On Detection and Visualization Techniques for Cyber Security Situation Awareness

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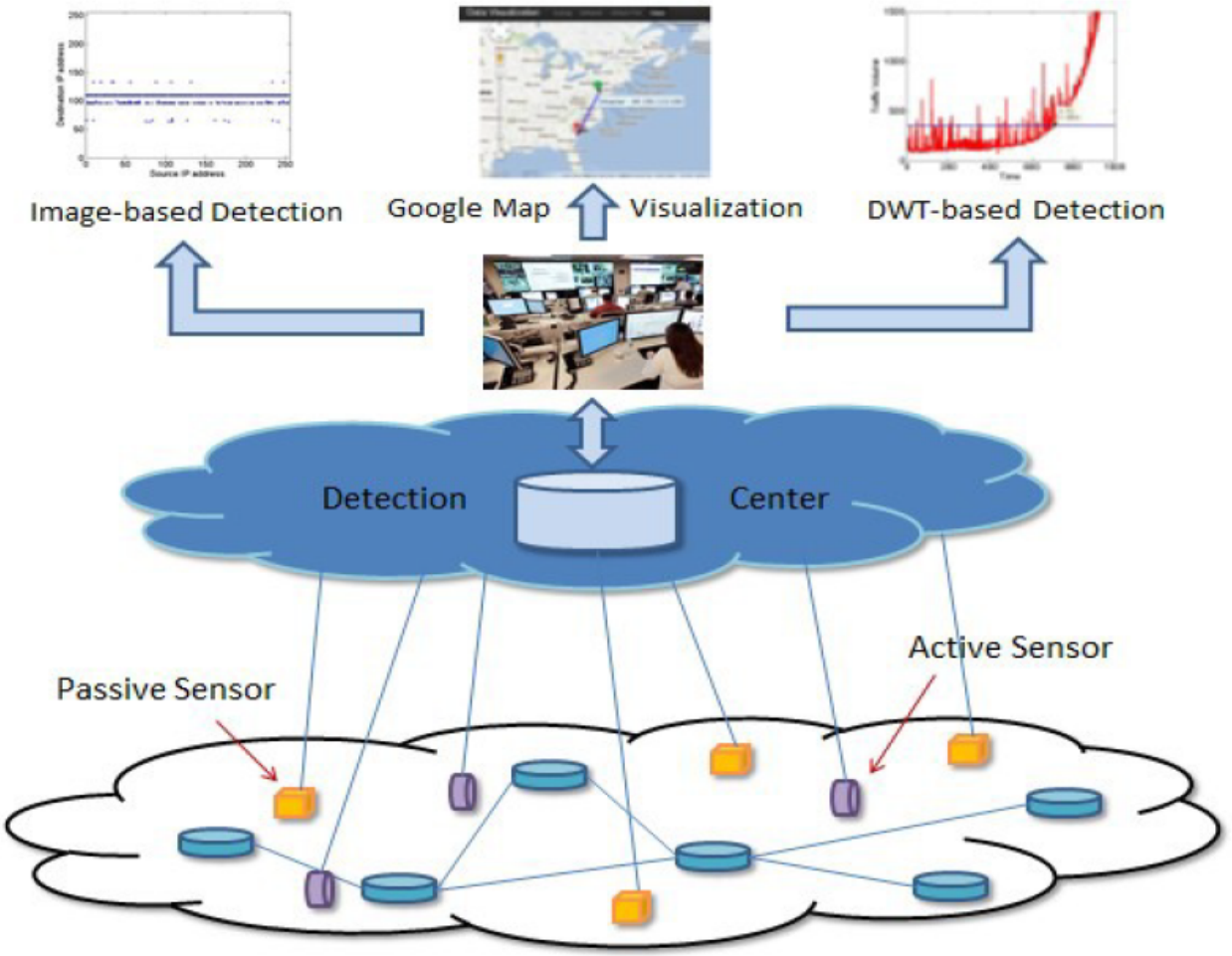
1. Introduction

- Prototypical system
- Visualization features
- Image-based track algorithm
- Two detection schemes: Discrete wavelet transform (DWT), traffic volume based approach
- Evaluation

2. System Architecture

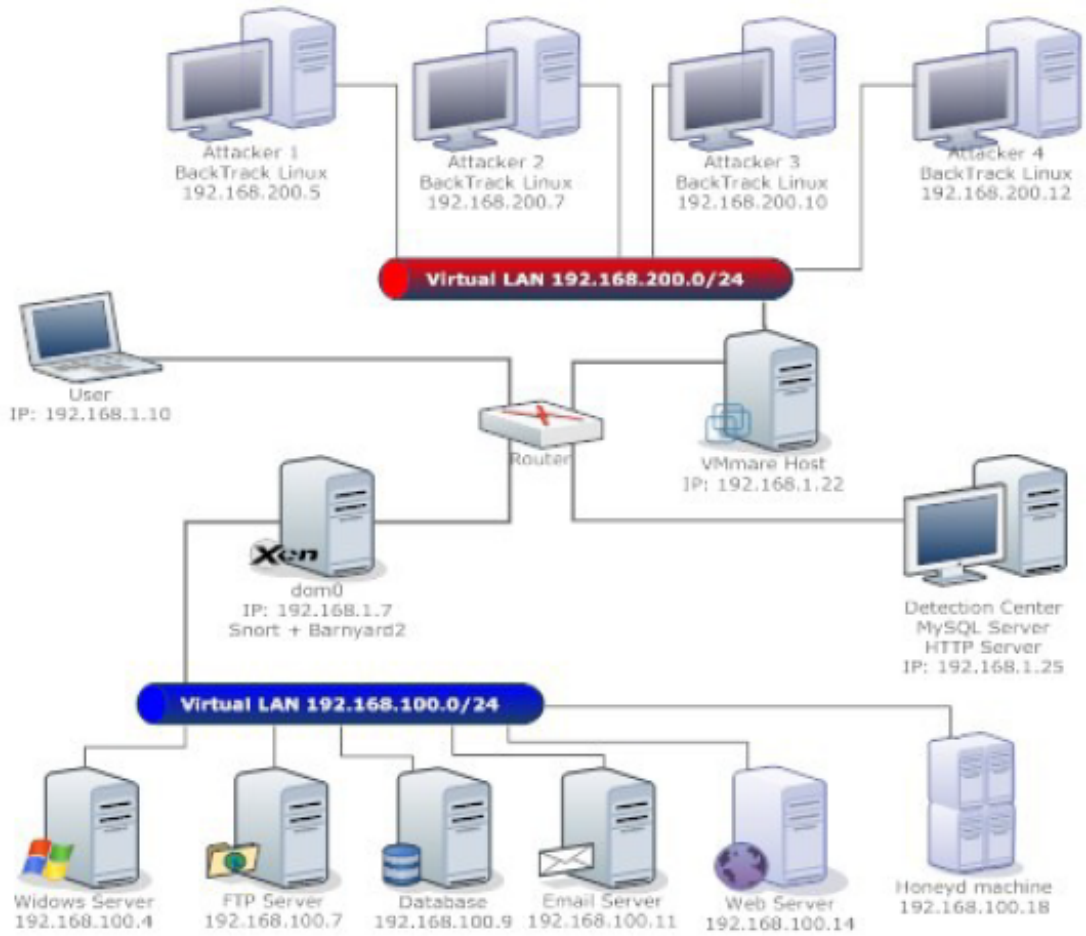


3. Testbed Setup

- Unpatched Windows Server: **vulnerabilities** and **effectiveness**

- BackTraceLinux server: hacking tools

3. Testbed Setup



4. Attack Visualization

- 1D : Network traffic volume.
- 2D : Source IP and destination IP addresses
- 3D : Geological attributes and victims.

5. Attack Detection

- Many to many attacks: worm/malware propagation
- Many-to-one attacks: DDoS
- One-to-many attacks: port-scanning attacks

5. Attack Detection

- **Image based detection scheme(**traffic volume based approach**):**
- 1. Information: packet headers, detection center
- 2. Traffic data: Construct 2D images

5. Attack Detection

- Image-based track algorithm

Algorithm 1: The Image Based Transform Algorithm

Input : Source IP Address $S_{i1}, S_{i2}, S_{i3}, S_{i4}$;
Destination IP Address $D_{i1}, D_{i2}, D_{i3}, D_{i4}$;
Traffic Volume Vector $X = [X_1, X_2, \ldots, X_8]$;
Total Traffic Volume M;

Output : Plot Image Based on Collected Data

Collect Traffic Data:
for $i = 1 : M$ **do**
  for $j = 1 : 4$ **do**
    $X_{ij} = S_{ij}$
    $X_{i(j+4)} = D_{ij}$ % Record Source IP and Destination IP address into Traffic Volume Vector
  end
end
Display Image of Traffic:
Input Traffic Volume Vector: $X = [X_1, X_2, \cdots, X_8]$;
for $i = 1 : M$ **do**
  for $j = 1 : 4$ **do**
    plot($X_{ij}, X_{i(j+4)}$) % Plot Image Based on Collected Data
  end
end
Display 2D Image for Network Traffic

5. Attack Detection

- Image-based track algorithm

Algorithm 2: The Image Based Track Algorithm

Input : Image of Traffic Data;
Traffic Volume Vector: $G = [G_1, G_2, \cdots, G_8]$;
Total Traffic Volume M;
Threshold Parameter: k;

Output : Print Attack IP Addresses

Gray Scale Image Generation:

$I = imread('image.jpg')$; % Read Generated Color Image and save it in an Array

G= rgb2gray(I); % Transform Color Image into Gray Scale Image along with Gray-Level Value

Display Image of Network Traffic:

Input the Array of Gray-Level Value: $G = [G_1, G_2, \cdots, G_N]$;

Define N as the Total Number of Array

$m = mean(G)$

$v = std(G)$ % Calculate Mean Value and Stand Derivation of Data Stored in Array

for $i = 1 : N$ **do**

  if $G_i > m + kv$ **then**

    $j = i$;

  end

end

5. Attack Detection

- Detection schema 1(image based detection):
- Use traffic volume as the detection feature (blue line is the threshold).

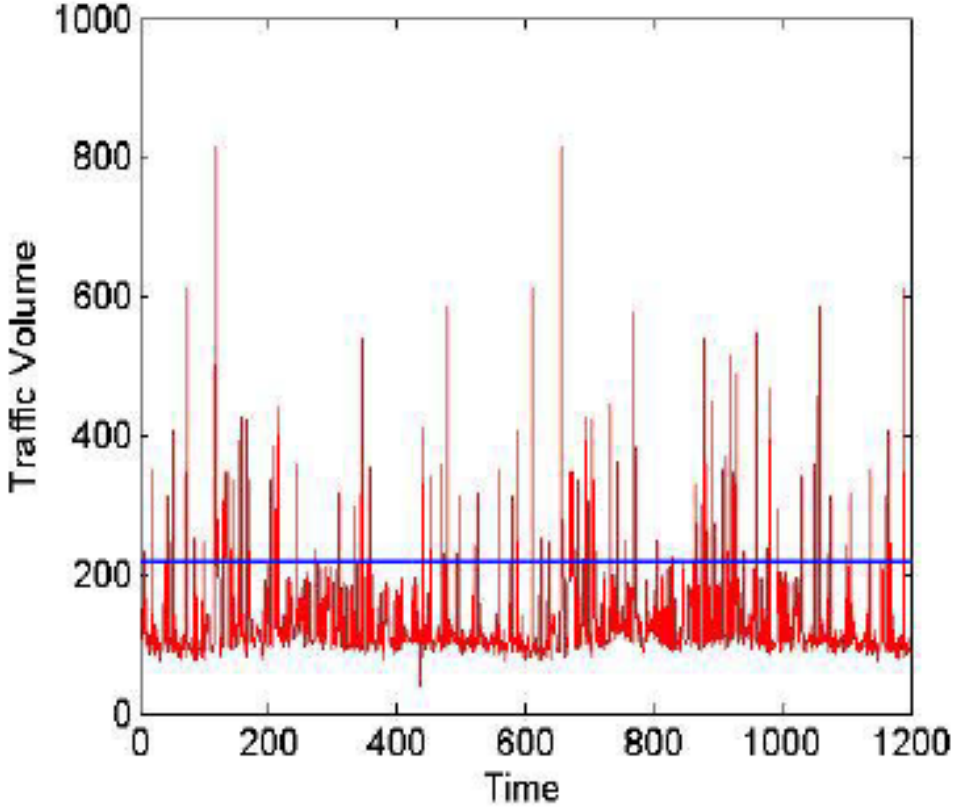


Figure1. random traffic volume

5. Attack Detection

- Detection schema 1(image based detection):
- Use traffic volume as the detection feature (blue line is the threshold).

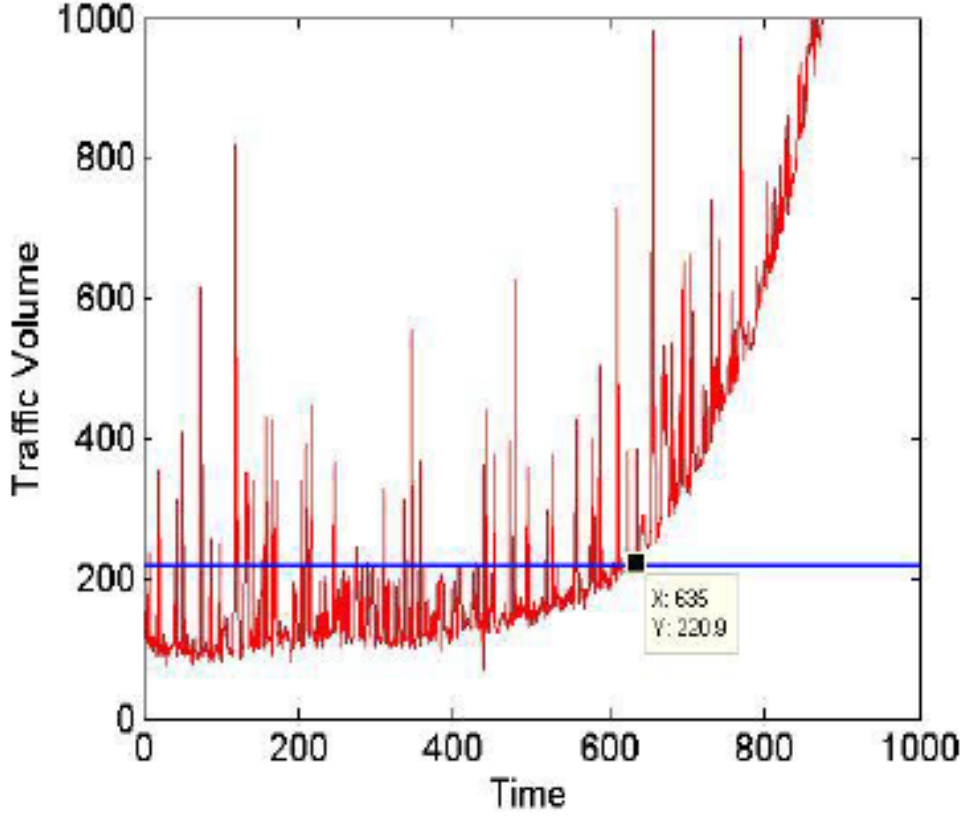


Figure2. mix attack and background traffic

5. Attack Detection

- Detection schema 2(Discrete wavelet transform):

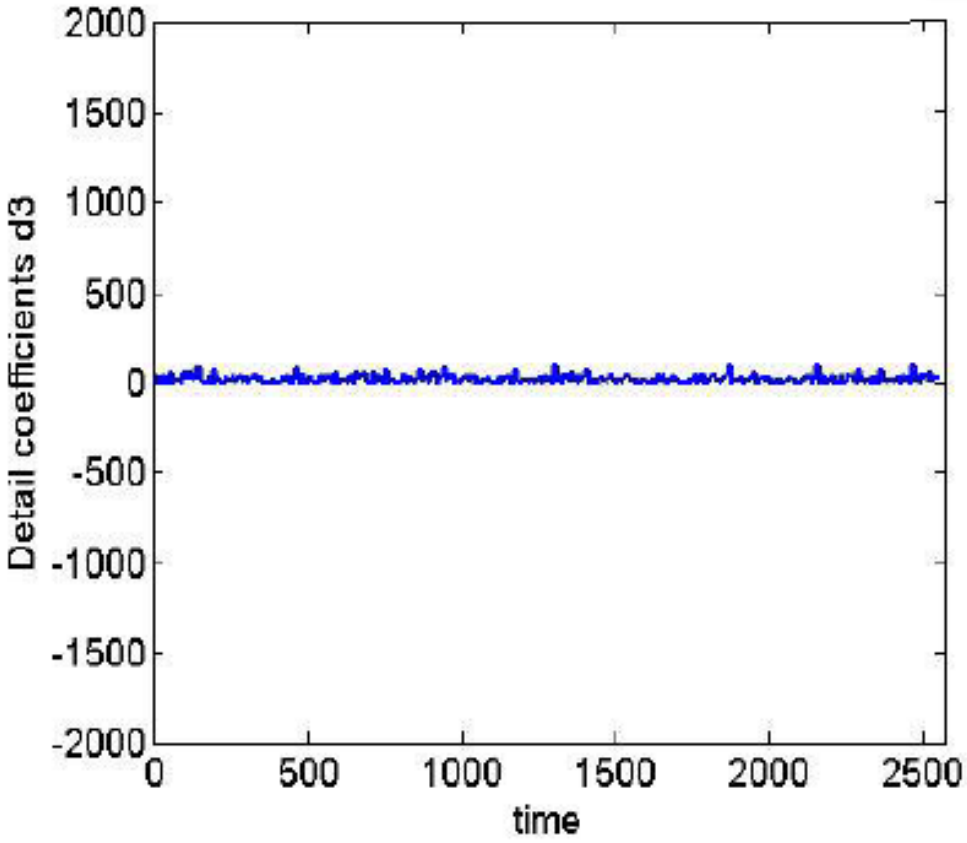


Figure 1:Background traffic

5. Attack Detection

- Detection schema 2(Discrete wavelet transform):

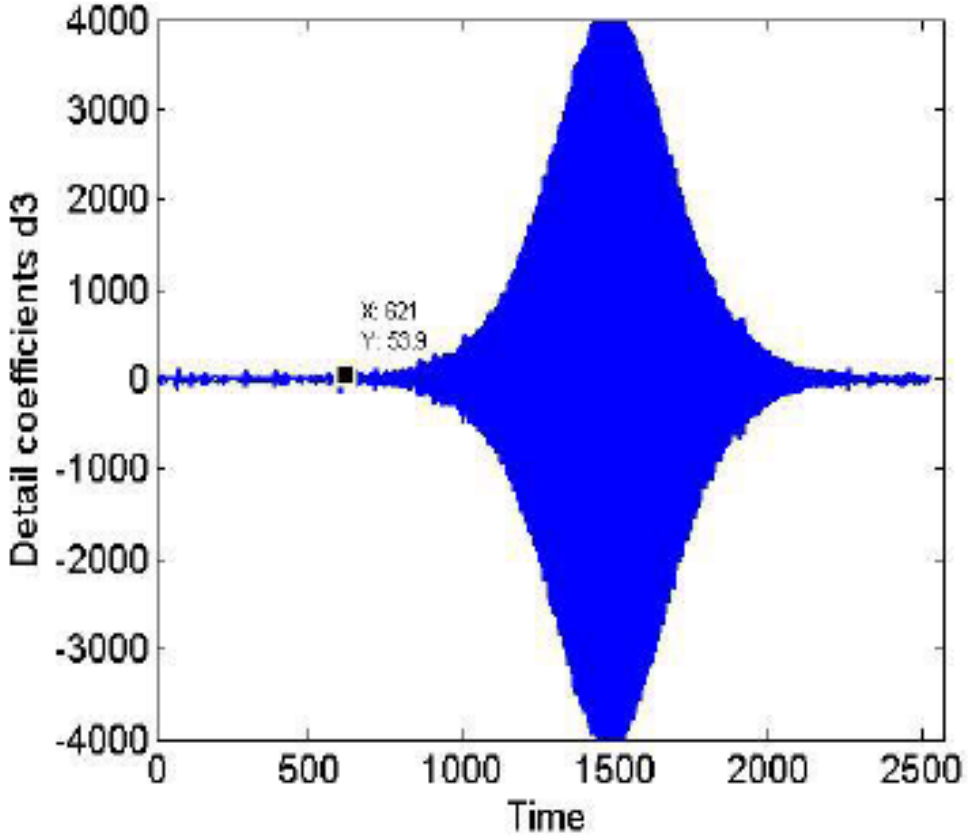


Figure 2: Mixture traffic with attack

6. Evaluation

- 2D visualization:

Figure 1: one-to-one

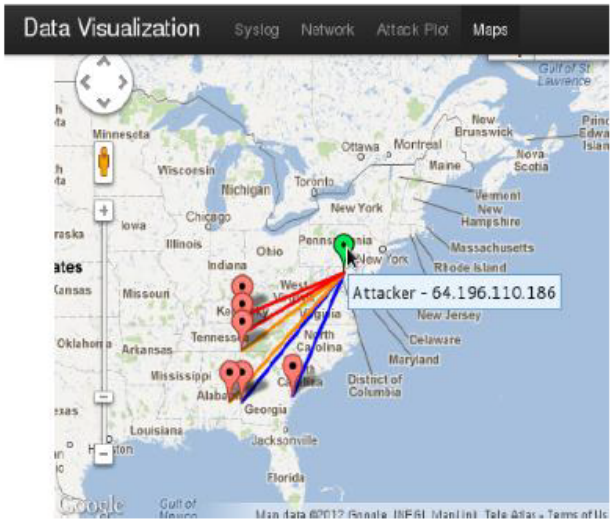


Figure 2: one-to-many

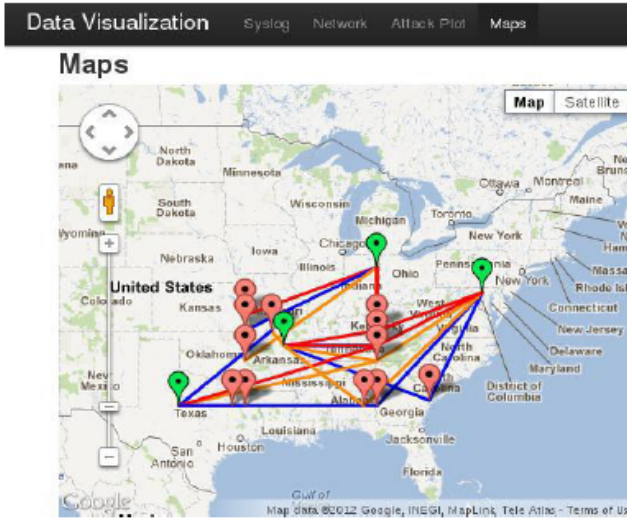


Figure 3: many-to-many

6. Evaluation

- 3D visualization:

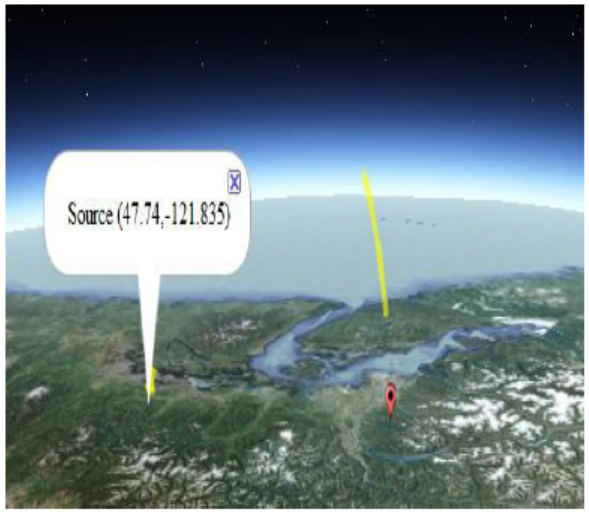


Figure 1: one-to-one

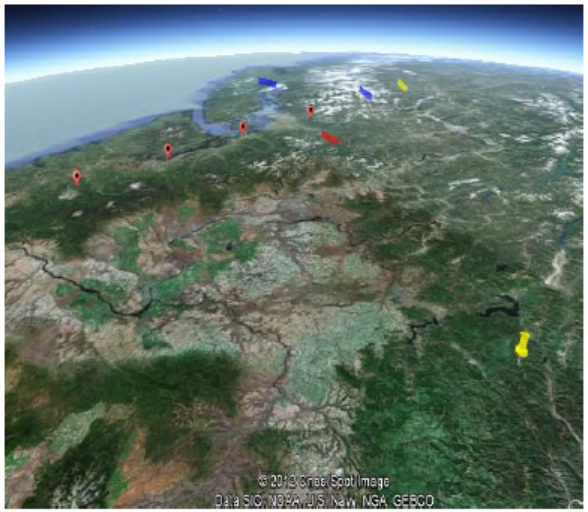


Figure 2: one-to-many

Figure 3: many-to-many

6. Evaluation

- **Detection Rate (Pd):** detection rate
- **False Positive Rate (Pf):** false positive rate
- **Detection Time**

6. Evaluation

- Real-world network traffic
- Propagation attack model
- Calculation

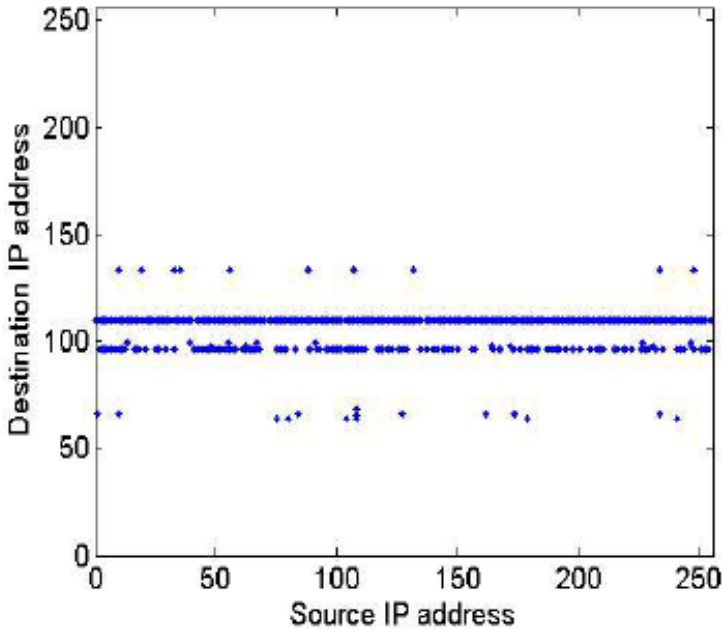


Figure 1: Image generated by related source and destination

6. Evaluation

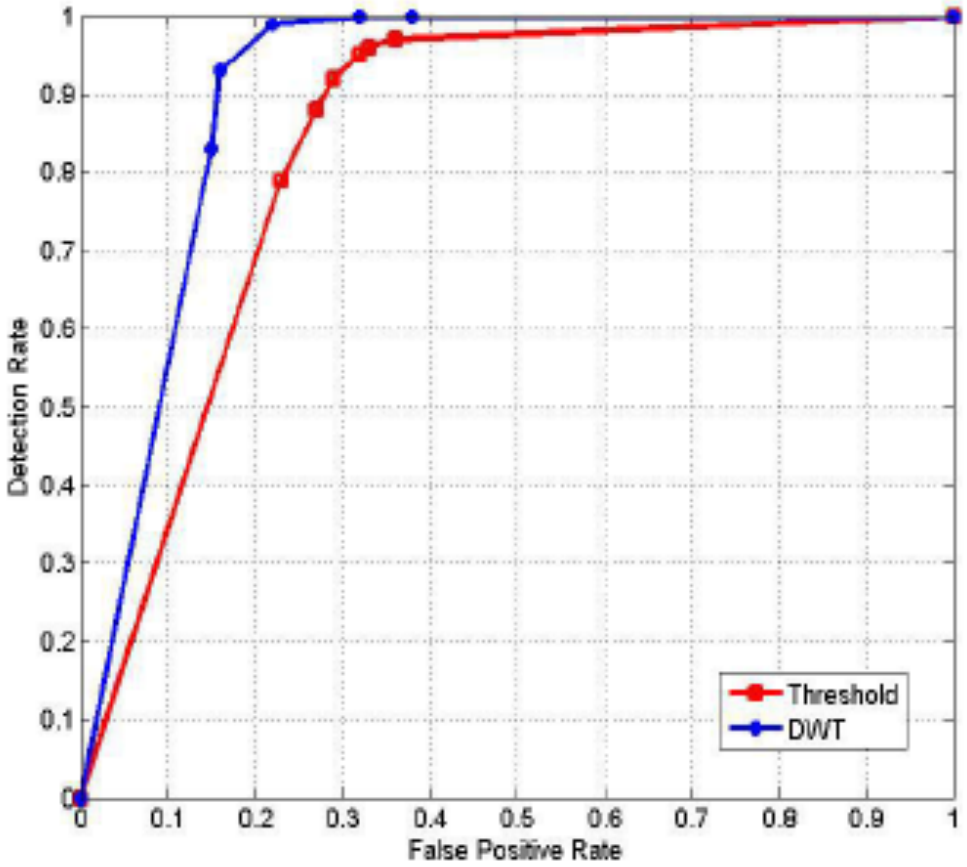


Figure 1: ROC of traffic volume Based and DWT Based detection

6. Evaluation

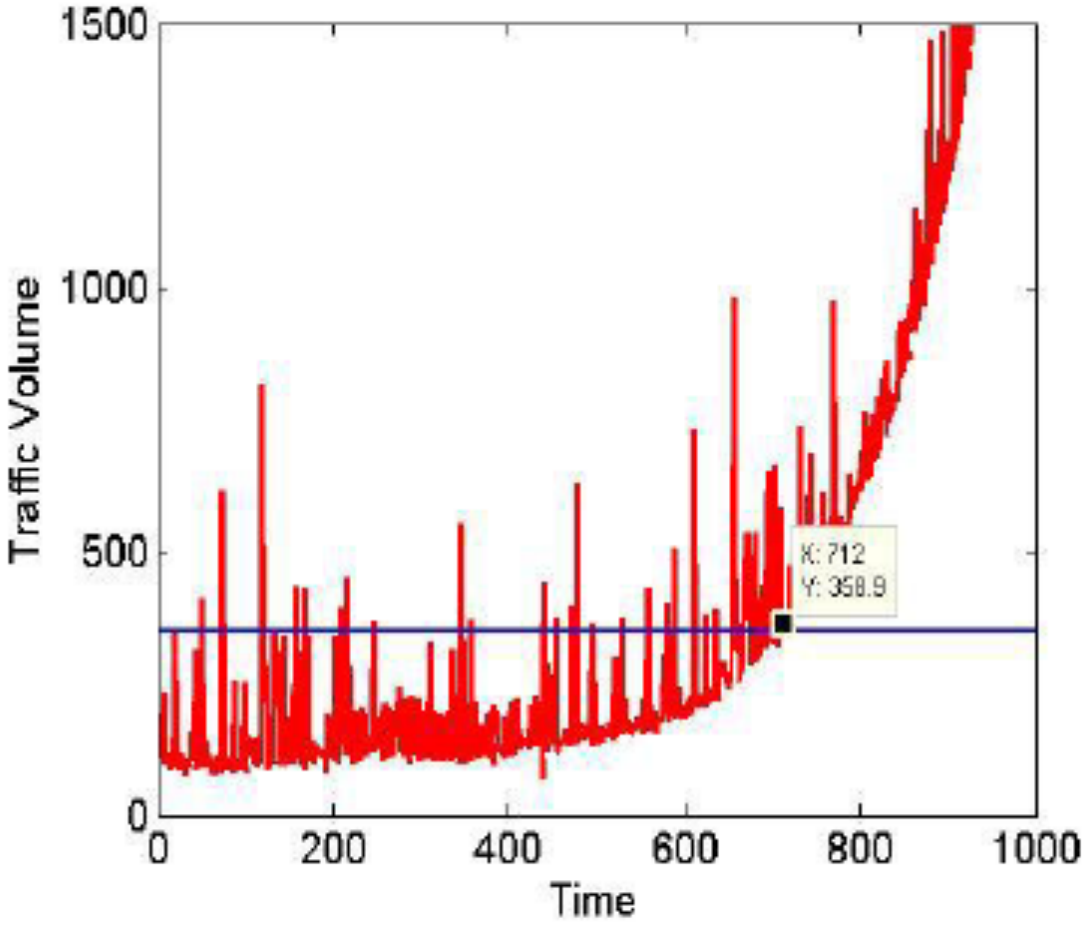


Figure 1: Detection Time of Traffic Volume Based Detection

6. Evaluation

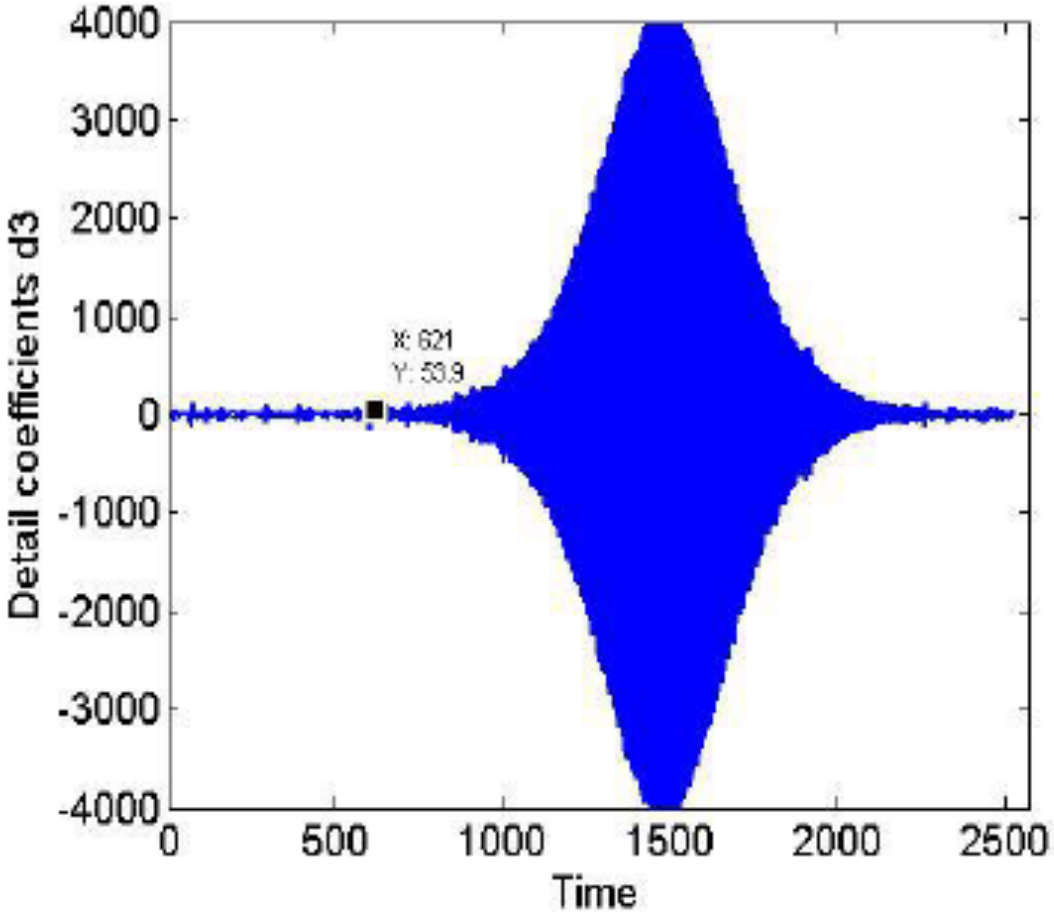


Figure 2: Detection Time of DWT Based Detection

Thank you!