# IMPLEMENTATION OF AN INTRUSION DETECTION SYSTEM (IDS) BASED ON STATISTICAL ACCESS PATTERN ANALYSIS

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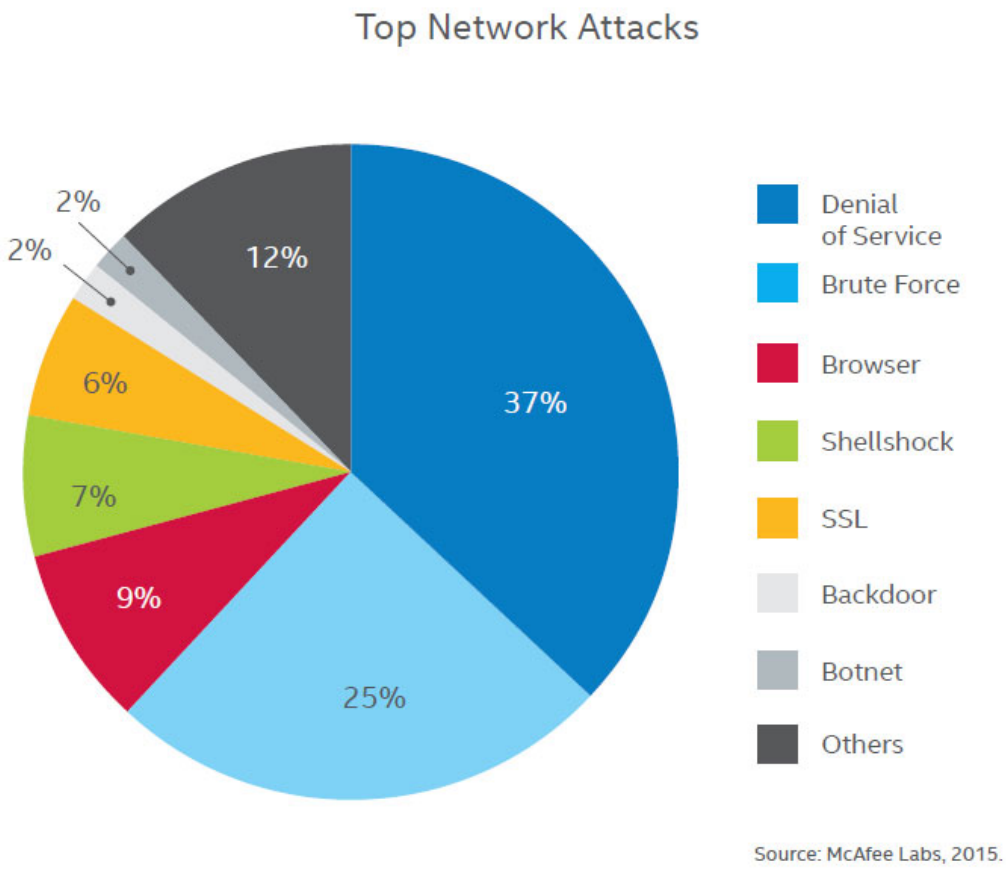
# Outline

- Attacks, Attack Types
- Prevention Approaches
- Literature Review
- Motivation
- Proposed Method
- Experimental Results
- References
- Questions

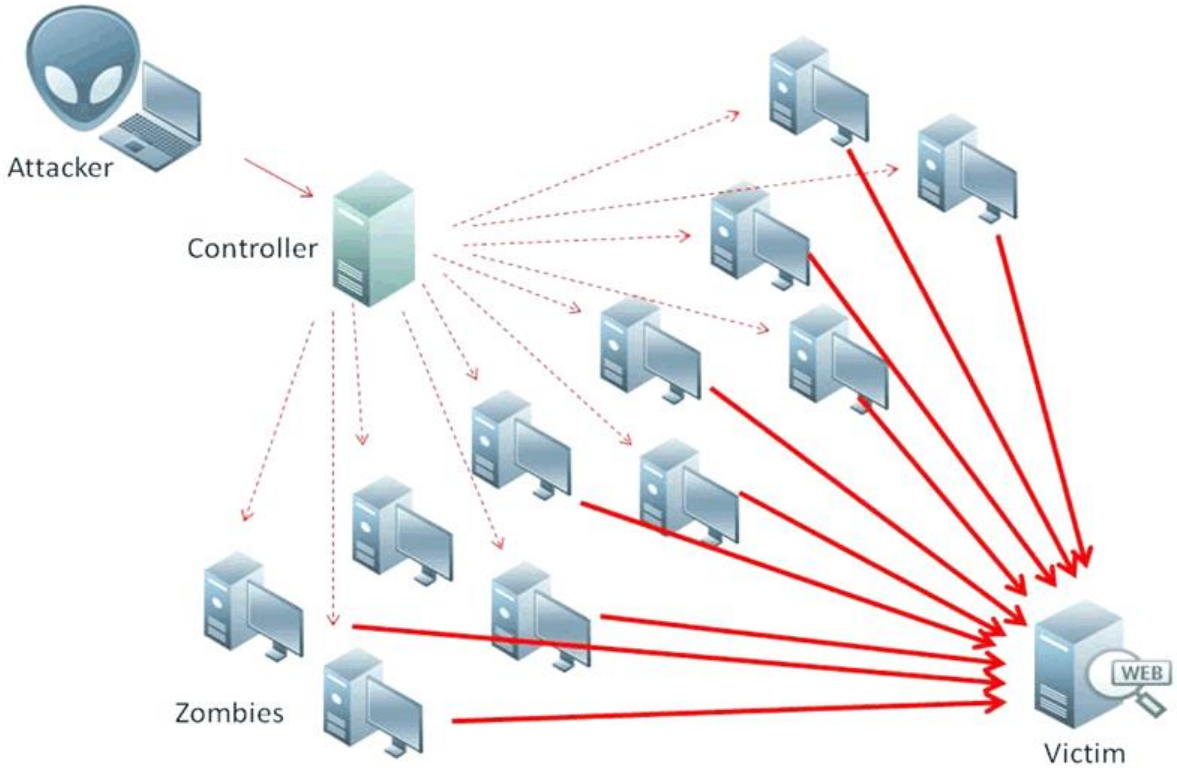
# Network Attacks

- Most common attack model: DoS & Brute Force



# DoS & Distributed DoS

- A denial of service (DoS) attack attempts to make a resource, such as a web server, unavailable to users.



# Types of DoS

1. **Network Layer Attacks**

- TCP, UDP and ICMP Floods (SYN Flood, Ping of Death, etc. )

2. **Application Layer Attacks**

- HTTP GET & POST Flood

Zombie machines attack the victim server through legitimate packets such that packets have legitimate format and are sent through normal TCP connections.

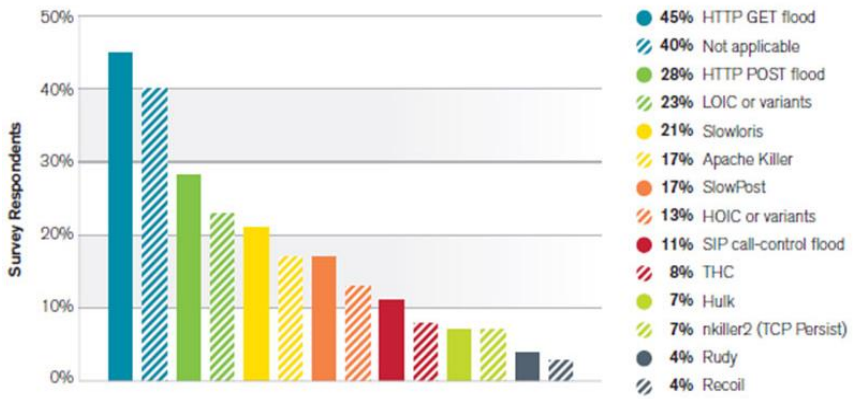



*Figure 23* Source: Arbor Networks, Inc.

# Preventing DoS Attacks

**On Network Layer**

- Analyzing # of TCP& UDP Packets in a Statistical Manner
- Analyzing Behavioral Status of Network (Resource Usages, etc.)

**On Application Layer**

- Analyzing payload of packet (DPI)
- Client-side techniques (CAPTCHAs)

# Literature Review

- CAPTCHA Puzzles [1, 2]

A CAPTCHA puzzle is a challenge-response test used in web applications as an attempt to ensure that the response is generated by a human not by a machine.

**Weaknesses:**

- Several image recognition techniques to break CAPTCHA [3]
- **Labor attacks:** There are free/cheap 3rd party human labor to break CAPTCHAs [4, 5]

- Yatagai's method [6]

Measure session durations and browsing order

**Weaknesses:**

Vulnerable to advanced DDoS attack scenarios with randomized distribution

# Literature Review

- ConnectionScore [8]

Statistical technique to protect from most common application layer DDoS attacks such as HTTP flood. It measures request times, request rates, download rates, browsing behaviour (link depth).

**Weaknesses:**

24% of the malicious connections do not get negative scores

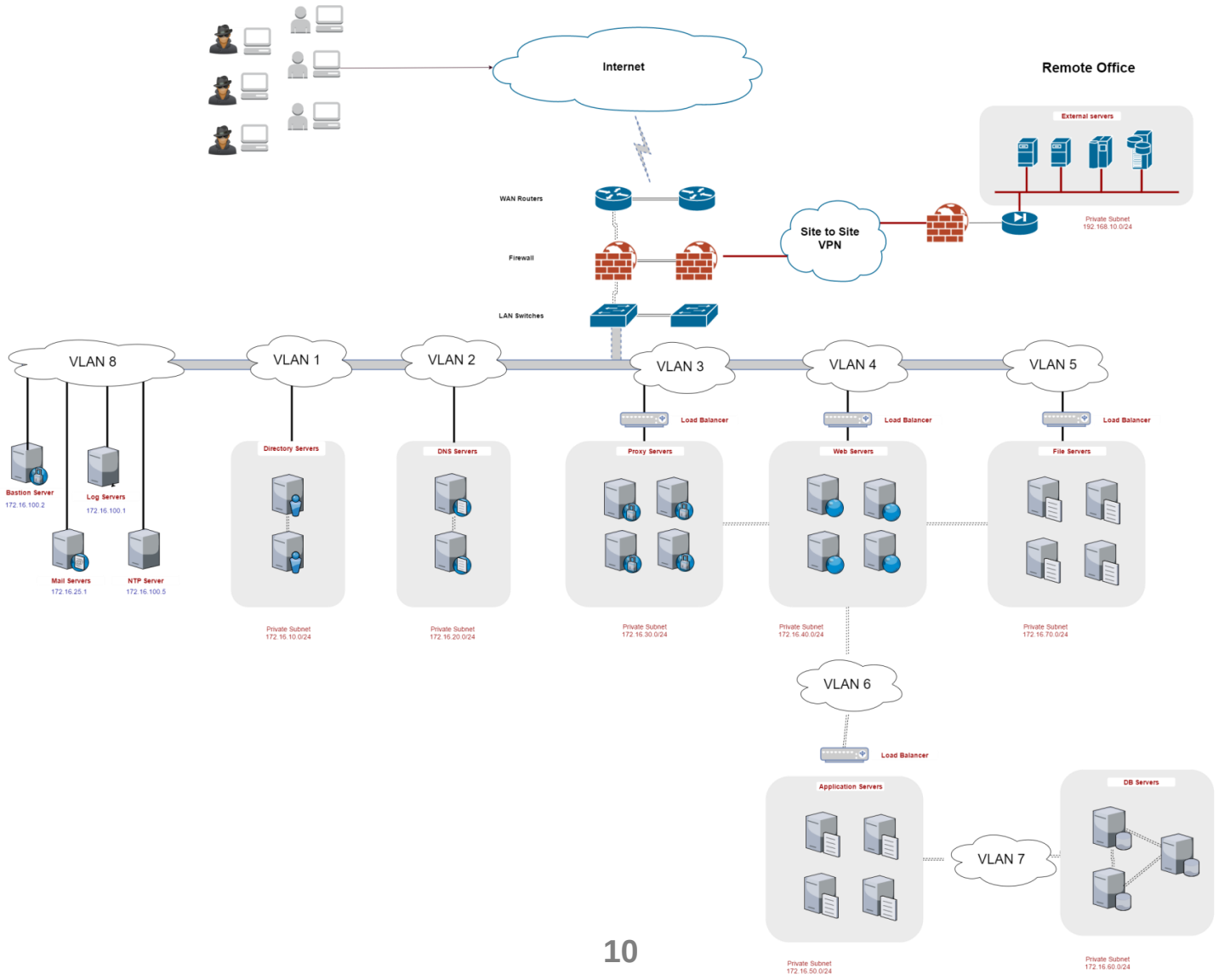
# Motivation

- Develop a new statistical method somewhat similar but not limited to Connection Score to prevent  application layer DDoS & brute force attacks by analyzing access logs in historic and volumetric distribution.

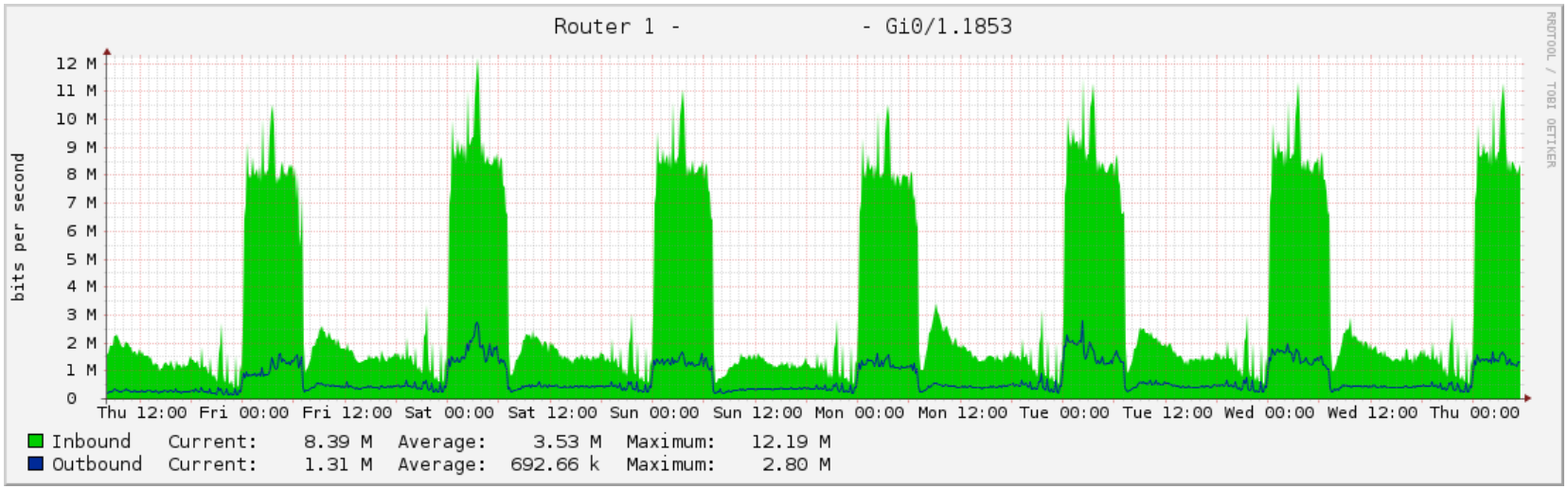
**IPScore**

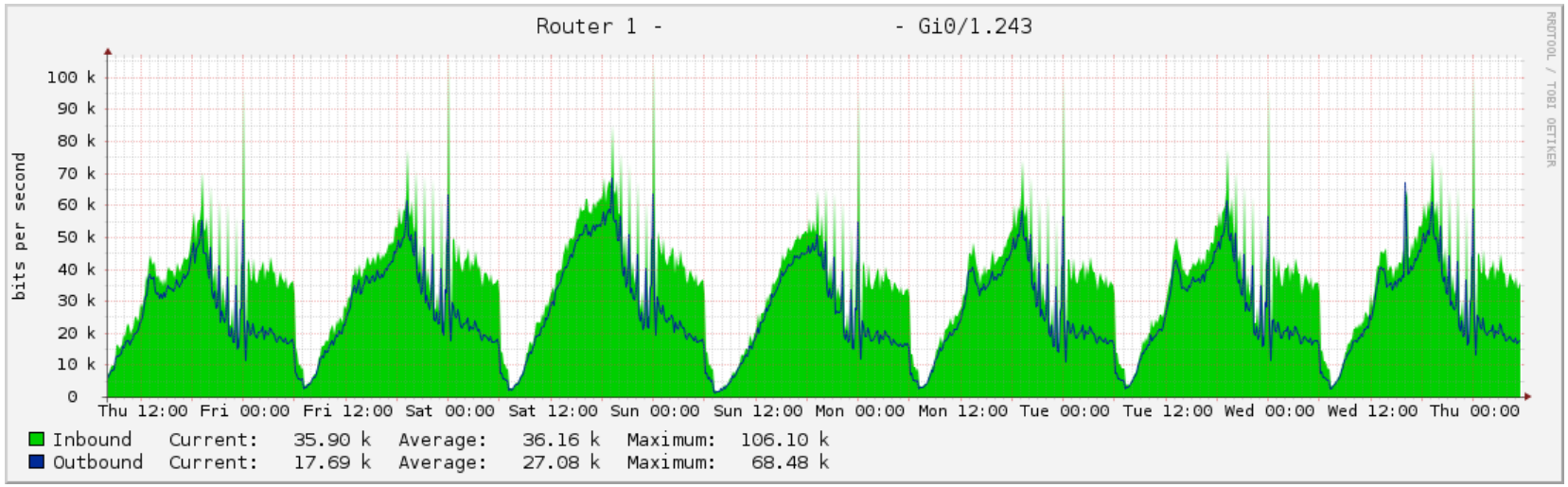
- 5 different metrics
- Some human defined constants to improve success ratio

# Network Infrastructure

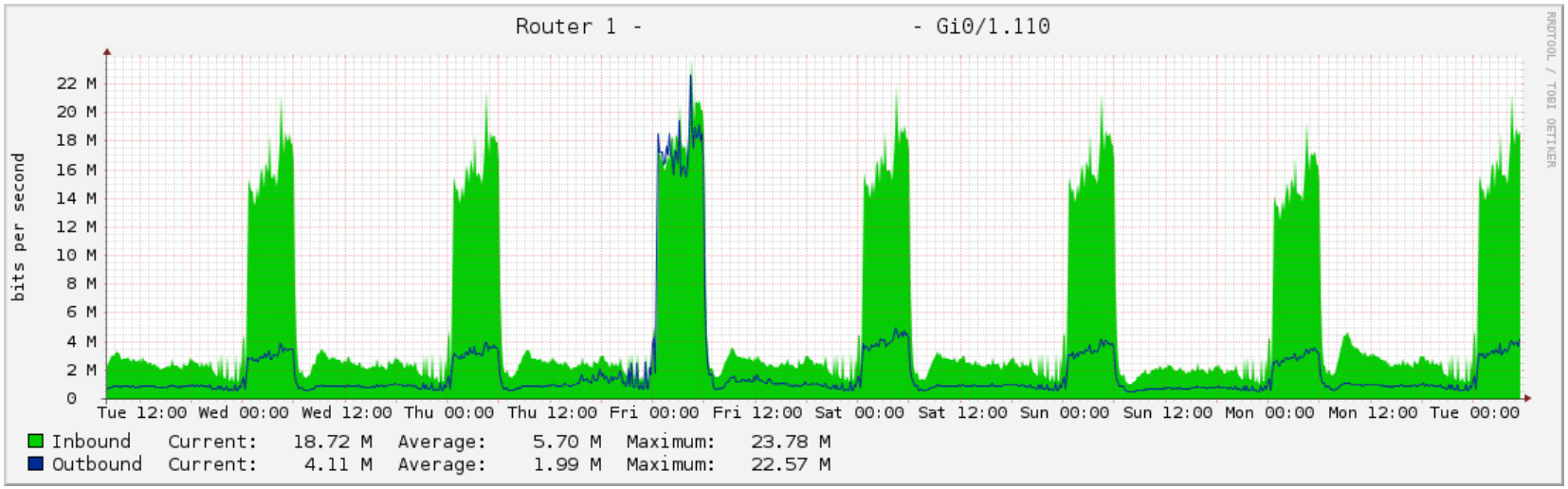


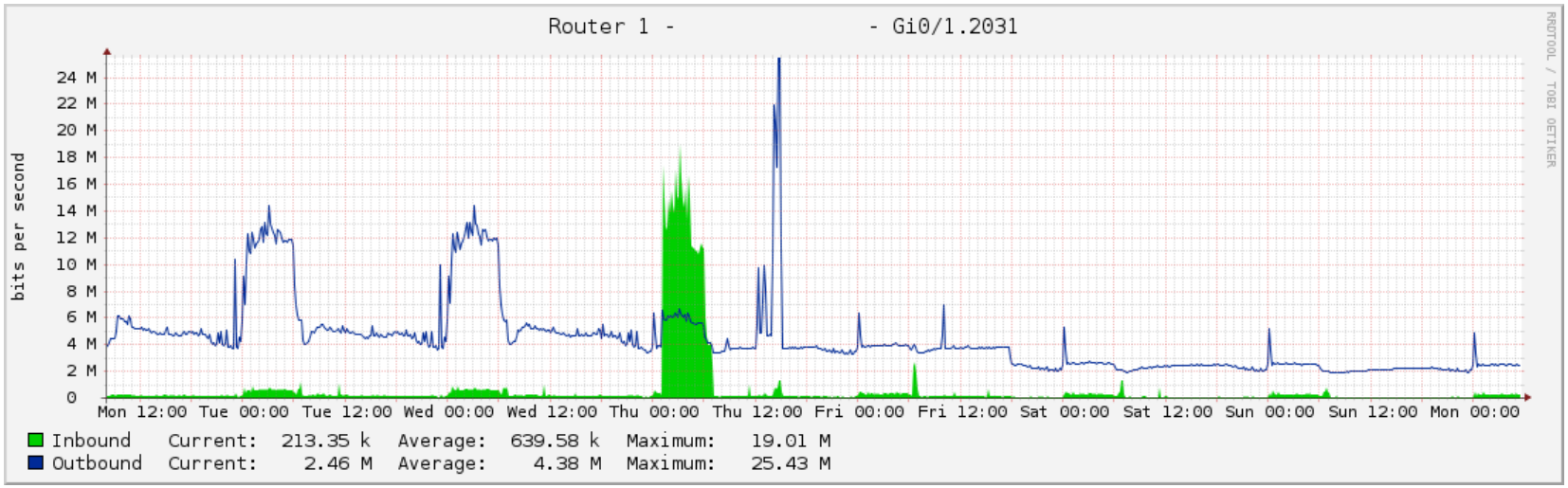
# Traffic Patterns (Volume)



# Traffic Patterns (Volume)



# IPScore

- We proposed a new approach to prevent mainly DoS attacks, brute force and network layer intrusions.

- Our method  analyzes network packets in 5 subjects
  - Source of traffic
  - Destination of traffic
  - Volume
  - Variation
  - Time distribution

- Several constants and parameters to calculate IP reputation

# IPScore - Constants

| Constant | Definition | Description |
|---|---|---|
| $N_U$ | Number of users/clients | The number of possible client connections (users/devices) that the system has. External connections to the system are made by users of the services. For instance, for a university system, the population of students and staff can be the maximum number for expected clients. This constant should roughly be defined by the system administrators. Clients can either be from users or devices. |
| $N_i$ | Number of internal nodes | The number of IP addresses used for the services and servers including the clusters. |
| $N_s$ | Number of services | The number of available services (such as FTP, HTTP, POP, SMTP, etc. ) that the system offers. |
| **t** | Tolerance | Tolerance ratio (%) (Default: %15) |
| **L** | Threshold Limit | Threshold score for deny operation defined by the system admin depending on the risk appetite of the organization 0.0 – 1.0 |

# IPScore - Parameters

| Parameter | Definition |
|---|---|
| $n_{max}$ | Maximum(peak) number of packets/10 minutes for a service in data set at all times |
| $n_{avg}$ | Average of number of packets/ 10 minutes for a service in data set |
| $n_{cur}$ | Number of packets to same service in last 10 minutes |
| $t_{ns}$ | Number of distinct source addresses in last 10 minutes towards to same port |
| $t_{nd}$ | Number of distinct destination addresses (ip+port) in last 10 minutes from same source |
| $n_{days}$ | Number of days that source IP observed in history before the current day |
| **h** | Number of days that training data has |

# IPScore – Score Metrics

1. Static Rule Score (K)
2. Source Score (S)

**IF $t_{ns} < N$ THEN $S = 1 - ((1-L) * (t_{ns} / N))$**
**ELSE $S = L + 1 - (t_{ns} / N)$**

3. Familiarity Score (F)

**IF $n_{days} > 0$ THEN $F = L + (1-L) * n_{days} / h$**
**ELSE F= 0**

4. Traffic Score (T)

**IF $n_{cur} > n_{max}$ THEN T=0** ($n_{max} \pm \%t$)
**ELSE IF $n_{cur} > n_{avg}$ then $T = (n_{max} - n_{cur}) / (n_{max} - n_{avg})$**
**ELSE T=1.0**

5. Variation Score (V)

**IF $t_{nd} < N_s$ THEN $V = 1 - ((1-L) * (t_{nd} / N_s))$**
**ELSE $V = L + 1 - (t_{nd} / N_s)$**

# IPScore – Score Metrics

- Overal Score:

**P = K + AVG ( S + F + T +V )**
**IF P > L THEN allow packet**
**ELSE deny packet**

- We keep track of 10-minutes traffic in memory for faster processing

# Next Steps

- Experiments on different attack scenarios

- **Future goals:** Integrate resource usage for network & server components as a metric  and geo-location data for IP reputation scoring. (Out of scope in the project)

# References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# Questions