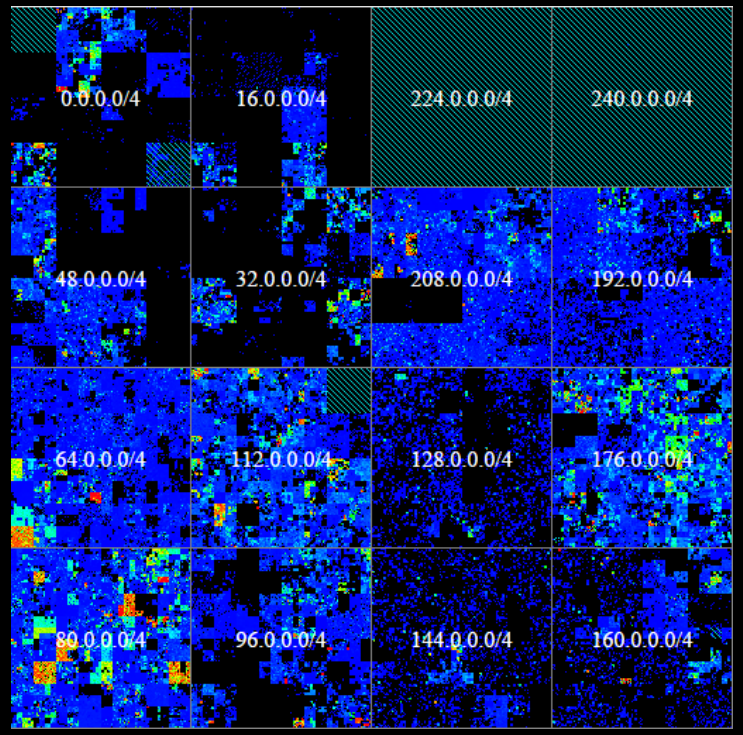


Global IPv4 Probe Responses

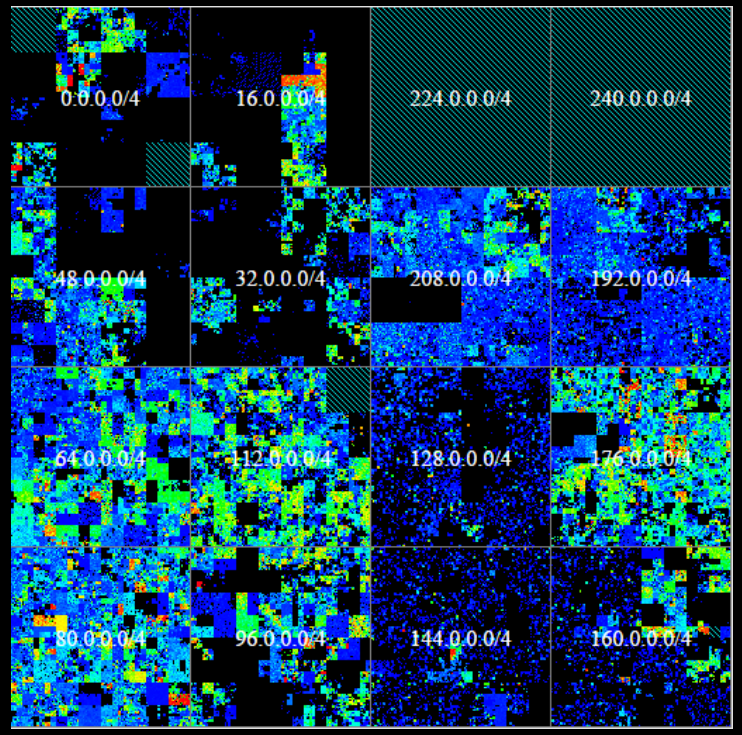


Source: 2015-04-06 Shodan ICMP scan + Project Sonar UDP & TCP scans

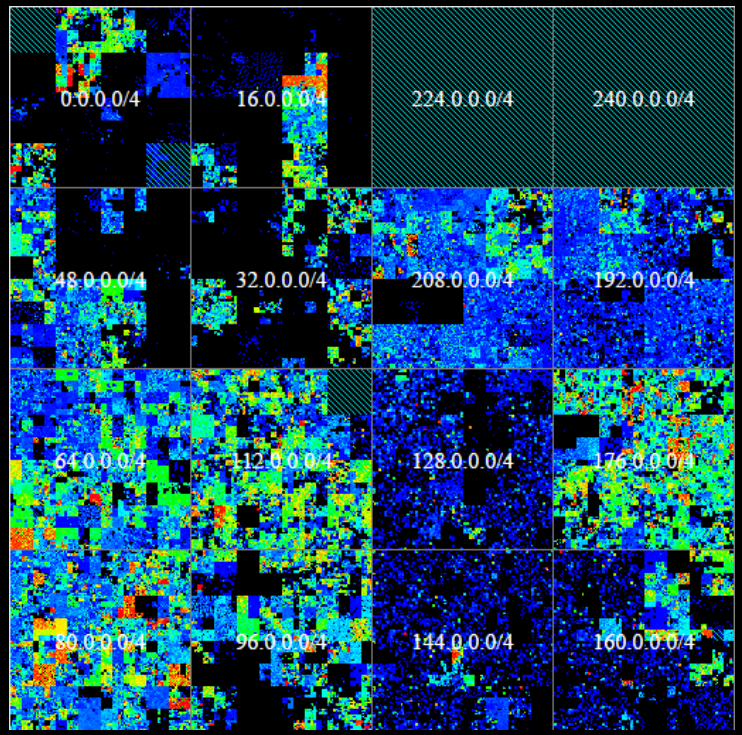
UDP Only



ICMP Only



Combined



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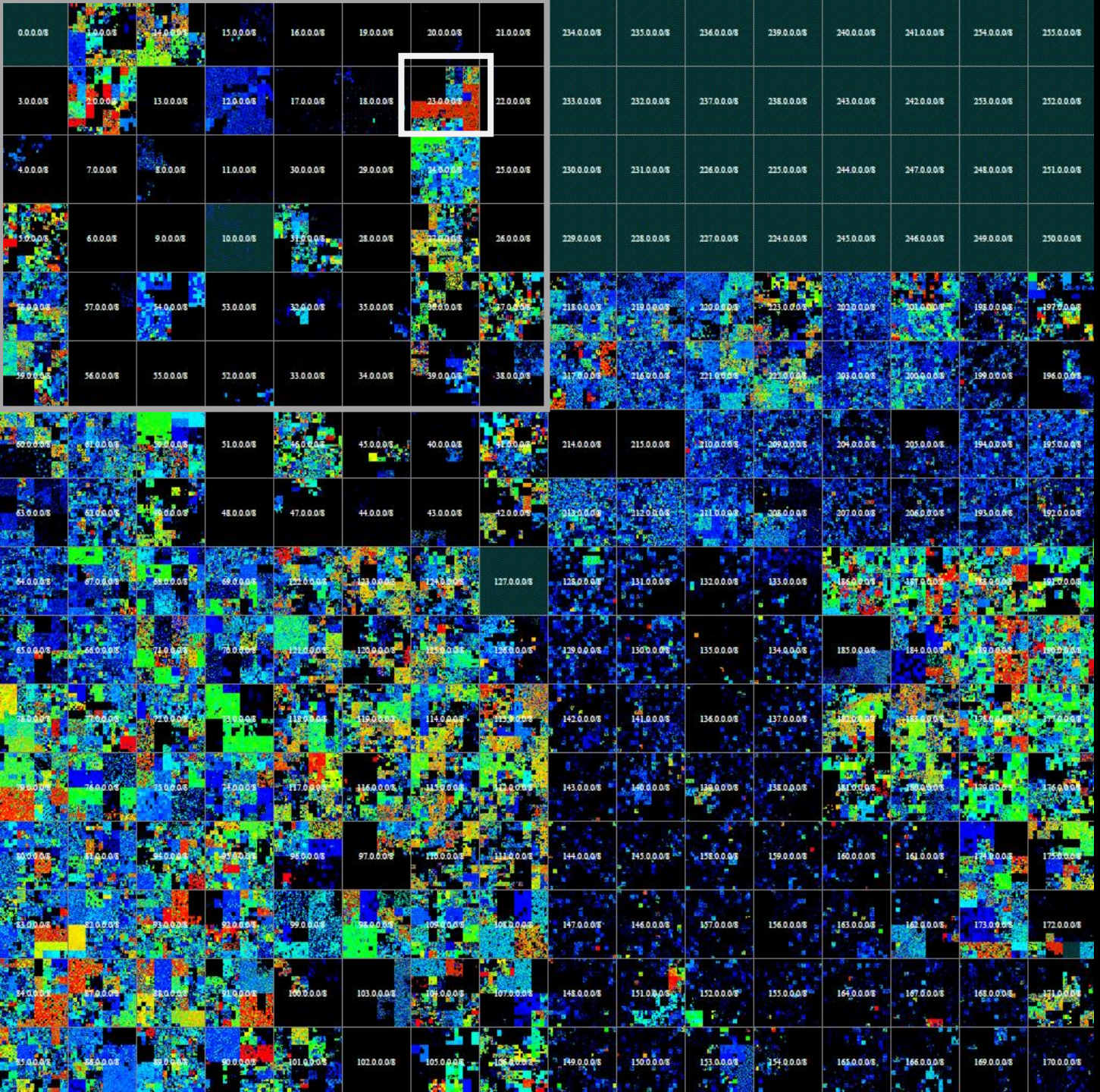
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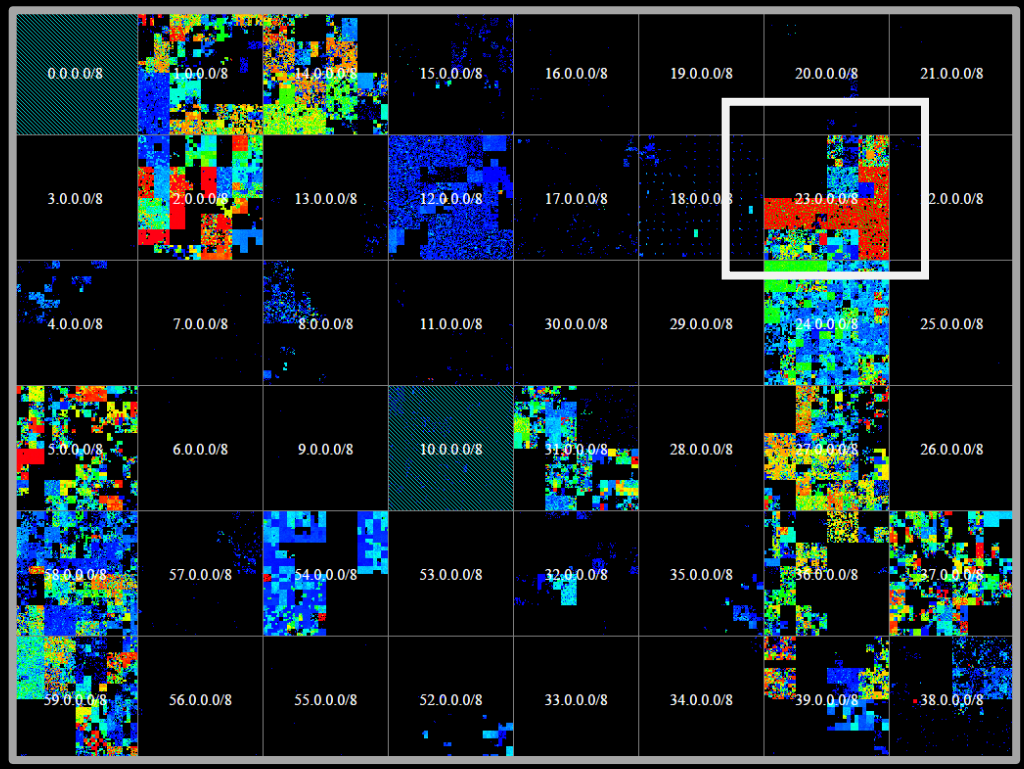
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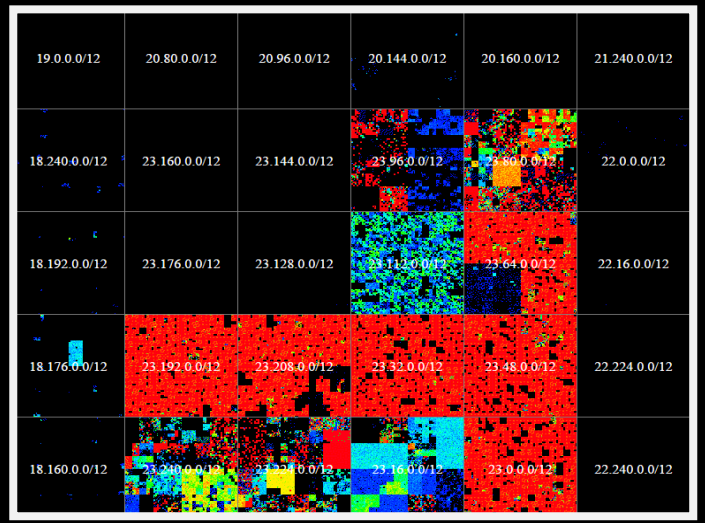
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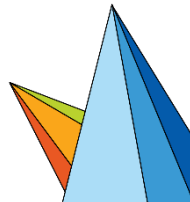
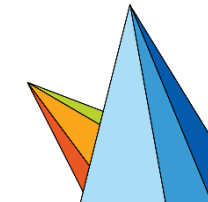
What is the internet?

- In terms of unique systems? Nobody really knows
  - Cisco claimed **8.7 billion** in 2012, predicted **15 billion** in 2015
  - Carrier NAT hides a millions of connected nodes
  - Firewalls and traditional NAT hide the rest
  - Over 7 billion active mobile phones
  - IPv6 gateways also do IPv4 NAT



What is directly exposed on the IPv4 internet?

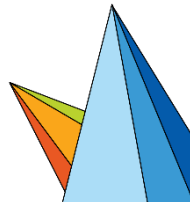
- Approximately 1 billion IPv4 systems are directly connected
  - ~500 million broadband clients and gateways
  - ~200 million servers (web, email, database, VPN)
  - ~200 million mobile devices (phones, tablets)
  - ~100 million devices (routers, printers, cameras)



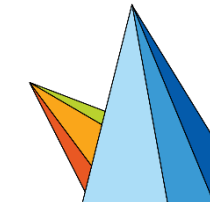
What about IPv6?

- Somewhere between 10-20 million IPv6 global unicast nodes
  - 97.6% of top-level domains have an IPv6 DNS record*
  - 6.7 million domain names with a top-level AAAA record*
  - RIPE has issued over 8000 network blocks
  - HE.net TunnelBroker alone serves 562,000 users

*** 2015-04-19 Hurricane Electric IPv6 Progress Report http://bgp.he.net/ipv6-progress-report.cgi**

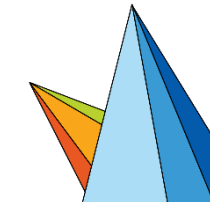


Exposure Trends

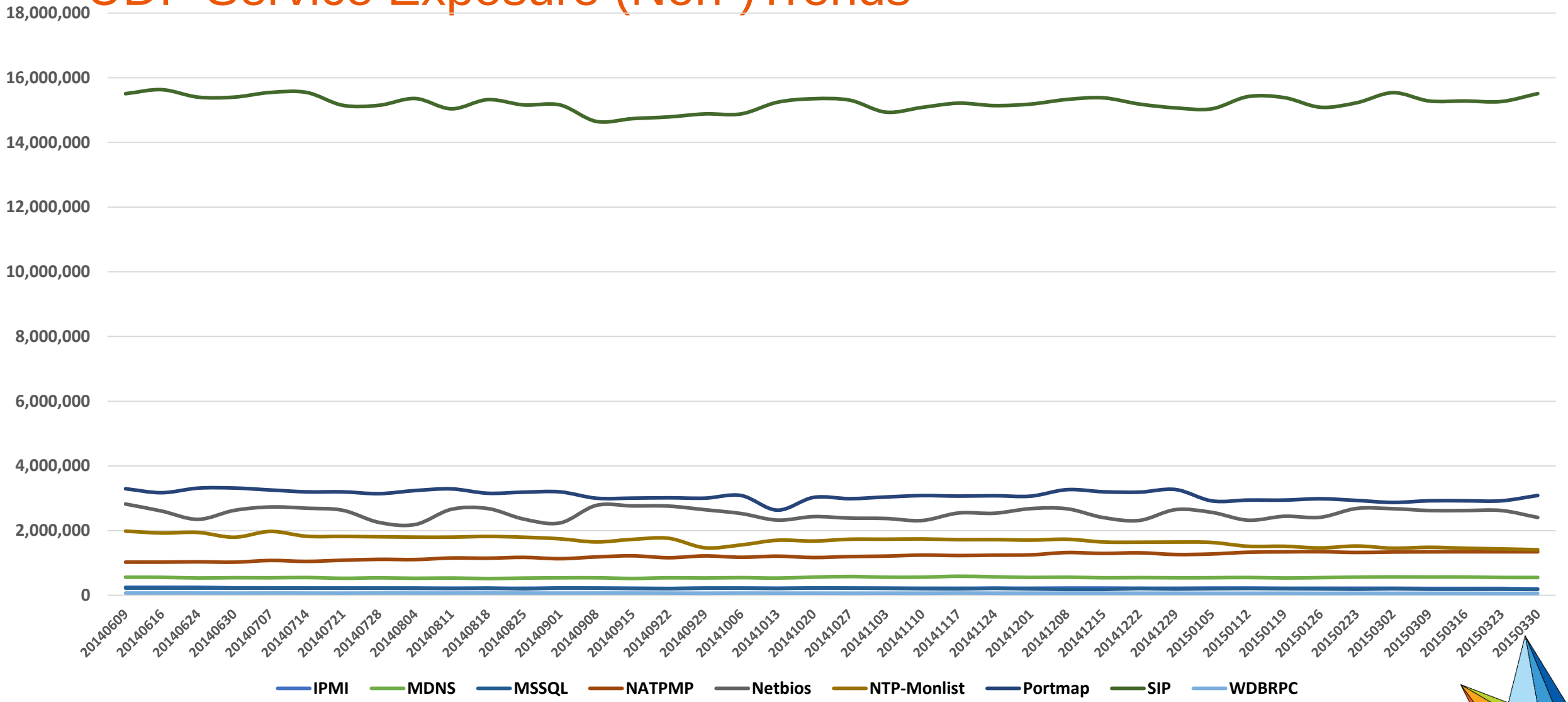


Service Trends

- Project Sonar scans 12 unique UDP services each week
- Most should never be exposed to the internet
- Many can lead to a direct compromise
- How have exposure levels changed?



UDP Service Exposure (Non-)Trends



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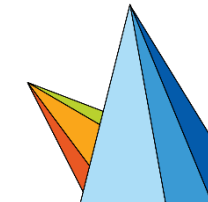
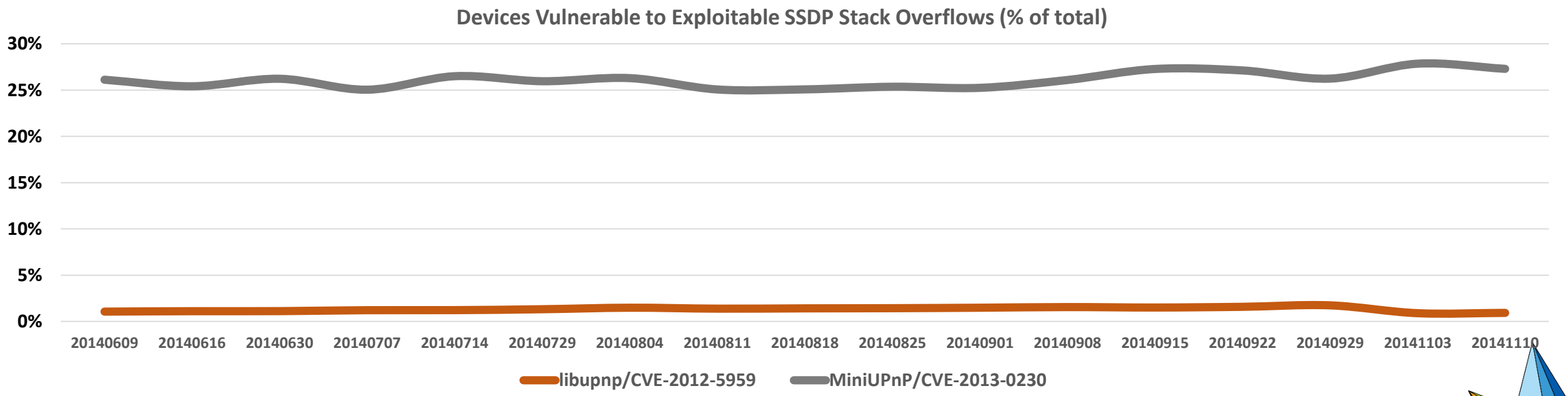
Vulnerability Trends

- Instead of service trends, how about vulnerability trends?
- Are known vulnerabilities getting patched?
- How quickly are patches being applied?



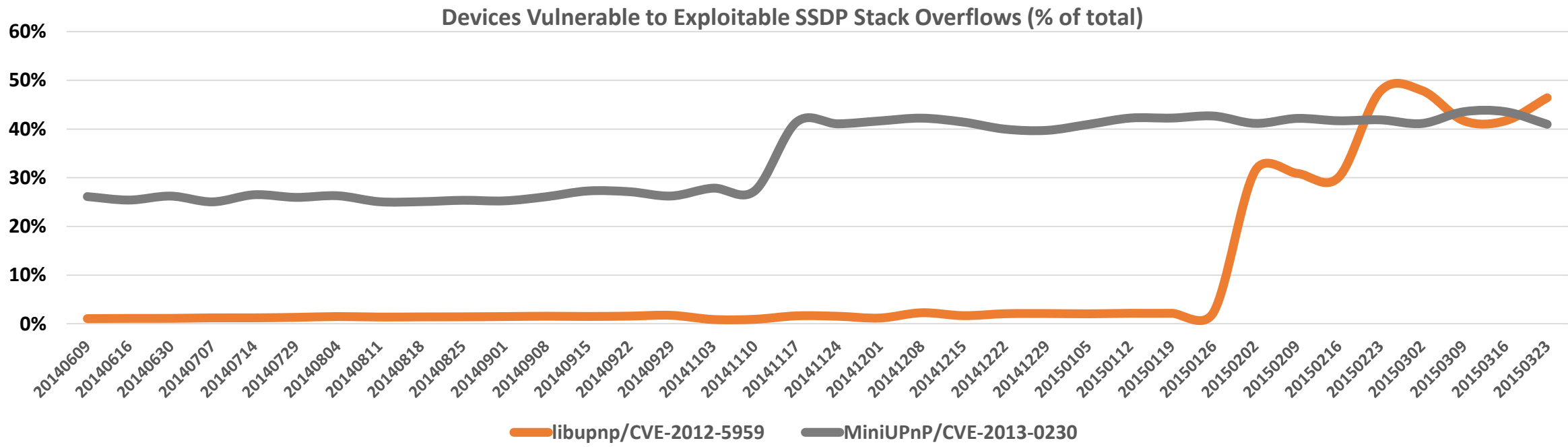
UPnP SSDP Vulnerabilities (1900/udp)

- Monitored two UPnP SSDP vulnerabilities that have public exploits
- We tracked the % of vulnerable services for libupnp & miniupnp
- June 2014 to November 2014 is basically flat…



UPnP SSDP Vulnerabilities (1900/udp)

- In late 2014, both of these issues spiked dramatically
- Likely the result of a new broadband ISP deployment
- Vulnerability ratio is higher in 2015 than 2014!



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SSDP Distributed Reflective Denial of Service

- SSDP should never be internet-facing in the first place
- DrDoS capabilities in addition to exploits
- 15+ million SSDP services
- Massive amplification
- Live stats at SS
  - https://ssdpscan.shadowserver.org/

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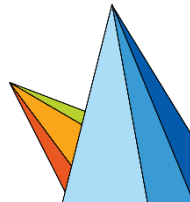
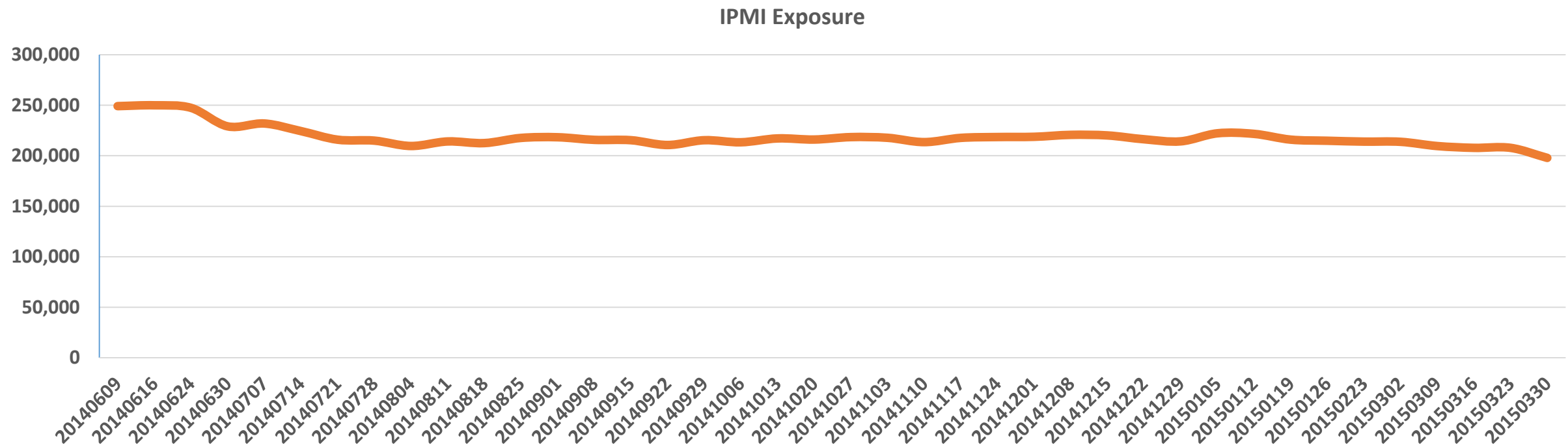
IPMI: The Server Backdoor (623/udp)

- IPMI is used for OOB server management (iDRAC, iLO, SMC IPMI)
- Almost the equivalent of physical access
  - Keyboard, video, mouse, ISO boot, I2C bus access
- Typically Linux running on ARM or MIPS SoCs
- Enabled by default on major server brands
- Dan Farmer broke the IPMI protocol
  - http://fish2.org/ipmi/



IPMI Exposure (623/udp)

- We identified ~300,000 exposed instances in 2013
- This dropped down to ~250,000 as of June 2014
- Leveled off at ~210,000 in January 2015



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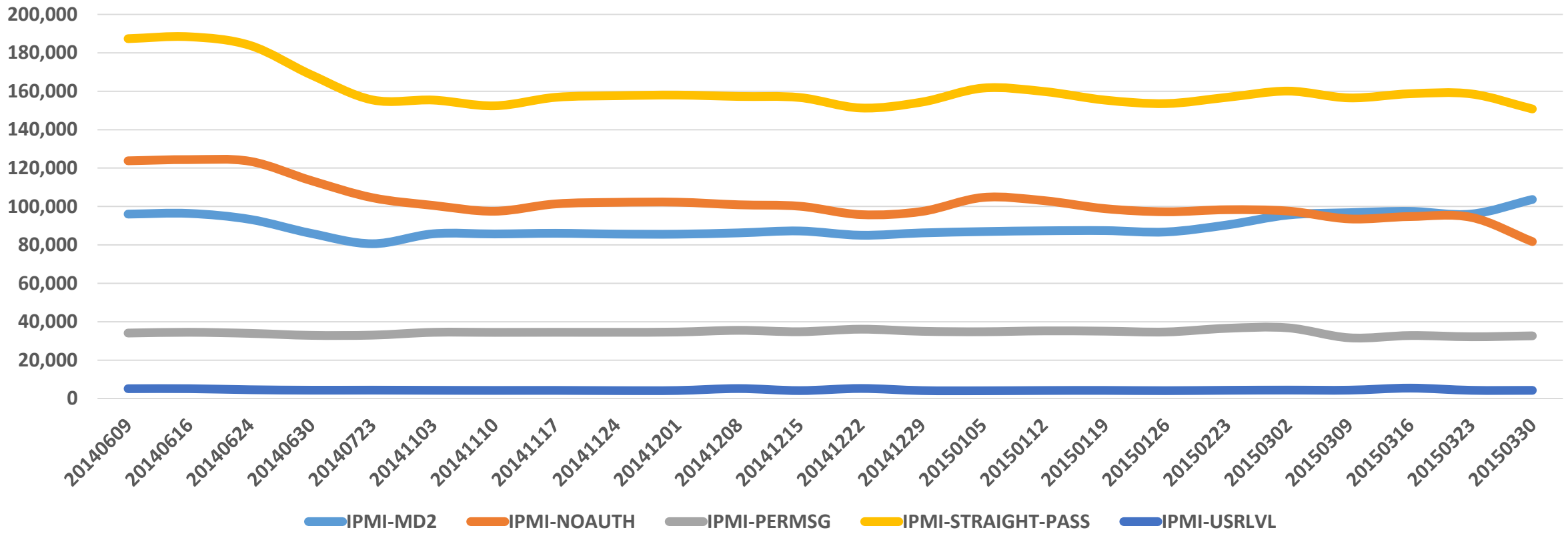
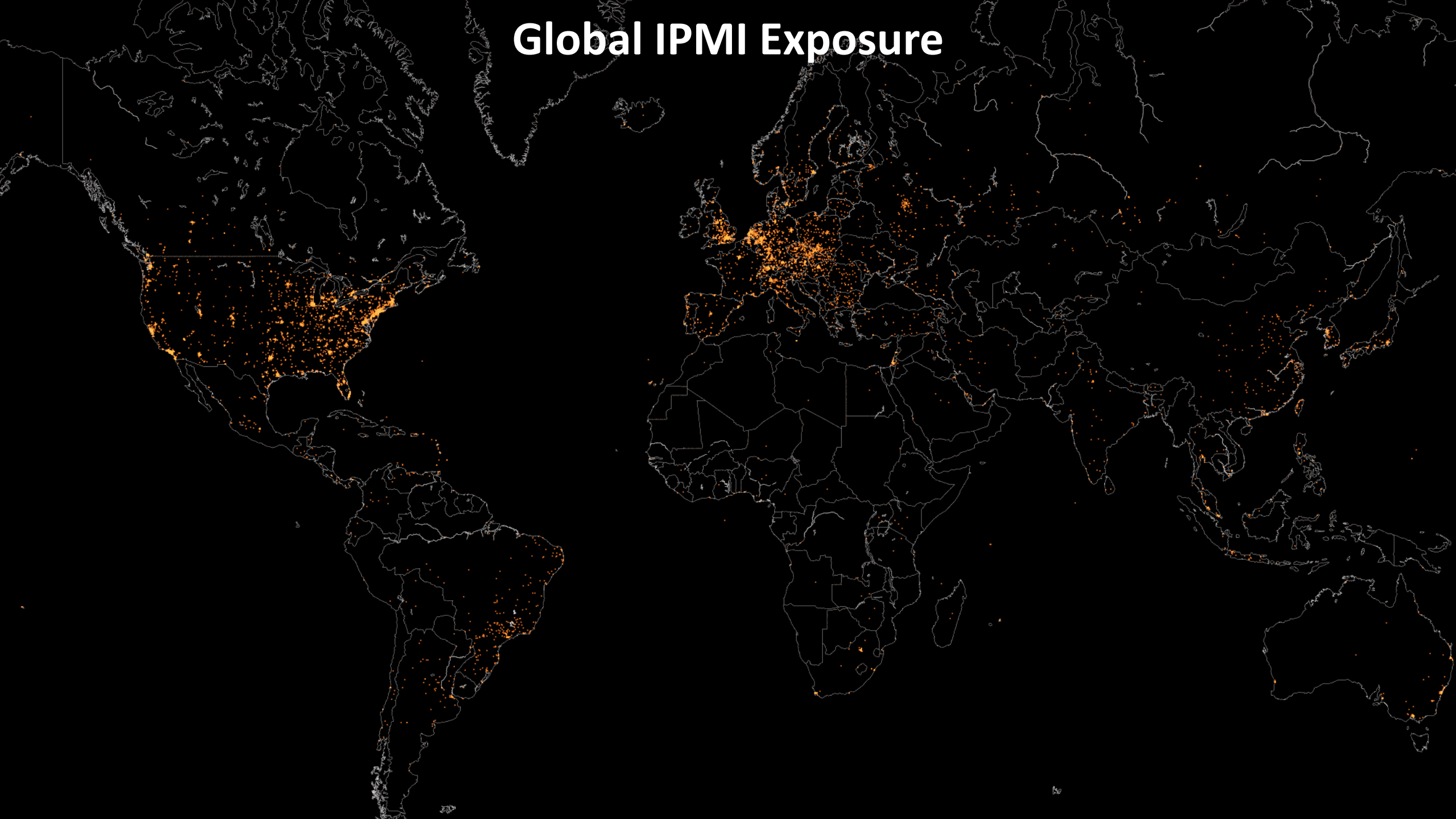
IPMI Capabilities

- The IPMI probe response includes a list of capabilities
- 50% support anonymous authentication!

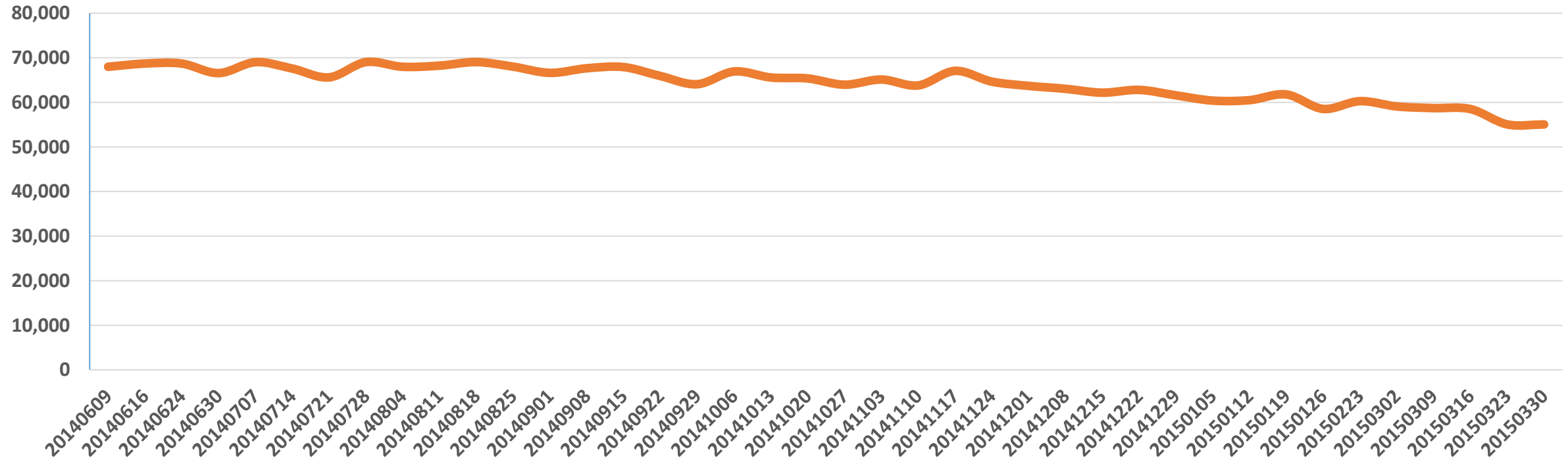


Global IPMI Exposure



Vxworks 5.x Debugger Exposure (17185/udp)

- WDBRPC has dropped from 300k to about 65k since 2010
- Provides remote memory access and OS control
- Relatively flat exposure level for the last year



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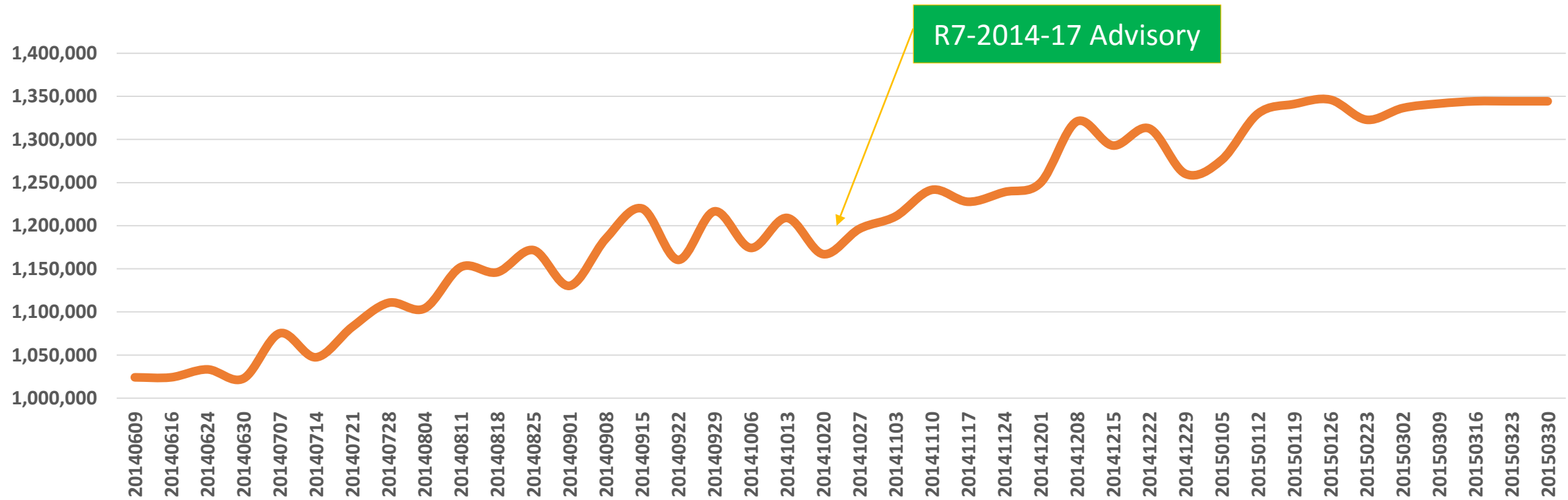
NAT-PMP Exposure (5351/udp)

- This service should never be on the internet by definition (RFC)
- Increasing exposure, even after CERT/CC advisory



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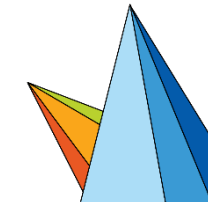
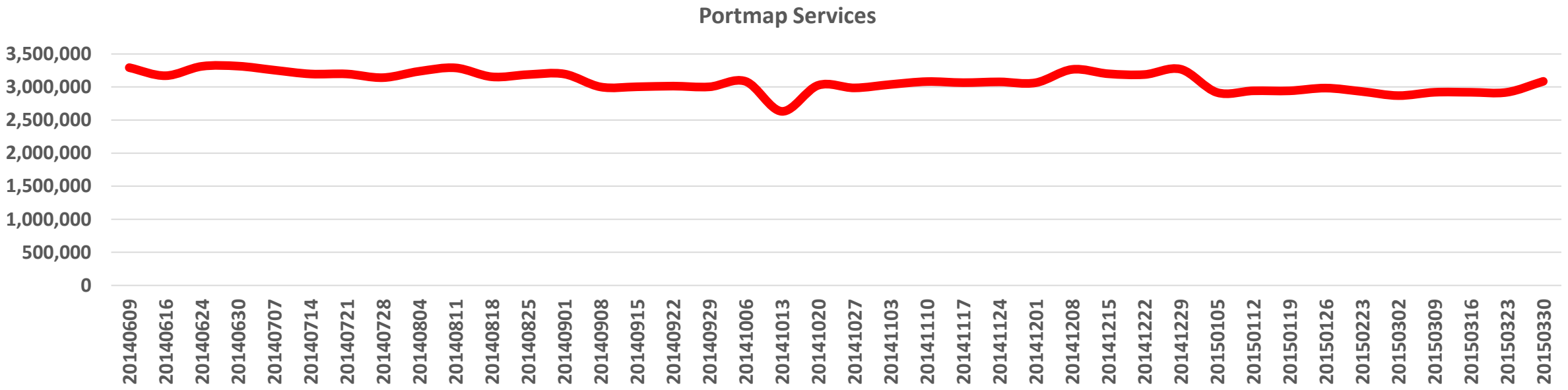
Vulnerability Trend Summary

- Vulnerability trends don’t follow the expected decreasing pattern
- Some flaws issues got worse after the advisory (NATPMP)
- Most things that Sonar measures are not improving
- We need vendors to take more responsibility



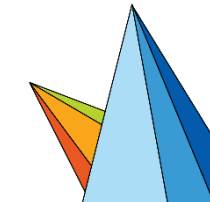
Portmap Exposure (111/udp)

- Portmap (SunRPC) is a discovery mechanism for other services
- Not commonly used in new application development
- Commonly open on Linux servers, not much of a risk

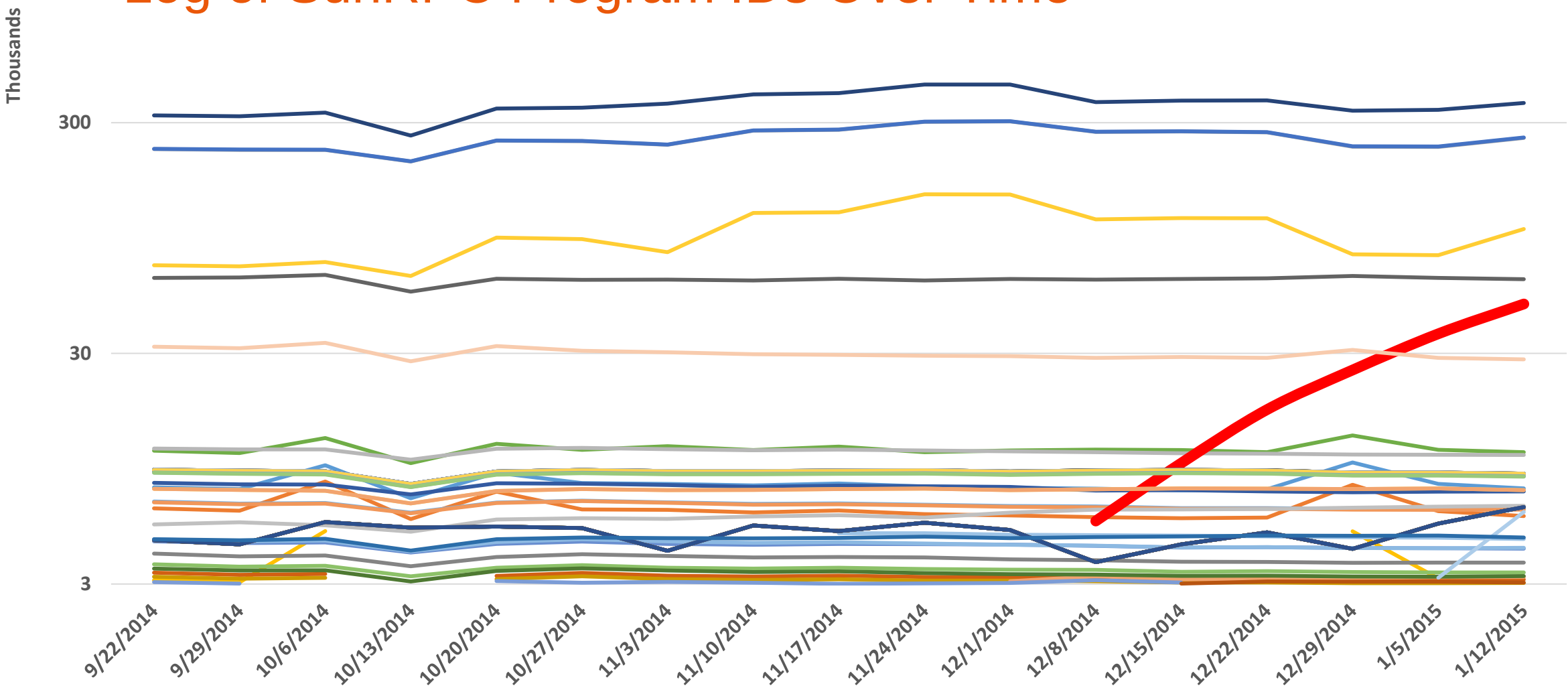


SunRPC Program Trends

- Analyzing SunRPC program IDs from portmap “dump” scans
- These provide a list of all registered programs
- Vendors often create proprietary program IDs
- These can be used for precise fingerprints



Log of SunRPC Program IDs Over Time



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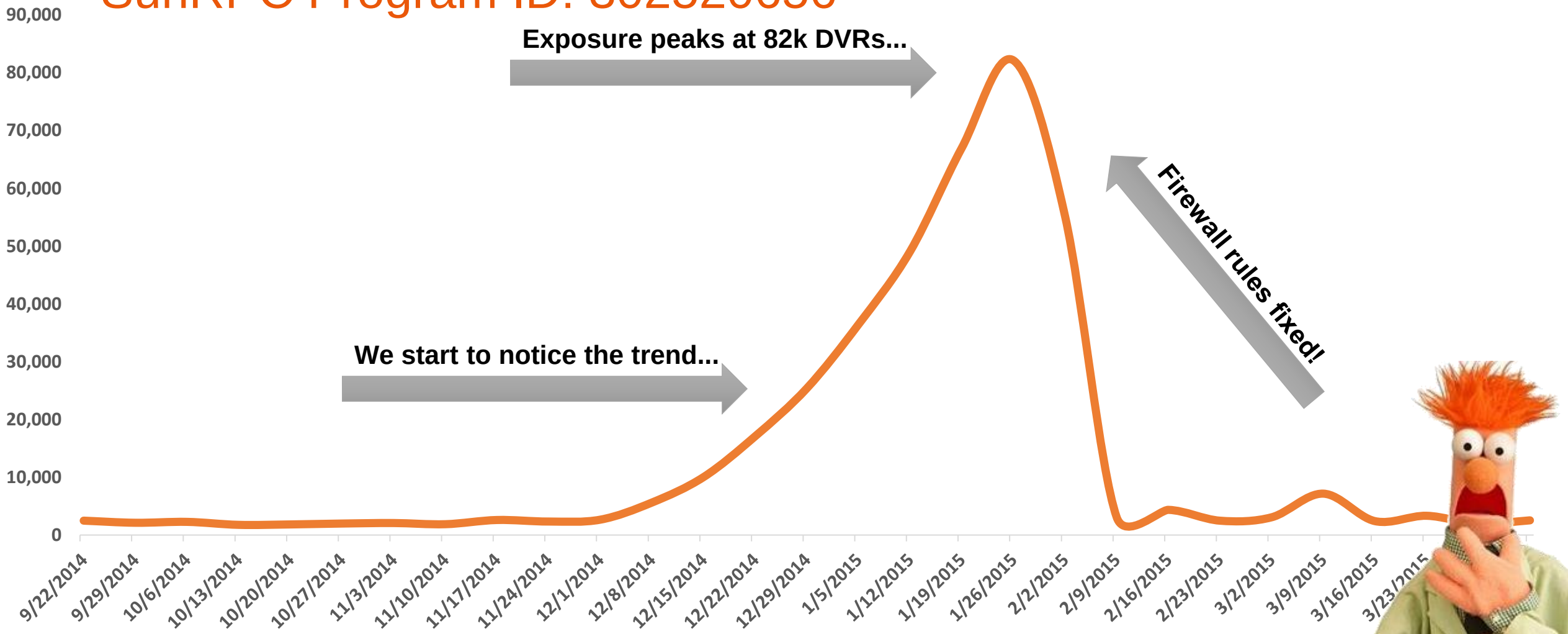
SunRPC Program ID: 302520656

- Zero to substantial in just a few months
- Seems to be a Samsung TV Set-Top Box DVR
- 80% of these show up on Comcast ranges...
- This is their 4K TV rollout!
- With no firewall?

SunRPC Program ID: 302520656



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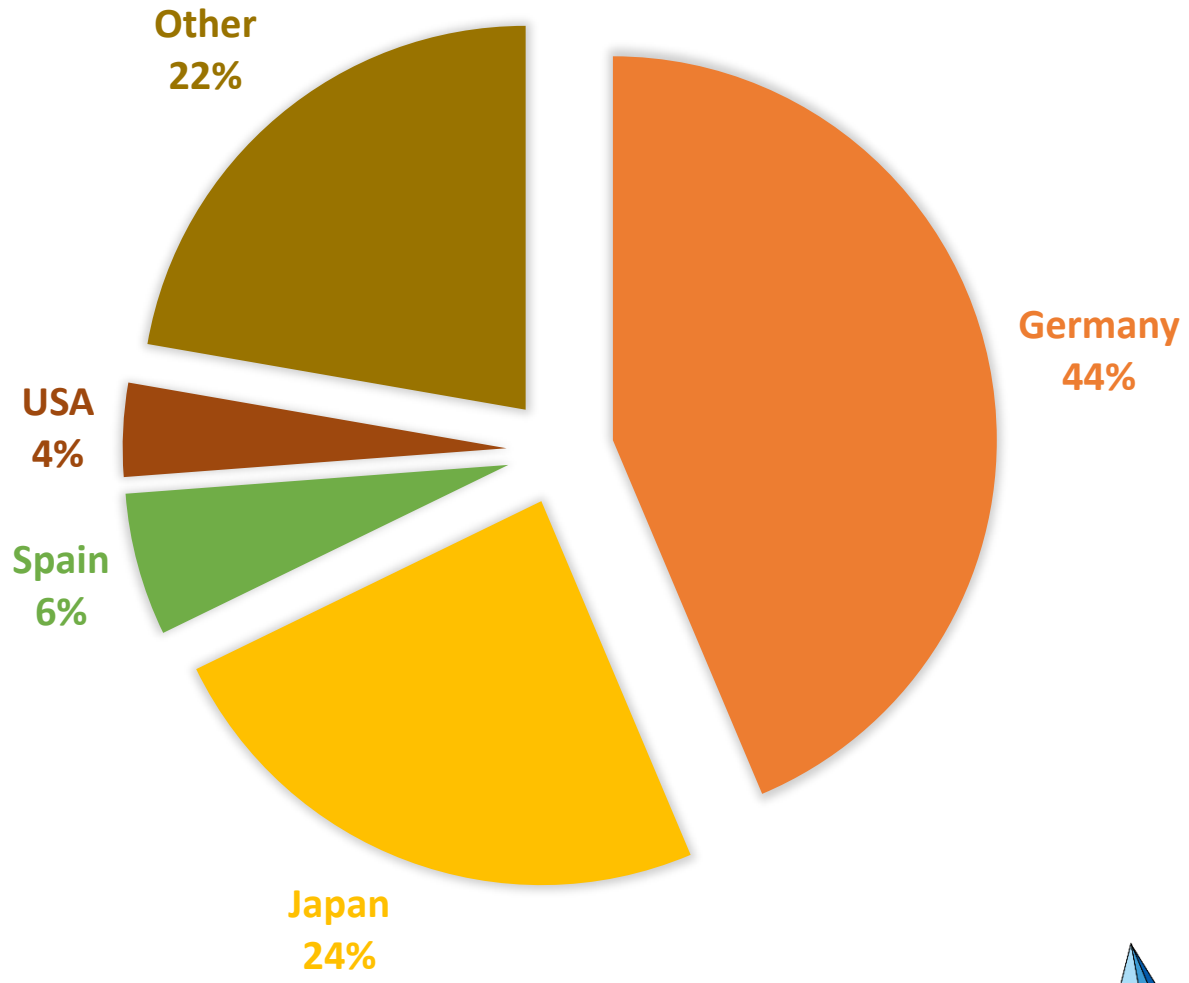
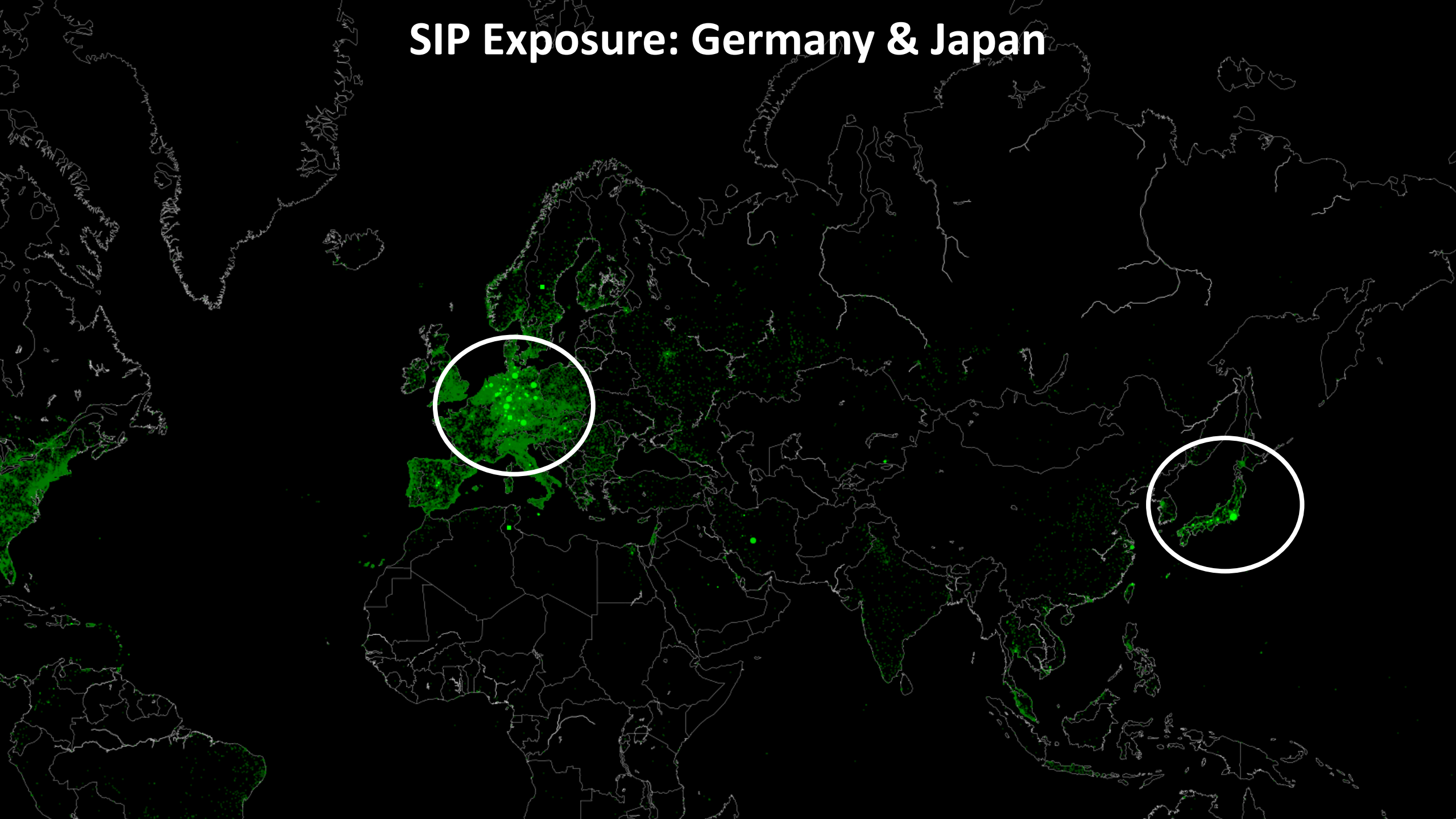
VoIP Session Initiation Protocol (5060/udp)

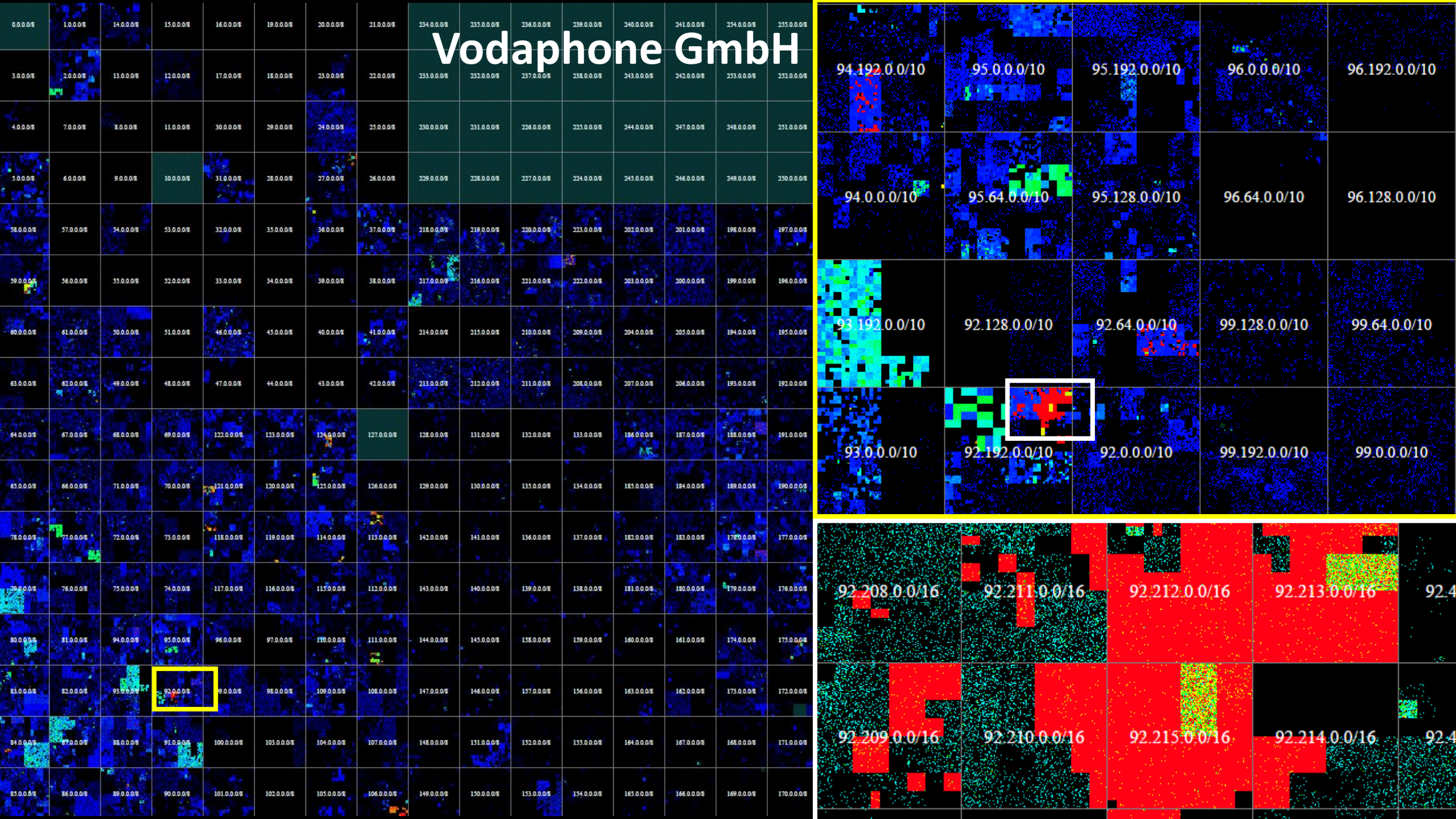
Internet-exposed SIP telephones

- 15 million exposed SIP endpoints
- 44% of these are in Germany
- 24% of these are in Japan
- Digging deeper…



SIP Exposure: Germany & Japan




Vodaphone GmbH
94.192.0.0/10
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94.0.0.0/10
95.64.0.0/10
95.128.0.0/10
96.64.0.0/10
96.128.0.0/10
93.192.0.0/10
92.128.0.0/10
92.64.0.0/10
99.128.0.0/10
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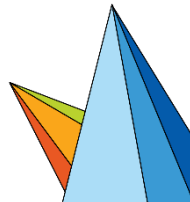
93.0.0.0/10
92.192.0.0/10
92.0.0.0/10
99.192.0.0/10
99.0.0.0/10
92.208.0.0/16
92.211.0.0/16
92.212.0.0/16
92.213.0.0/16
92.209.0.0/16
92.210.0.0/16
92.215.0.0/16
92.214.0.0/16

SIP: Hallo from Germany

- 5.5 million devices over three primary ISPs
  - All based on the FRITZ!BOX sold by AVM.de
  - All running variants of the same firmware
  - Not the best security record
  - At the least, DDoS potential
  - At the worst, shells!
- 2014 RCE flaw abused for fraud
- Likely more bugs...



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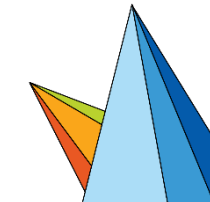
Conclusions

- Internet-wide scanning highlights global security challenges
- ISPs have far too much control over internet security
- Vulnerabilities have an incredibly long half-life
- Public data is driving security improvements



Thanks!

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