Towards Designing Effective Visualizations for DNS-based Network Threat Analysis

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What is Network Threat Analysis?

Analyst

The Domain Name System (DNS) is an essential protocol used by both legitimate Internet applications and cyber attacks

[Building a Dynamic Reputation System for DNS, Antonakakis et al. 2010]

Challenges

Threat Intelligence Acquisition

"Security analysts are still collecting threat intelligence via email, spreadsheets, and cutting/pasting information from web-based sources. Obviously, these manual processes don't scale"

[Enterprise Strategy Group (ESG) Research Report: Threat Intelligence and Its Role Within Enterprise Cybersecurity Practices,

June 2015]

Analytics

"Threat intelligence may offer clues but human beings are left to do the heavy lifting by investigating and analyzing the data on their own"

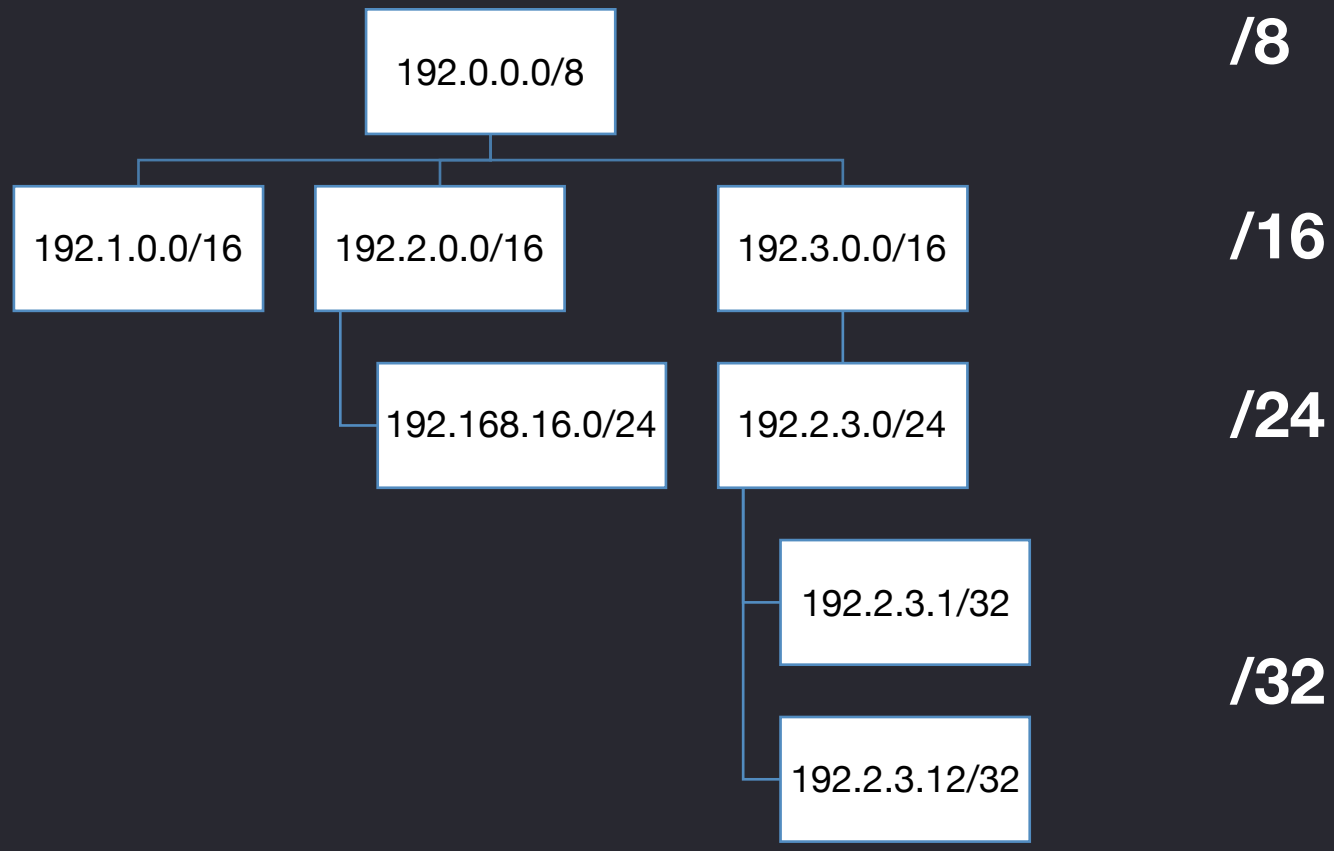
[ESG Research Report: Threat Intelligence and Its Role Within Enterprise Cybersecurity Practices, June 2015]

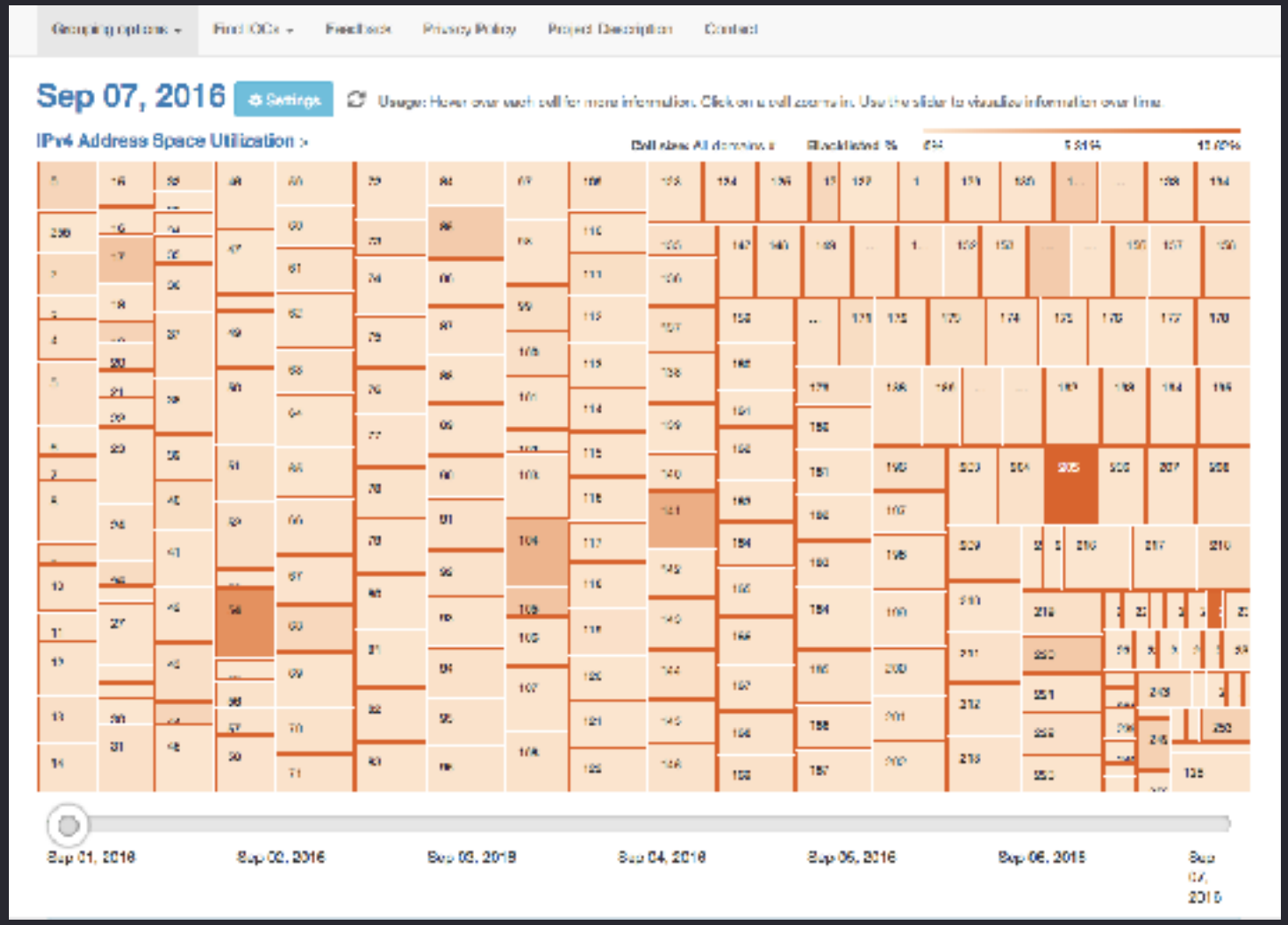
Our Approach:
Open Source THreat Analysis COnsole (THACO)

Open Datasets

Visualization Techniques

Classless Inter-Domain Routing (CIDR) Notation





Access to THACO live demo: https://ipviz.gtisc.gatech.edu/

User-centered Visualization Design

Domain Problem / Data Characterization

Design

Prototype

Evaluation

Domain Problem & Data Characterization

- Procedure: informal interviews with two domain experts in network threat analysis during two months
- Output: two main high-level categories of tasks and data requirements:

Top-down network threat analysis or Threat Hunting

Bottom-up network threat analysis or Incident Response

Domain Problem & Data Characterization

- Effective threat intelligence involves the combination of multiple data sources:
  - Active DNS datasets (https://www.activednsproject.org/)
  - Public Domain Blacklists such as abuse.ch
  - Malware Traces (https://www.virustotal.com)
  - Domain WHOIS records (https://www.threatminer.org/)

Design

- Design Goals
    1. Multiple views
    2. Different levels of detail
    3. Scalability

Multi-grouping, zoomable treemap

Evaluation

- Participants:
  - Network threat analysts are hard to find
  - Seven in-situ and thirty-one online network threat analysts from both academia and industry
  - Years of experience ranging < *1 year* to > *10 years*
- Procedure:
  - In-situ evaluation: tasks scenarios and semi-structured interviews
  - Online evaluation: web-based survey (SUS, System Usability Scale)

Evaluation

- Main Results:
  - Threat analysis experience of participants affects neither task completion rates nor task completion times using THACO
  - Experience analysts satisfaction garnered THACO an “A” grade in usability
- Limitations:
  - THACO could be improved for tasks involving keeping track of different pieces of information over time

Want data?

Active DNS datasets: https://www.activednsproject.org/

Want a demo?

THACO live demo: https://ipviz.gtisc.gatech.edu/

Want code?

Source code on GitHub: https://github.com/Astrolavos/THACO

Questions?

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