Week 12

An Introduction to Cyber Security – CS 573

Instructor: Dr. Edward G. Amoroso
eamoroso@tag-cyber.com

Week 12: Modern Enterprise Security (Part 1)

Final Examination

Time travel to January 2036 (15 years from now) and explain in a 1500-word essay the following:

1. What are the major cyber security threats that are facing the world.
2. What are the major cyber security protections being used to address cyber risk.
3. What are your recommendations to global leaders to reduce cyber risk.

Final Examination – Typical Outline

Title: State of Global Cyber Security – 2036

your name

Introduction (150 words)

During the last fifteen years, since 2021, the globe has seen . . .

Major Cyber Security Threats (450 words)

The major cyber security threats facing our globe can be grouped into the following X categories . . .

Major Cyber Security Protections (450 words)

The major cyber security protections protecting our globe today can be grouped into . . .

Recommendations (450 words)

My recommendations for world leaders today in 2036 include . . .

What is Virtualization in Computing and Why is it Relevant to Security?

Making One Thing into Multiple Virtual Copies

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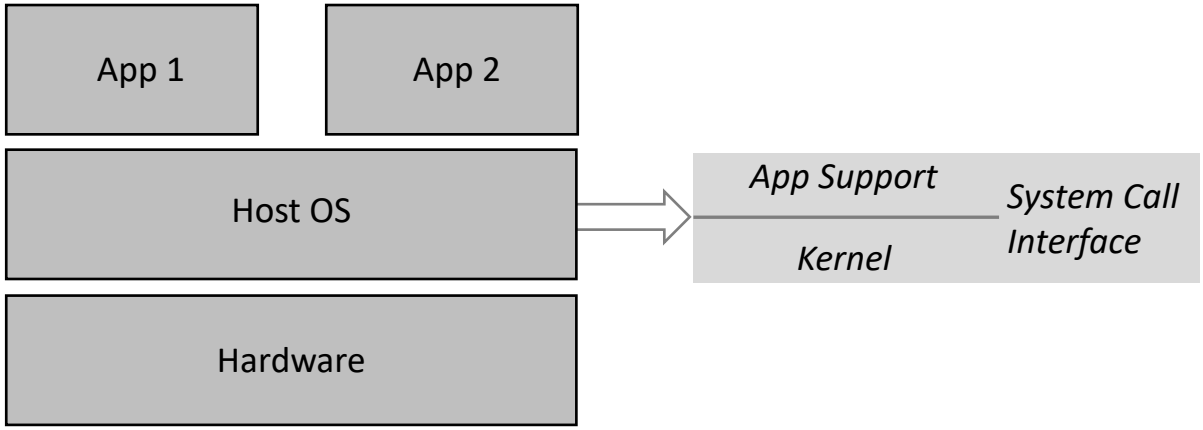
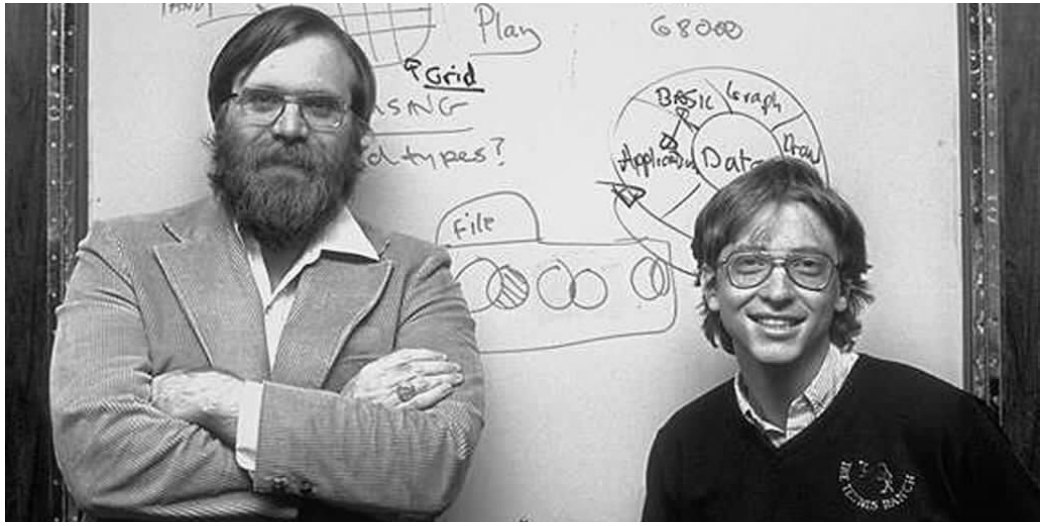
Early Operating System (OS) Model in Computing



Traditional Model



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Multi-Boot Operating System Model in the 1990's

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Five Types of Modern Computing Virtualization

- **Desktop Virtualization**
  - Desktop OS runs as a VM on a physical server with other virtual desktops (e.g., VDI services)

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  - Grouping of physical storage into multiple virtual storage devices
- **Network Virtualization**
  - Decouples virtual networks from underlying hardware
  - Management and control through software-defined switches

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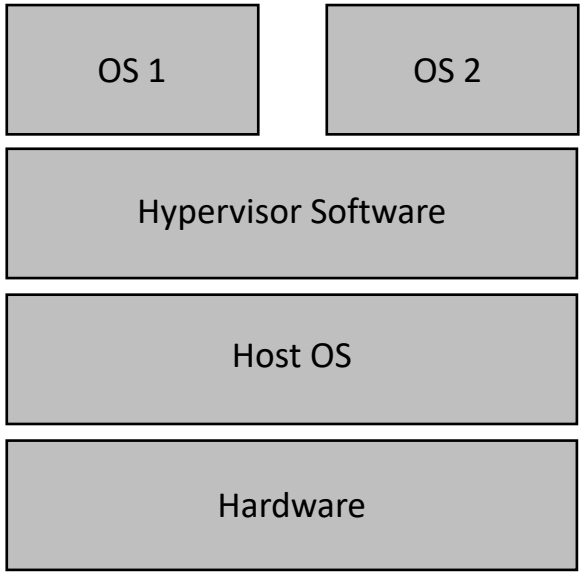
Popular Server Virtualization Models



Hosted Hypervisor

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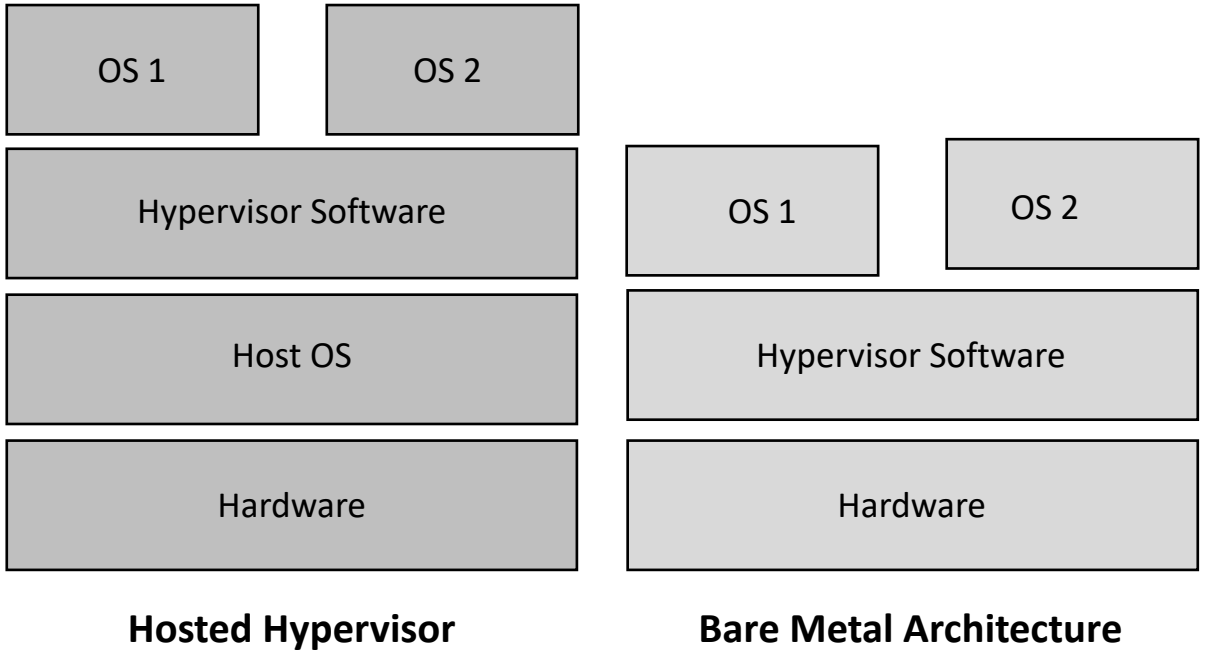
Popular Server Virtualization Models



Hosted Hypervisor **Bare Metal Architecture**

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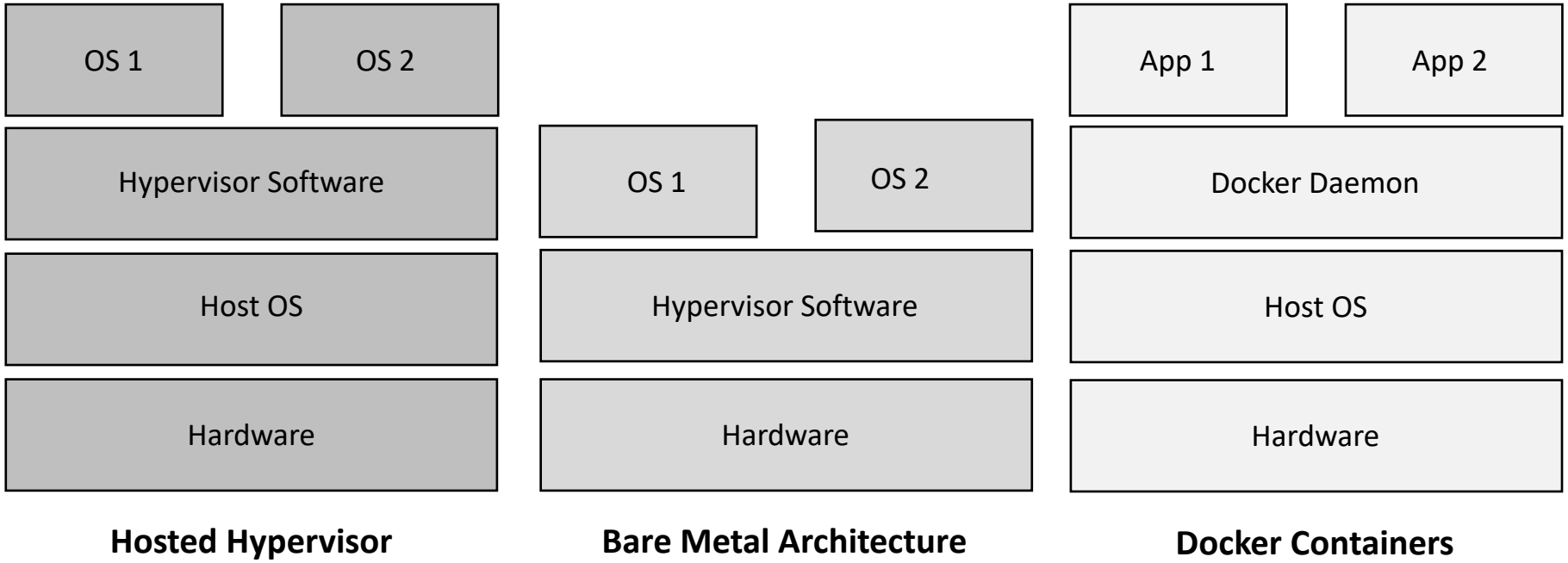
Popular Server Virtualization Models



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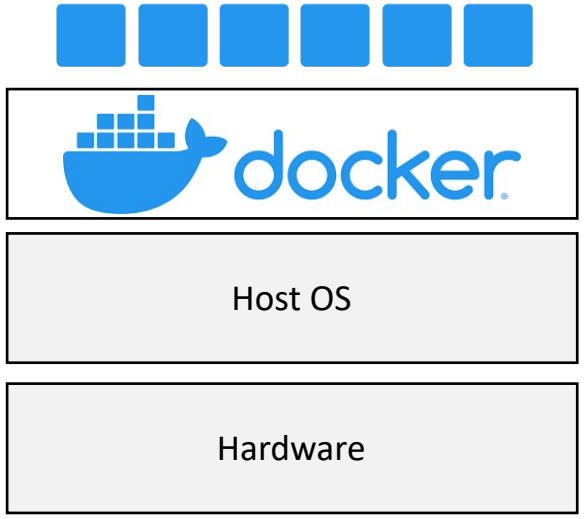
Docker Containers



Docker Container Deployment

Platform-as-a-Service (PaaS)
Delivers Software in Containers

Containers Share Single Host OS
Use Fewer Resources than VMs

Originated in 2010 as Y-Combinator Project
Released as Open Source in 2013

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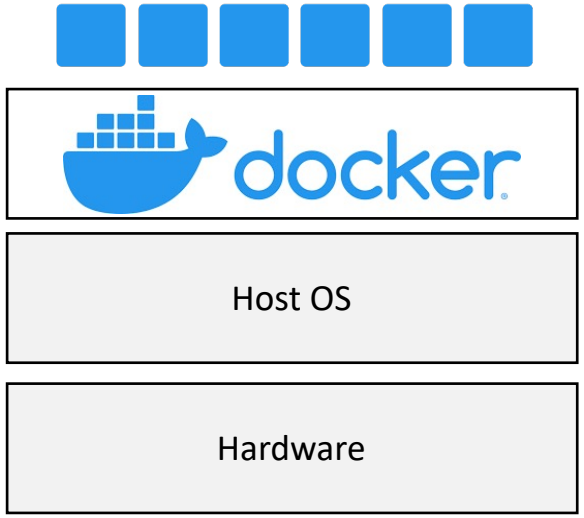
Docker and Kubernetes

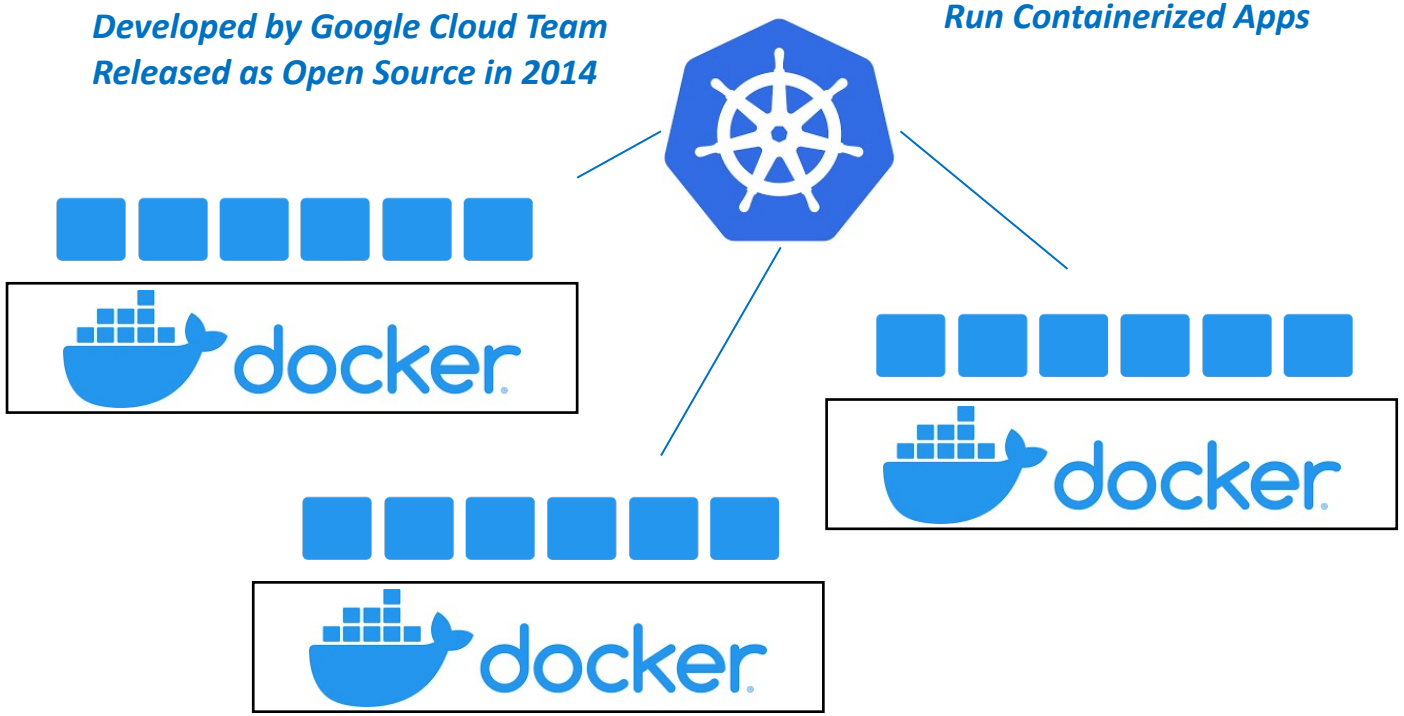


Docker Container Deployment

Docker Runs as a "Single Node"

Developed by Google Cloud Team
Released as Open Source in 2014

Kubernetes and Docker Coordinate to Build and Run Containerized Apps



Docker Container and Kubernetes Deployment

Kubernetes Coordinates Clusters of Nodes

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China Trade Monitor
News and analysis of China's economic relations with the world

NATIONAL SECURITY

Three U.S. Senators Call For Penalties Against Chinese "Internet of Things" Company

By **Simon Lester** - September 12, 2021

On September 9, U.S. Senators Marco Rubio (R-FL), Rick Scott (R-FL), and Tom Cotton (R-AR) sent a letter to Treasury Secretary Janet Yellen expressing concern about Chinese "Internet of Things" (IoT) company Tuya, and asking the Treasury Department to add Tuya to a "Chinese Military-Industrial Complex Companies List," which would restrict U.S. persons from purchasing and

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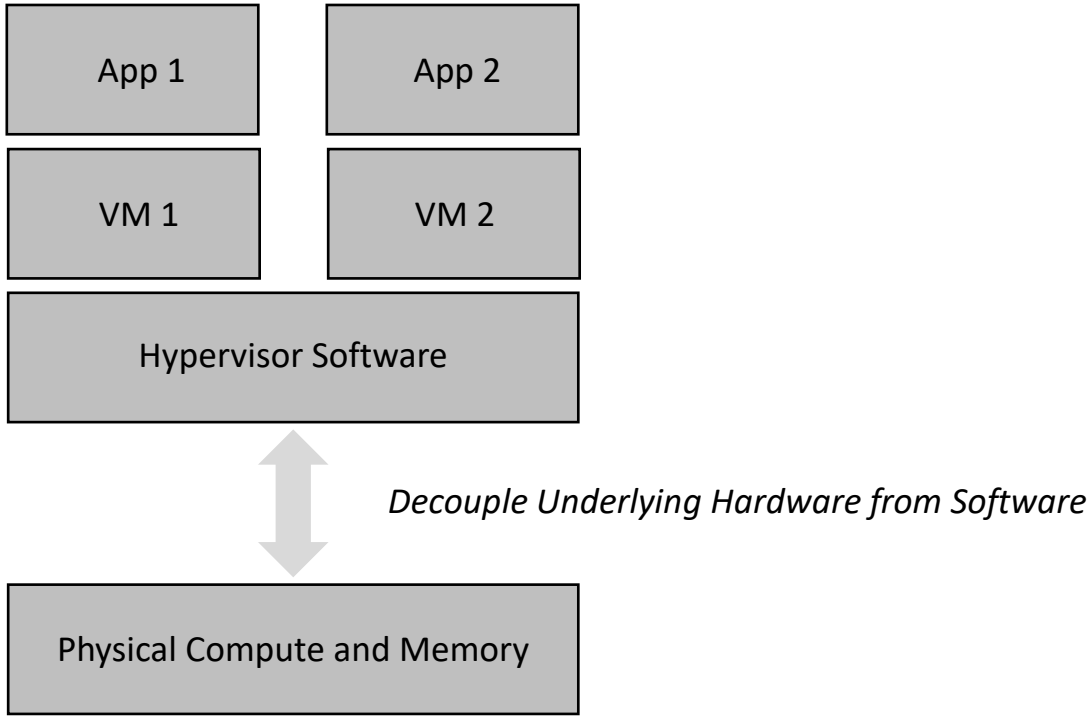
Decoupling Hardware and Software



Server Virtualization

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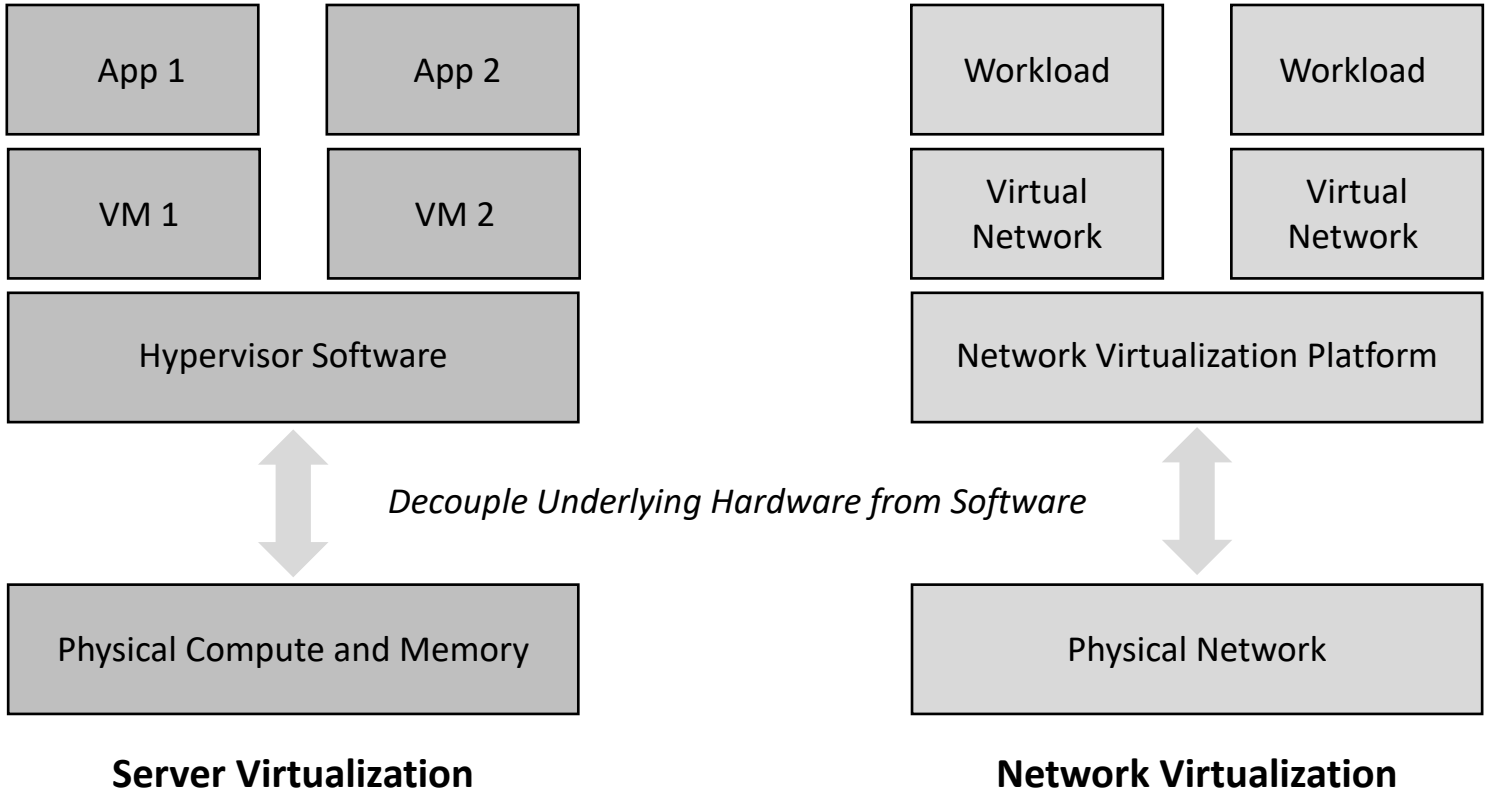
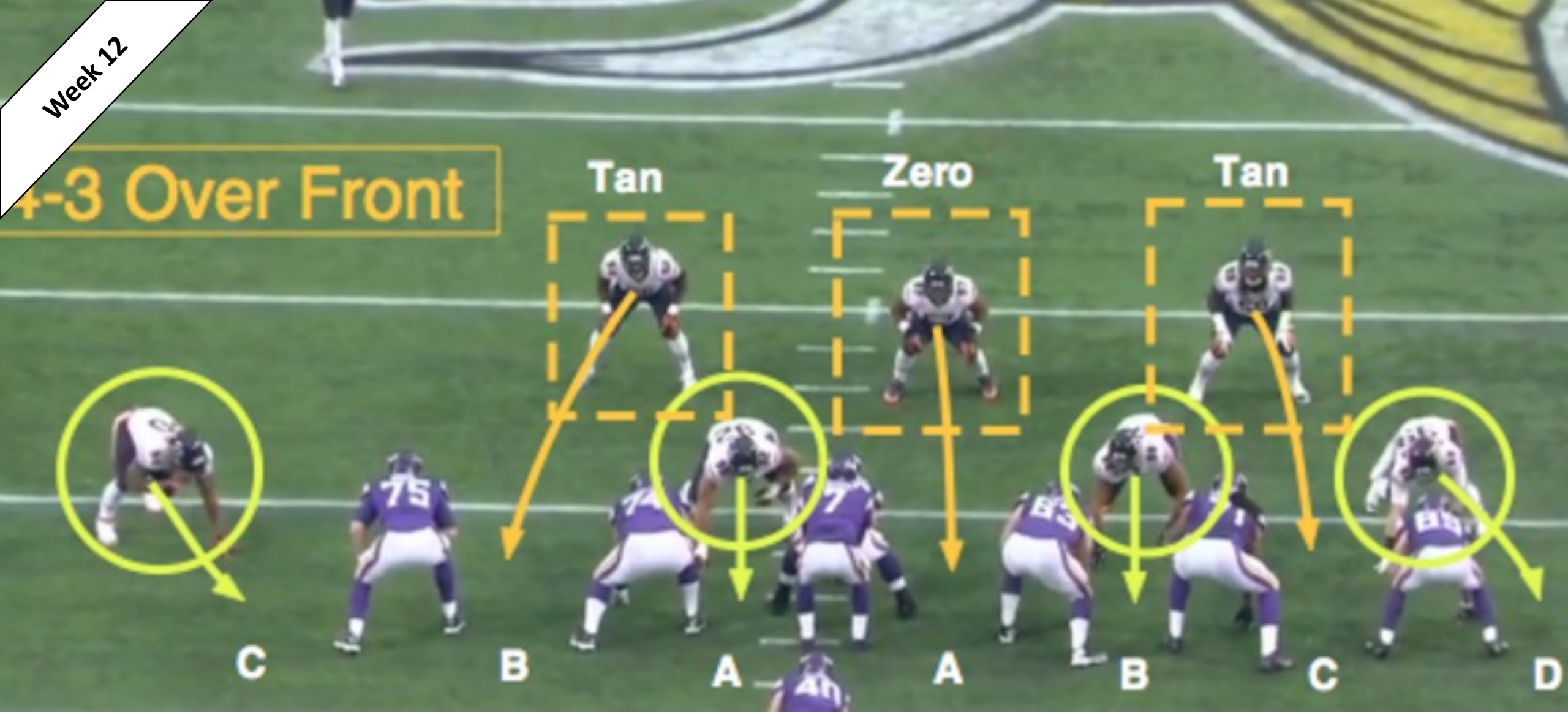
Decoupling Physical Infrastructure from Virtual Networks





Key Concept: Virtual Systems Can Dynamically Reconfigure During an Attack

What is Cloud Computing and Why is it Relevant to Security?

Week 12

What is Cloud Computing?

- **Delivery of on-demand computing services over the Internet**
  - Servers, storage, databases, networks, software, analytics
  - Pay for what you use (lowers operating costs)

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- **Cloud computing approaches**
  - Public Cloud – third-party delivery by cloud provider
  - Private Cloud – operated by sponsoring organization
  - Hybrid Cloud – combination of public and private

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Common Cloud Service Types

- **Infrastructure as a Services (IaaS)**
  - Pay for IT infrastructure on pay-as-you-go basis
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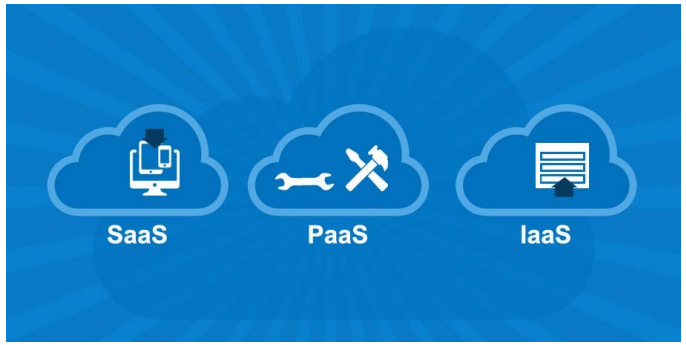

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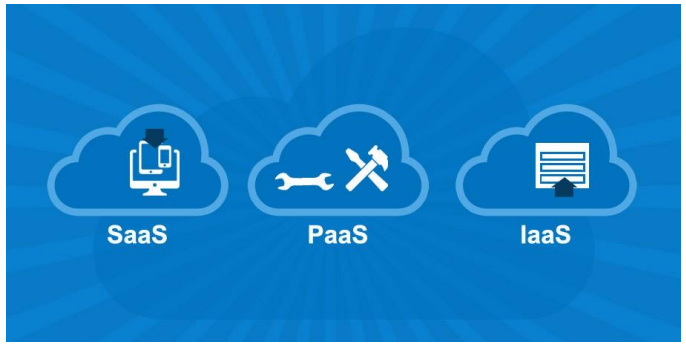

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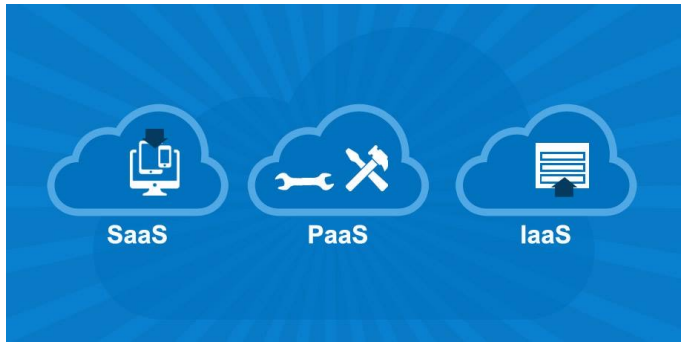
- **Software as a Service (SaaS)**
  - Delivers software apps on-demand, over the Internet
  - Users typically access SaaS apps via subscription



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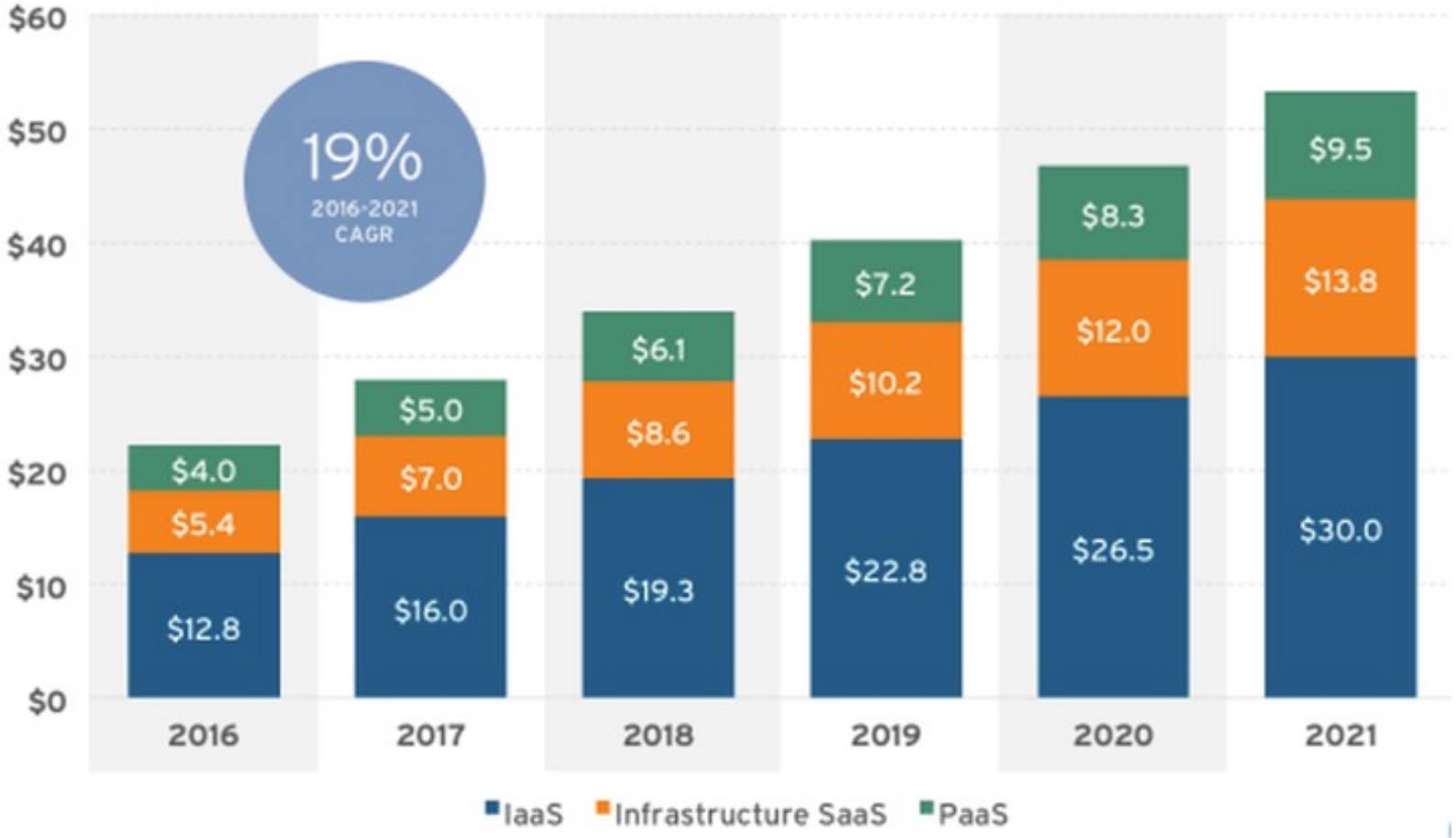
Cloud Computing Growth



Source: 451 Research's Market Monitor: Cloud Computing, November 2017

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Comparing Public Cloud Services

	aws	Azure	Google Cloud
Compute	Elastic Cloud Compute (EC2)	Virtual Machines	Compute Engine
App Hosting	Elastic Beanstalk	Cloud Services	App Engine
Serverless	AWS Lambda	Azure Functions	Cloud Functions
Container	ECS/EKS Containers	AKS Container	Kubernetes Engine
Storage (File)	S3 Storage	Azure Storage	Cloud Storage
Storage (Block)	Elastic Block Storage	Azure Blob	Persistent Disc
Backup	AWS Glacier	Azure Backup	Cloud Storage
Orchestration	Data Pipeline	Data Factory	Cloud DataFlow
Management	AWS Redshift	SQL Data Warehouse	Google BigQuery
NoSQL DB	AWS DynamoDB	Cosmos DB	Cloud DataStore

Can This Baseball Team Beat the New York Yankees?

Can This IT Security Group Beat the Russian Military?

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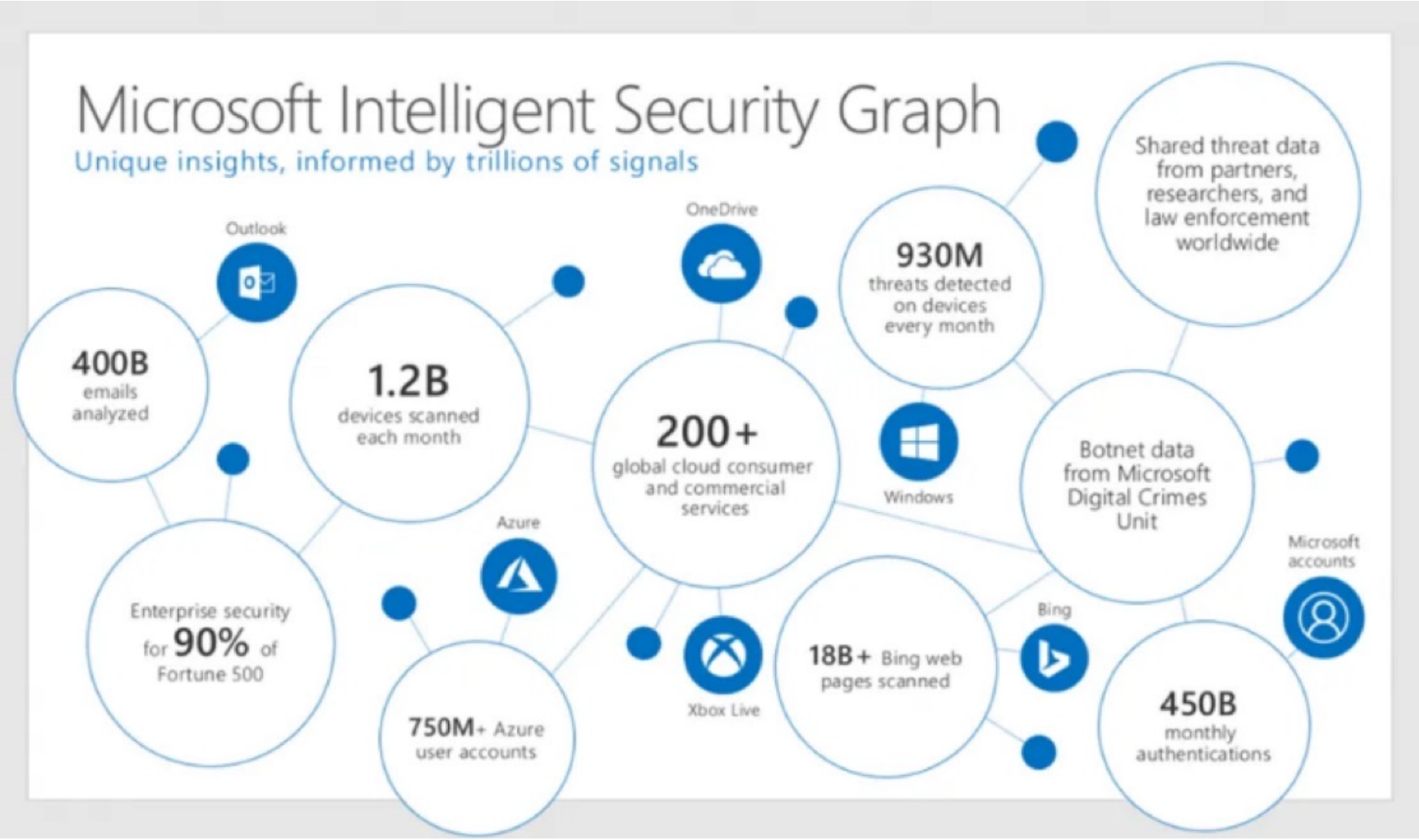
Microsoft Invests $1B/Year in Cyber Security



What is Software Defined Networking and How is it Used for Security?

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What is Software Defined Networking (SDN)?

- **Software Defined Networking (SDN) is a network architectural model**
  - Popular to virtualize data centers
  - Important aspect of Tier One carrier network infrastructure including 5G

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- **Separates and decouples data and control plane using a centralized SDN control function**
  - SDN involves centralized control versus distributed router configuration
  - Network resources can be configured and secured at scale

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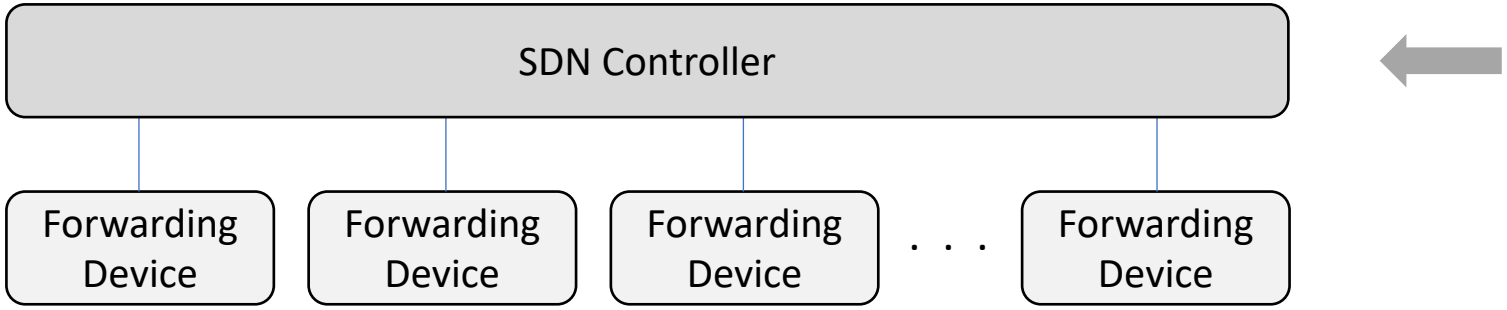
SDN Controller Configuration



Replaces Top of Rack Router in a Traditional Data Center

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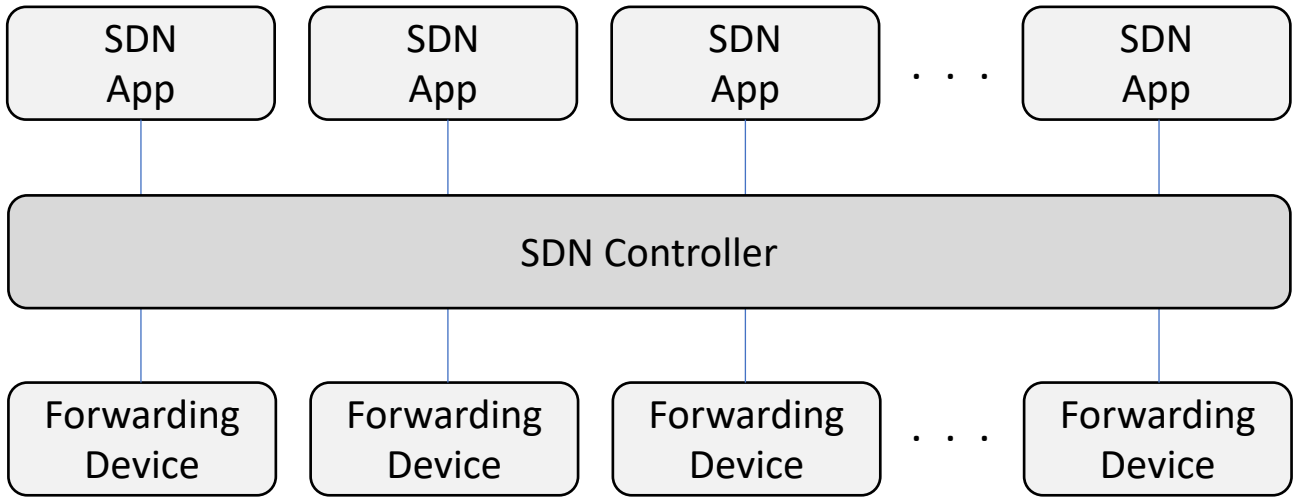
SDN Controller Configuration



SDN Security Apps Provide Extensible Protection (e.g. Analytics)

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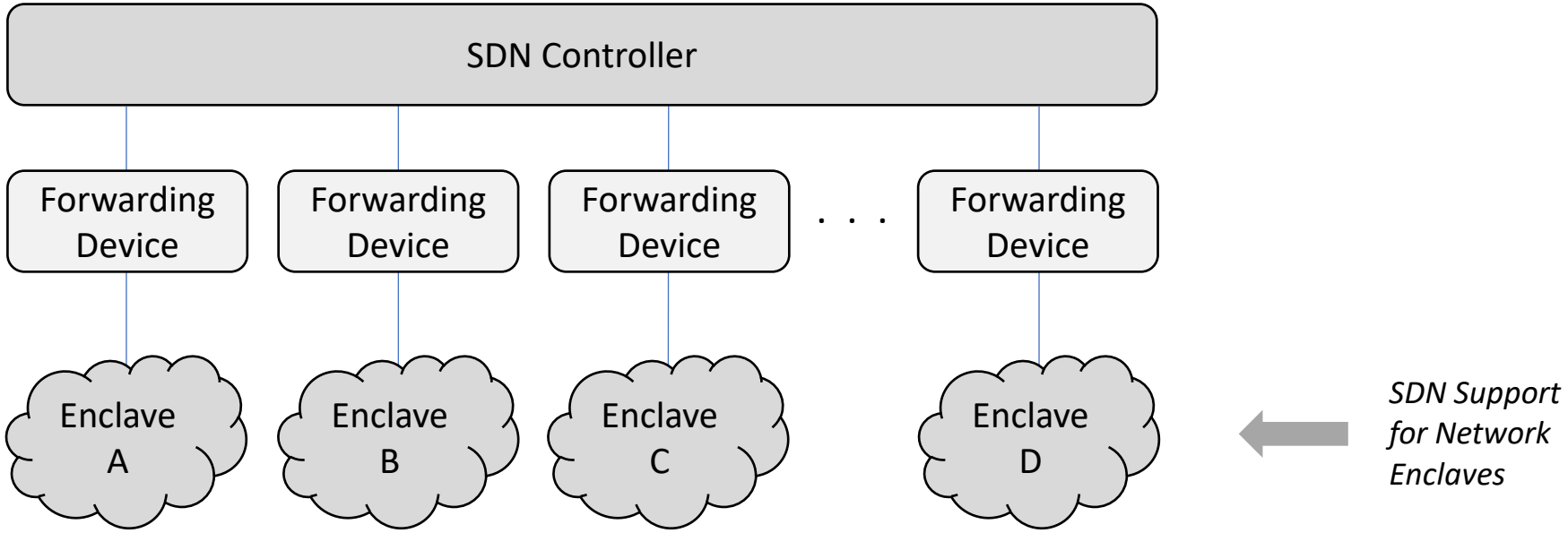
SDN-Based Network Visualization and Situational Awareness



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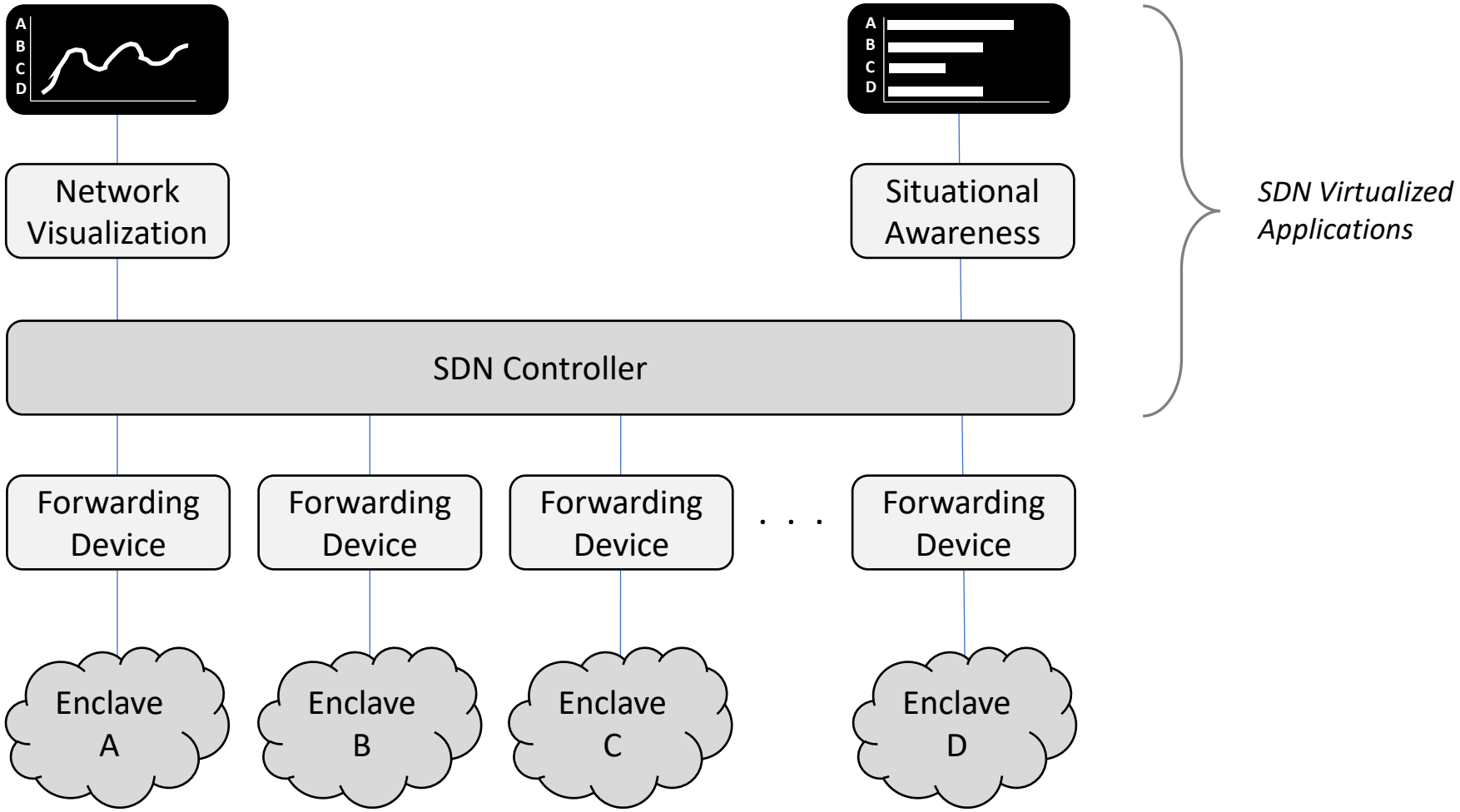

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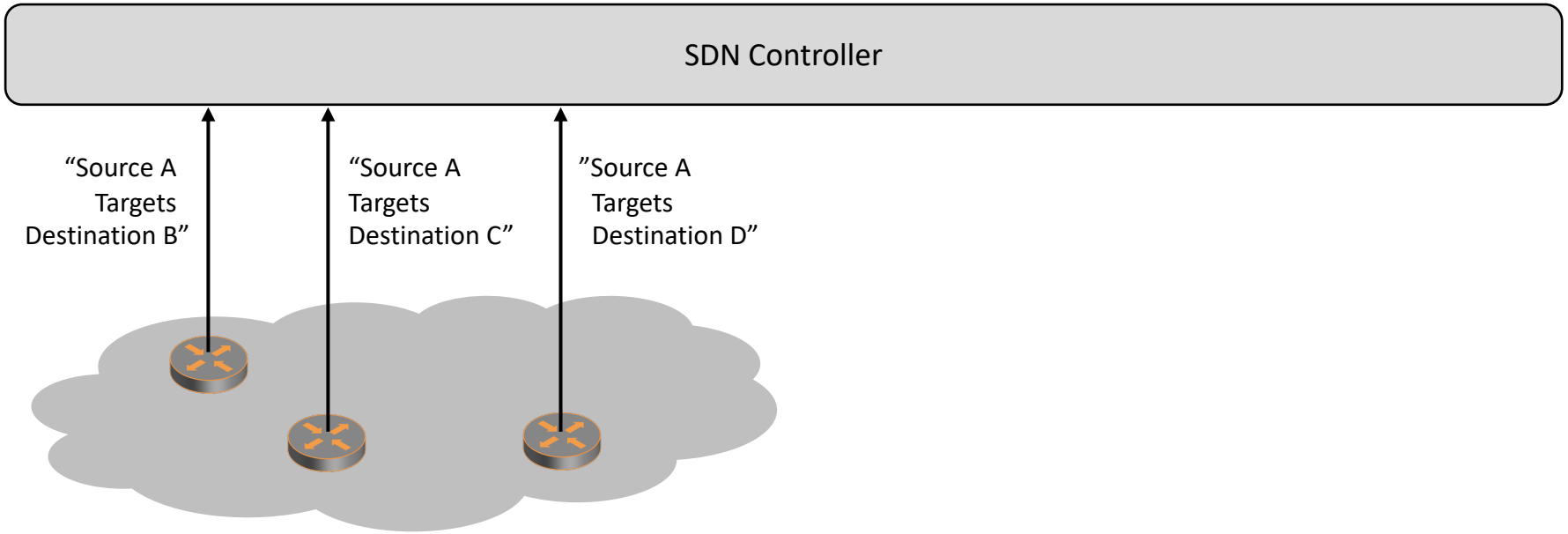
SDN Detection and Response (SDN-DR)

Step 1:
Metadata
Indicators
Provided



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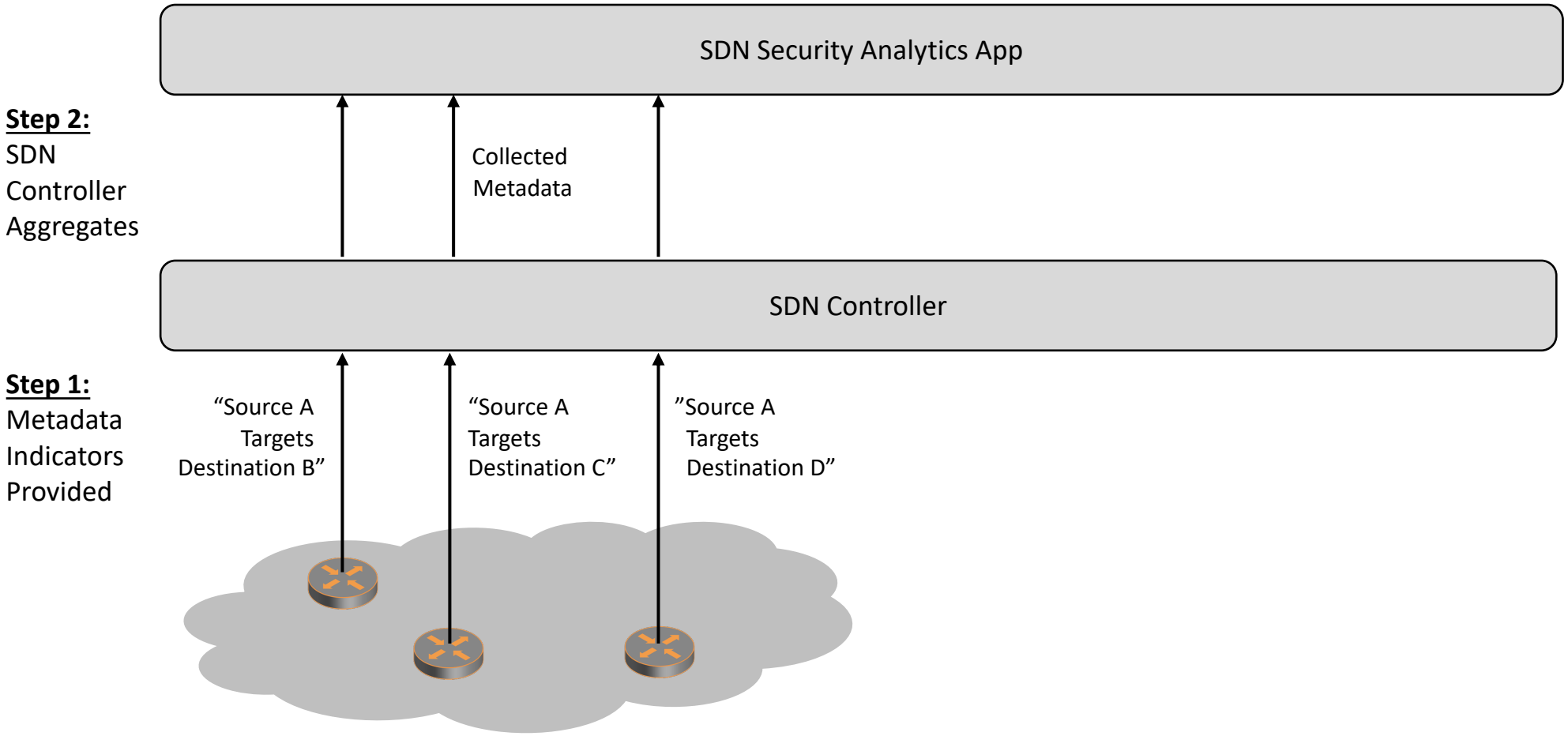

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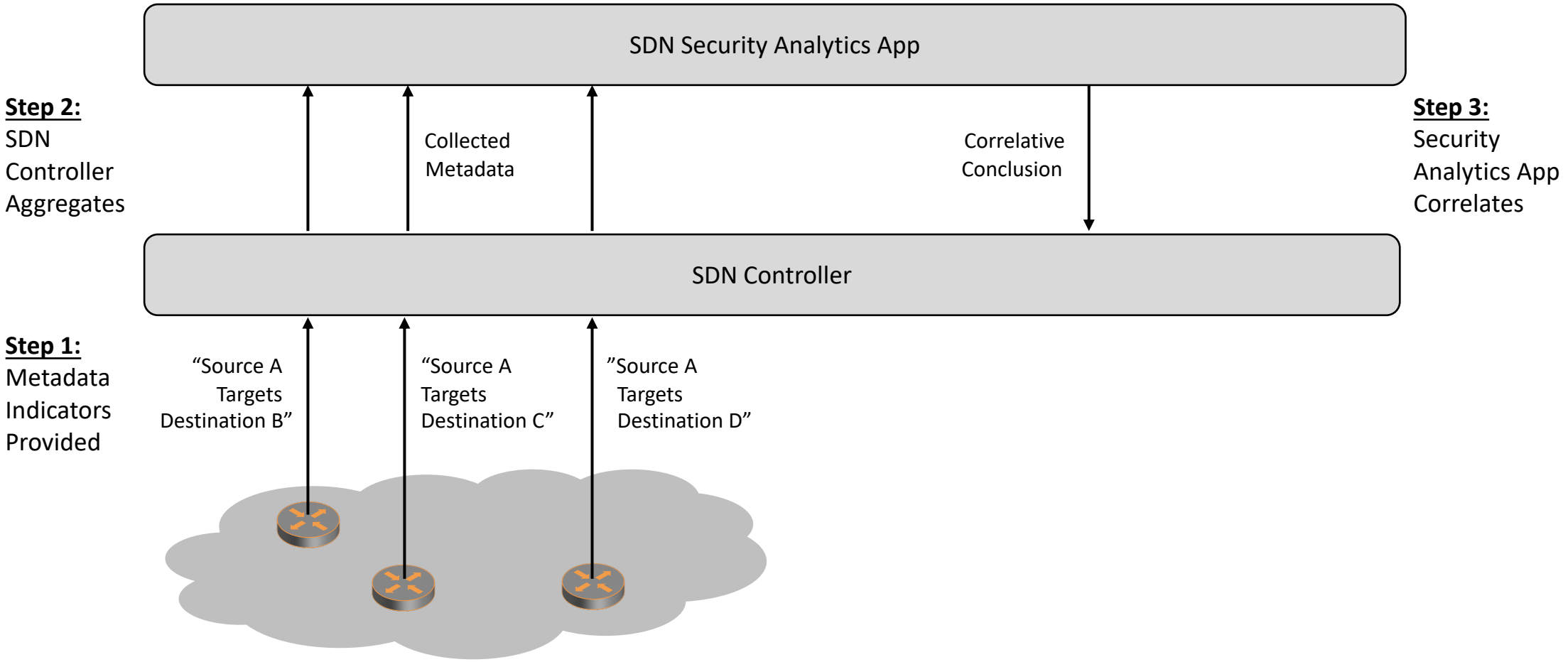

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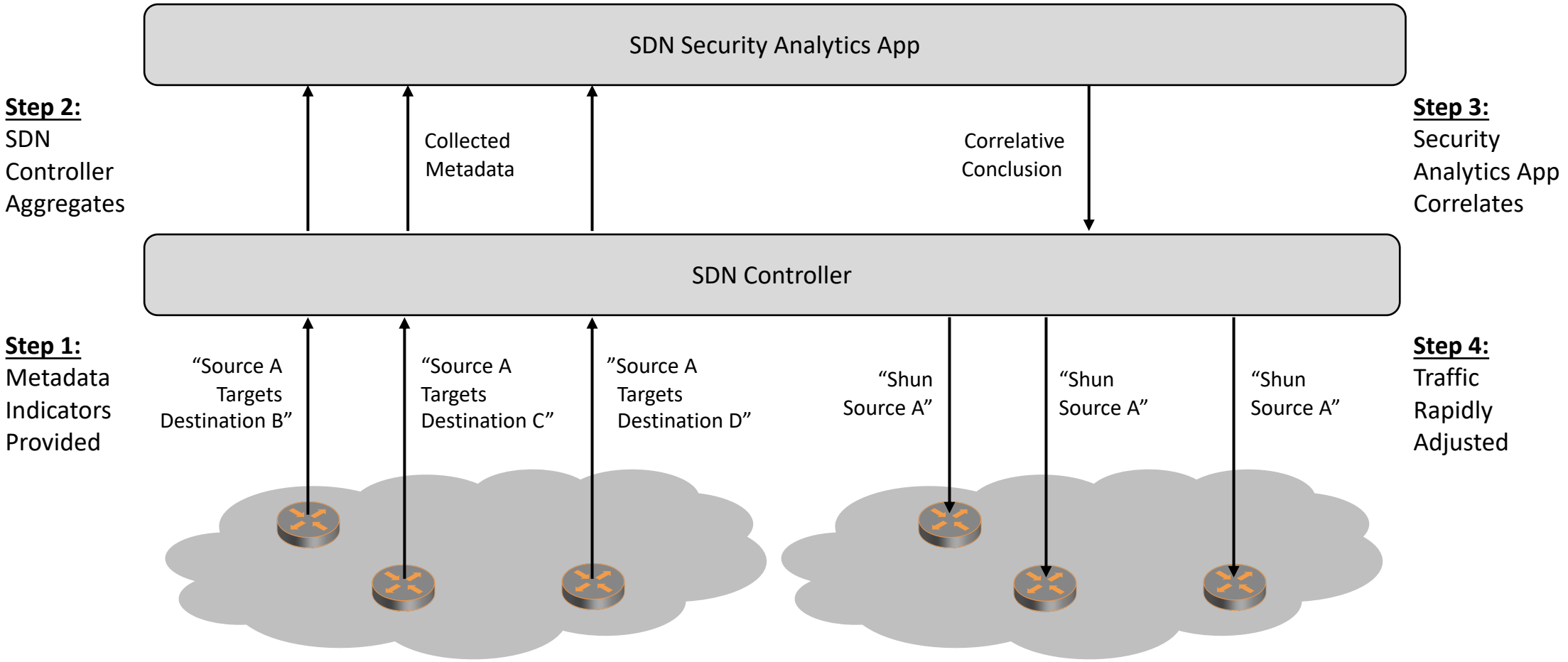

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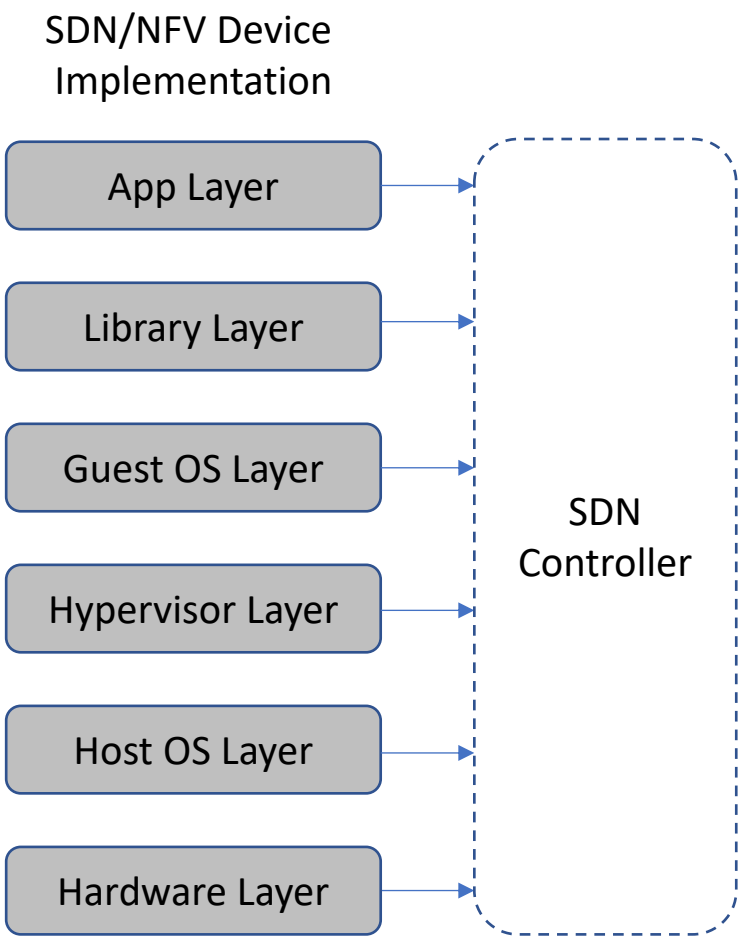
Delivery of Forensic Artifacts via SDN



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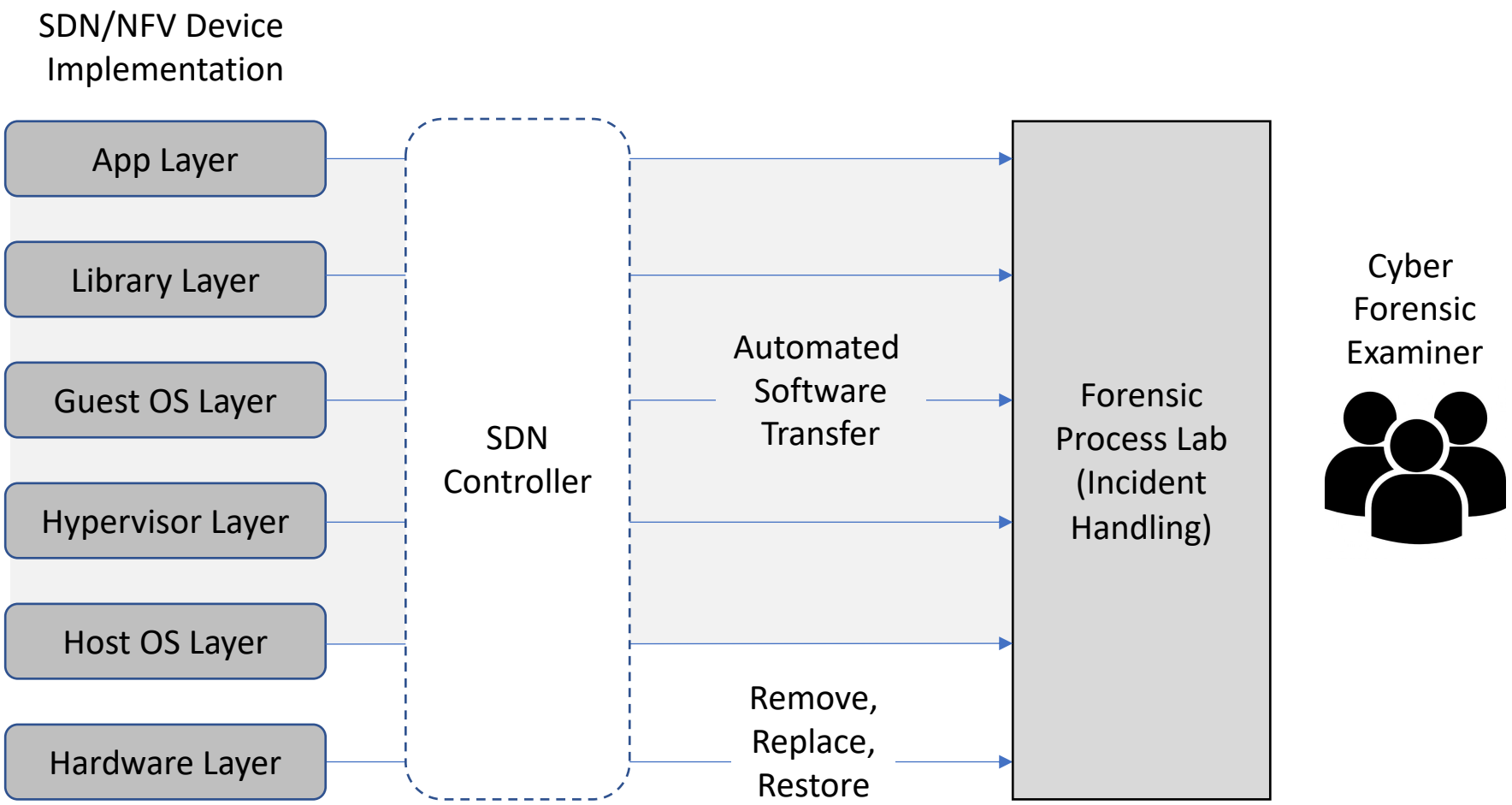

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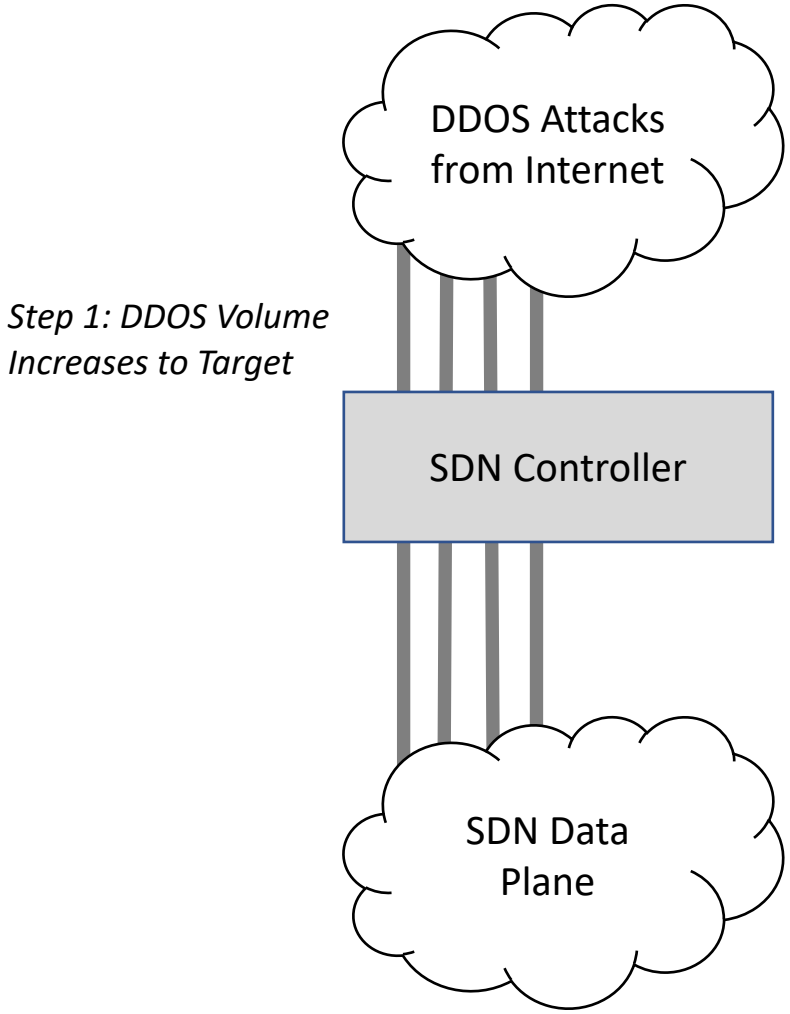
Potential DDOS Delivery via SDN



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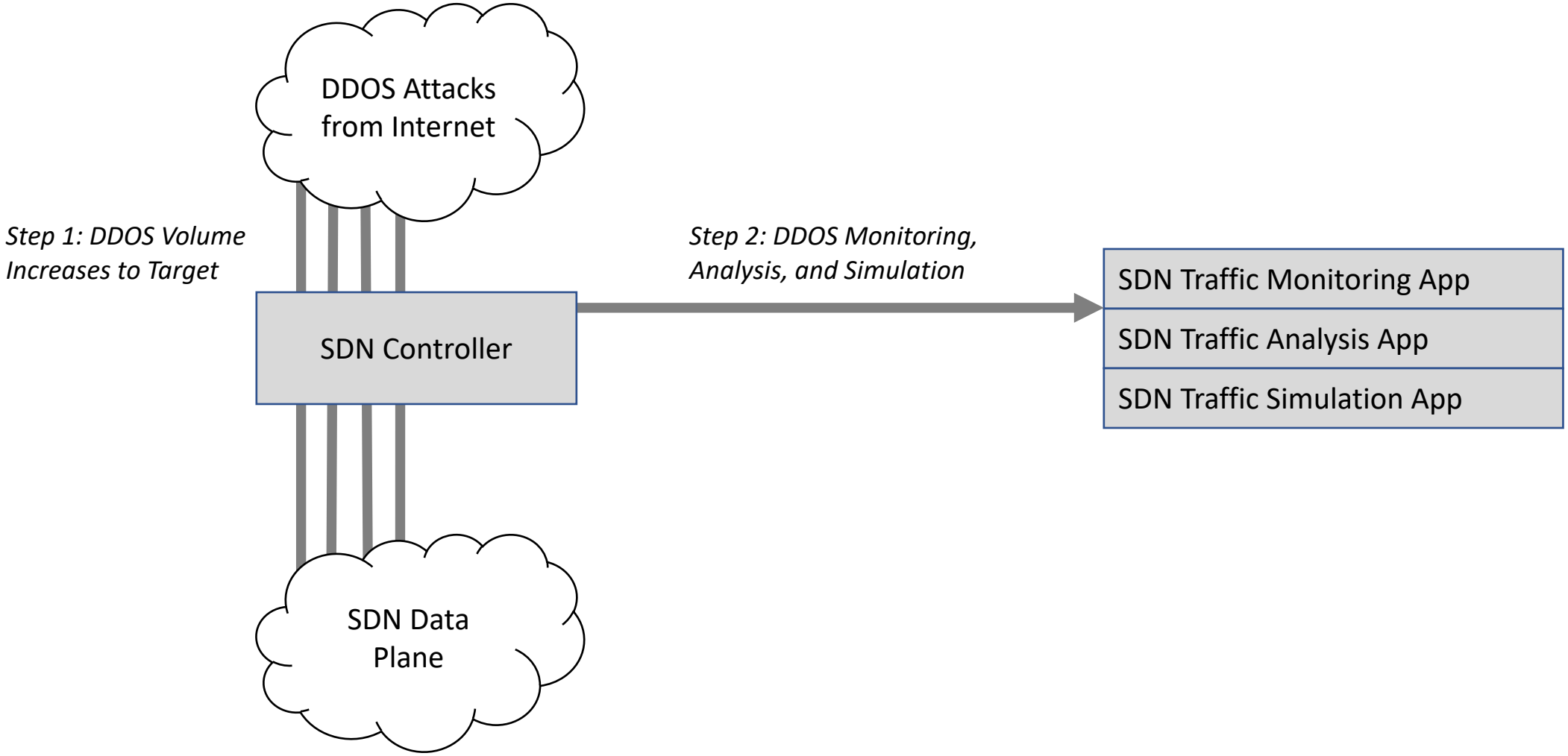

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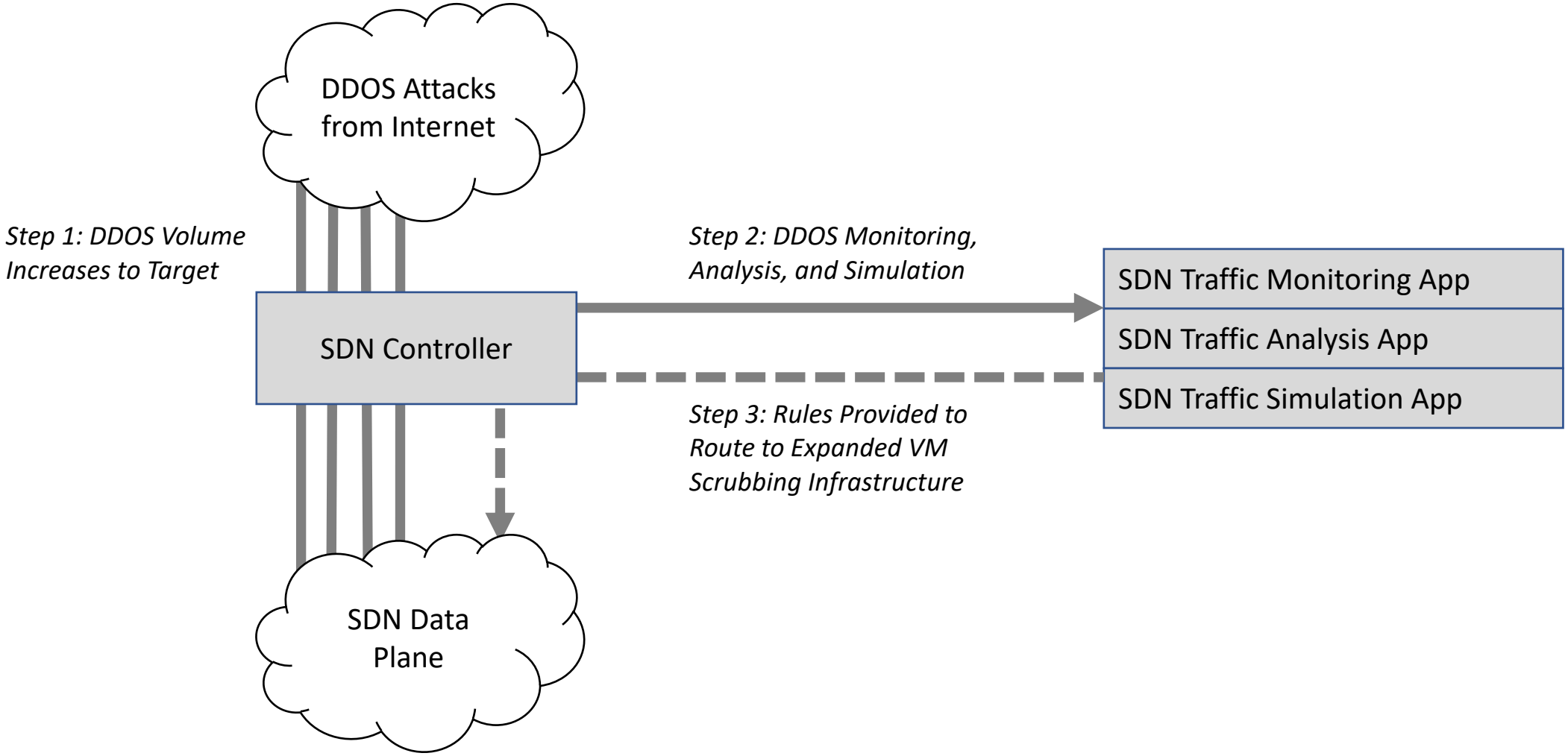

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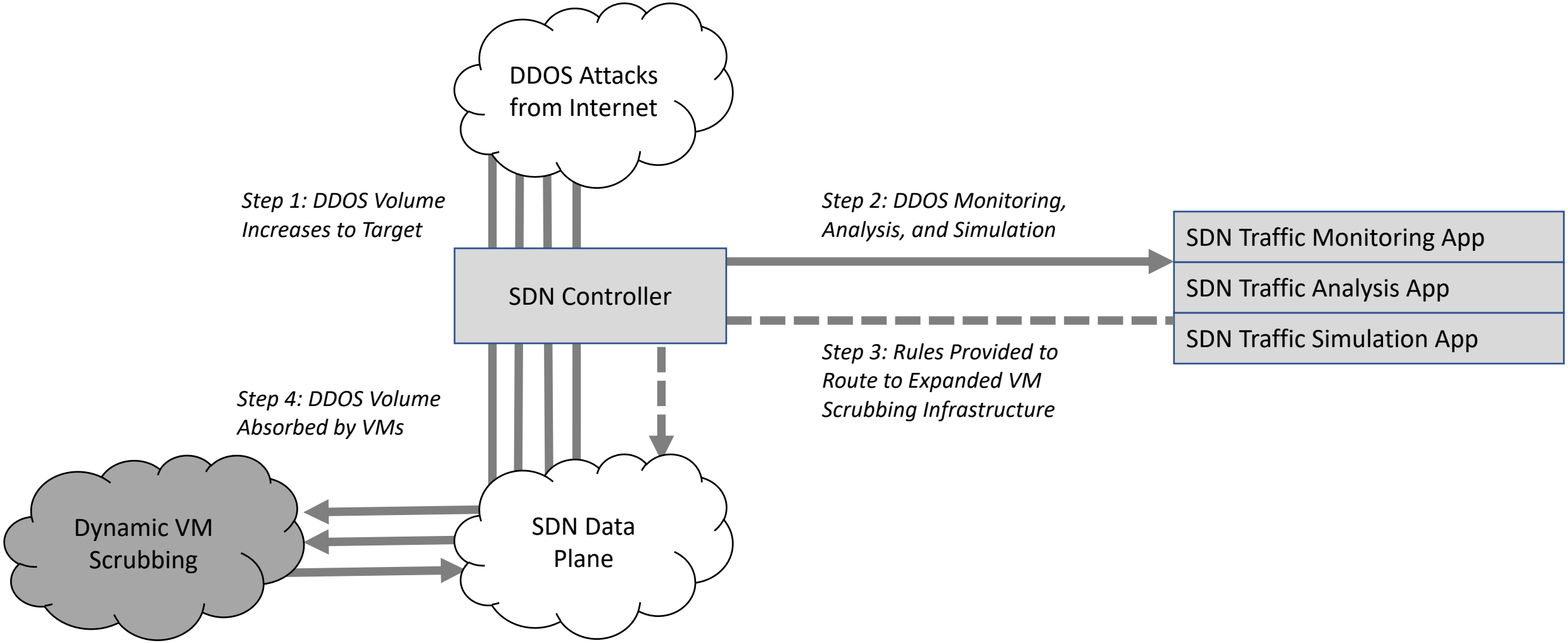
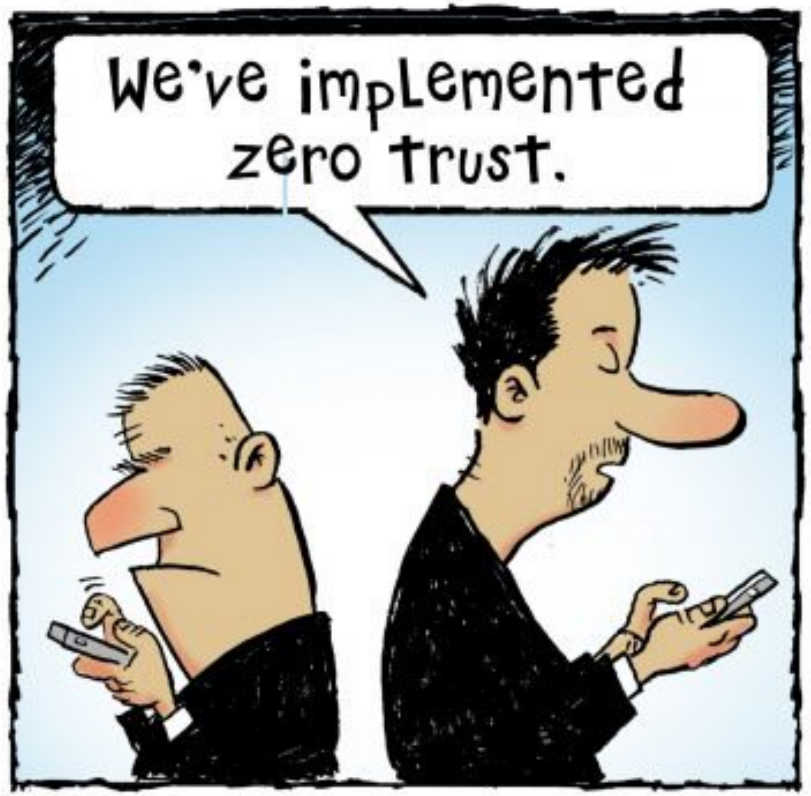


SDN Enables Dynamic, Expandable DDOS Attack Absorption

What is Zero Trust?

Week 12

Charlie Ciso



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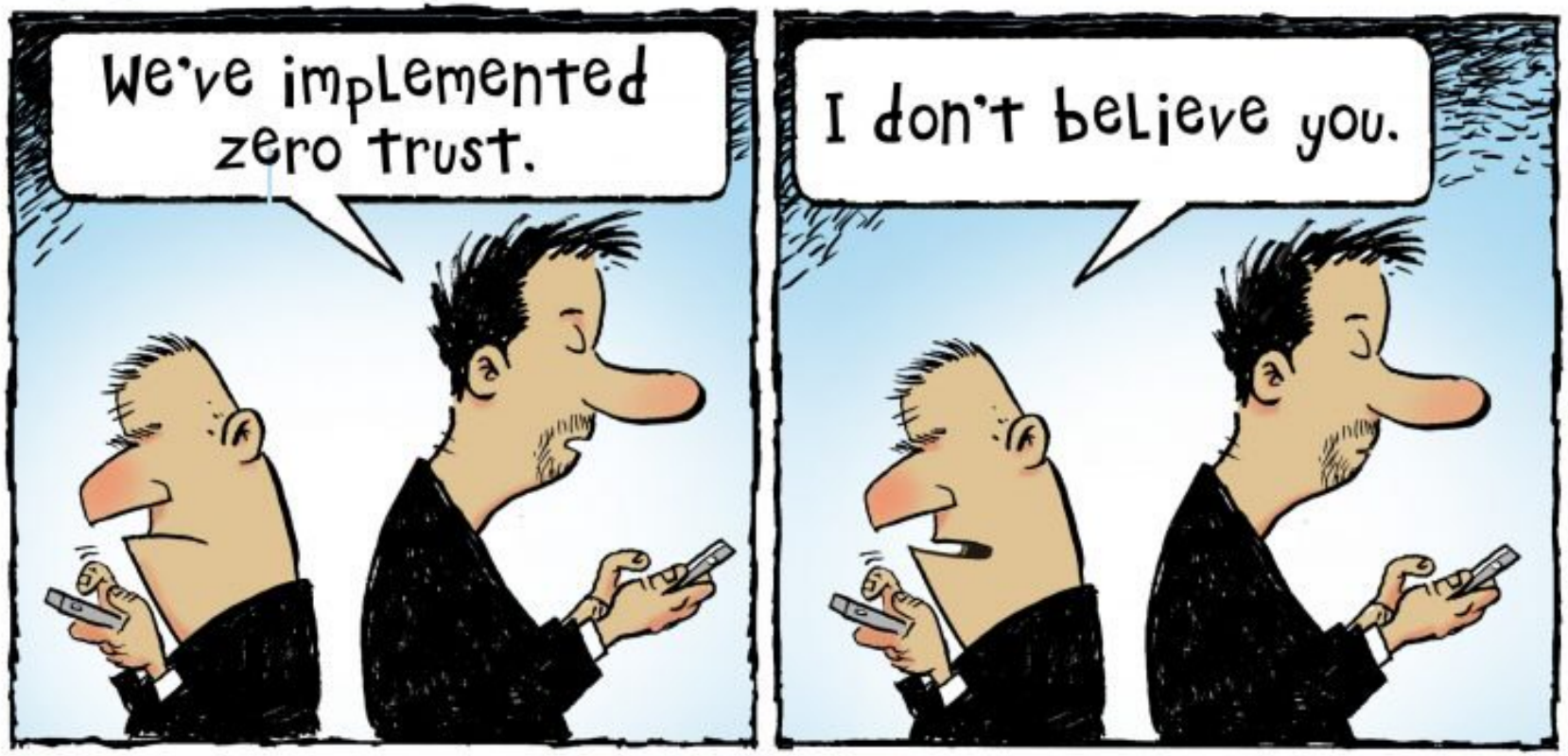

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- **Trust no longer established by enterprise perimeter**
  - Firewall perimeters no longer a primary control in Zero Trust

Week 12

Perimeter Vulnerability: Target's 2014 Incident

40 Million Credit Cards Stolen from Target

- Hacked third-party vendor access unnoticed from 12/2/13 to 1/16/14
- CEO and CIO of Target apologized and resigned
- Remediation/legal costs: $162M (Target) and $200M (Banks)

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Perimeter Vulnerability: Home Depot's 2014 Incident

Five Month Undetected Attack at Home Depot

- Compromised 56 million customer payment cards
- CEO apologized publicly after the cyber attack
- Famous security budget retort from ex-employee: "We sell hammers."

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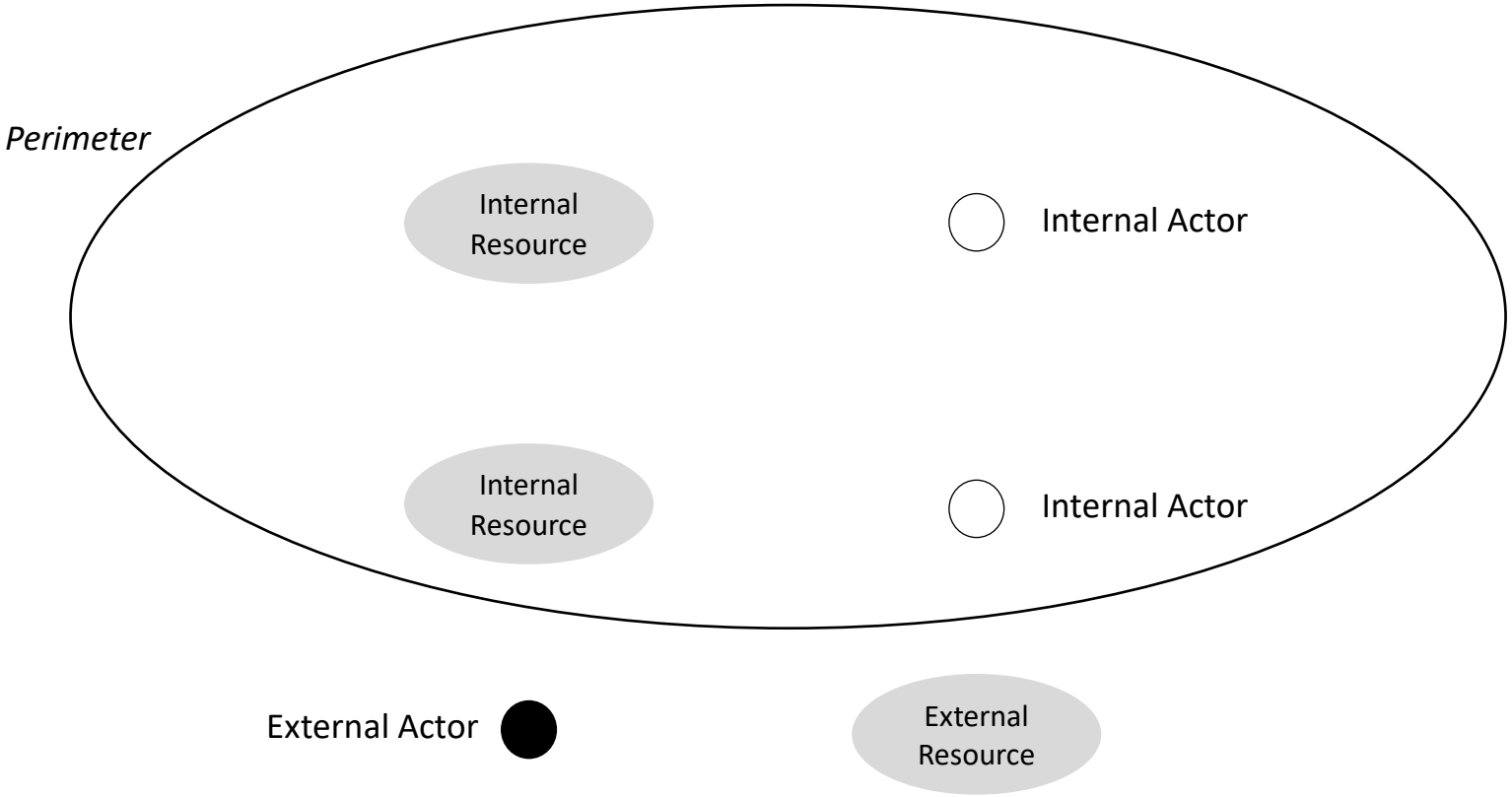
North-South Versus East-West Access



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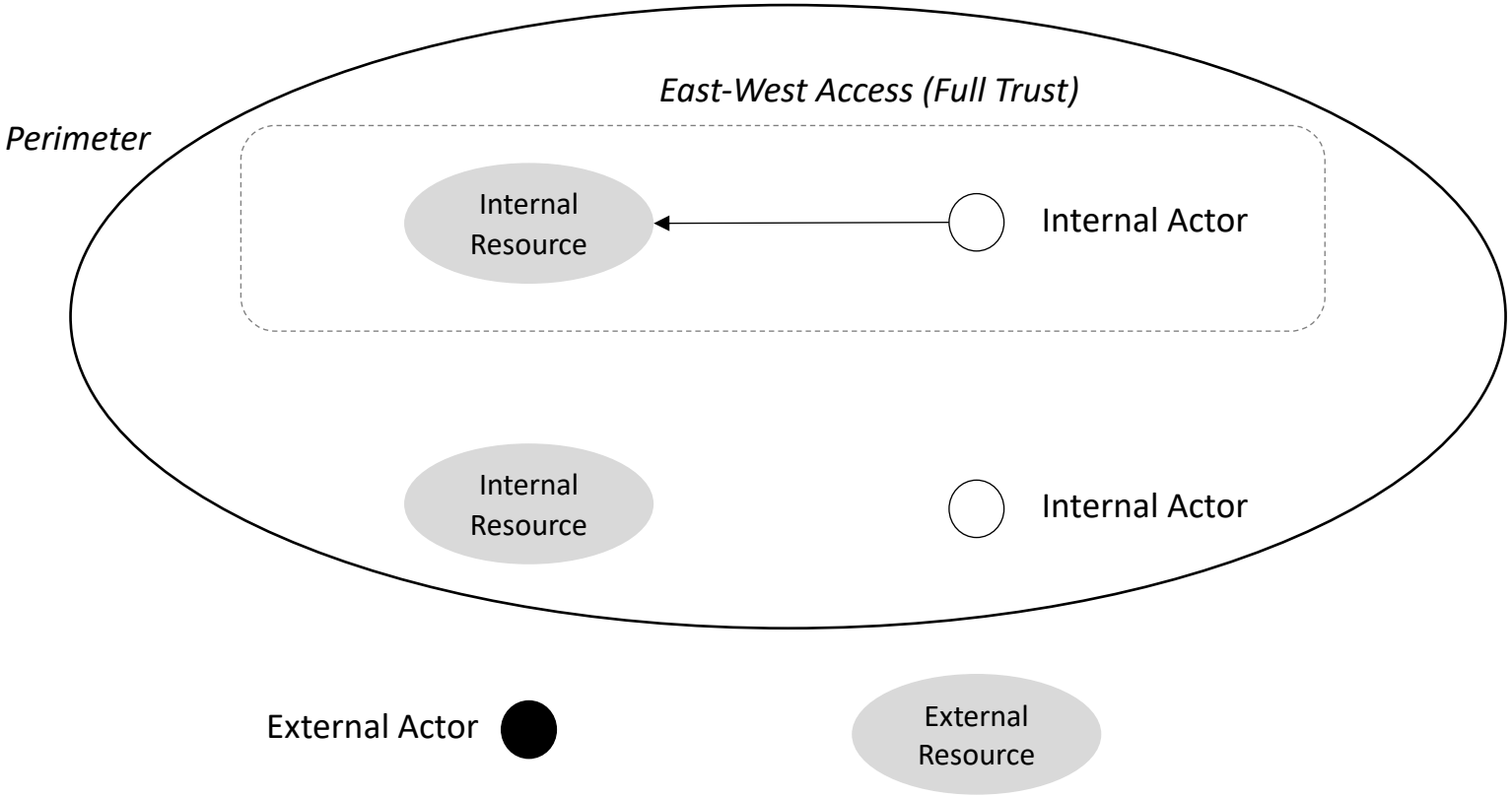

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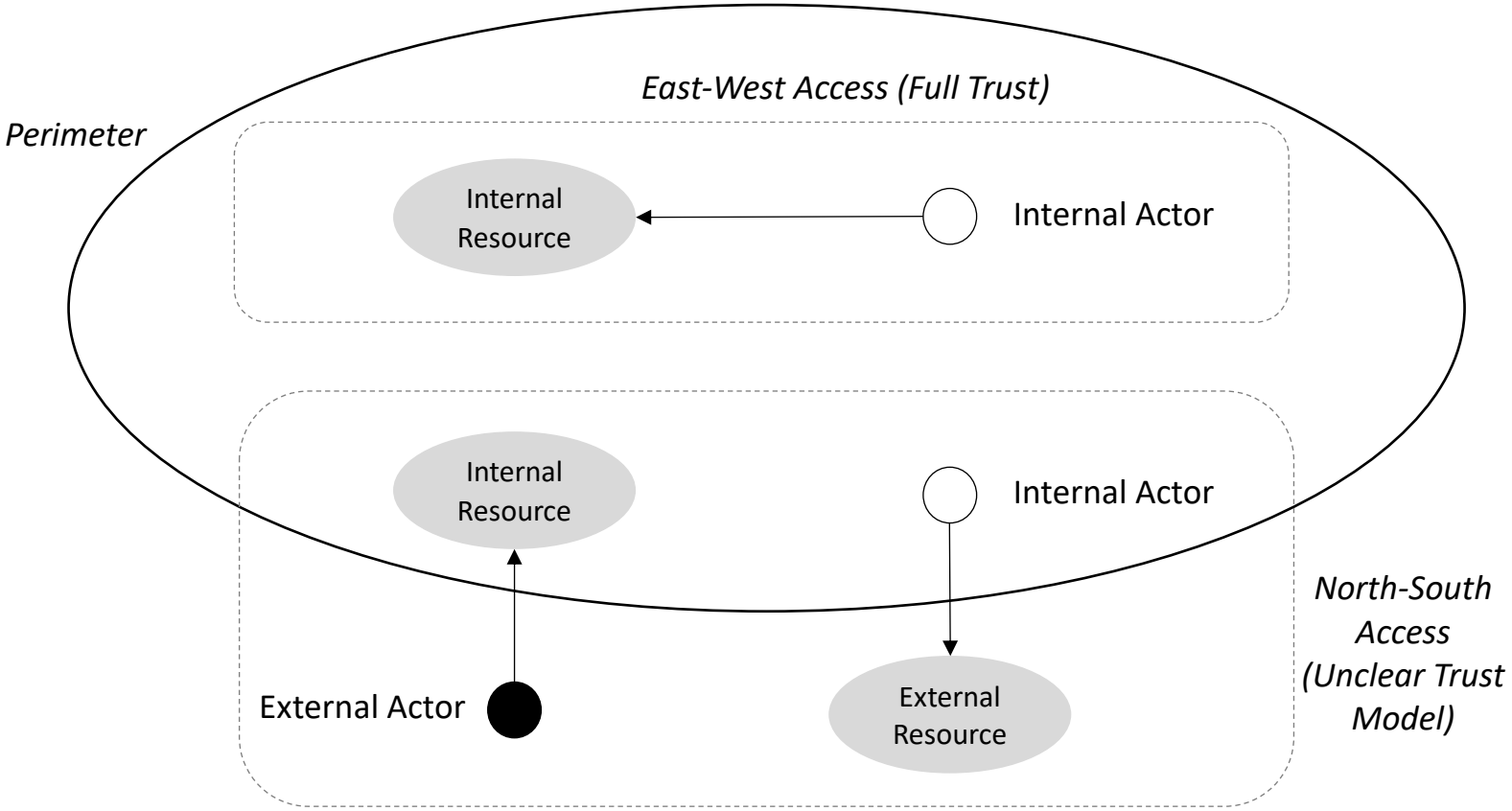

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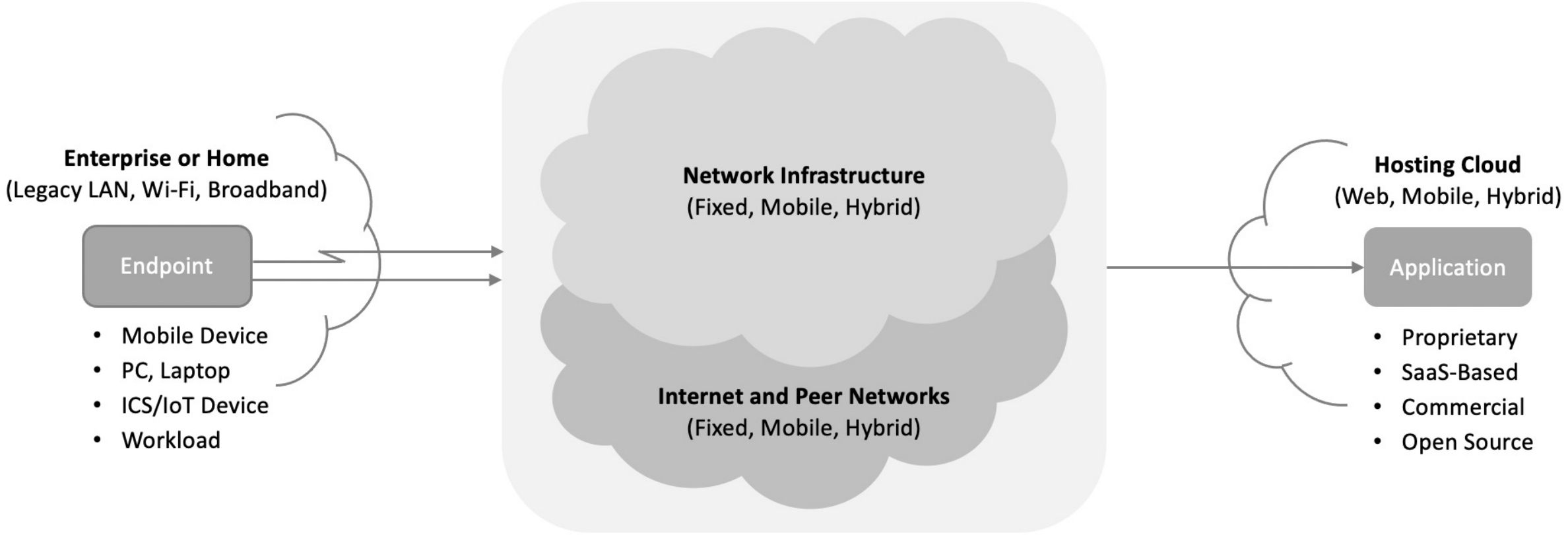
Zero Trust Use Case – Endpoint Device to Cloud-Hosted App



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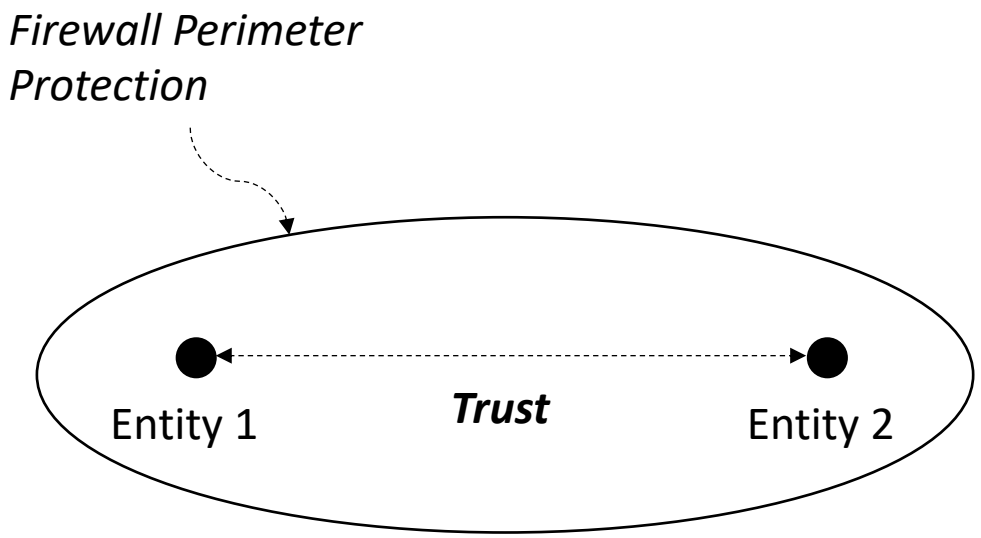
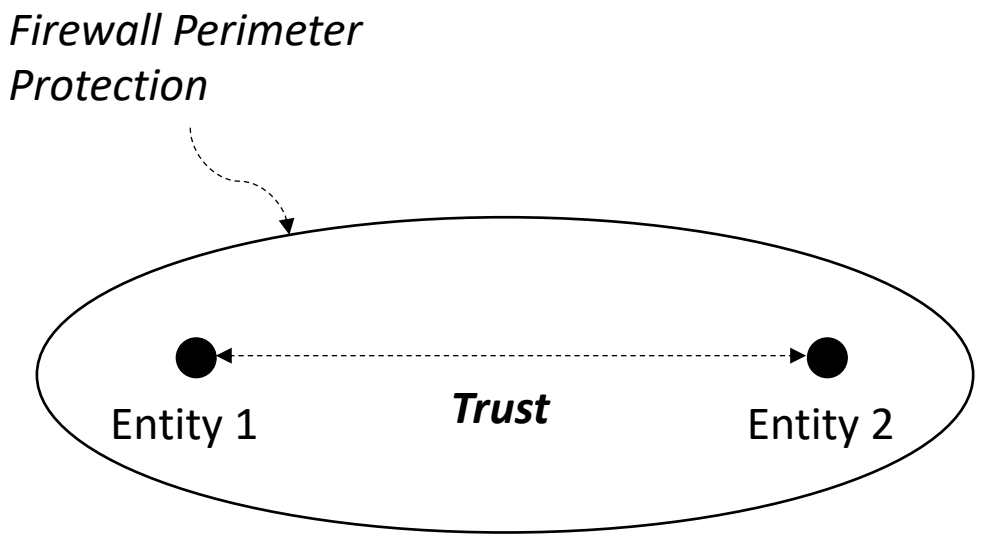
Firewall Perimeter Protection (Opposite of Zero Trust)

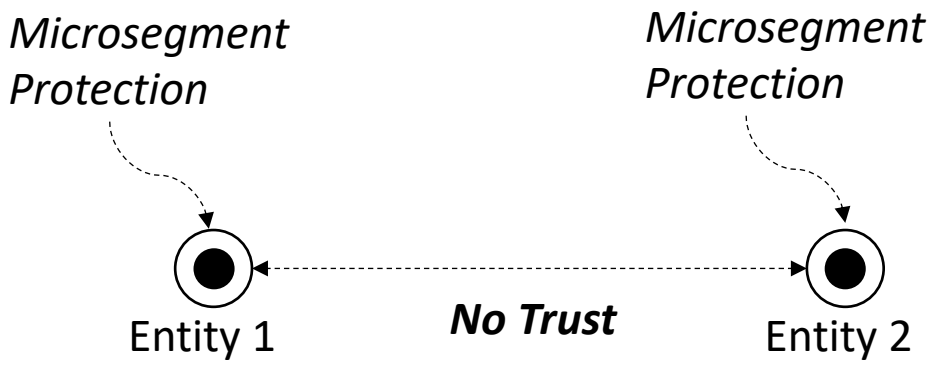


1. Entity 1 and 2 can share freely (bidirectional)
2. No mutual authentication (no 1FA, 2FA, etc.)
3. Shared boundary protection (perimeter)
4. Malware can traverse laterally from 1 to 2

Week 12

Comparison to Zero Trust with No Perimeter



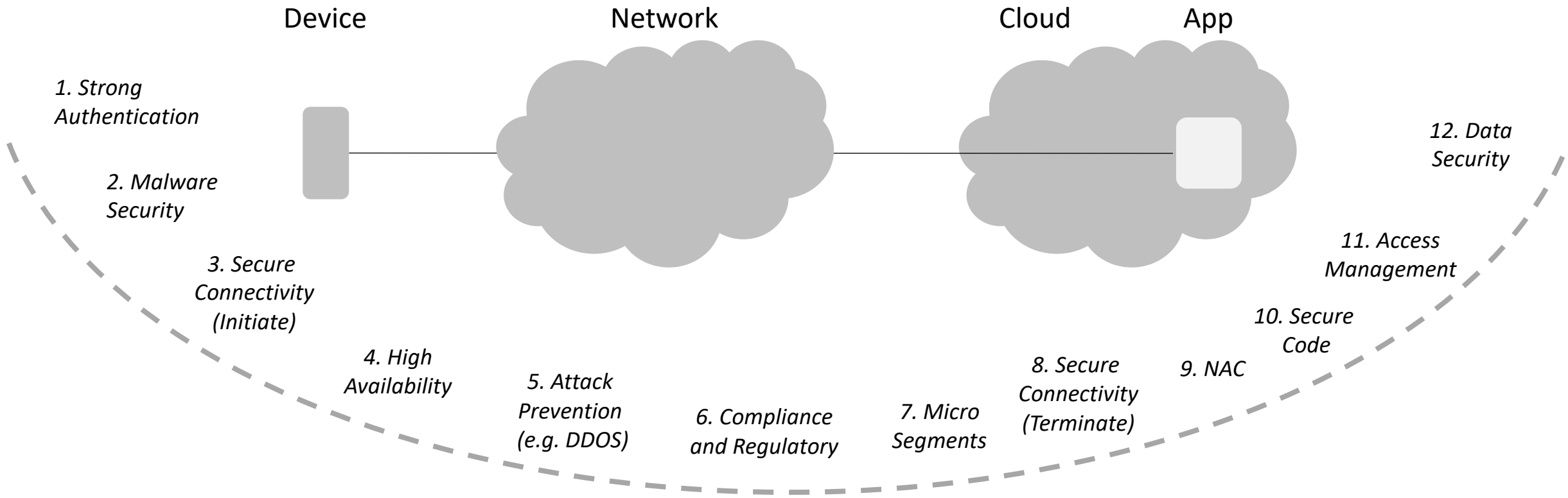


1. Entity 1 and 2 can share freely (bidirectional)
2. No mutual authentication (no 1FA, 2FA, etc.)
3. Shared boundary protection (perimeter)
4. Malware can traverse from 1 to 2 freely

1. Entity 1 and 2 will only share if necessary
2. Mutual authentication (1FA, 2FA, etc.)
3. Local boundary protections (no perimeter)
4. Malware cannot traverse from 1 to 2 freely

Week 12

Components of Zero Trust Network Access (ZTNA)



What are the Dimensions of Modern Data Protection?

Week 12

Dimensions of Modern Enterprise Data Protection

- **Data Discovery** – “Where is my data located (including cloud and SaaS)?”

Week 12

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- **Data Leakage Prevention** – “How do I make sure my data doesn’t leak to unauthorized users?”

What is Data Leakage Prevention (DLP)?

Week 12

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- **DLP is an enterprise cyber security control designed to prevent sensitive data from leaking out to unauthorized individuals or groups**
  - Often referenced as data leakage prevention, data leakage protection, and data loss prevention (all roughly synonymous)

Week 12

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- **DLP controls address two primary enterprise use-cases**
  - Deliberate and malicious actions by an adversary to intentionally leak data outside a protected enclave
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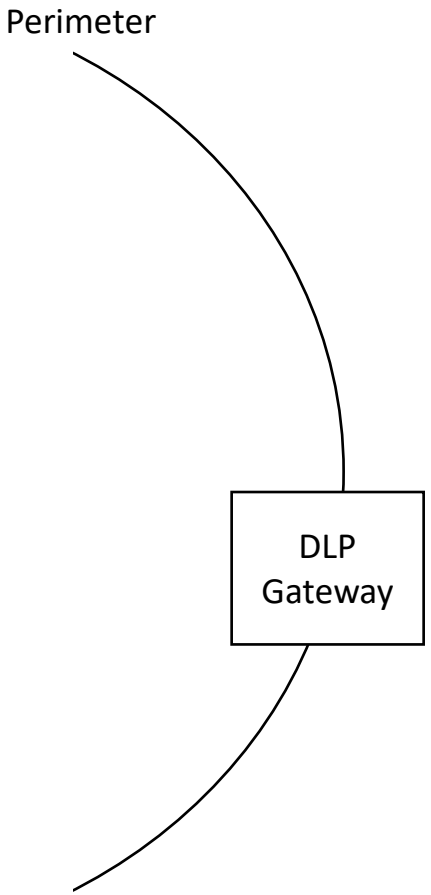
- **DLP tools and platforms typically include many types of functional methods**
  - Data classification, content inspection, contextual analysis, incident response, and real-time mitigation

Week 12

Original DLP Methodology

Step 1: Internal actor classifies and explicitly marks internal data



Week 12

Original DLP Methodology

Process is prone to error and poor judgment

Step 1: Internal actor classifies and explicitly marks internal data

Step 1': Internal actor might not classify and explicitly mark some internal data

Perimeter

DLP Gateway

Week 12

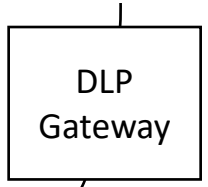
Original DLP Methodology

Step 1: Internal actor classifies and explicitly marks internal data

Step 1': Internal actor might not classify and explicitly mark some internal data

Perimeter

Step 2: Rule added to DLP gateway to block exfiltration of data marked "Proprietary"



Week 12

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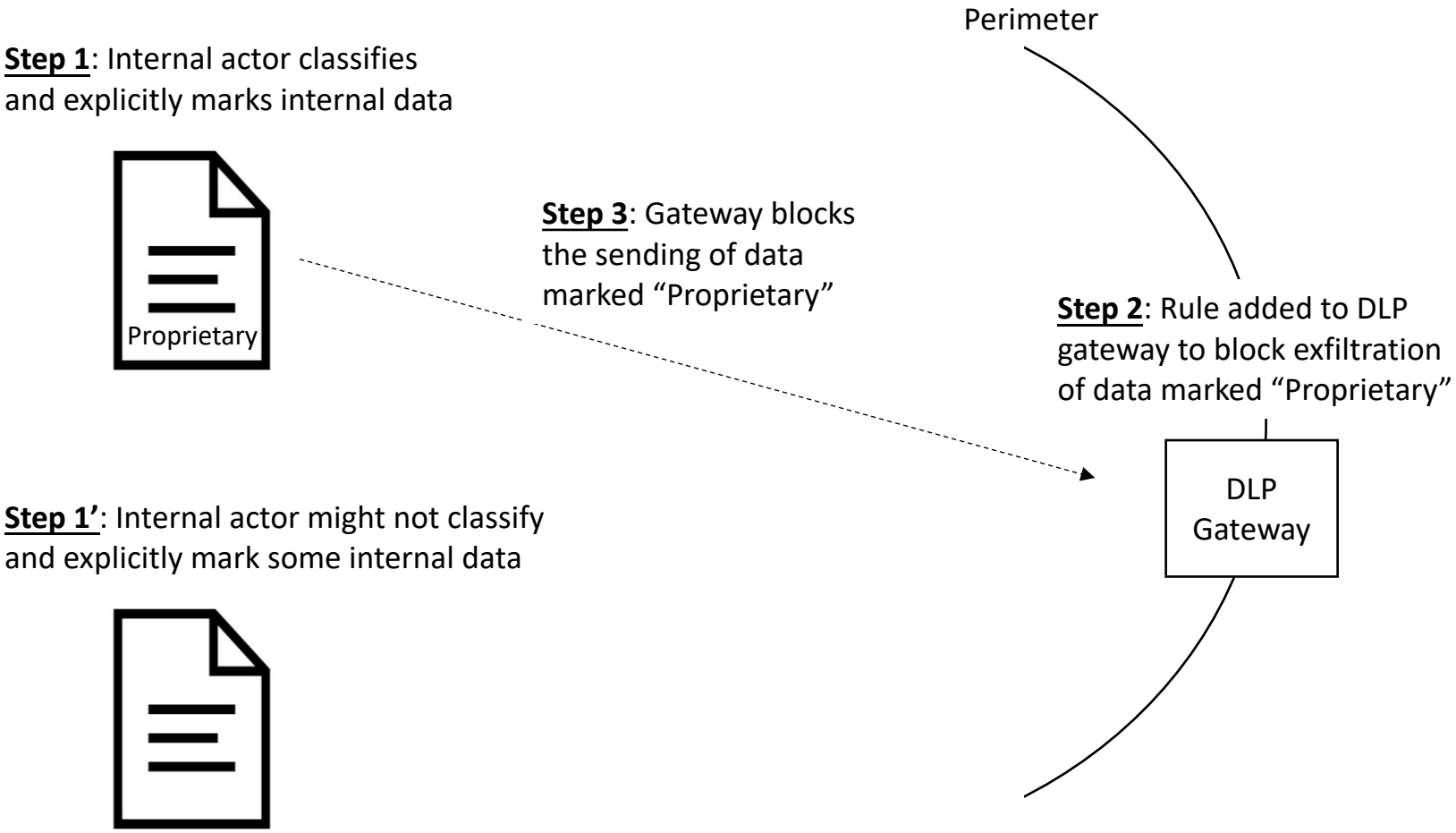

Week 12

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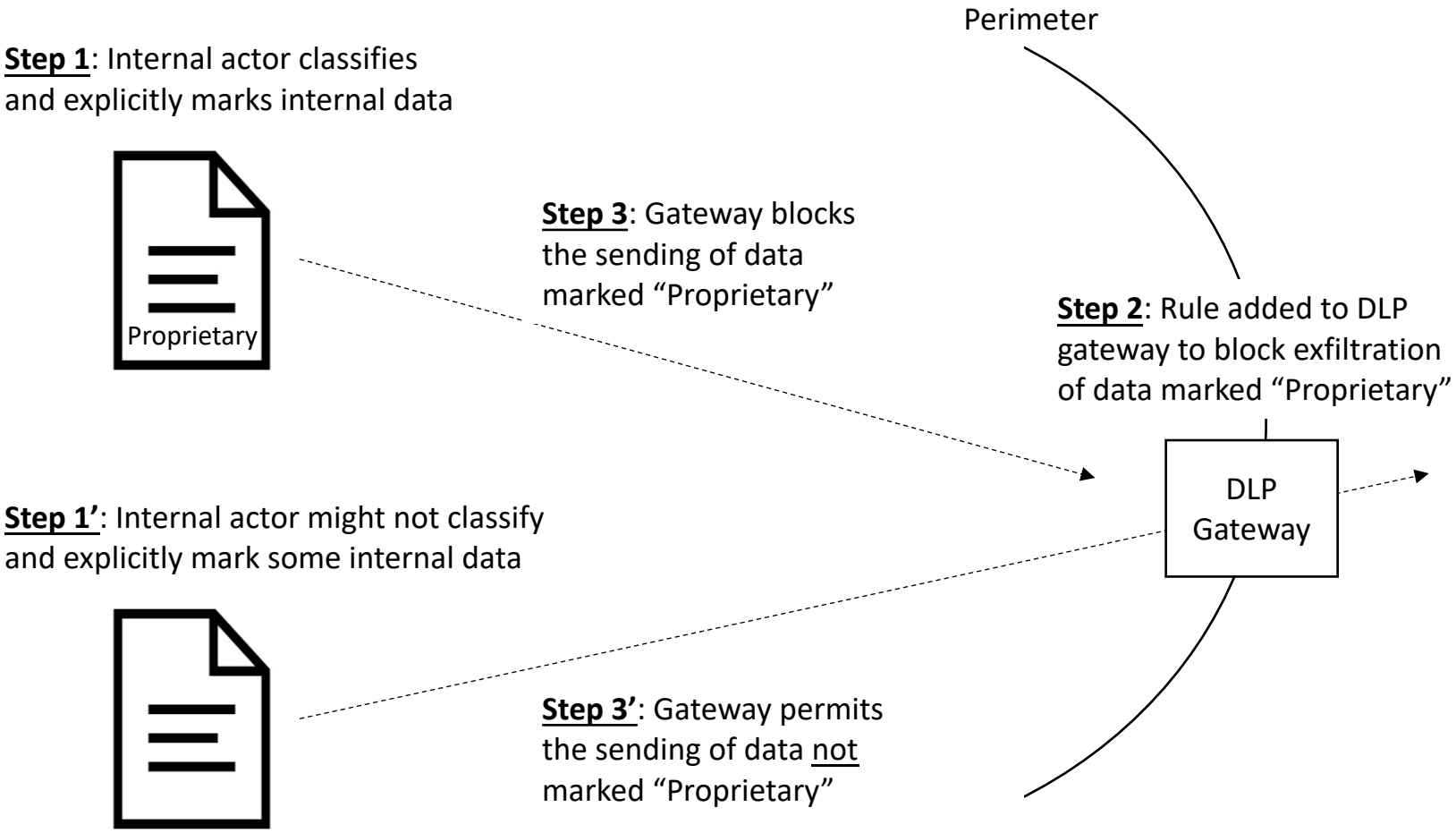
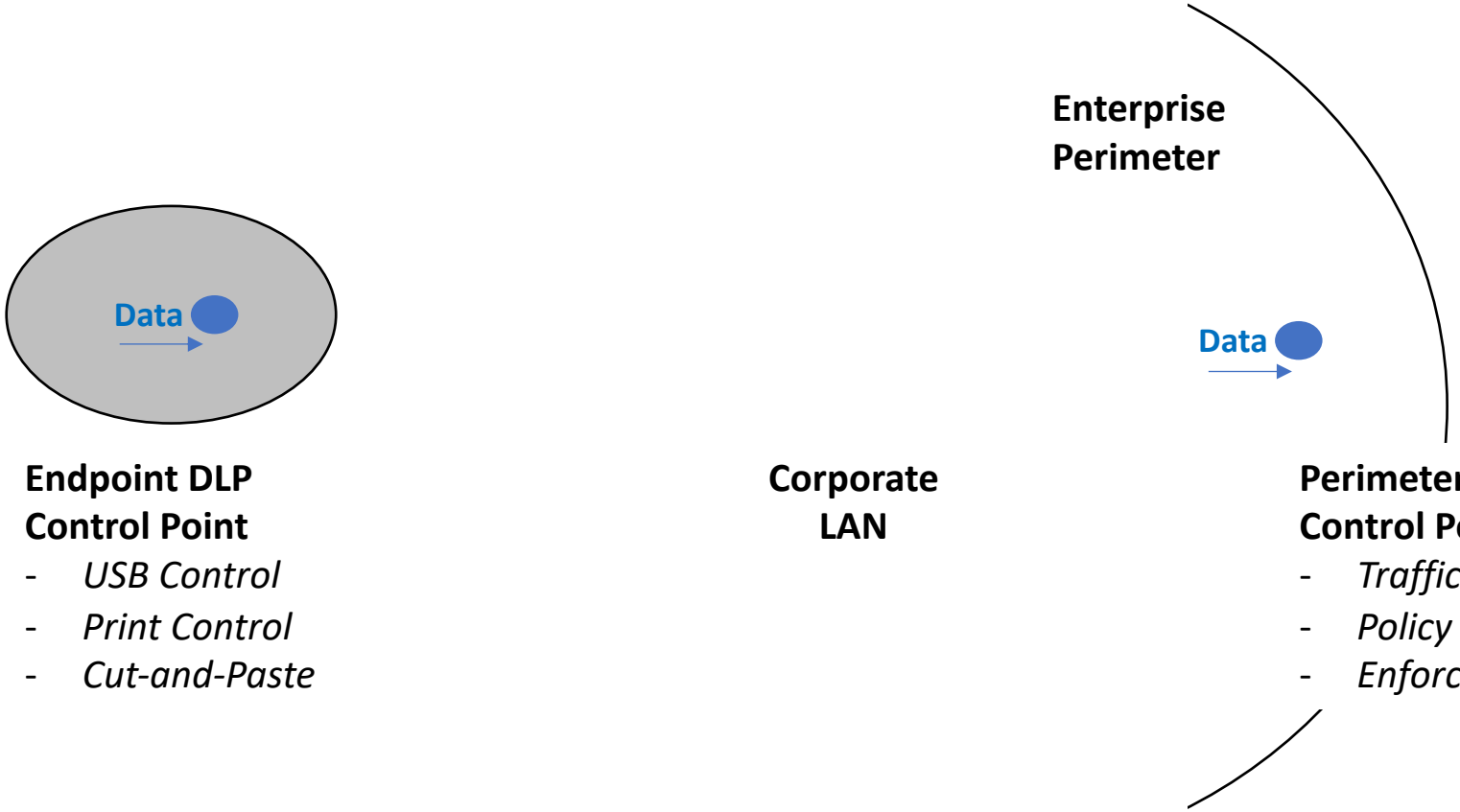


Week 12

Traditional DLP Control Points – First Generation



Endpoint DLP Control Point

- *USB Control*
- *Print Control*
- *Cut-and-Paste*

Corporate LAN

Perimeter DLP Control Point

- *Traffic Scan*
- *Policy Rules*
- *Enforce/Log*

Week 12

Enhanced DLP Control Points – Second Generation

Endpoint DLP Control Point

- *USB Control*
- *Print Control*
- *Cut-and-Paste*
- ***Heuristic Processing***
- ***Behavioral Analytics***
- ***Predictive Security***
- ***UBA Integration***

Corporate LAN

Perimeter DLP Control Point

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What is a Secure Web Gateway (SWG)?

Week 12

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  - Excellent option for perimeter-based networks with gateway chokepoints to and from data centers.

Week 12

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- **Typical SWG functions include URL filtering, malicious code protection, and application-level controls for major web applications.**
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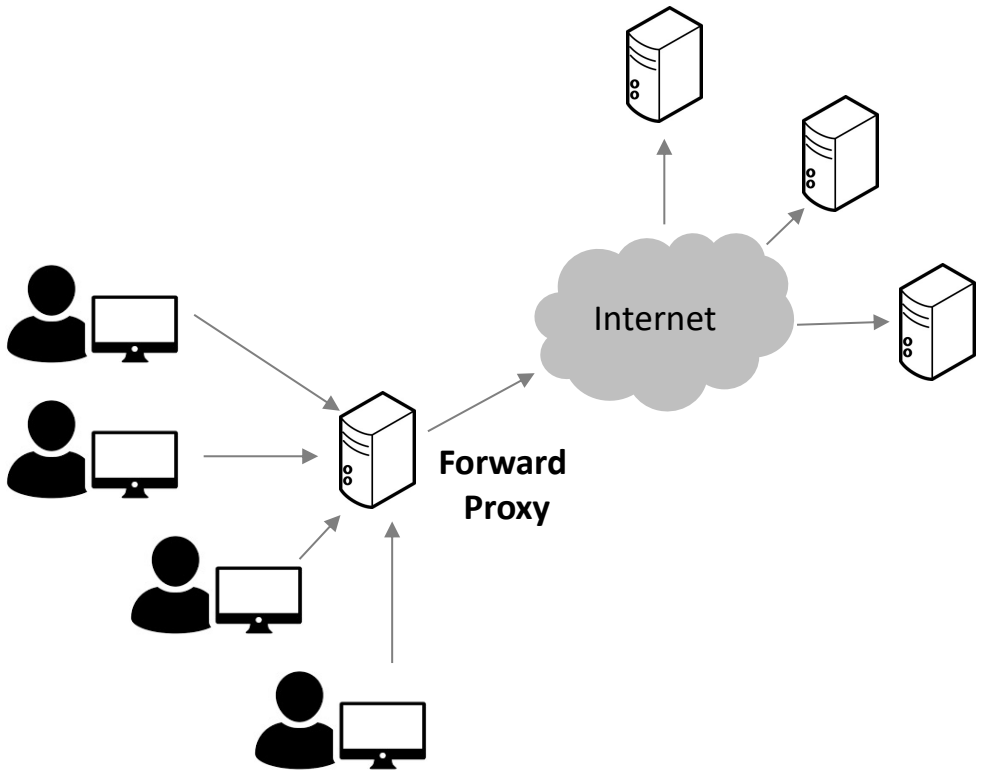
- **Typical SWG functions include URL filtering, malicious code protection, and application-level controls for major web applications.**
  - Increasingly seeing extension to include DLP and other functions as adversary threats have intensified.
- **SWGs include many modes of deployed operation such as advisory, discretionary, and mandatory control implementation.**
  - SWG control of access to inappropriate content and improper sites complicates the security mission.

Week 12

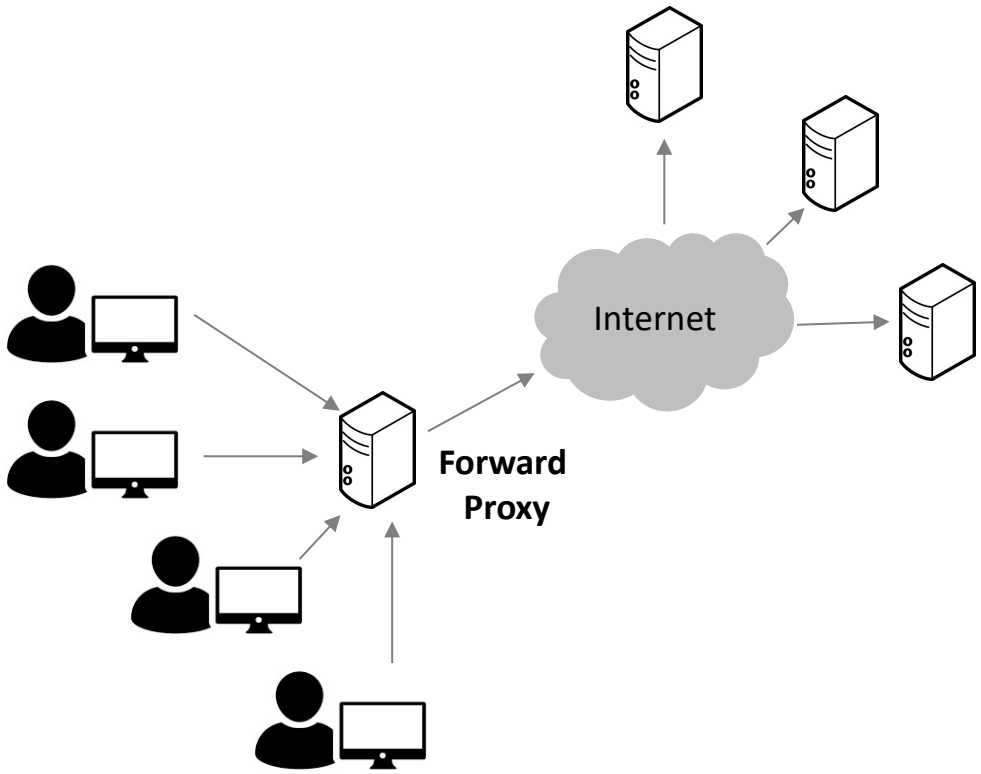
Understanding Proxy Operations



Protects Users from Malicious Content Access (Inbound to Users)

Week 12

Understanding Proxy Operations



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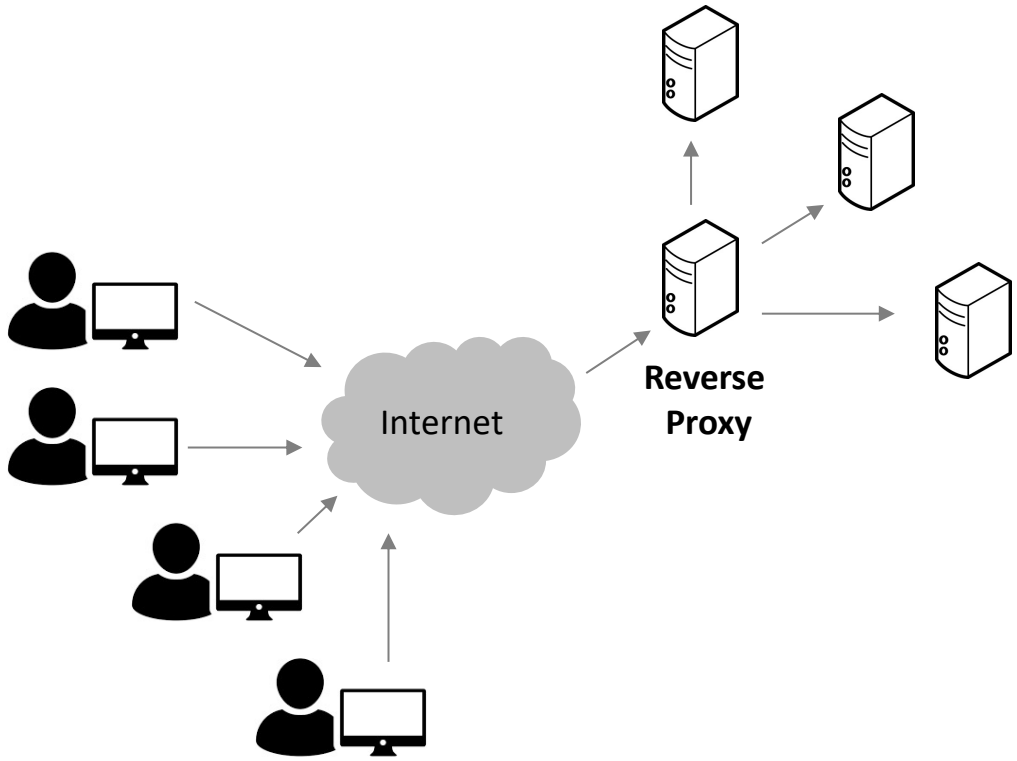
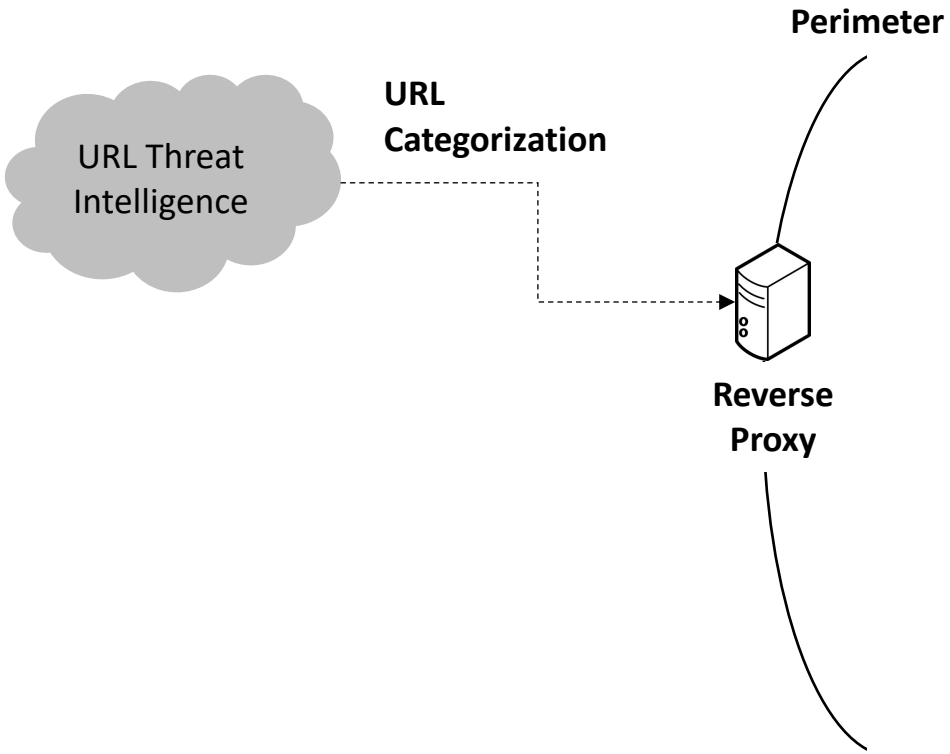


Protects Servers from Malicious Content Access (Inbound to Servers)

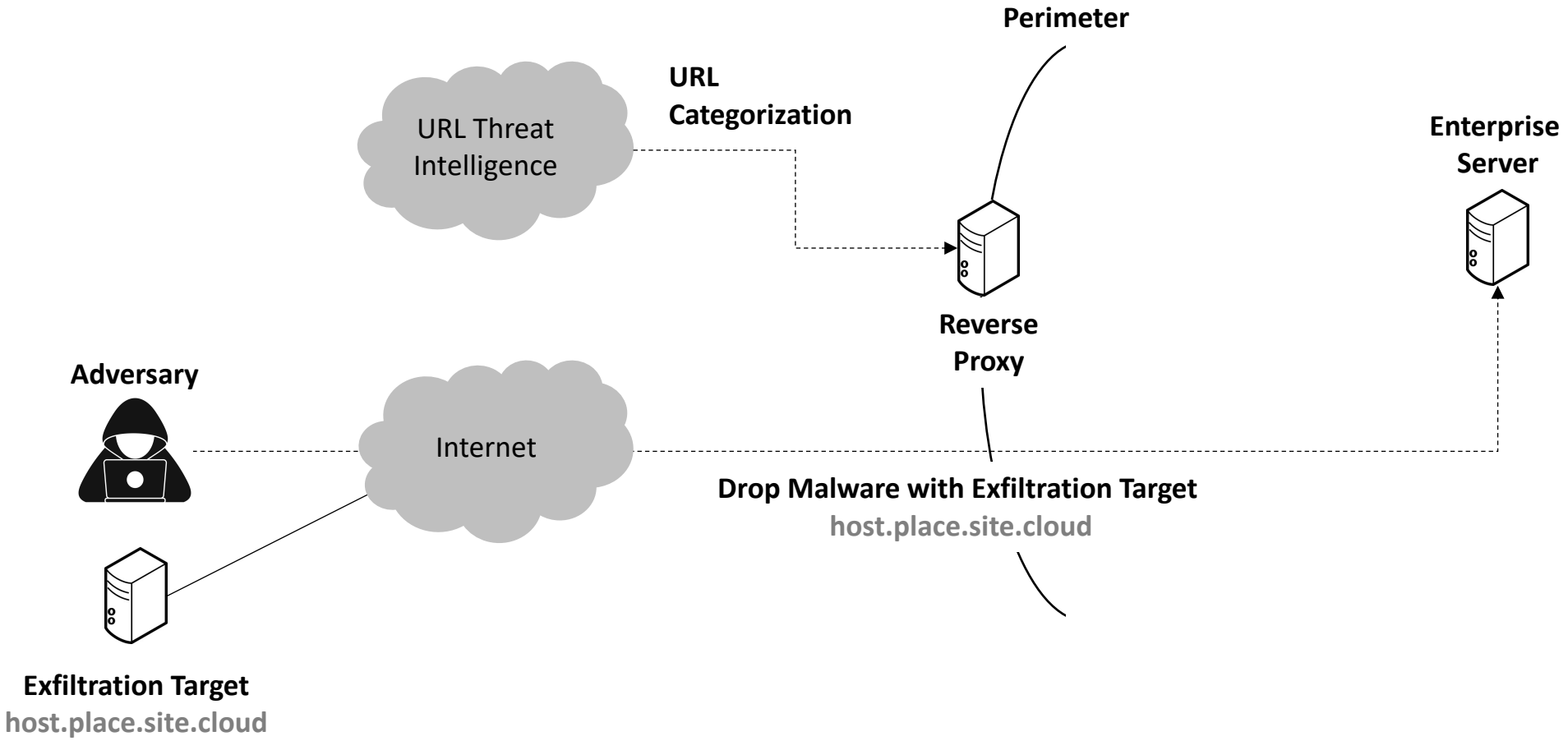
Week 12

Preventing Data Exfiltration with Reverse Proxy



Week 12

Preventing Data Exfiltration with Reverse Proxy



Week 12

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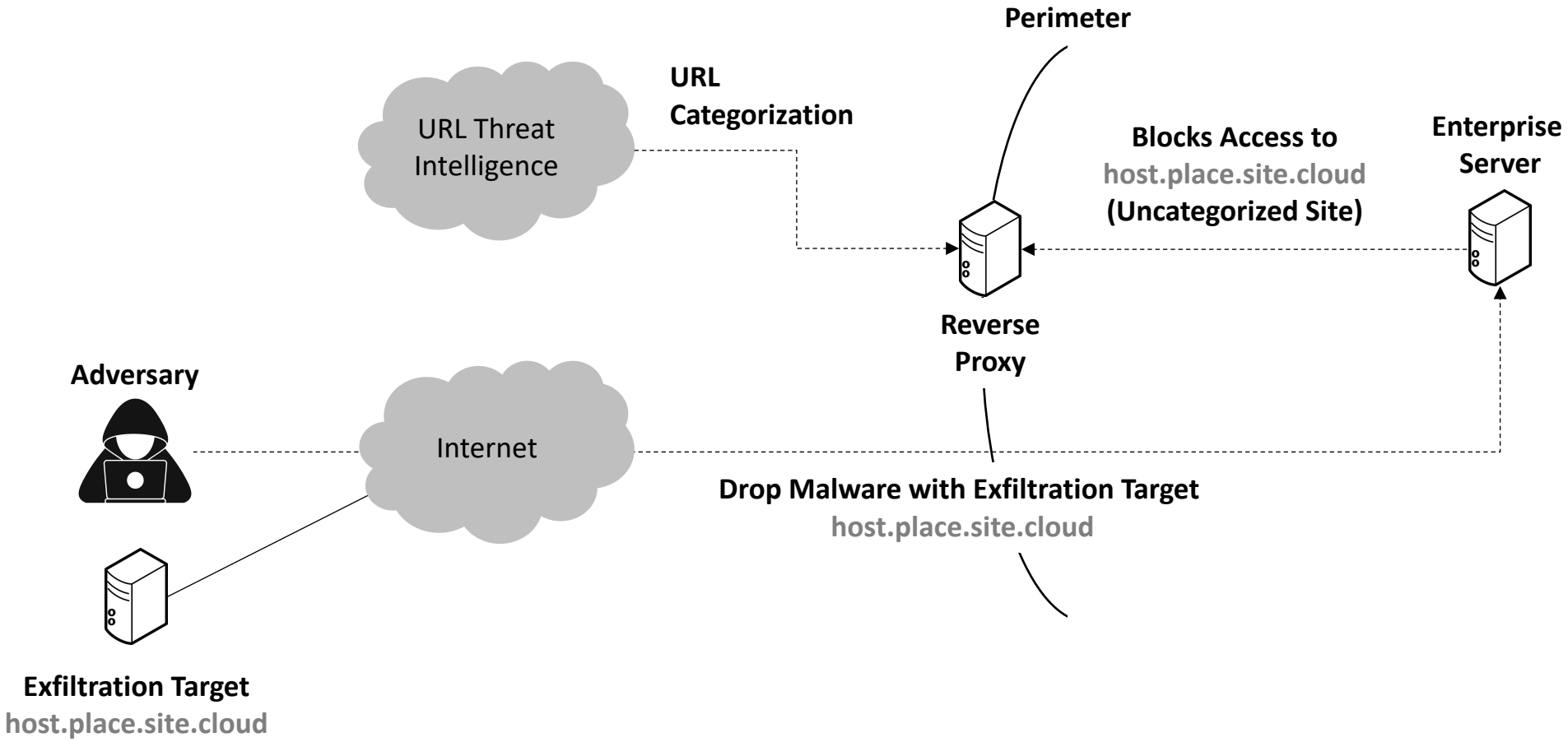
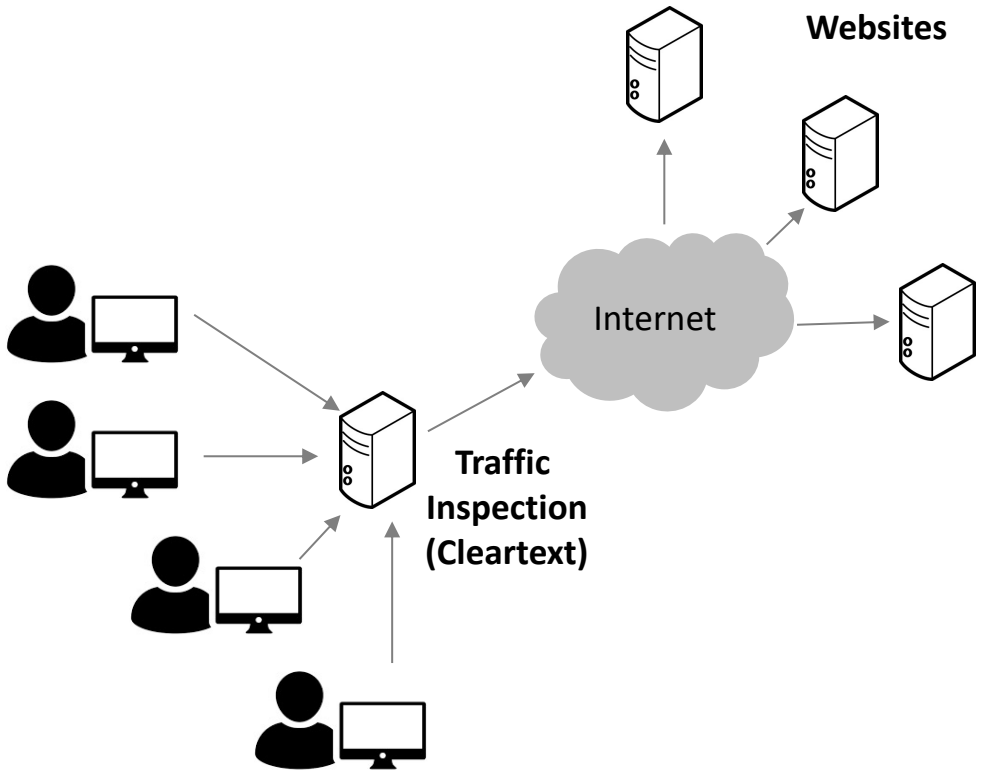


Week 12

Enterprise Traffic Inspection – First Generation

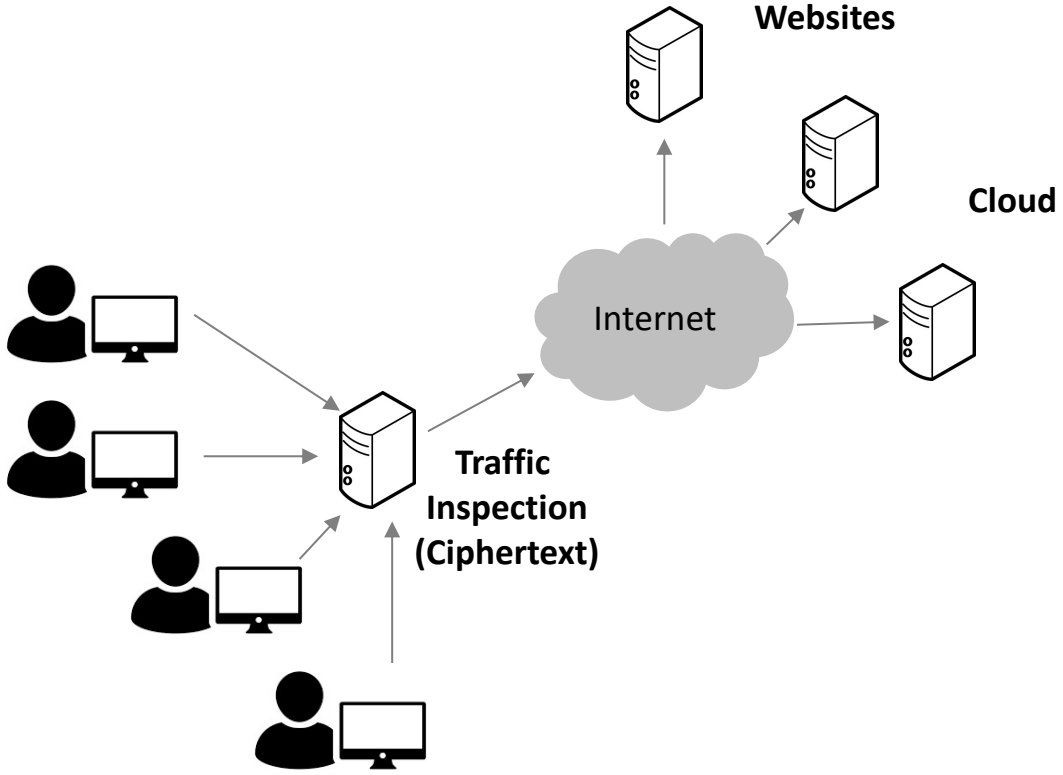


- **Traffic is mostly <u>non-encrypted</u>**
- **Traffic is mostly <u>web-based</u>**
- **Proxy inspection is straightforward**

Requirements for First-Generation SWG in context of Perimeter Architecture

Week 12

Enterprise Traffic Inspection – Next Generation



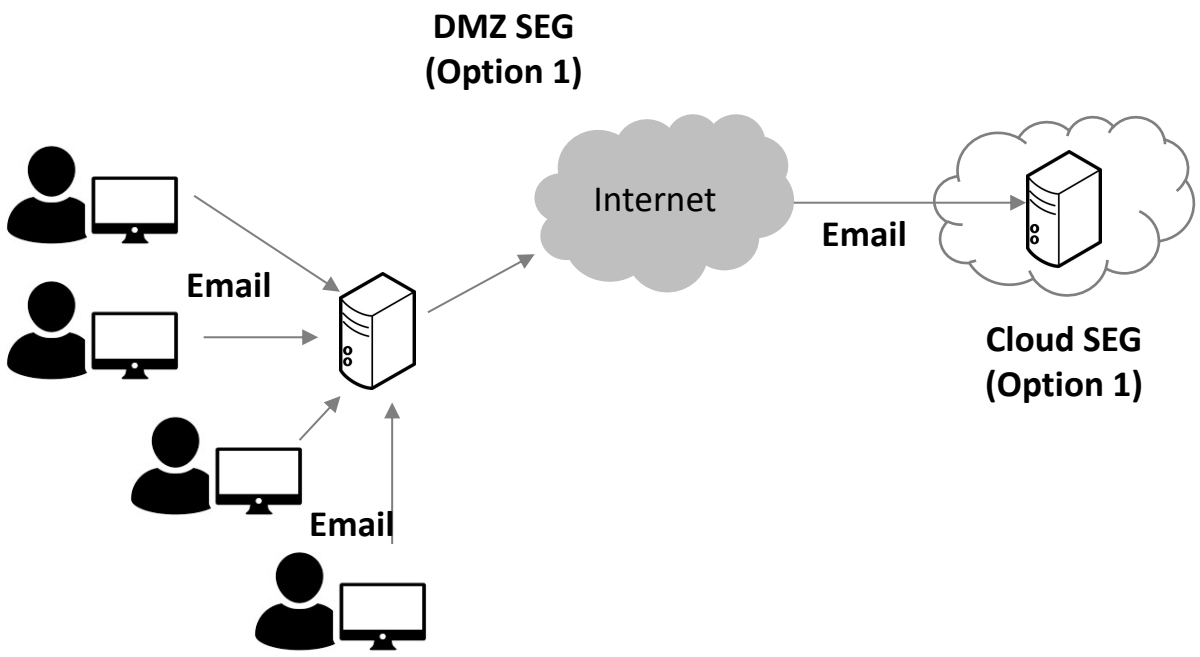
- **Traffic is mostly encrypted**
- **Traffic is >70% cloud-based**
- **Proxy inspection is more complex**

Requirements for Next-Generation SWG in context of SASE Architecture

What is a Secure Email Gateway (SEG)?

Week 12

Understanding Secure Email Gateway (SEG)



- **Email remains important in business**
- **SEGs filter attachments for malware**
- **Reduces SPAM, phishing, and viruses**

Requirements for Next-Generation SEG in context of SASE Architecture

Week 12

Fact: Too Many Malicious Emails Make it Through Commercial SEGs