Anomaly Detection of Network Traffic
Based on
Analytical Discrete Wavelet Transform

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Introduction

MAIN OBJECTIVES :

-a new detection mechanism of network traffic anomaly based on Analytical Discrete Wavelet Transform (ADWT) and high-order statistical analysis;

-evaluate our technique with the 1999 DARPA/MIT Lincoln Intrusion Detection Dataset .

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Motivation (1)

- the expansion of the Internet and the great number of available services;
- the emergence of a variety of wireless networks;
- the mobility of network hosts;
- the vulnerability of present-day software and protocols;
- companies have increasingly put critical resources online.

Attacks/intrusions :

- virus, spamming, worms, malware, privilege escalation, unauthorized logins, access to sensitive information, attacks against vulnerable services, injection of unwanted packets into the target networks.

The classical solutions to reduce the risks of security problems → **Firewalls**

Cryptographic techniques

INTRUSION DETECTION SYSTEMS (IDS) ← **+**

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Intrusion Detection Systems

Detection method :
- Misuse/Signature-based Systems
- Anomaly-based Systems

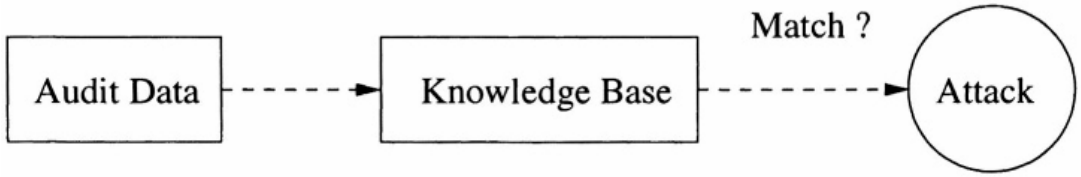

Figure 1. Block Diagram of a Typical Knowledge-Based IDS

Advantage:
- Very accurate in detecting known attack

Disadvantage:
- cannot detect previously unknown attacks

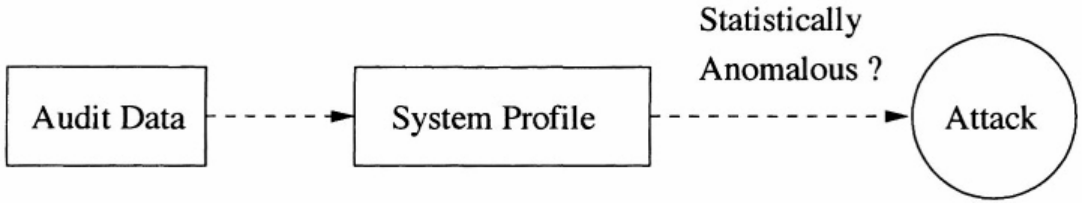

Figure 2. Block Diagram of a Typical Behavior-Based IDS

Benefit:
- Can detect previously unknown attacks

Drawback:
- generation of many false alarms

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Anomaly based detection IDS based on ADWT (1)

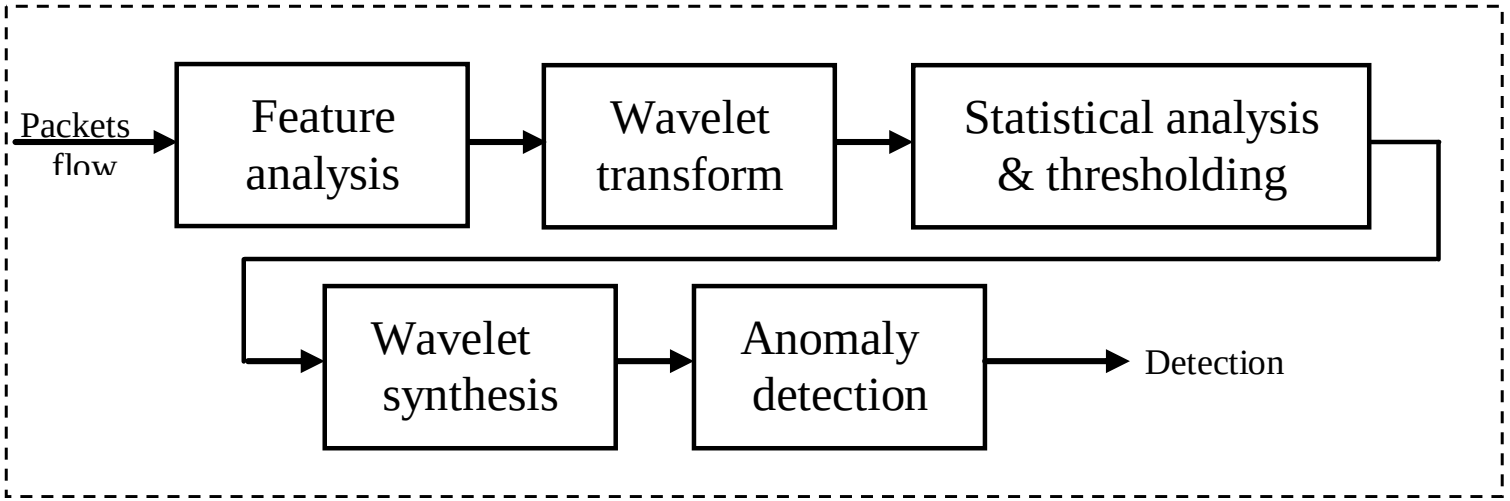

Figure. 3. The model of network traffic anomaly detection

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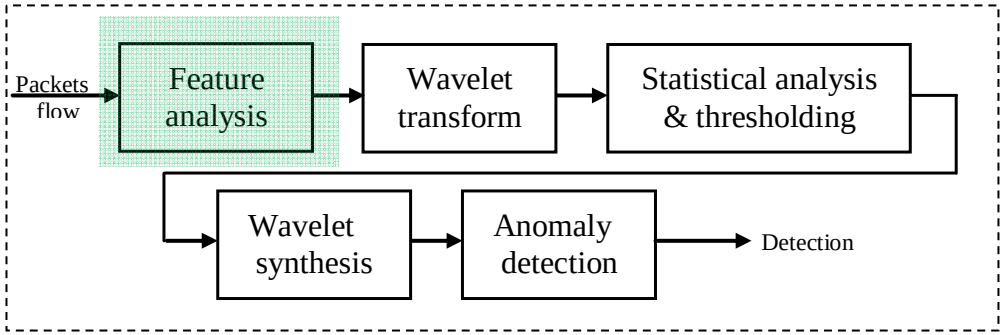
Anomaly based detection IDS based on ADWT (2)



Feature Analysis

Network flows – TCP, UDP and ICMP

Packets flow (Tcpdump) → **Editcap** → **Tshark** →

flow count over a time period
average number of packets in a flow over a time period
average number of bytes in a flow over a time period
average packet size in a flow over a time period
and ratio of flow count to average packet size

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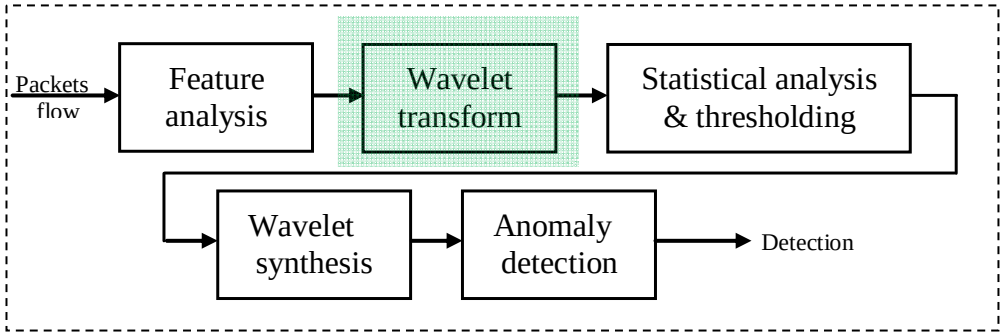
Anomaly based detection IDS based on ADWT (3)



Wavelet transform

Network flows → **ADWT** → **[cA4, cD4, cD3, cD2, cD1]**

- 4 level of decomposition
- Daubechies(db6)
  - localization
  - vanishing moments
  - linearity
  - symmetry

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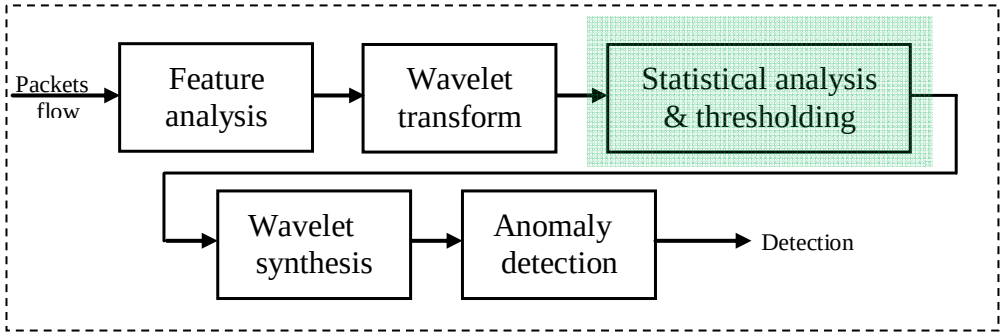
Anomaly based detection IDS based on ADWT (4)



Statistical analysis & thresholding

High-order statistics - 4th order cumulant :

$$\tilde{C}_2^2[s] = \tilde{M}_2^2[s] - 2\left(\tilde{M}_1^1[s]\right)^2 - \tilde{M}_2[s]\tilde{M}^2[s]$$

where $\tilde{M}_p^q$ ***is the complex moment of the signal s .***

The thresholds are set through the research of historic traffic over several days.

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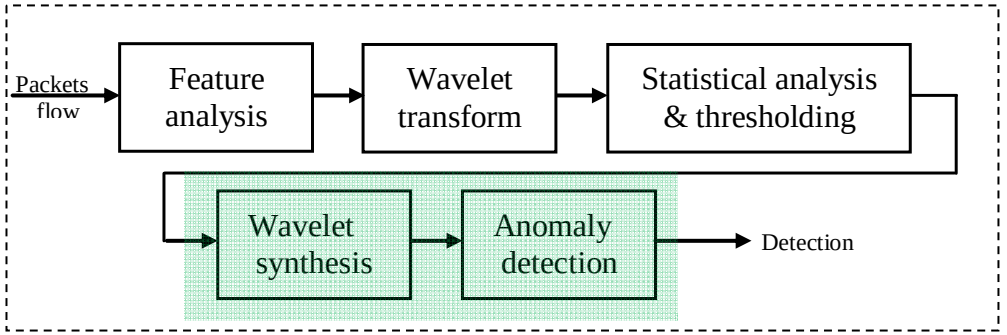
Anomaly based detection IDS based on ADWT (5)



Wavelet synthesis & Anomaly detection

Filtered signal → **IADWT** → **Anomaly detection** → **Attack**

- better shift-invariance
- simplicity
- flexible structure
- reduced computational time

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Results (1)

1999 DARPA/MIT Lincoln Intrusion Detection Dataset

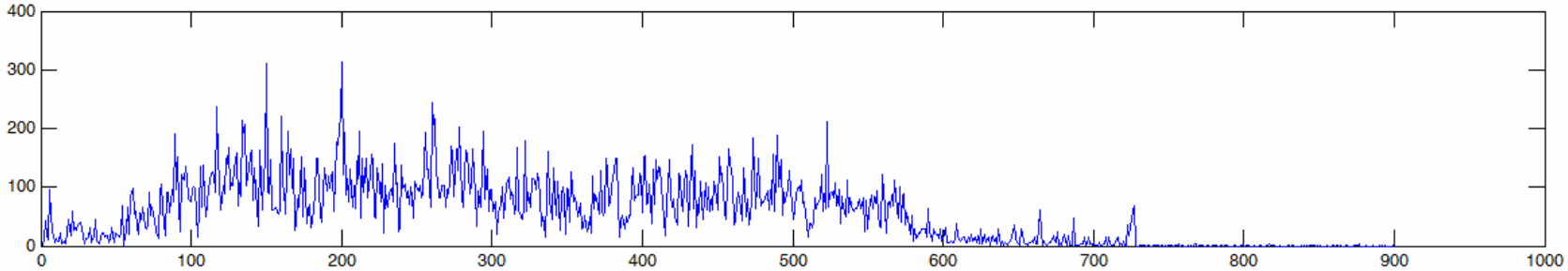
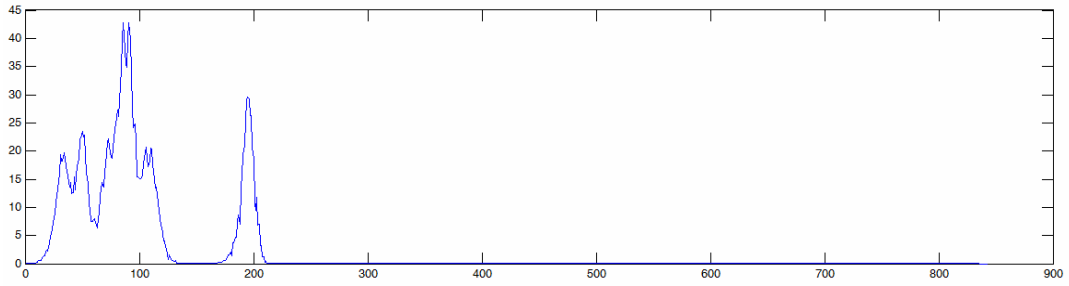


Figure. 4. Number of TCP flows per minute over one day



4 attack detected :

- ***Ntinfoscan***
- ***pod***
- ***back***
- ***httptunnel***

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Results (2)

1999 DARPA/MIT Lincoln Intrusion Detection Dataset

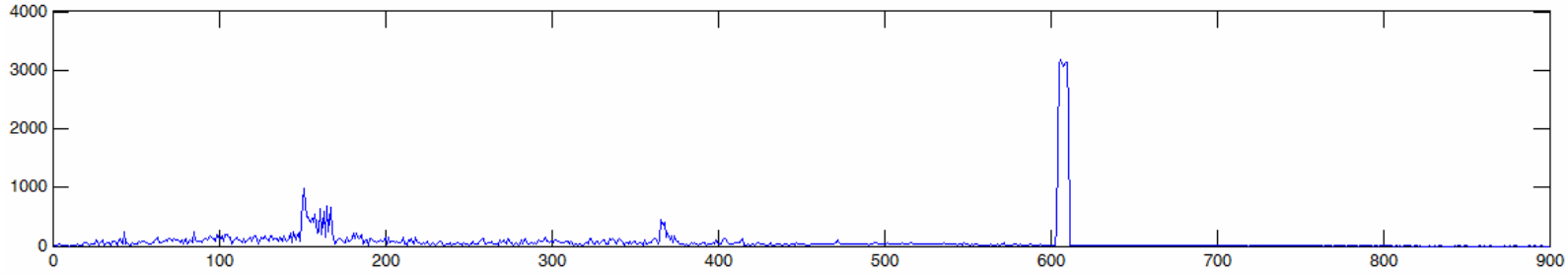
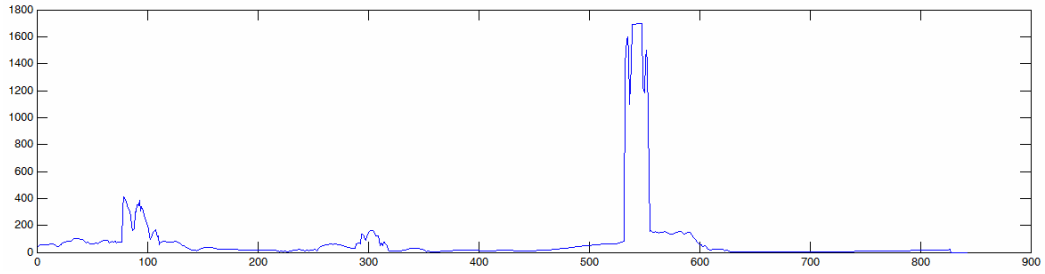


Figure. 5. Number of TCP flows per minute over one day



5 attack detected :

- ***portsweep***
- ***ipsweep***
- ***pod***
- ***apache2***
- ***dict***

Perspectives

PERSPECTIVES :

- Optimal selection of the alert thresholds
- Applying different wavelet basis functions, and study the impact in detecting the attacks
- Implementation of the proposed method in real-time