# Detecting Sensitive Data Exfiltration by an Insider Attack

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## Outline

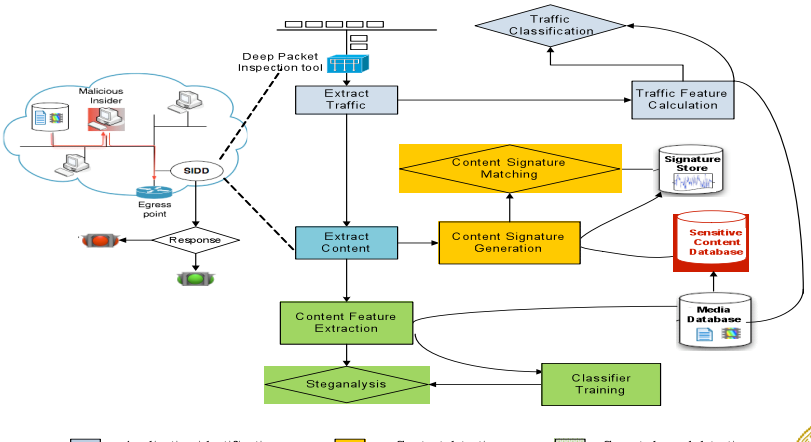
- Application Identification
- Content Signature Generation and Detection
- Detecting Covert Communication
- Research Directions



## Insider Attack and Insider Threat

- Insider attack
  - "*The potential damage to the interests of an organization by a person who is regarded, falsely, as loyally working for or on behalf of the organization, or who inadvertently commits security breaches.*"
- An insider attack can occur through
  - Inadvertent security breach by an authorized user
  - A planned security breach by an authorized user
  - A compromised system by an outsider

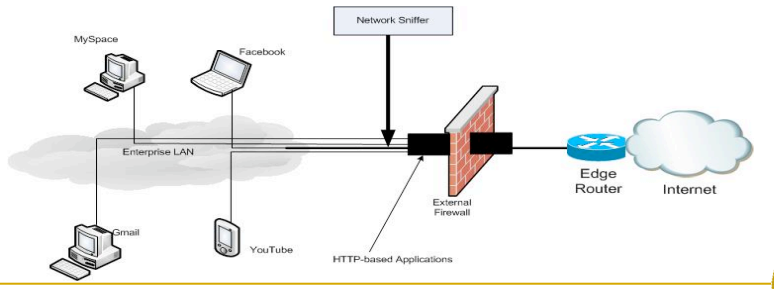
# Sensitive Information Dissemination Detection (SIDD) System






# Application Tunneling

- Current research has addressed the issue of identifying the application layer protocols
  - SSH, HTTP, FTP, etc.
- More fine grained identification is required for variety of applications that run over HTTP.
  - Social networking (MySpace and Facebook)
  - Web-mail (Gmail and Hotmail)
  - Streaming video applications (Youtube and Veoh)



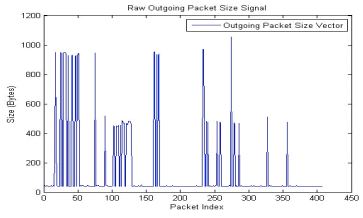
# Signals

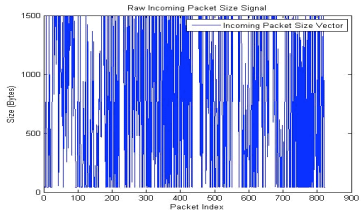
- **Inter-arrival time**: derived from the sequence of timestamps noted by the sniffer for packets inbound to the host
- **Inter-departure time**: derived from the sequence of timestamps noted by the sniffer for packets outbound from the host
- **Incoming packet size**: vector of packet sizes for HTTP packets inbound to the host
- **Outgoing packet size**: vector of packet sizes for packets outbound from the host
- **Outgoing Discrete Time Total Bytes**: vector of outgoing bytes of data aggregated over discrete and fixed time bins



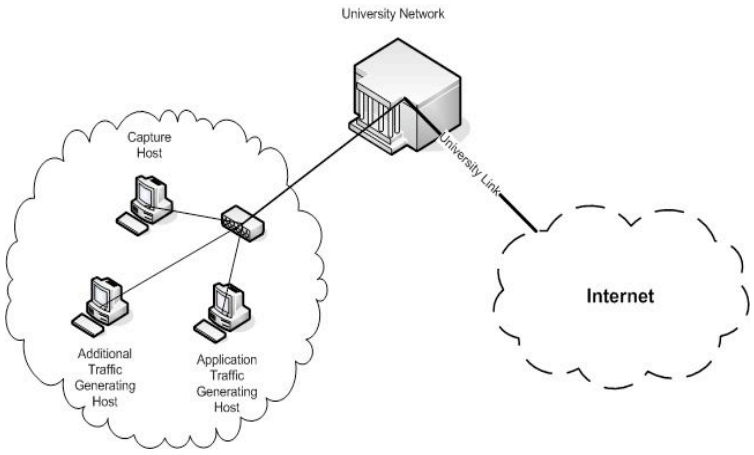
# Signals – Examples

- Outgoing packet size vs. incoming packet size



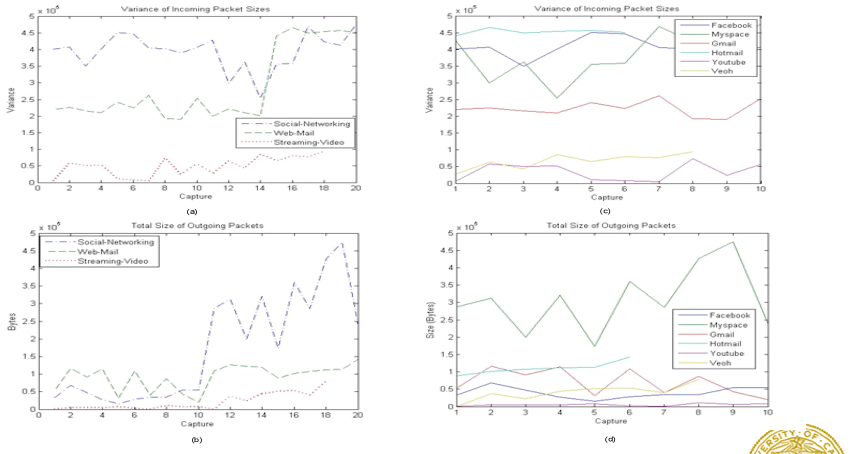




# Experimental Setup






# Temporal Statistics

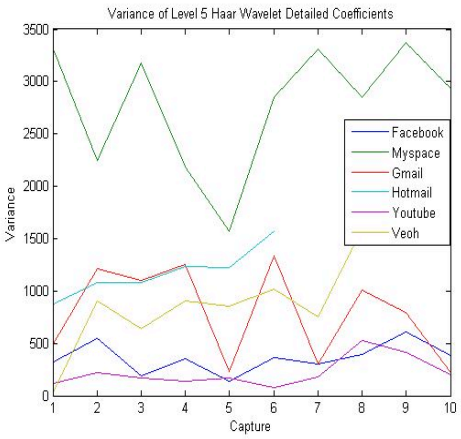


# Temporal Characteristics

| | Interdeparture | | Outgoing Packet Size | | | | Incoming Packet Size | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Q3 | | Mean | | Var | | Var | | Total Bytes | |
| | Mean ($x10^{-2}$) | Var ($x10^{-5}$) | Mean ($x10^{2}$) | Var ($x10^{3}$) | Mean ($x10^{4}$) | Var ($x10^{9}$) | Mean ($x10^{4}$) | Var ($x10^{7}$) | Mean ($x10^{5}$) | Var ($x10^{11}$) |
| Facebook | 6.04 | 38.1 | 1.15 | 1.87 | 5.59 | 1.73 | 39.9 | 119 | 9.55 | 2.33 |
| Myspace | 1.94 | 3.1 | 3.27 | 8.37 | 28.6 | 4.89 | 38.4 | 509 | 31.1 | 29.9 |
| Gmail | 21.54 | 650 | 2.71 | 1.41 | 18.8 | 16.7 | 21.9 | 46.1 | 8.73 | 2.1 |
| Hotmail | 6.2 | 17.2 | 2.18 | 0.598 | 18 | 4.29 | 45.3 | 7.14 | 7.19 | 0.432 |
| Youtube | 11.26 | 250 | 0.82 | 1.35 | 4.53 | 14.9 | 3.47 | 69.4 | 121 | 133 |
| Veoh | 5.43 | 54.5 | 0.96 | 0.75 | 4 | 4.17 | 6.71 | 49.5 | 169 | 118 |

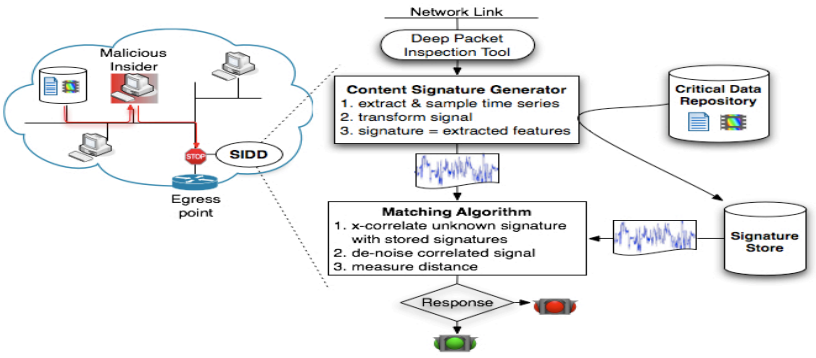


# Wavelet Analysis




- Use Haar wavelet
- Feature used for comparison
  - Variance of the Level-5 detailed co-efficients

# Content Identification: Motivation




***Can we detect illegal dissemination of protected digital (media) assets?***



# Content Signature

- Content-based Signature
  - "The media itself is a watermark"
  - Unique and robust
    - Different content should have distinct signatures
    - The signatures are tolerant to various forms of noise and distortions
  - Requirements vary with applications
    - From video search to detecting video copying

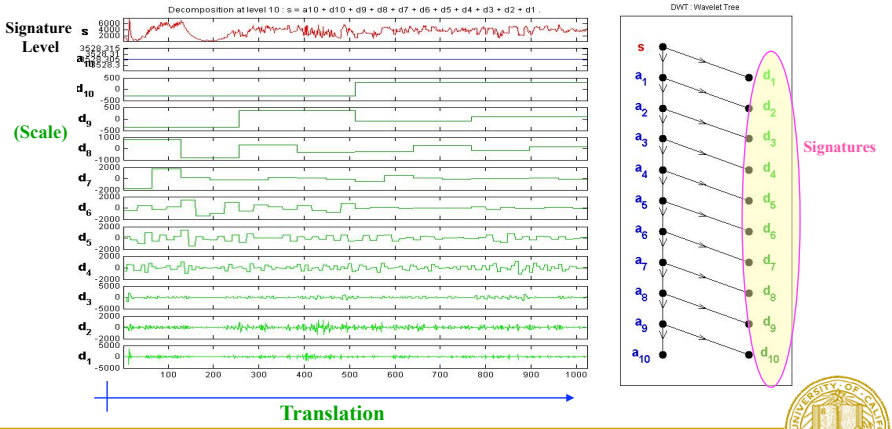
# Content Signature Generation

- Basic idea
  - Extract a time series (or signal) of the content and analyze the signal to generate the signatures
  - Capture the temporal correlation in the signature
  - Treating the content signatures as time series
    - Use signal processing techniques and tools to analyze
      - Wavelet transform
    - Any portion of the content can be used for detection
    - Computation cost saving



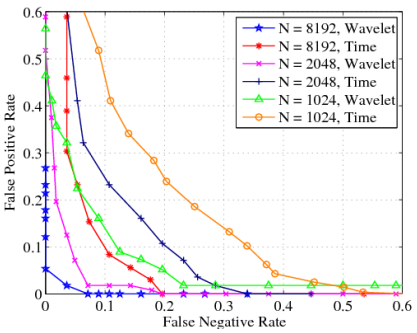
# Content Signature Generation – Example

- The Detailed Coefficients of the Star Wars Movie

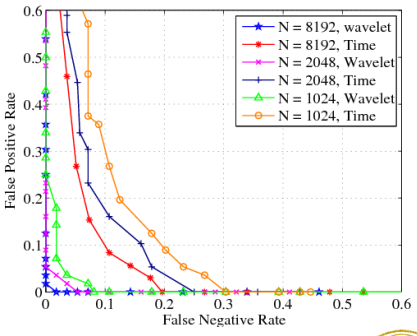



# Preliminary Analysis

ROC curve in rate adaption case 1




ROC curve in rate adaption case 2






# Detecting Covert Communication

- Exfiltration of sensitive information may be carried out using covert communication
  - Hiding content/communication in an innocuous carrier using a steganography tool
- Challenges
  - The content may be encrypted
  - Different types of carriers

## Audio Steganalysis

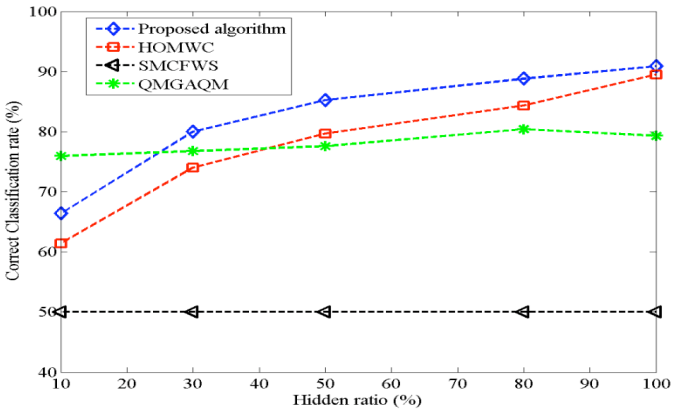
- The analysis and classification method of determining if an audio bears hidden information
- Easy to establish
  - Voice over Internet Protocol (VoIP) and other Peer-to-Peer (P2P) audio service
- High hidden capacity
  - Inherent redundancy in the audio signal
  - Its transient and unpredictable characteristics
- Human ear is insensitive to small distortions



## Main Points

- A new approach to detect hidden content in audio files
- Uses Hausdorff distance and feature vectors based on higher-order statistics
- Good detection rate even with low hidden ratio

# Comparative Analysis






# Research Directions

- Improving the techniques
  - Wavelet analysis allows time frequency localization
    - Where approximately time certain frequencies occur
    - Is it useful in disambiguating applications?
  - Co-integration can extract similarities in signals that may be uncorrelated
    - Can this be used to detect content that is encrypted and/or modified to evade detection?
- Developing prototypes
  - A VoIP steganalysis tool
  - A classifier for network level application identification