ForNet: A Distributed Network Forensics System

By

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ForNet: A Distributed Forensic Network

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Outline

- Motivation
- Overview of Proposed System
- System Architecture
- An Illustrative Example
- Research Challenges

Current Security Infrastructure

- Passive Security & Networks:
  - Security is usually an overlay on network infrastructures
  - Network components are unaware of security needs
- Vendors are beginning to realize the gap
  - Cisco SAFE Initiative
  - Other NP-based solutions for IDS, Firewalls, VPNs etc.
- Need for better network forensics:
  - Lack of attack attribution on networks
    - Every year numerous cyber crimes go unsolved. Why?
  - Lack of a good response model
  - Increasing interest in prosecutions
  - Steady increase in financial losses due to cyber crimes

Current Response Model

- Typical Response to Breaches:
  1. Adversary breaks in & do his/her work
  2. Security personal identifies the breach
  3. Find out where the adversary came from (log files if still there)
  4. Pick-up the phone & call the ISP, FBI
  5. ISP/FBI notifies the other end
  6. Go To Step 2
- Average response time is in days/weeks
- Involves several human interventions
- Requires coordination among several administrative domains

Challenges Facing Network Forensics

- Lack of infrastructure for forensic data collection, storage, and dissemination
  - Packet logs are usually kept at network edges which do not witness many events inside a network
- Growth of network traffic outpaces Moore’s law making prolonged storage, processing, and sharing of raw network data infeasible
- Most of the process is manual and spans multiple administrative domains making response times undesirably long (e.g. digital evidence disappears quickly)
- Inability of current logging mechanisms to help forensic analysts explore networks incrementally
- Unreliable logging mechanisms on hosts
- Growing support for mobility makes it difficult to maintain prudent logging policies on hosts

A Solution

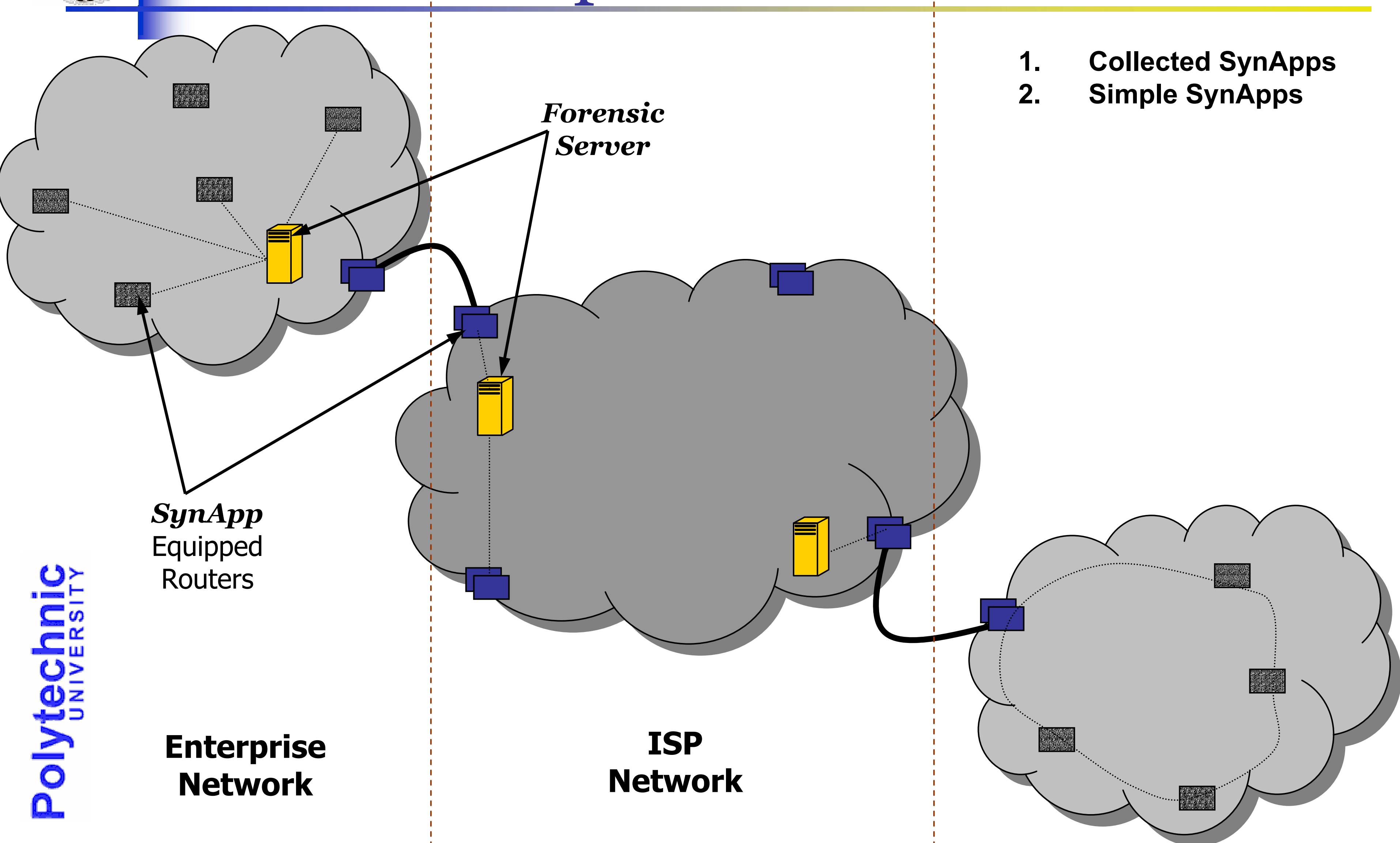
- Let the network securely collect, store, disseminate, and process *synopsis* of network traffic
- Give networks ability to remember network events so that they can answer questions like:
  - Where did a worm appear first in a domain?
  - Who sent this (possibly spoofed) packet?
  - Where else was this packet observed on the network?
- Goal: development of tools, techniques, and infrastructure to aid rapid investigation and identification of cyber crimes

What is a Synopsis?

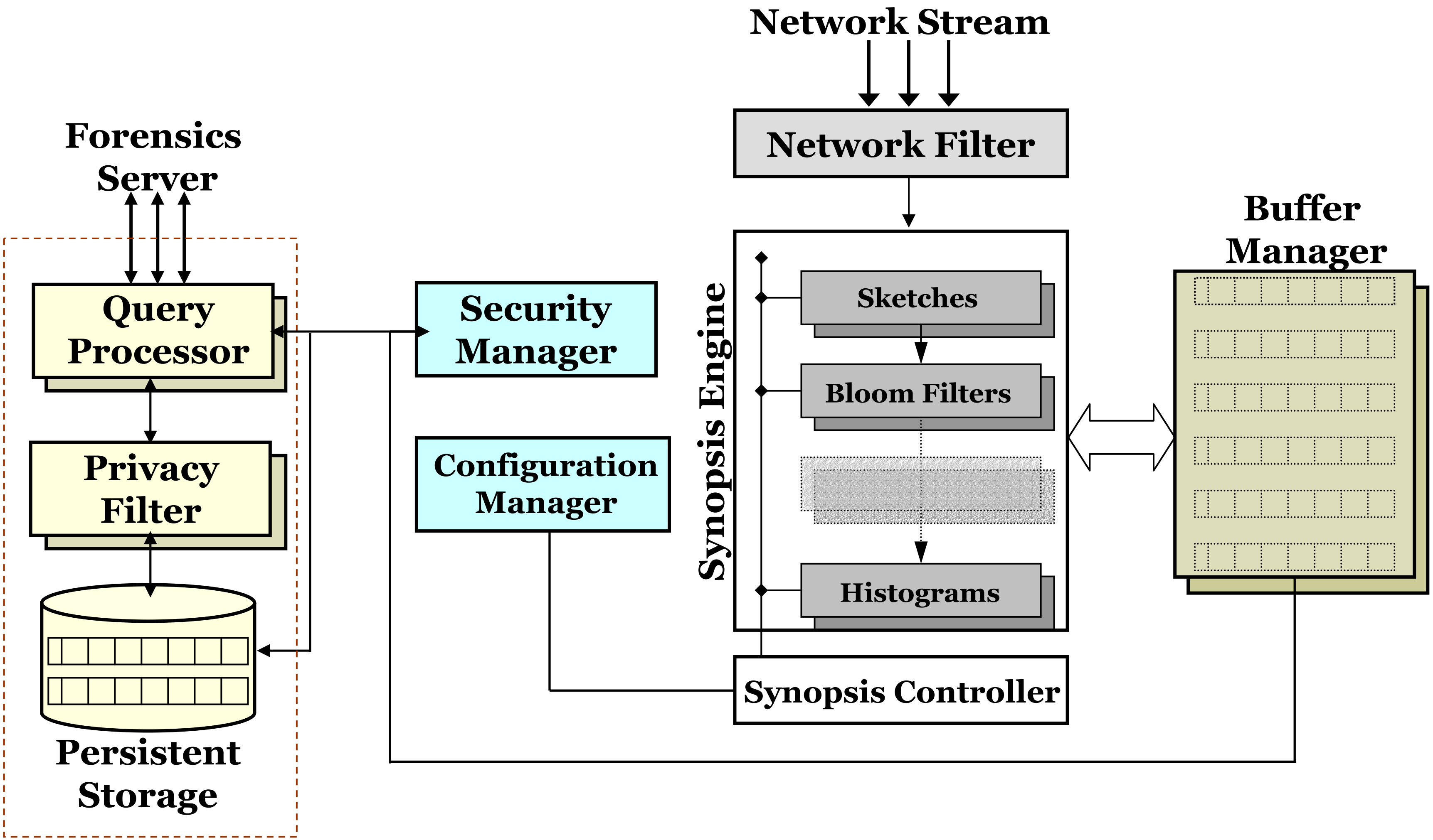
- Properties:
  - Contains information to answer certain classes of queries
  - Contains information to compute confidence interval
  - Have small memory footprint
  - Easy to update
- Examples of synopsis techniques:
  - Connection Records, Bloom Filters, Sampling, Histograms, Decision Trees/Clusters,Wavelets
- Advantages of using synopses:
  - Without synopses it is difficult to store network traffic
  - Succinct representation of base data makes it possible to transfer network data to disk/storage
  - Query processing would be expensive with raw data
  - Sharing/transferring raw data over network is impossible
  - Easily adaptable to various resource requirements

ForNet Blueprint

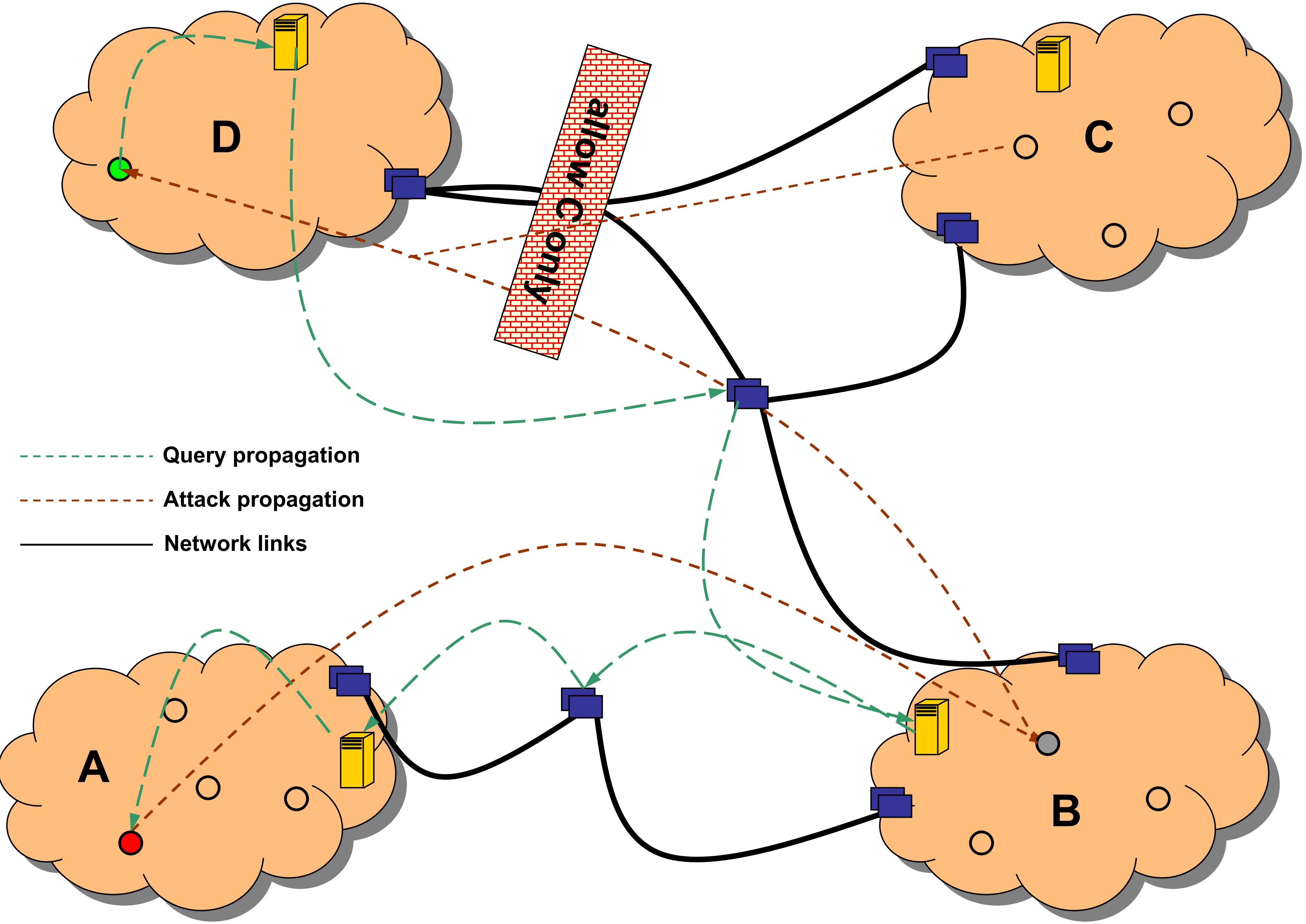
1. Collected SynApps
2. Simple SynApps



Architecture of SynApp



An Illustrative Example


D
allow C only
C
Query propagation
Attack propagation
Network links
A
B

Research Challenges

Research Challenges

- Identification of useful network events
  - Network is the virtual crime scene that holds evidence in the form of network events
- Identification of various query types
  - Selection queries
  - Neighbor queries
  - Temporal queries
  - Similarity queries
  - Aggregate queries
  - Spatio-temporal joins
- Developing efficient synopses
  - Handling connection oriented & connectionless traffic
  - Cascading synopsis techniques to achieve various tradeoffs

Research Challenges

- Integration of information from synopses across networks
  - Real power of ForNet is realized when information from SynApps is fused to answer queries
  - Development of a protocol for secure communication of various ForNet components
- Storage and query processing of synopses
  - Various storage and garbage collection strategies for collected-SynApps
  - Storage and query processing infrastructure for Forensics Servers
  - A query language transparent of various underlying synopsis techniques
  - Optimization of query processing and storage

Questions…