MAZEBOLT

WHITEPAPER

Beginners Guide to DDoS Mitigation

This whitepaper offers MazeBolt's research-based recommendations on the process to build strong DDoS defenses by understanding existing DDoS mitigation solutions

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MazeBolt Introduction

MazeBolt is an innovation leader in cybersecurity and part of the DDoS mitigation space. Offering full DDoS risk detection and elimination and working with any mitigation system to provide end to end full coverage. Supporting organizations in avoiding downtime and closing DDoS vulnerabilities before an attack happens.

Read more about MazeBolt

Read more about DDoS RADAR™

Read more about Limitations of DDoS Mitigation

Executive Summary

In general, the more **complex a** mitigation system, more **likely the failure** will be due to **configuration issues**. This is because most enterprises' IT cells don't have the time or resources to ensure that every aspect of their **DDoS Mitigation posture** is **updated, integrated, and is running the right settings** for their specific environment(s). This keeps enterprise security open to DDoS attacks. When an attack occurs it can be expensive in terms of downtime, leading to lost customers and business. According to Forrester, a DDoS attack costs an enterprise an estimated US$2.1 million dollars lost for every four hours of downtime and US$27 million for a 24-hour outage.

To prevent attacks, enterprises, both small and large have likely invested in one or the other mitigation solutions highlighted below:

- Scrubbing Center (BGP)
- Content Delivery Network (CDN)
- Vendor Appliances (CPE Equipment)
- Intrusion Detection System/Intrusion Prevention System
- Web Application Firewall

This whitepaper reviews the five above mentioned mitigation solutions in detail, to provide clarity on their capabilities to mitigate DDoS attacks.

Questions This Document Answers:

- Do Web Application Firewalls (WAFs), Firewalls and Load balancers protect against DDoS Traffic?
- What is the difference between an Intrusion Prevention System (IPS) and a DDoS Mitigation system?
- Can a Content Delivery Network (CDN) replace DDoS mitigation in totality?

- What are the crucial systems a specific network needs for optimal DDoS mitigation?
- Does cloud-based mitigation (scrubbing) deprecate on-prem DDoS mitigation?

Components of a DDoS Mitigation System

There are generally three types of DDoS mitigation postures:

- Cloud based,
- On-Prem solutions, and
- Hybrid combinations of the two.

Mitigation systems consist of a combination of these components. This combination is essential because each component is proficient in responding to certain types of attacks.

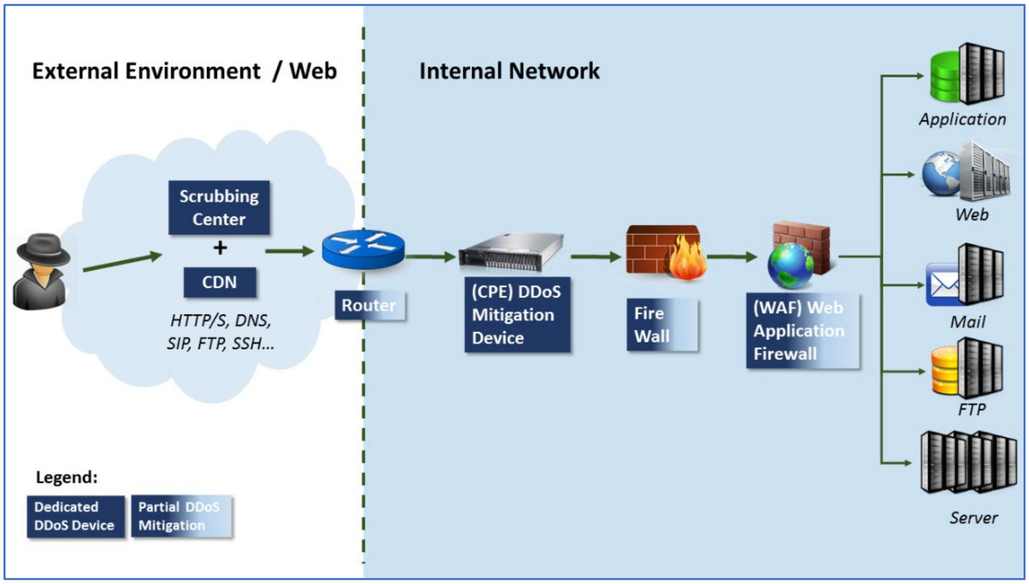
Each component has its own **advantages and disadvantages** and the decision regarding which posture is preferable depends largely on the existing infrastructure and enterprise's business needs.

Most enterprises today opt for a hybrid setup. At the very least they would include a **scrubbing center** to protect their bandwidth. **In its absence**, the **internet pipe** is very likely to be easily **saturated**, even if the attack traffic does not penetrate the internal network.

In October 2019, a major DDoS attack, roughly eight hours long struck Amazon Web Services (AWS), making it impossible for users to connect because AWS miscategorized their legitimate customer queries as malicious.

However, companies that host their infrastructure exclusively in the cloud (AWS, Google, Azure) **cannot have on-prem mitigation devices** (as they just don't have an infrastructure premise) but should still have a scrubbing center.

FIGURE 1: ILLUSTRATION OF A TYPICAL HYBRID DDOS MITIGATION POSTURE



Approaches to Mitigation Activity

DDoS mitigation generally follows one of two approaches:

- **Continuous**, `always on' – goes into effect **automatically**. All traffic is inspected, and suspicious traffic is separated before it reaches the infrastructure, preventing it from going down.

- **Reactive**, "on demand" – Also known as **Monitoring Mode** does not block suspicious traffic automatically but monitors and waits for a block order. This is not always automated, which means by the time the mitigation provider discovers the problem – often reported via a client calling the customer service line – it is usually too late to prevent downtime.

Cloud Based Solutions

Scrubbing Center

Component Case	Deployment Location:	**Cloud-based**
	Functional Role:	**Scalable Data Cleanser**
	DDoS Mitigation Capabilities:	**Layer 3 & 4** – Strong
		Layer 7 – Conditional on SSL visibility

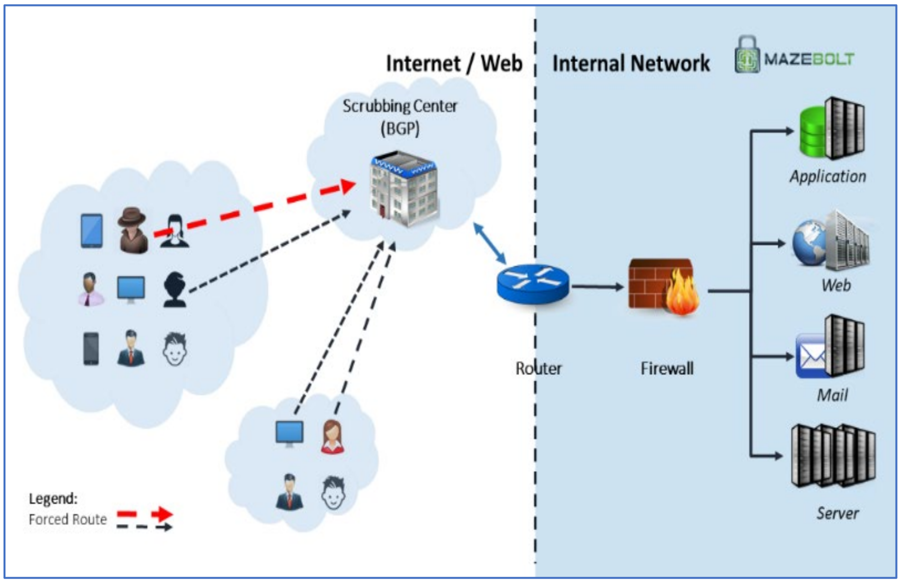
Introduction to Scrubbing Center

Scrubbing centers are essentially data cleansers – they **review traffic** going through them and **remove packets** that **do not adhere to the rules** and guidelines defined. Scrubbing centers are often cloud-based. They are the first source of **defense** for **volumetric attacks**, which send an enormous number of packets in an attempt to overwhelm existing network resources and saturate bandwidth.

In a recent article titled `How traffic scrubbing can guard against DDoS attacks', ComputerWeekly says, "Although most scrubbing services can help fend off distributed denial of service attacks, a more comprehensive mitigation strategy is required to remain unscathed".

DDoS vulnerabilities are generated all the time. Mainly because the production network that DDoS Mitigation protects undergo changes all the time. Only when a Continuous Feedback is built on the DDoS Mitigation, these vulnerabilities are identified and eliminated.

FIGURE 2: ILLUSTRATION OF A CLOUD SCRUBBING SERVICE



Advantages of Cloud Scrubbing

- **Ability to scale and match**: The reason cloud scrubbing is used against large volumetric attacks is because of the **ability to scale and match** even some of the **largest floods** exceeding 10Tbps.
- **Uses BGP**: Scrubbing centers generally use the **Border Gateway Protocol (BGP).** BGP routes traffic according to **rulesets, policies and metrics**. It forces all traffic to go through the scrubbing center, where the incoming attack traffic is cleaned before being forwarded to the organizations' IT infrastructure.
- **DNS or IP Target protection:** Scrubbing centers **protect** organizations against attackers **targeting** the name (**DNS** name) of the organization or the **numerical IP address**.

Disadvantages of Scrubbing Centers:

- **Application Layer Attack**: A scrubbing center's advantage is analyzing large volumes of traffic however are generally less able to **recognize application-layer attacks**. This is because most Application Layer (Layer 7) traffic is **encrypted, as well as scrubbing centers being cautious of applying incorrect settings resulting in false positives**. This means that the **ability** of a scrubbing service to **effectively** mitigate **malicious** Application Layer traffic is highly **dependent** on whether it has the **relevant decryption keys** i.e. "**SSL Visibility".** and professional services engagement.
- **Expensive**: Scrubbing centers can have **expensive subscription fees, especially with regards to always on scrubbing.**
- **Sophisticated Attacks**: Sophisticated **multi-layer attacks** require a **granular capability for detecting and blocking attacks** which scrubbing **centers are not always efficient at adapting to.**

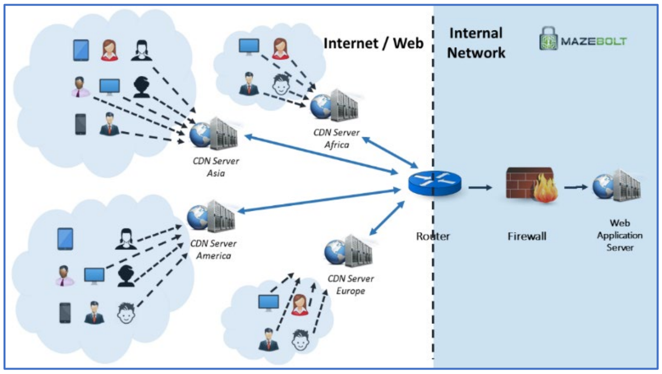
Content Delivery Network (CDN)

Component Case	Deployment Location:	**Cloud-based**
	Functional Role:	**Static Content Serving**
	DDoS Mitigation Capabilities:	**Good - Situational**

Introduction to Content Delivery Networks

Content Delivery Networks (CDNs) use the DNS (Domain Name System) protocol to **route traffic** through the **CDN** provider's system. Distributed Denial of Service (DDoS) attacks are a serious threat to a content delivery network. Remote **malware** can **overwhelm a network**, making it unavailable or very slow to users. CDN's primary role is to ensure that **content** is **delivered** to end customers **without delay**. A **DDoS attack** can result in **latency** which can lead to loss of reputation, and revenue.

FIGURE 3: ILLUSTRATION OF A CONTENT DISTRIBUTION NETWORK (CDN)



Advantages of CDN to mitigate DDoS

- **Access to website**: In its most basic form, a Content Deliver Network is used to improve customers' access to a website's content. CDNs often offer a full security service and have the capability to perform real-time analysis of ongoing attacks.
- **Volumetric attacks**: They by design block Layer 3 and 4 attacks.
- **Real Time visibility**: They may monitor and provide real-time visibility into security events. They offer NOC services to continually monitor traffic to ensure that they can react on time.

Disadvantages of CDN:

- **IP addresses not protected**: CDNs only protect organizations against attacks that use the DNS names as their target. For example: An attacker targeting www.bankingplusonline.com will be forced to go through the CDN. But, if the attacker targets the same organization by inputting the site's IP address directly, i.e. 10.249.3.2 – **the site is not protected because the CDN provider never even sees the attack.**
- **CDN can be circumvented**: A CDN can only be a part of a bigger DDoS mitigation scheme. Usually more advanced attackers can find and attack the source IP of the website directly, circumventing the CDN completely.

On-Premise-based Solutions

Vendor Appliances (Customer Premises Equipment - CPE)

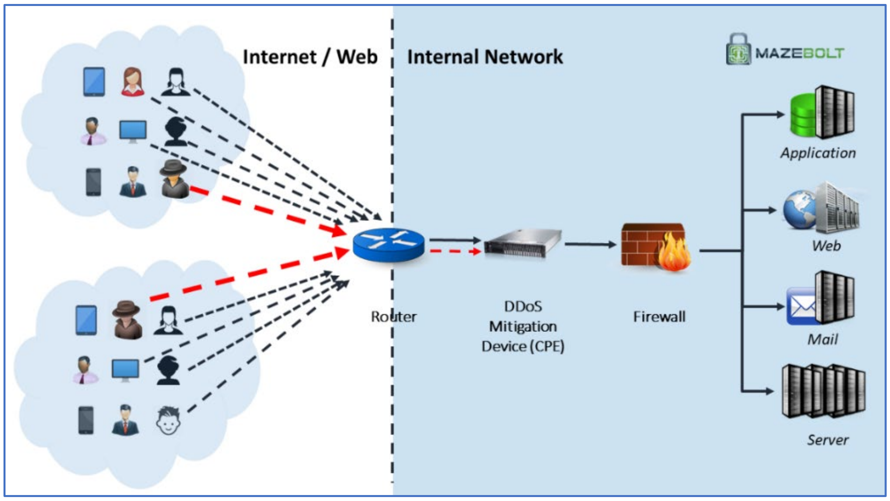
Component Case	Deployment Location:	**On-Prem.**
	Functional Role:	**DDoS Mitigation and Protection**
	DDoS Mitigation Capabilities:	**Strong**

Introduction to Vendor Appliances

Vendor appliances contain a variety of proprietary technologies, but, at their **core**, they are all **tuned** to **detect** and **stop DDoS attacks**. The appliances vary from being a combination of other components – to be a completely proprietary device consisting of highly specialized software and hardware fine-tuned to protect against DDoS attacks.

DDoS CPE equipment is generally located at the very edge of the **organization's network**, **after the router** but before reaching the internal network infrastructure, E.g. Firewalls, Load Balancers etc.

FIGURE 4: ILLUSTRATION OF DEDICATED ON-PREM DDOS MITIGATION EQUIPMENT



Advantages of CPE:

- **Network traffic planning and analysis**: Many of the devices deliver in-depth traffic analysis, bandwidth monitoring, and anomaly reports, allowing for **better network traffic planning** and DDoS attack analysis.
- **Improvisation from analysis**: Detection of malicious packets triggers filters, that only allow the legitimate traffic to get through. Post-attack forensics may provide lessons learned, so the systems can be better tuned for **mitigation of future attacks**.
- **AI based intelligence**: With the increasing use of AI, vendors are including more specialized detection software based on behavioral analysis, better-tuned anomaly detection, and active intelligence gathering.

Disadvantages of CPE:

- **Standalone CPE has limitations**: CPE equipment without a scrubbing center will not protect against large volumetric attacks, even if the CPE equipment is well configured. The CPE will not provide protection against **internet pipe saturation.**
- **Requires manual fine tuning**: On-premise equipment requires manual fine tuning as well as ongoing costs related to infrastructure management making it expensive and often undependable.

Intrusion Prevention Systems (IPS)

Component Case	Deployment Location:	**On-Prem.**
	Functional Role:	**Detecting and Stopping Cyber Attacks**
	DDoS Mitigation Capabilities:	**Poor**

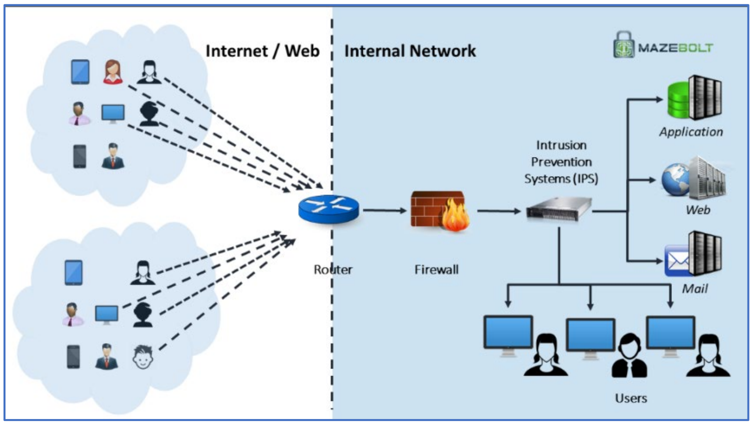
Introduction to IPS:

These appliances specifically **monitor suspicious activities** within the network. They can be part of the router system, integrated into the firewall, serve as a back-up to a firewall, or **sit deeper** within the **network infrastructure**.

They **inspect** and **scan packets** based on pre-existing rule sets, signatures, protocol status, or anomaly detection, **creating alerts and/or blocking** when any type of **cyberattack** is suspected.

Generally, most DDoS attacks cannot be mitigated using IPS systems. Having to use an IPS system to block an attack most likely means the organization targeted is under a very advanced DDoS attack campaign in which CPE and or scrubbing center services are failing to mitigate Layer 7 attack traffic.

FIGURE 5: ILLUSTRATION OF AN INTRUSION PREVENTION SYSTEM (IPS)



Advantages of IPS

- **Custom filters in place:** IPS inspects incoming traffic to weed out malicious requests by using advanced filters. Also customized filters may be created on the fly.
- **Additional threat blocking: IPS does block additional cyber threats in fact, IPS is not thought of as a DDoS mitigation mechanism/component.**

Disadvantages of IPS:

- **Inability to stop initial DDoS attack:** The underlying design is focused on blocking security breaches and is **not set to stop a DDoS attack**. These systems generally have some layer 3, 4 and 7 protection capabilities, but can only be used to help filter out leakage from components up stream, or potentially to block prolonged Layer 7 attack campaigns.
- **Can create false alarms:** IPS is beneficial when the all is configured and works as expected. If the IPS is not well configured, it can result in a false alarm, causing wasted time and effort to identify its source.
- **Gap in security:** Encrypted packets can **remain undiscovered by IPS** leaving a gap in security.

Web Application Firewalls (WAFs)

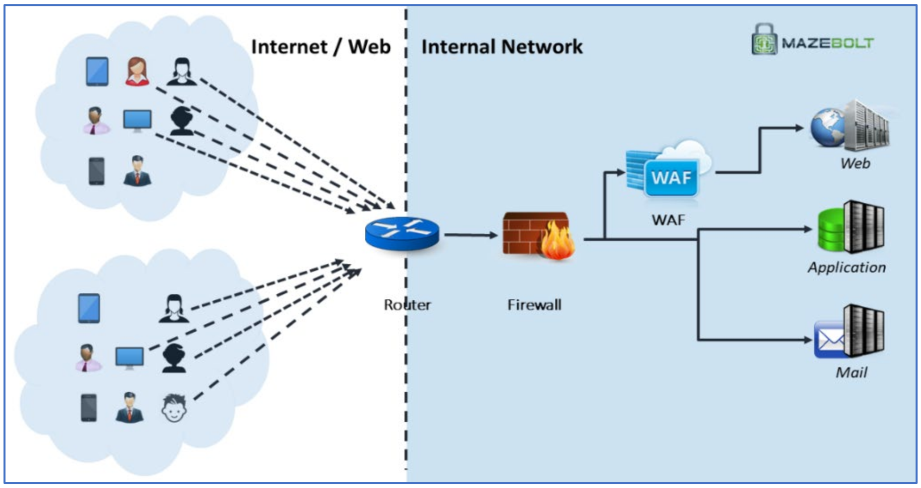
Component Case	Deployment Location:	**On-Prem./Cloud-based**
	Functional Role:	**Protection against Layer 7 Application Attacks**
	DDoS Mitigation Capabilities:	**Mild to negligible**

Introduction to Web Application Firewalls

WAFs perform multiple functions – **intrusion detection and web based analytics.** They **analyze** application traffic, **distinguishing** potential risks from legitimate usage, **controlling access** to applications or services by applying a set of rules to **incoming HTTP traffic**. They perform **deep-packet inspections**, locating, identifying, classifying, rerouting and/or blocking packets with specific data or code payloads.

“The variety of cyber threats today – as well as the vulnerabilities they target – are so diverse that organizations can only hope to fend them off by deploying multiple layers of defenses.” Says CSO Online in the article, `Enhancing DDoS Defences with a Web Application Firewall.’

FIGURE 6: ILLUSTRATION OF A WEB APPLICATION FIREWALL (WAF)



Advantages of Web Application Firewalls

- **Listings control:** WAFs depend on white-listing and black-listing, which means they must be updated continuously. **Legitimate user traffic will be allowed** through, while suspicious traffic will be routed elsewhere for further inspection or simply blocked.
- **Customization possible:** The web application firewall can be **customized** to your applications. For example, protecting from certain attacks against functionality – they generally protect against layer 7 attacks, which **directly affect applications**. The inspection process does increase latency and affects the user experience, so efficiency is key.
- **Can be cloud-based:** The WAF can also be cloud-based via a service provider like AWS. Still, it generally does not protect against volumetric attacks on layers 3 and 4 that target network availability.

Disadvantages of Web Application Firewalls:

- **Protocol vulnerability:** Application firewalls require proxy applications for each protocol. This is cumbersome and difficult to create and manage. Proxy agents are often used to **support undefined protocols and applications**, but the fact that they are undefined makes them a vulnerability.
- **Manual intervention:** Firewalls require **manual intervention for installation**, **configuratio**n and **ongoing maintenance** creating budget escalations.
- **Network reconfiguration:** All WAF network security solutions require **network re-configuration**, and all require **tuning** as they attempt to **“learn” the applications** they are protecting.

Load Balancer

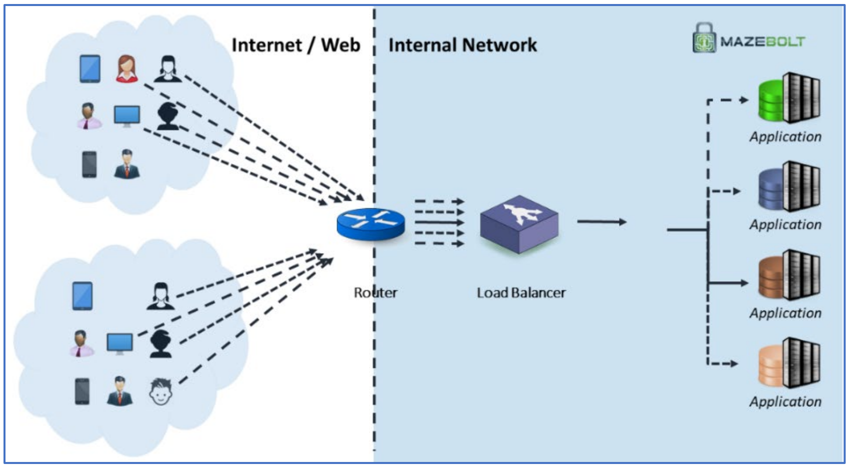
Component Case	Deployment Location:	**On-Prem.**
	Functional Role:	**Distributing Incoming Traffic**
	DDoS Mitigation Capabilities:	**Poor**

Introduction to Load Balancers:

A Load Balancer receives traffic from many clients and distributes that traffic evenly between multiple application servers of the same type. In many cases multiple servers are preferred over a single stronger server for the **increased reliability and availability they provide.**

A Load Balancer acts as a **man-in-the-middle**. Clients connect to it on one end, and the load balancer creates a connection to one of the application servers on behalf of the client. In this way, the load balancer has to keep track of every connection's state i.e. **the load balancer is a stateful device.**

FIGURE 7: ILLUSTRATION OF A LOAD BALANCER



Advantages of Load Balancers:

- **Agility:** They provide agility to deploy **high performance load balance** to align with business requirements.

- **Prevent overload:** By evenly **distributing traffic** they help to **prevent failure from overload**. As a result, there is a **predictable performance** and **availability** of applications and **websites**.
- **Traffic reroute when required:** Load balancers while spreading workloads, add **resiliency** by **rerouting traffic** from **one server to another** if it falls prey to DDoS attacks.

Disadvantages of Load Balancers:

- **Vulnerability to state-table attacks:** Like many other stateful devices, the load balancer is vulnerable to state-table saturation attacks e.g. HTTP attacks and a SYN flood.
- **Can be overwhelmed:** A Load Balancer can help **offset DDoS Attacks** by **distributing** the malicious **traffic** between the **application servers**. Unfortunately, without a stronger DDoS mitigation component upstream to filter out most of the attack traffic, the **load balancer** will **not be enough** to **stop a site** from being **overwhelmed**.
- **Interception possible:** Attackers can directly send **volumetric DDoS traffic** to the **custom TCP and UDP communication protocols** used for custom gaming protocols, remote server access (SSH), secure file transfer services (SFTP), and email (SMTP). They can also use these ports to **intercept unencrypted data** in transit. Defending these ports and protocols without compromising performance requires additional resources. Be sure your **load balancer supports protection against layers 3 and 4 DDoS attacks**, along with TLS/SSL protection to encrypt customer data.

RADAR™, assists organizations in achieving, maintaining, and verifying the continuous closing of their DDoS vulnerability gaps. Reducing and maintaining the vulnerability level from an average of 48% to under 2% ongoing.

Firewalls

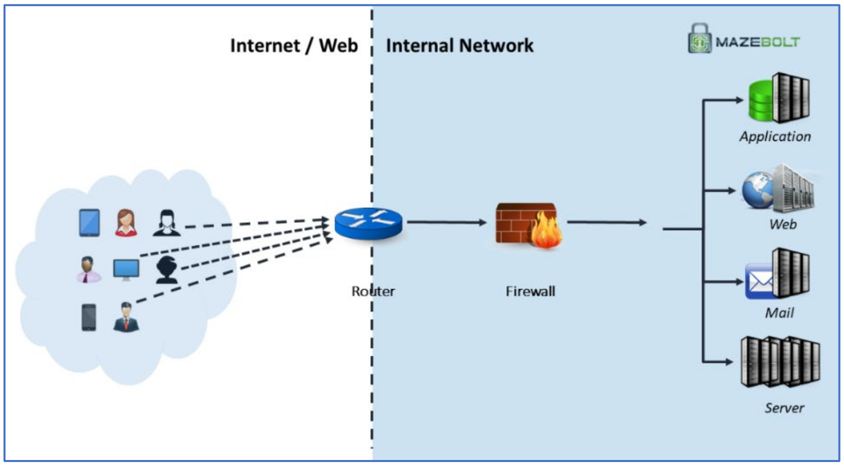
Component Case	Deployment Location:	**On-Prem.**
	Functional Role:	**Rule-based Traffic Filtering**
	DDoS Mitigation Capabilities:	**Mild**

Introduction to Firewalls:

The Firewall **guards** the **entrance** to the **internal network**, **preventing** certain types of **packets** or requests from reaching the **servers**. It does so by using **rules** defined at **setup time**, and mostly filters according to allowed packet types and the connection states. A recent survey by Gartner estimates that through the year 2023, “99% of firewall breaches will be caused by misconfigurations, not firewalls.”

A Firewall keeps **a record** of the state of **every connection opened** between **external clients** and the **internal servers** and uses those records to **filter** out any packet that is out-of-state. Unsurprisingly, that qualifies the **Firewall as a stateful device.**

FIGURE 8: ILLUSTRATION OF A FIREWALL



Advantages of Firewalls:

- **Protection against layer attacks:** Firewalls offer protection against application-layer attacks in HTTP and HTTPS traffic
- **Request restriction:** They enable restriction of requests for certain geographical regions increasing security
- **Limit violations:** Controls can be pre-defined, **configured to address and limit violations** and protect against application-layer DDoS and other volumetric attacks.

Disadvantages of Firewalls:

- **Vulnerable to state table attacks**: Like many other stateful devices, the firewall is vulnerable to state-table saturation attacks e.g. HTTP attacks and a SYN flood.
- **Results in downtime:** A Firewall can filter the packets that are part of a DDoS attack, but is usually not optimized for the amount of incoming packets that a DDoS entails. It will become overloaded very quickly and will go into a fail-open or fail-closed state, both of which **are sure to cause downtime.**
- **Volumetric traffic can exploit firewalls:** Firewalls work well to protect internal assets but may be overwhelmed on a perimeter network which is shared with third party platforms. Volumetric traffic can exploit firewalls and their limited bandwidth since most average **DDoS attacks exceed 6 Gbps.**

You have DDoS Mitigation in place but still experience disruption intermittently. Then, there are techniques to build a strong DDoS mitigation defense.

Components Summary

No.	Component	Network Location	DDoS Mitigation Capabilities	Comments
1.	Scrubbing Center	Cloud-based	**Layer 3 & 4** – Strong **Layer 7** – Conditional on SSL visibility	The main protection against volumetric attacks
2.	CDN	Cloud-based	Good – Situational	Can mitigate DDoS Attacks but will not stop skilled attackers.
3.	CPE	On-Prem.	Strong	The main on-site protection
4.	IPS	On-Prem.	Poor	Unsuitable for DDoS Mitigation
5.	WAF	On-Prem. /Cloud-based	Mild	Cannot process the volume of traffic a DDoS attack entails.
6.	Load Balancer	On-Prem.	Poor	Has no defensive capabilities
7.	Firewall	On-Prem.	Mild	Cannot process the volume of traffic a DDoS attack entails.

Conclusion

Even with the most sophisticated DDoS mitigation and testing solutions deployed, most companies are left with a staggering 48% DDoS vulnerability level. The vulnerability gap stems from DDoS mitigation solutions & infrequent Red Team DDoS testing being reactive, instead of continuously evaluating and closing vulnerabilities.

Mitigation solutions do not constantly re-configure and fine tune their DDoS mitigation policies. Leaving their ongoing visibility limited and forcing them to troubleshoot issues at the very worst possible time, that is, when systems are brought down by a successful DDoS attack. These solutions are all reactive, reacting to an attack and not closing DDoS vulnerabilities before an attack happens.

DDoS Red Team Testing simulates a small variety of real DDoS attack vectors in a controlled manner to validate the human response (Red Team) and procedural handling to a successful

DDoS attack. Red team testing does not identify a company's vulnerability level to DDoS attacks and is usually performed on average twice a year. Red team testing is a static test done on dynamic systems. Any information gained from this testing, is valid for that point in time only. Red Team testing is very disruptive to IT systems and requires a planned maintenance window.

About RADAR™

RADAR™, MazeBolt's new patented technology solution is part of the MazeBolt security platform. RADAR™, simulates DDoS attacks continuously and non-disruptively. Delivering advanced intelligence, through straightforward reports on how to remediate the DDoS vulnerabilities found. With RADAR organizations achieve, maintain, and verify the continuous closing of their DDoS vulnerability gaps. Reducing and maintaining the vulnerability level of a damaging DDoS attack from an average of 48% to under 2% ongoing.

Benefits of DDoS RADAR™

RADAR™, eliminates in advance any chance of downtime if attacked. Customers enjoy continuous DDoS mitigation gap detection & remediation with no integration time and zero impact to ongoing IT systems. Where required, Red team testing is drastically cut due to full ongoing DDoS intelligence reports, and DDoS defenses are at their highest possible level. RADAR™ provides a far superior ROI and performance for DDoS mitigation, risk management, ongoing vulnerability elimination and infrequent Red team testing.

About MazeBolt

MazeBolt is an innovation leader in cybersecurity and part of the DDoS mitigation space. Offering full DDoS risk detection and elimination and working with any mitigation system to provide end to end full coverage. Supporting organizations in avoiding downtime and closing DDoS vulnerabilities before an attack happens.

Sources

1. https://en.wikipedia.org/wiki/Application_firewall
2. https://www.techwalla.com/articles/what-are-the-advantages-and-disadvantages-of-using-a-firewall
3. https://searchnetworking.techtarget.com/definition/deep-packet-inspection-DPI
4. https://arxiv.org/pdf/1710.08628.pdf
5. http://www.ijiss.org/ijiss/index.php/ijiss2/article/view/248/pdf_561
6. https://www.sans.org/reading-room/whitepapers/intrusion/summary-dos-ddos-prevention-monitoring-mitigation-techniques-service-provider-environment-1212
7. http://www.infosecurityeurope.com/__novadocuments/22581
8. https://en.wikipedia.org/wiki/Data_monitoring_switch
9. https://www.darkreading.com/cloud/eight-hour-ddos-attack-struck-aws-customers/d/d-id/1336165https://www2.deloitte.com/content/dam/Deloitte/us/Documents/risk/us-building-resilience-to-denial-of-service-attacks.pdf

10. https://www.csoonline.com/article/3234529/enhancing-ddos-defenses-with-a-web-application-firewall.html
11. https://www.computerweekly.com/news/252456702/How-traffic-scrubbing-can-guard-against-DDoS-attacks