

SSH Compromise Detection using NetFlow/IPFIX

Rick Hofstede, Luuk Hendriks

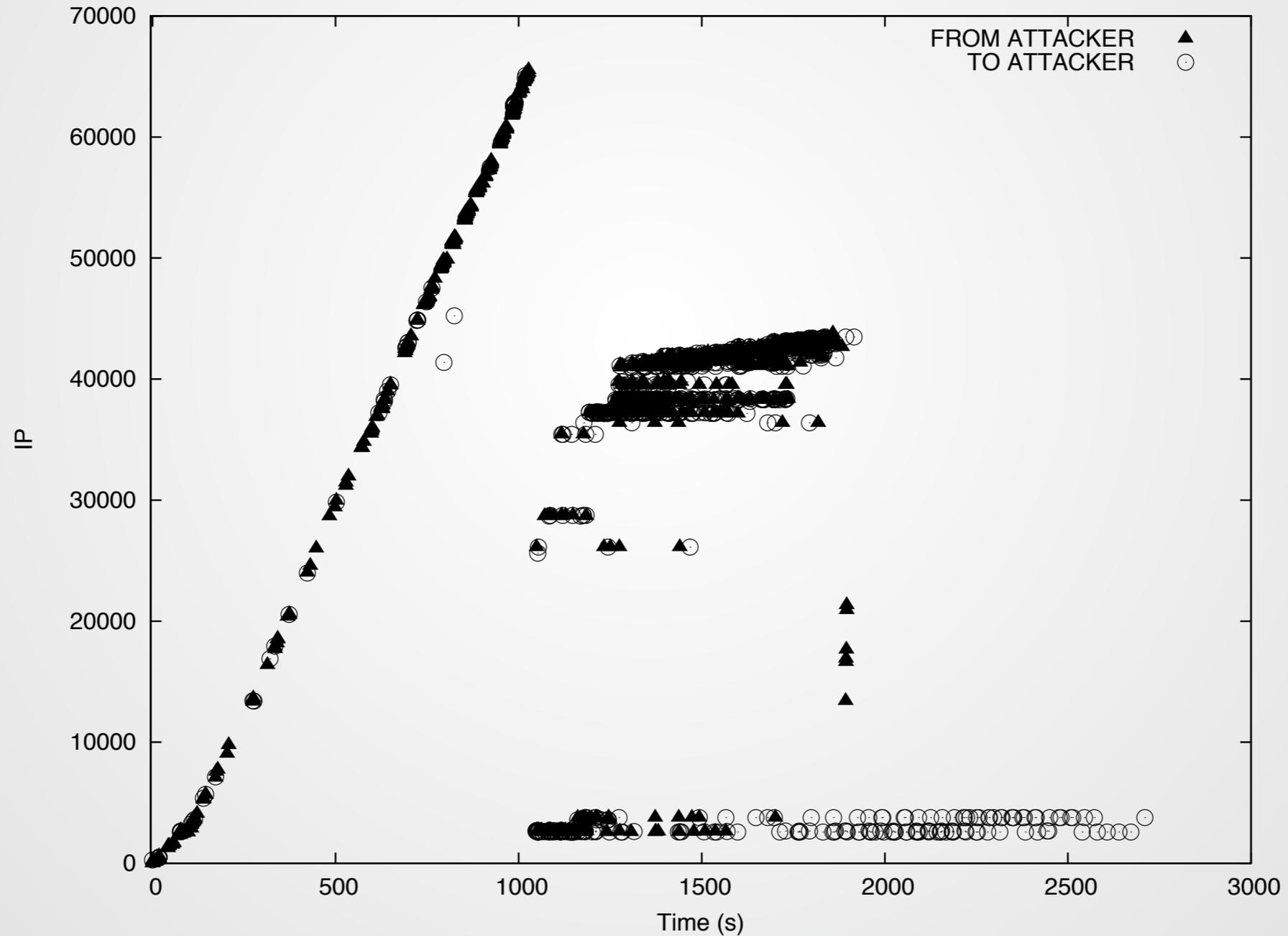
“51 percent of respondents admitted that their organizations have already been impacted by an SSH key-related compromise in the last 24 months.”

–Ponemon 2014 SSH Security Vulnerability Report

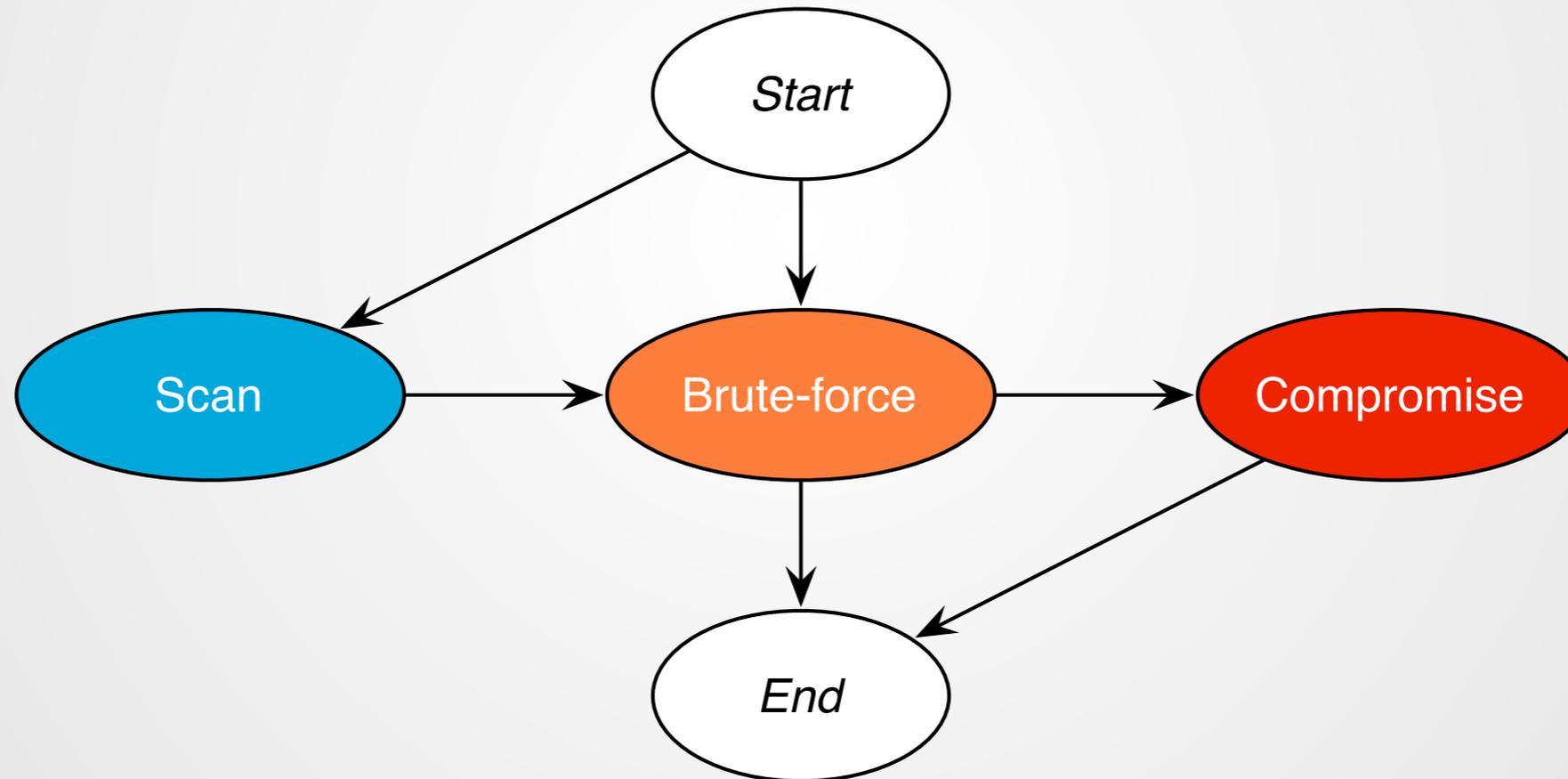
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SSH attacks



SSH attacks



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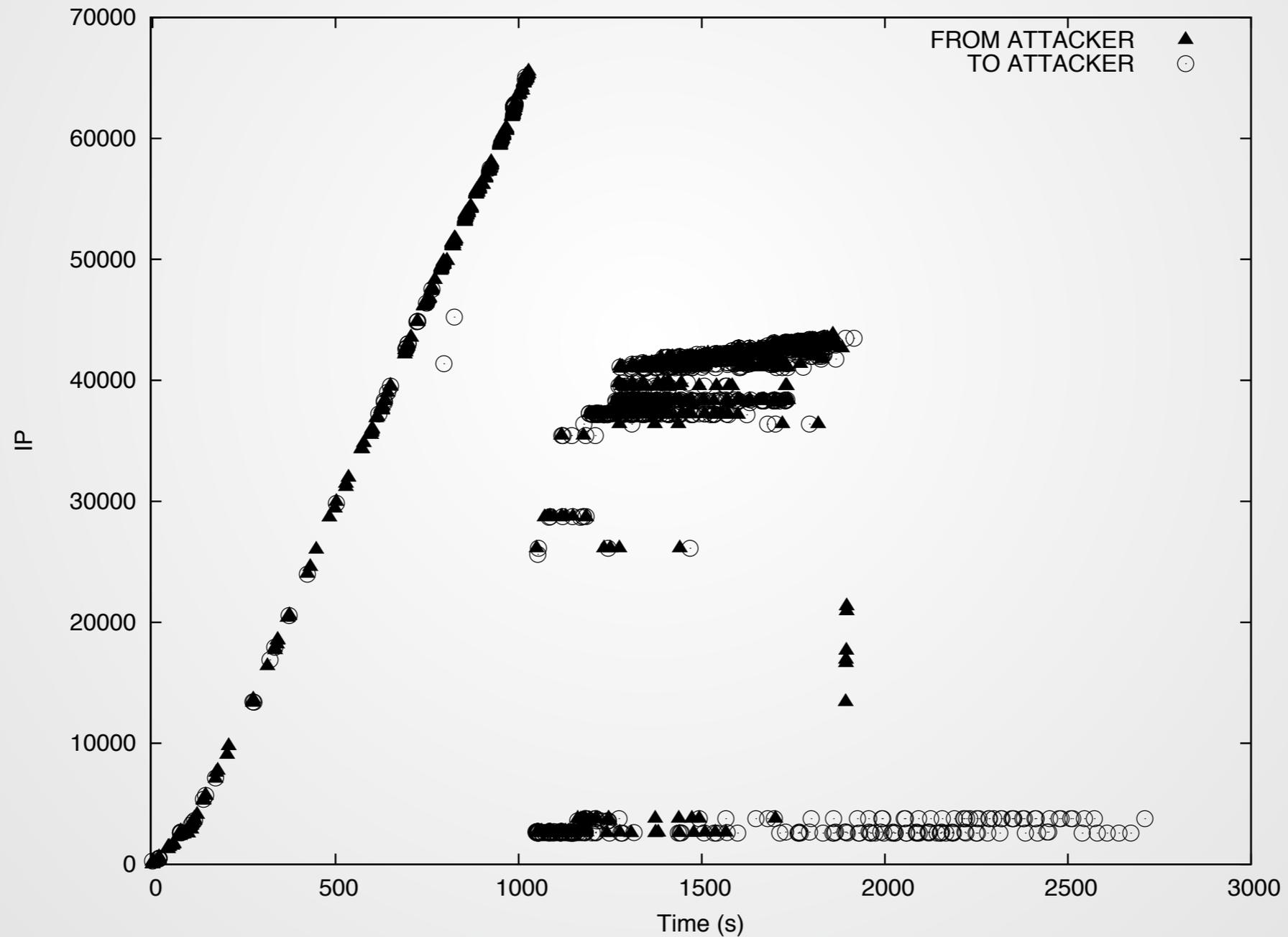
- SSH intrusion detection on end hosts is hardly scalable
- Network-based approaches exist, but only inform security operators about the presence of attacks

We perform **compromise** detection.

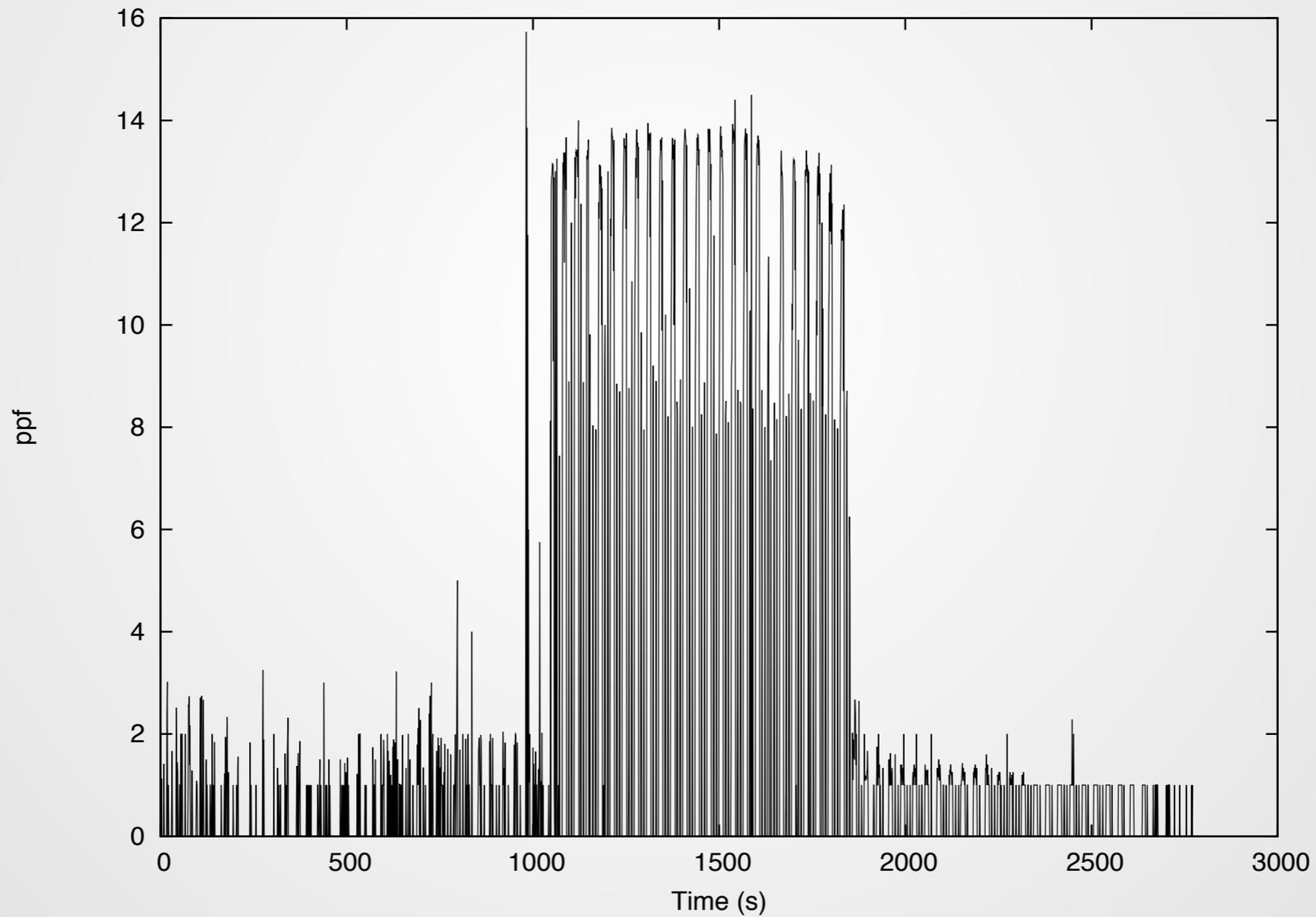
We perform compromise detection.

All flow-based.

SSH attacks



SSH attacks

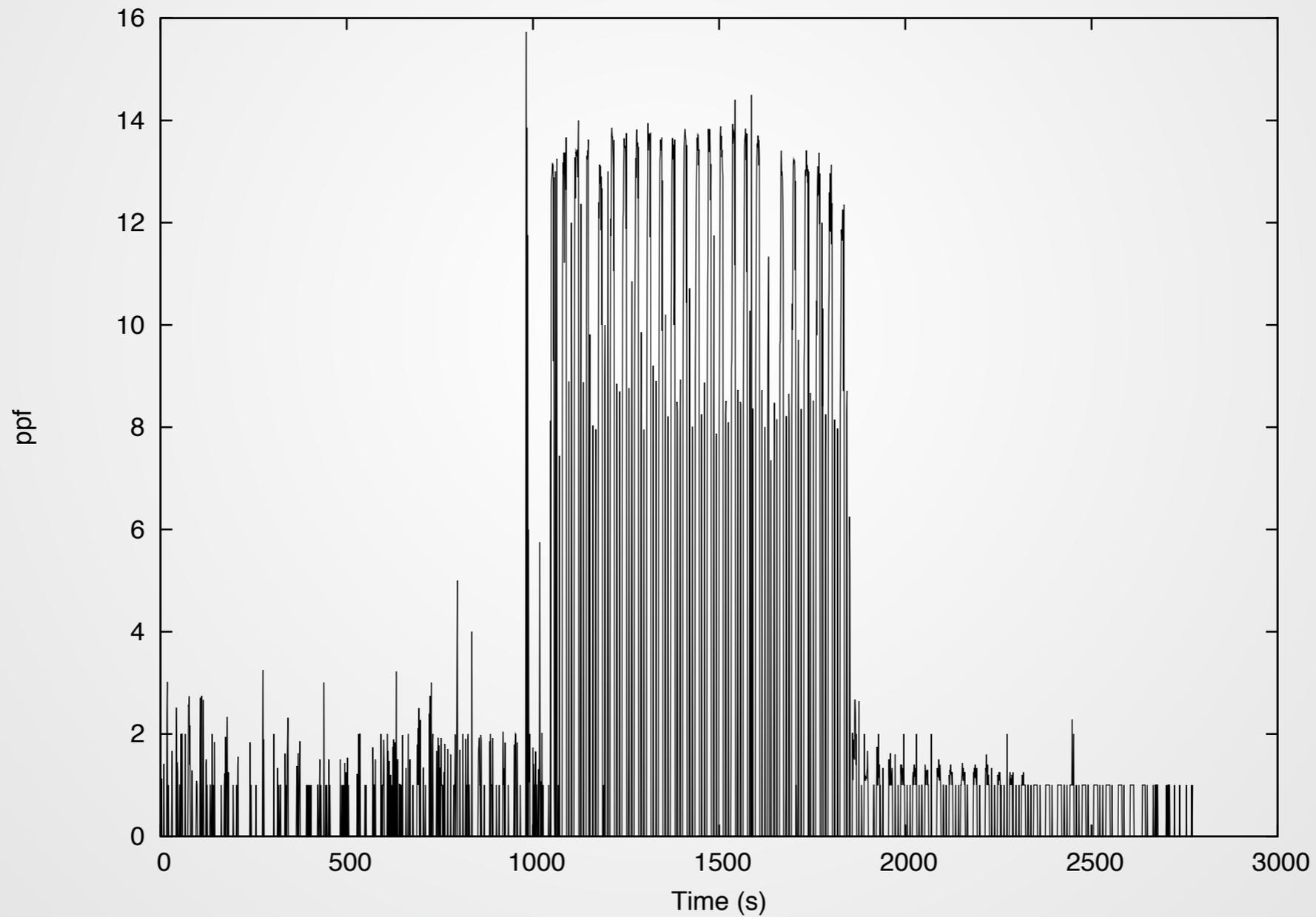


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 - Purely deviation-based compromise detection
- SSHCure 2.0 (May '13):
 - Notifications, database maintenance, performance profiling, ...

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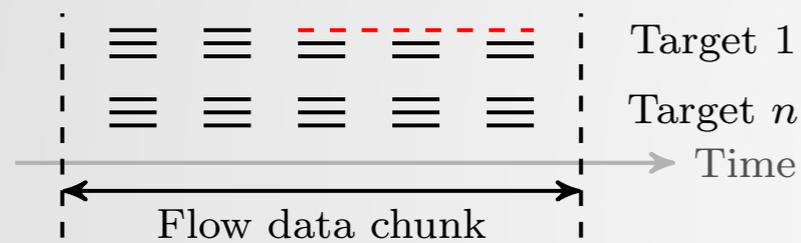
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Recent/upcoming releases

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- SSHCure 2.4 (July '14):
 - New compromise detection algorithm (CCR paper release), based on 'action upon compromise'
- SSHCure 3.0 (January '14):
 - New frontend, ingress vs. egress attacks

Recent/upcoming releases



(a) Maintain connection, continue dictionary (1)

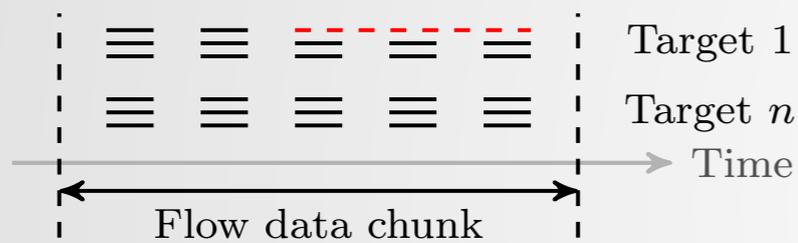


(d) Maintain connection, abort dictionary (1)

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In: ACM SIGCOMM Computer Communication Review, October 2014

Recent/upcoming releases



(a) Maintain connection, continue dictionary (1)



(d) Maintain connection, abort dictionary (1)



(c) Instant logout, continue dictionary

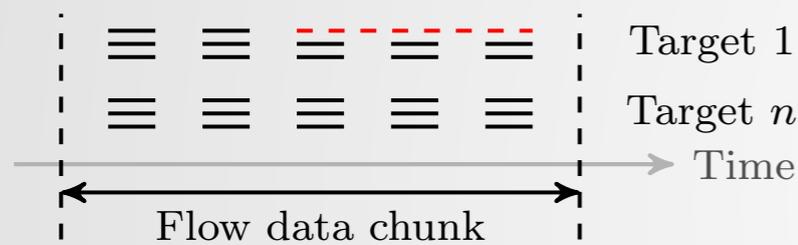


(f) Instant logout, abort dictionary

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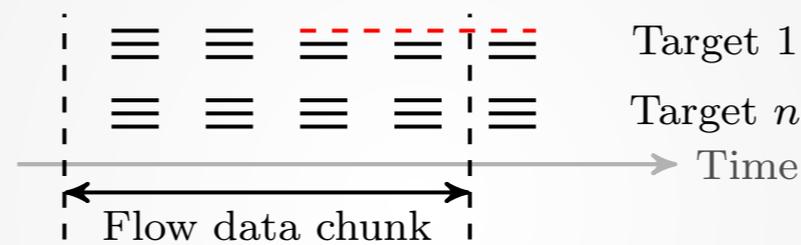
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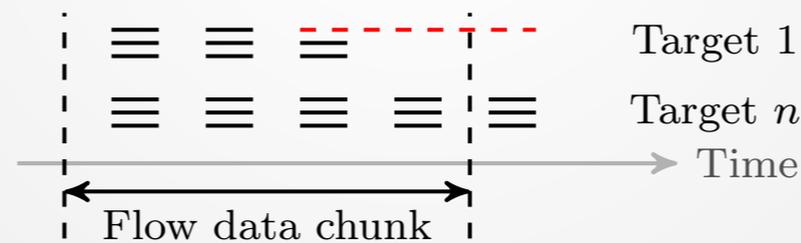
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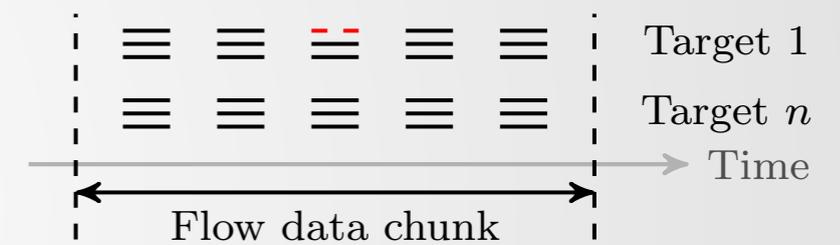
(d) Maintain connection, abort dictionary (1)



(b) Maintain connection, continue dictionary (2)



(e) Maintain connection, abort dictionary (2)



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Dashboard

Incoming

Outgoing

Hosts

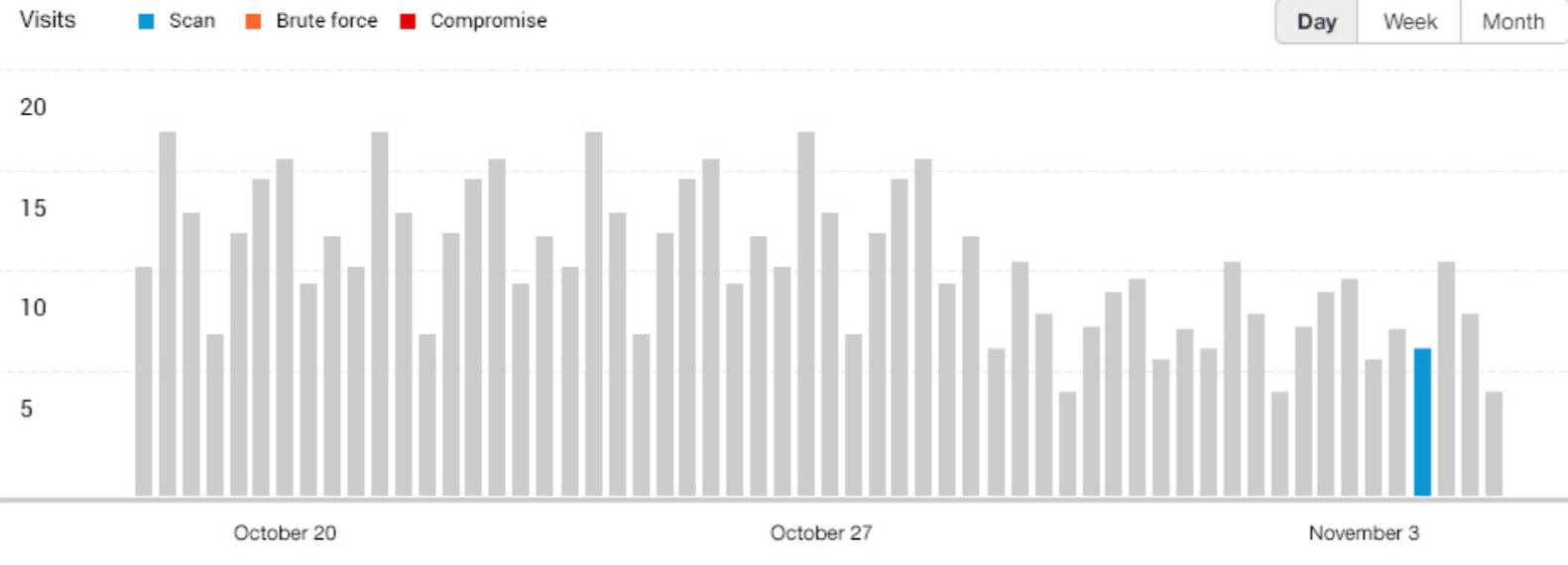
Search

Status

Help

Settings

Incoming attacks



Incoming attacks

Phases	Active	Attacker	Date	Targets
■ ■ ■	⚡	123.123.123.123	Mon. Jun 30, 2014 19:57	12
■ ■ ■		123.123.123.123	Mon. Jun 30, 2014 19:57	456
■ ■ ■		130.89.148.136	Mon. Jun 30, 2014 19:57	32
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Top targets - Compromise

Target	Attacks	Compromise
123.123.123.123	12	2
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Outgoing attacks

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Top targets - Brute Force

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SSHCure

Validation approach

- Ground truth: `sshd` logs from 93 honeypots, servers and workstations, divided over two datasets:
 - Dataset 1 — easy targets
 - Dataset 2 — more difficult targets

	Honeypots	Servers	Workstations	Attacks
Dataset 1	13	0	0	636
Dataset 2	0	76	4	10353

SSH Cure

Validation results

- Evaluation metrics:
 - TP / FP — correct / false identification of incident
 - TN / FN — correct / false identification of non-incident
- Detection accuracy close to 100%

	TPR	TNR	FPR	FNR	Acc
Dataset 1	0,692	0,921	0,079	0,308	0,839
Dataset 2	—	0,997	0,003	—	0,997

SSHCure

Deployment

- SSHCure is open-source and actively developed
 - Download counter SourceForge (Dec. '14): 3k
 - Recently moved to GitHub (summer '14)
- Tested in several nation-wide backbone networks
- Many successful deployments already:
 - Web hosting companies
 - National Research and Education Networks (NRENs)
 - Campus networks
 - Governmental CSIRTs/CERTs

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 - Experience with SURFmap [1]

[1] <http://surfmap.sf.net/>

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- CSIRTs are becoming more responsible *towards* the Internet: Keep it clean!

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- Integration with existing systems is necessary: IODEF, X-ARF, QuarantineNet, ...

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- GitHub vs. SourceForge

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 - Problem for our algorithms
 - Admins are 'afraid' of increasing sampling rates

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- Examples:
 - Availability of TCP flags
 - Assumptions on flow cache entry expiration

Thanks!





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Questions?

<https://github.com/sshcure/sshcure>