CYBER SECURITY DIVISION

Stucco

Situation & Threat Understanding by Correlating Contextual Observations

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January 2014

Homeland Security

Science and Technology

Team Profile

Need

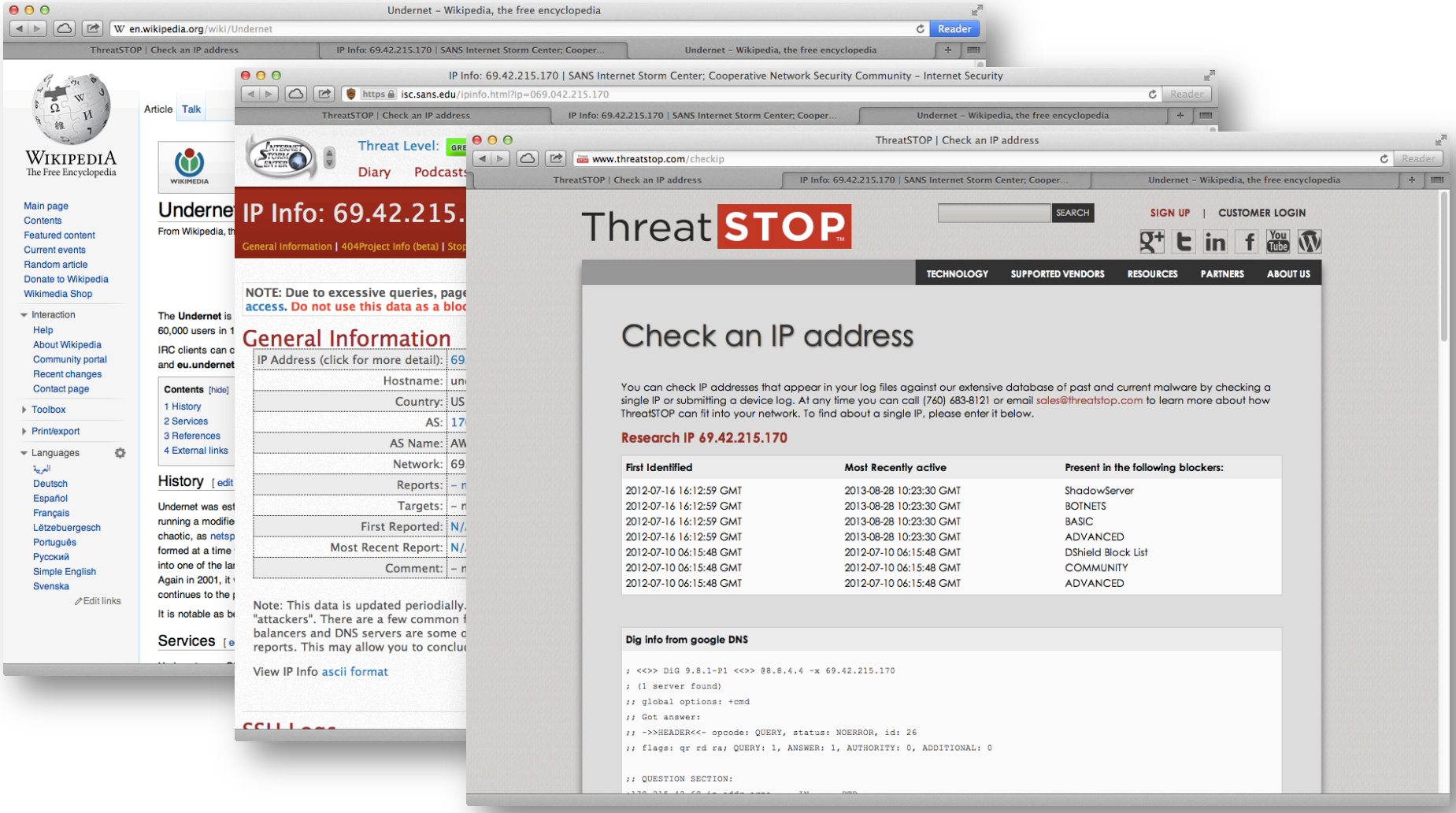
```
[**] 1:234:56 IRC - Channel JOIN [**]
[Classification: A Network Trojan was detected]
09/04-17:11:45.456789
10.32.92.230:6667 -> 69.42.215.170:33982 {TCP}
TTL: 34 TOS:0x0 ID:3456 IpLen:20 DgmLen: 44 ******S*
Seq:
TcpL
[Xre
```

Provides a starting point…
but additional **context** is necessary to determine impact

Gather information on traffic

```
lip   lipn          rip                              ripn
  d_port date        start end   fl    tb

-------------------------------------------------------------------
  ------------------------------------

mary 10.32.92.230  vmurzlic1.rz.uni-leipzig.de  139.18.17.138
  6667  2012.09.05 01:52 11:43 12   348

mary 10.32.92.230  vmurzlic1.rz.uni-leipzig.de  139.18.17.138
  40600 2012.09.05 00:02 22:07 775  26964

mary 10.32.92.230  undernet.awknet.com          69.42.215.170
  33982 2012.09.05 00:00 22:01 593  48088
```

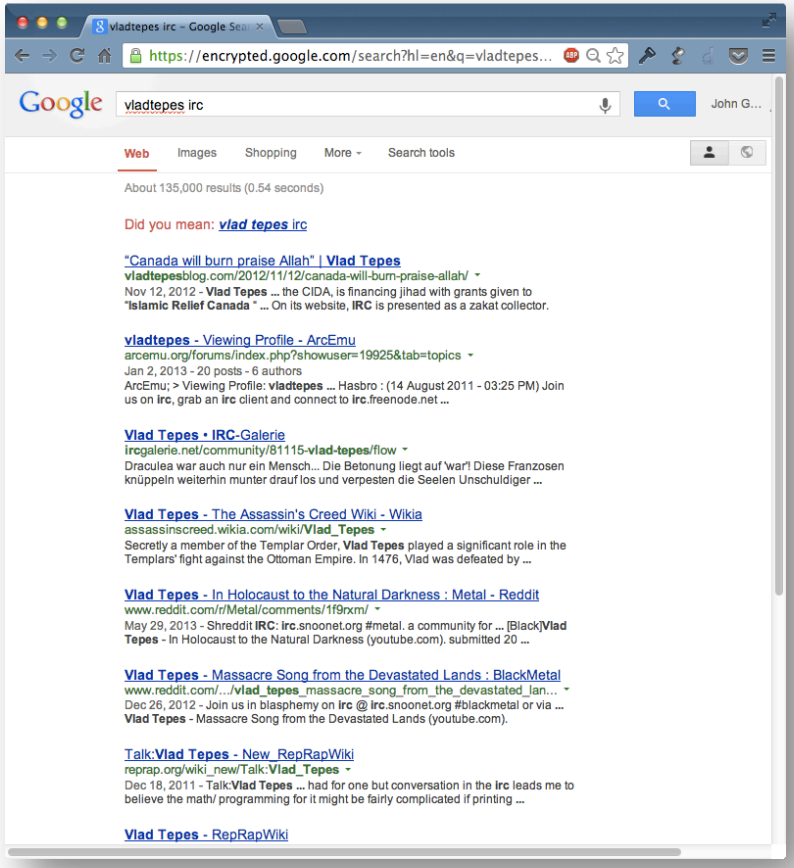
Gather information on remote host



Gather information on processes

```
$ top

command not found: top
```

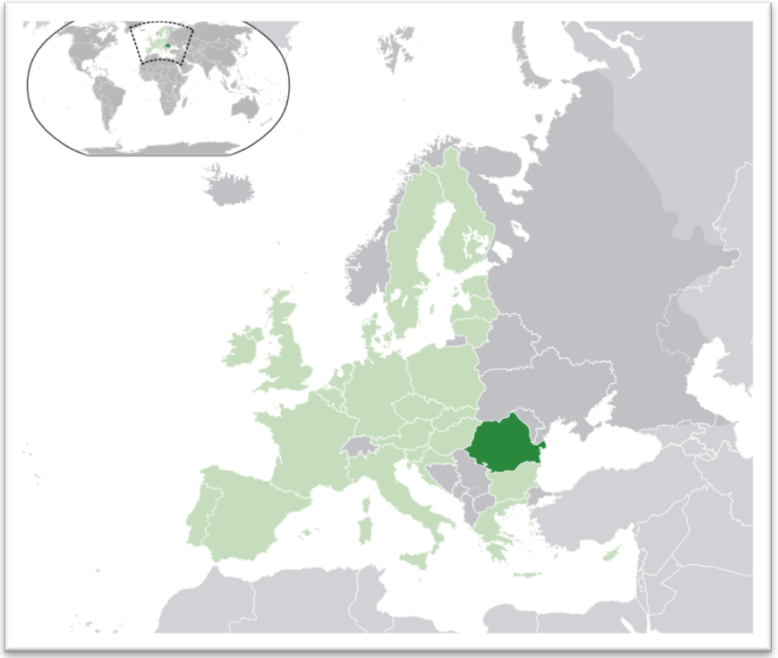
Google: 135,000 results. Nothing useful.



Combination of commands (`netstat ps lsof`) shows two binaries one with an outbound IRC connection (`vladtepes` on port 33982) and one offering an IRC service (`tiresias` on port 40600)

Gather information on user logins

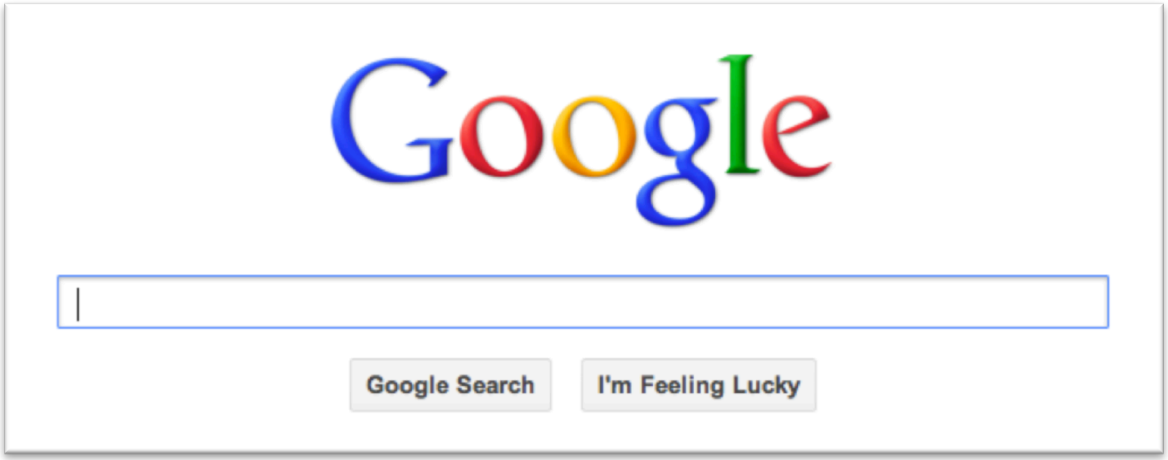
```
aanjneya pts/1        example-09-14108 Wed Sep  5 19:40 - 22:21  (02:40)
franklin pts/0        c-76-126-210-61. Wed Sep  5 18:57 - 19:57  (01:00)
lfyg     pts/0        dn0a203a11.exnet Wed Sep  5 10:04 - 10:27  (00:22)
reehj    pts/0        c-67-180-35-133. Tue Sep  4 19:51 - 19:52  (00:01)
rebrekm  pts/2        kalo.exampled.ed Tue Sep  4 18:08 - 18:11  (00:03)
usoah    pts/2        peter-pc.example Tue Sep  4 17:24 - 17:25  (00:00)
avvasm   pts/1        dnab4043eb.examp Tue Sep  4 16:29 - 19:16  (02:47)
silakkok pts/0        dnab4046d9.examp Tue Sep  4 16:27 - 18:33  (02:05)
fred     pts/0        79-116-146-15.rd Tue Sep  3 13:35 - 14:40  (01:05)
franklin pts/0        70.102.234.3     Tue Sep  4 06:41 - 06:41  (00:00)
cagatay  pts/0        dn0a210425.exnet Mon Sep  3 18:32 - 18:33  (00:01)
gnauhccj pts/0        dn0a210240.exnet Mon Sep  3 14:36 - 15:39  (01:02)
srk      pts/1        c-98-210-153-100 Mon Sep  3 08:51 - 09:03  (00:11)
msb      pts/0        192-119-20-89.pa Mon Sep  3 08:20 - 10:35  (02:15)
fred     pts/1        macbocon.example Sun Sep  2 22:39 - 23:57  (01:17)
fred     pts/0        macbocon.example Sun Sep  2 21:11 - 22:39  (01:27)
fred     pts/1        macbocon.example Sun Sep  2 18:07 - 19:23  (01:15)
fred     pts/0        dn5221a5.exnet   Sun Sep  2 16:05 - 18:26  (02:21)
thomasjm pts/1        dn0a208bad.exnet Sun Sep  2 15:11 - 17:12  (02:01)
fred     pts/0        dn522169.exnet   Sun Sep  2 13:17 - 16:00  (02:42)
alerim   pts/0        bzq-84-110-37-10 Sun Sep  2 12:19 - 12:19  (00:00)
kbw5     pts/1        c-76-102-15-39.h Sat Sep  1 23:31 - 02:24  (02:53)
fred     pts/0        c-67-180-21-231. Sat Sep  1 22:53 - 01:27  (02:34)
fred     pts/1        c-67-180-21-231. Sat Sep  1 21:10 - 22:23  (01:13)
reehj    pts/0        50-193-59-150-st Sat Sep  1 20:35 - 21:26  (00:51)
fred     pts/2        c-67-180-21-231. Sat Sep  1 19:38 - 21:10  (01:31)
msb      pts/1        dn5221c4.exnet   Sat Sep  1 15:46 - 20:55  (05:08)
```



Gather information on user activity

```
Sep  4 13:37:06 mary su[1632]: Successful su for root by root
Sep  4 13:37:06 mary su[1632]: + /dev/pts/0 root:root
Sep  4 13:37:
for user roo
Sep  4 14:04
closed for user fred
Sep  4 14:04:31 mary su[1632]: pam_unix(su:session): session closed
for user root
```

Weird privilege escalation at a time when user `fred` was logged in



Problem summary

- Endogenous data
  - Collect log files from multiple hosts
  - Run commands to identify ongoing relevant activity
  - Consult past incident logs for similar attacks
- Exogenous data
  - Search security sites on similar exploits and vulnerabilities
  - Collect information on remote IPs
  - Search blogs and mailing lists for similar events

Analysts need tools that support efficiently identifying, gathering, and synthesizing contextual data to understand and reason about events

Current approaches

- Current tools focus almost exclusively on endogenous data
- Current methods for obtaining context are manual and time-consuming
  - Endogenous data is scattered in a variety of systems
  - Exogenous data can be hidden deep in search results or on forums, in mailing lists, or within APIs
- Current methods are inefficient and take time away from deeper analytical investigation

Approach

Develop a platform to collect contextual data from endogenous and exogenous sources to organize the data into a **knowledge graph** of domain concepts that analysts and other systems can quickly find relevant information

Core components

- Continuous collection and processing of documents from endogenous and exogenous sources
- Domain Specification Language for parsing and extracting domain concepts and relationships from structured data
- Natural language processing for extracting domain concepts and relationships from text documents
- Alignment methods for instantiating the knowledge graph
- API for programmatically accessing the graph
- Visualizations for exploring the graph to derive context

Benefits

- More time can be spent analyzing suspicious events and less time spent searching for relevant context
- Context can help analysts make better decisions
- Information can be made available more quickly
- Can perform analytics on the graph to learn new insights
- Public API can be used by other security systems
- Security community can leverage ontology, relevant data sources, labeled data sets and other projects
- Methods and tools may be useful to other domains

Current status

- Draft specification of domain ontology
- Ontology visualization and editing tool
- DSL to parse/transform structured documents into graph
- Proof-of-concept prototype of information extraction for unstructured data sources
  - Method to automatically tag security data to create labeled data sets for supervised learning
  - Complementary approaches for extracting entities based on entropy maximization and bootstrapping
- Demonstration of collecting and processing structured data sources within real-time pipeline

Open source projects

Numerous open-source projects on github.com/stucco

- Ontology: github.com/stucco/ontology
- Ontology editor/vis: github.com/stucco/ontology-editor
- Morph parser/transformer: stucco.github.io/morph/
- Security data sources: stucco.github.io/data/
- Labeled data: github.com/stucco/auto-labeled-corpus
- Demonstration: github.com/stucco/dev-setup

In 2014

- Plans for this year
  - Integrate NLP methods into processing
  - Fill out core functionality: alignment and UI
  - Research relationship extraction methods
  - Iterate on use case, data sources, collectors, extractors
- Technology Transition Activities
  - Publicize ideas to practitioner community

Questions

http://stucco.github.io/

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This project is funded by the U.S. Department of Homeland Security Science & Technology Directorate, the Dutch National Cyber Security Centre, and the Defence Research and Development Canada (DRDC) pursuant to the Agreement between the Government of the United States of America and the Government of Canada for Cooperation in Science and Technology for Critical Infrastructure Protection and Border Security. This material represents the position of the authors and not necessarily that of the funders.

The Department of Homeland Security sponsored the production of this material under DOE Contract Number DE-AC05-00OR22725 for the management and operation of Oak Ridge National Laboratory.