Behavioral Study of Bot Obedience using Causal Relationship Analysis

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- Botnets have become an increasing menace
- Tens of strategically placed hosts to hundreds of thousands
- Life-cycle:
  - Infection directly through the network or user interaction
  - Trojan payload downloaded and/or executed
  - Bot joins the botnet
  - Bots are used for some activity
  - Bots are upgraded to new versions

Introduction

- Active/passive
- Scope: Individual machines/network
- Detection time: proactive/reactive
- User: end-user, network operator etc.
- Type: Indirect, Direct

Detection mechanisms

Data source	Scope	Detection time	User	Type
Victim	Individual machine	After infection	Unhappy end-user	Direct, Indirect
Honeypot or spampot	Varies	Early	Security researcher	Direct
Antivirus software	Individual machine	Infection attempt	End-user, network operator	Direct
IDS with signature	Network	Infection attempt	Network operator	Direct
IDS without signature	Network	After infection	Network operator	Indirect
DNS-based IDS	Network	After infection	Network operator	Indirect
Flow data	Several networks	Early to postmortem	Network operator	Direct, Indirect

Botnet detection methods

- Attempt to collect live instances of malware
- High-interaction (traditional honeypot)
- Low-interaction (Nepenthes)
- Only catches the low-hanging fruit
- Privacy and liability issues
- Requires expertise
- Still, provides the best intelligence about botnets

Honeypots and spampots

- Finds signatures of malware running on the system or malicious activity in general
- Can only spot activity for which signatures exist
- Usefulness as information source for botnet investigations depends on the deployment

Anti-virus software

- Collect data from network and attempt to find botnet traffic
- IRC traffic as signature
  - Easy to evade, just change the protocol a bit or encrypt
  - Legitimate traffic as false positives
  - Ephemeral port numbers -> have to look at all traffic
- Secondary botnet behaviour
  - Portscans, DDoS's etc.

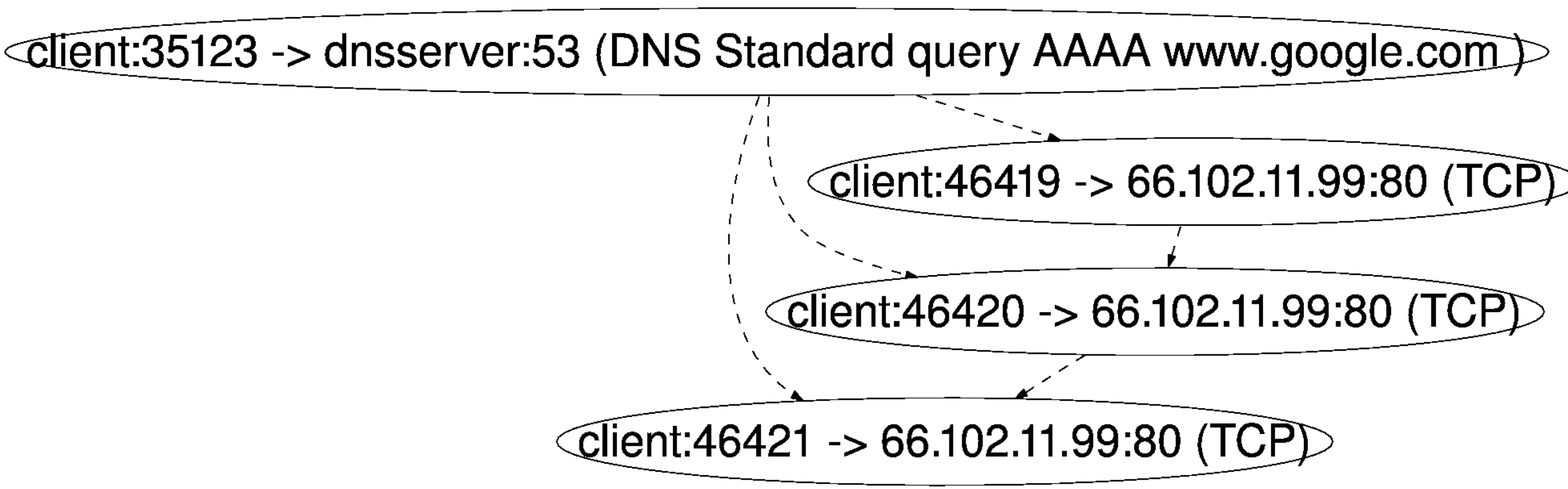
- New type of IDS especially useful for botnets
- Catch anomalies in DNS queries
  - Known controllers
  - Popular hosts
  - Abnormal qtypes
- False positives a problem
  - Correlate with NetFlow data
- Passive DNS replication
  - Gets around privacy issues, but cannot be proactive

DNS-based IDS

- Summary data collected at border router
- Data rate is (almost) manageable
- Timestamp, Source/destination address & port, protocol, packet count, byte count, ...
- Isolating relevant data and anonymization needed for sharing

NetFlow

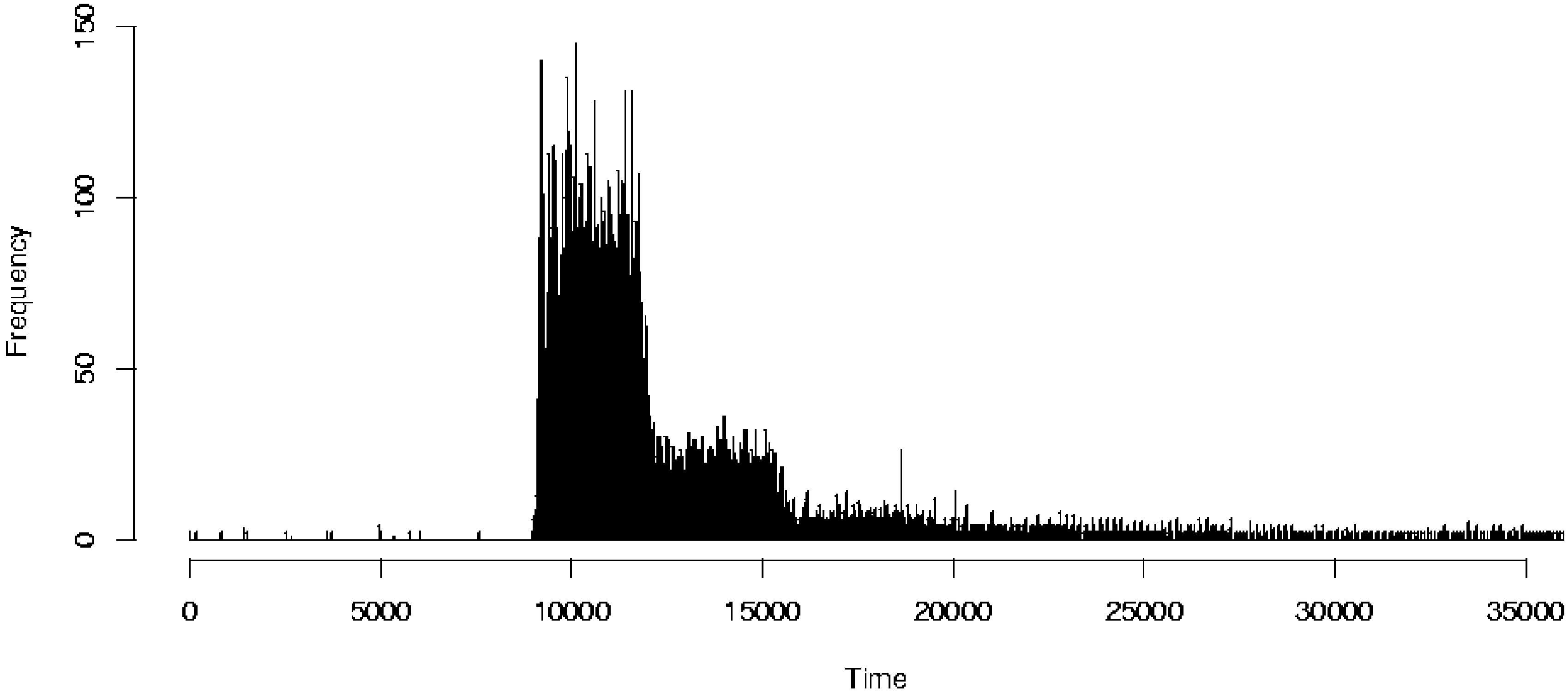
- Method for modeling and visualizing interactions in network traffic
- Groups potentially related events together



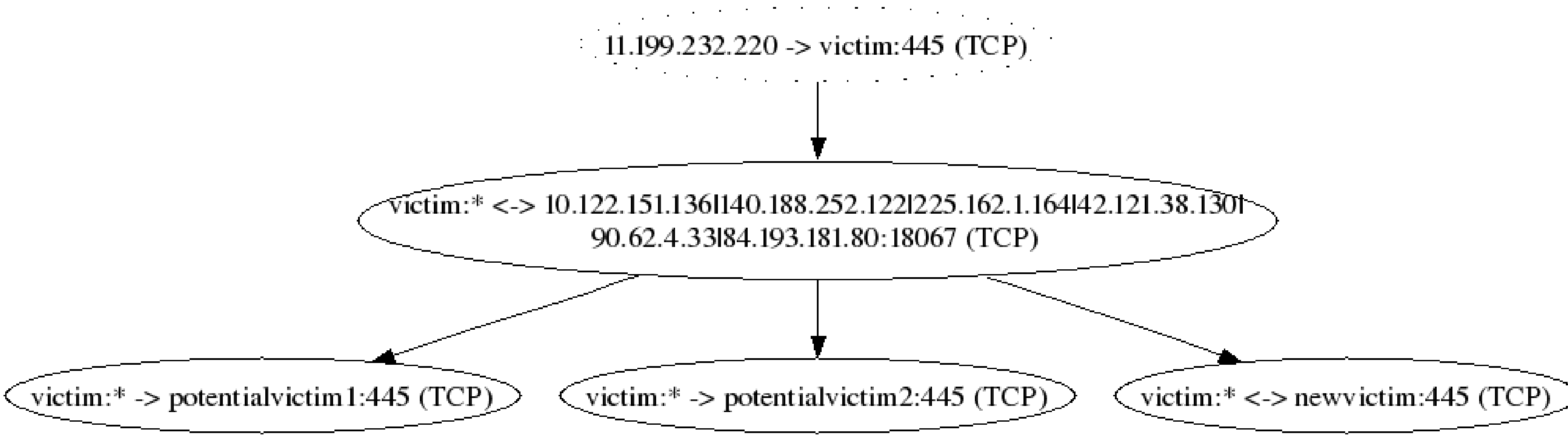
Causality analysis

Total distinct addresses:	8293953
Total flows:	62393760
Control port flows:	18269
C&C hosts:	6
C&C flows:	18157
Number of victims:	546
Victim flows:	23753270
Control port flows:	17892
Port 445 flows:	23484991
Other traffic:	250387

Summary of incident



C&C port activity



Causality graph

Conclusions

- There is no single silver bullet for botnets
- Correlation of data from several methods is needed
  - Flow + DNS-based IDS to find potential targets for further analysis
  - Causality analysis to understand botnet activities better
  - Sharing of data between organizations
- Evidentiary value of flow data
  - Number of victims can be enumerated and monentary value estimated
  - Causality analysis can be used to minimize flow data to the essentials

THE END

http://www.ee.oulu.fi/research/ouspg/