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Packet Space Analysis of Intrusion Detection Signatures

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Motivation

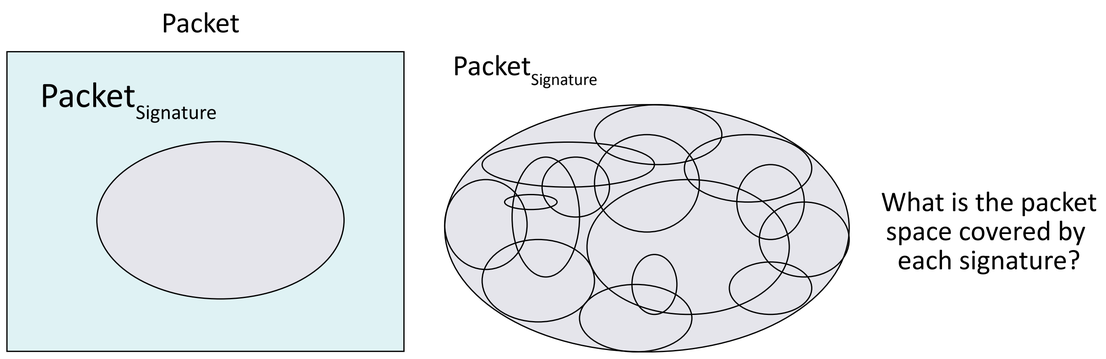
- A single packet can trigger more than one IDS signature
  - Different signatures may include/intersect each other
- These problems can be used to design evasion/denial of service attacks
  - IDSs can raise a limited number of events on a single packet (some signatures are not triggered)
  - Dangerous overlap in the signature sets (a specific packet can be used to trigger many signatures at the same time)
- We need to be able to compare two different signatures designed for the same attack
- We need to be able to analyze the IDS signatures for inclusions and intersections

Example in Snort

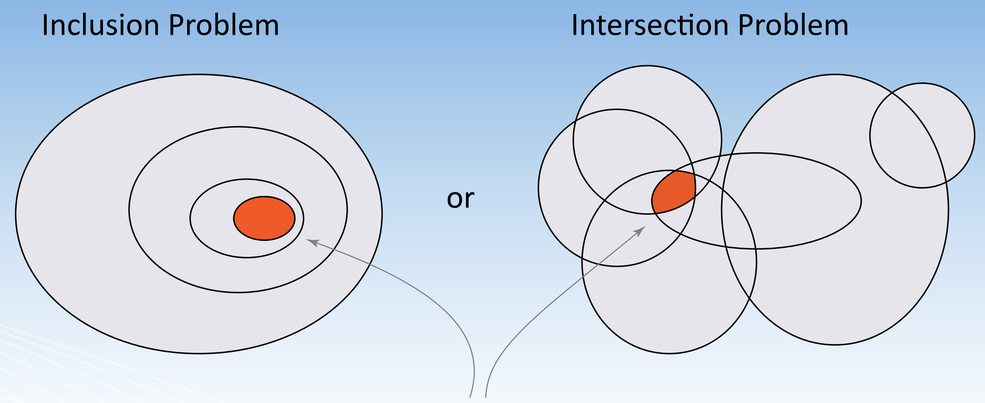
```
alert tcp $EXTERNAL NET any ->  $HOME NET 21 (msg:"FTP CWD  ~attempt";
flow:to_server,established;
content:"CWD"; nocase;
pcre:"/^CWD\s+~/smi";
sid:1672; rev:11;)

alert tcp $EXTERNAL NET any -> $HOME NET 21 (msg:"FTP CWD ~root attempt";
flow:to_server,established;
content:"CWD"; nocase;
content:“~root"; distance:1; nocase;
pcre:"/^CWD\s+~root/smi";
sid:336; rev:10;)
```

$S_{336} \subset S_{1672}$?

Packet Space Model



How do we identify these situations?



What about the packets in these packet spaces?
Are we missing IDS events?

Proposed Approach

- Transform each signature into a set of packets (e.g., $S_1 \ldots S_i \ldots S_n$)
  - Set of ranges
  - Set of finite state automata
- Our Signature Space Analysis approach allows the identification of:
  - Equal signatures (i.e., $S_i = S_j$)
  - Signature inclusions (i.e., $S_i \subset S_j$)
  - Inclusion sequences (i.e., $S_i \cap S_j \ldots \subset S_n$)
  - Signature intersections (i.e., $S_i \cap S_j \neq \varnothing$)
  - Intersection sequences (i.e., $S_i \cap S_j \ldots \cap S_n \neq \varnothing$)

Current Results

- We analyzed various versions of Snort signature databases (i.e., 12 signature database versions from Snort 1.8.6 to 2.4.5)
  - So far, we only analyzed the inclusion problem
  - We observed similar results across Snort signature database versions.
- Results for Snort 2.4.5
  - Number of equal signature pairs: 3
  - Number of inclusion pairs: 266
  - Number of inclusion sequences of three: 2