A Functional Reference Model of Passive Network Origin Identification

By

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A Reference Model of Passive Network Origin Identification

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What am I talking about?!

- Origin Identification Systems
  - Where did that network traffic come from?
  - Not just IP spoofing and island hopping
  - We’re concerned with causality here.

- Active – Mark or redirect traffic to assist in finding its origin

- Passive – Just listen to collect evidence of the origin

- Passive is what we’re talking about here
Outline

- Some introductory material
- Reference Models
- Our Reference Model
- Implications of the model
- What does this mean for network forensics?
Past Work in NOIS

- Passive
  - Host-based (CISIE, Carrier’s STOP)
  - Network-based (Traffic Thumbprinting, IDIP, DoSTracker)

- Active
  - Traffic Marking (Authentication, Probabilistic Packet Marking, embedding watermarks)
  - Route Modifying (Centertrack, Deciduous)
Some Intro Material

Network Assumptions

\[ G = (V, E, IM, XM) \] where \( IM \subset V \) and \( XM \subset E \)

Messages follow an unbounded path through \( G \) to some destination

Observables

- Content
- Headers
- Timing and Location
- Signal Characteristics
Reference Models

- Structured construct that defines a class of mechanisms
- Describes the member’s of the class in a structured way
- Defines the interaction
- Compare to the ISO OSI 7 layer reference model
- Why are reference models important?
  - Assists understanding components,
  - their interactions,
  - education,
  - generalizations about systems, and
  - build terminology.
Our Reference Model

- Network Monitors
  - Collect and process data for online or later use
  - Internal
  - External

- Analysis Program(s)
  - Collect data from Monitors
  - Make/support decisions about tracing traffic to origin
  - Direct tracing procedure
Network Monitors

- External Monitors are arguably less powerful than internal
- Capabilities of Internal monitors are optimistic
Observer

- An abstraction of one or more monitors
- Merges observations of many distinct monitors

Edge Observed Networks

- Reduce a network topology to a simplified one
- such that all edges in new network are monitored.

What are EOG’s good for?

- Allow merging internal and external monitors in one NOI System
- Abstracts away enough detail that general statements can be made.
Components of a Passive NOIS

Data Available

Selection

Data Reduction

Storage

Control

Analysis Program

Commands

Query Responses

Conditions for Passive NOI

- **Necessary Conditions**
  - Network Separation
  - Enough Storage
    \[ history > \frac{storage}{obsfreq \times obssize} \]

- **Mutually Sufficient Conditions (in addition to above)**
  - Analysis Program
  - Trusted Communication Paths
  - Correlation of an input to any given output across all nodes in EOG

- Sufficient because these together allow a step by step trace to succeed.
Forensic Implications

- Passive NOIS’s will be limited to initial investigation
  - Data reduction is key to success of NOI, but at odds with corroborating evidence or integrity.
  - Future research needs to consider this tradeoff

- Current NOIS proposals’ utility for investigation is limited
  - Most non-host-based NOISs trace a single type of network traffic
  - Hence, complex attacks can only be traced so far by these systems.
  - Host-based solutions (e.g. Carrier’s STOP) are useful, but require widespread deployment
  - Future research should address the problem of deployable systems that trace multiple types of traffic and how to take advantage of different types of NOISs
Conclusions

We hope this model and future refinements will prove useful in education, research, and development of network forensics tools.

There are forensics objectives that conflict with objectives of current passive NOISs.

This reference model has motivated our current work in Divide and Trace methods for tracing traffic.
Questions?

- Thanks for the wonderful workshop experience!
- Rock Out, Jam Out
- More info can be found in my dissertation at http://www.eng.iastate.edu/~daniels/diss.pdf