Threat Modeling Cloud Applications

What You Don't Know Will Hurt You

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Agenda

- Cloud Terminology and Background
- Threat Modeling Basics
- Threat Modeling a Hybrid, IaaS Application
  - Canonical use case for S3
  - AWS Security Credentials
  - EC2 Security Groups
  - S3 Security Controls
  - Cloud Doomsday Scenarios and Attackers

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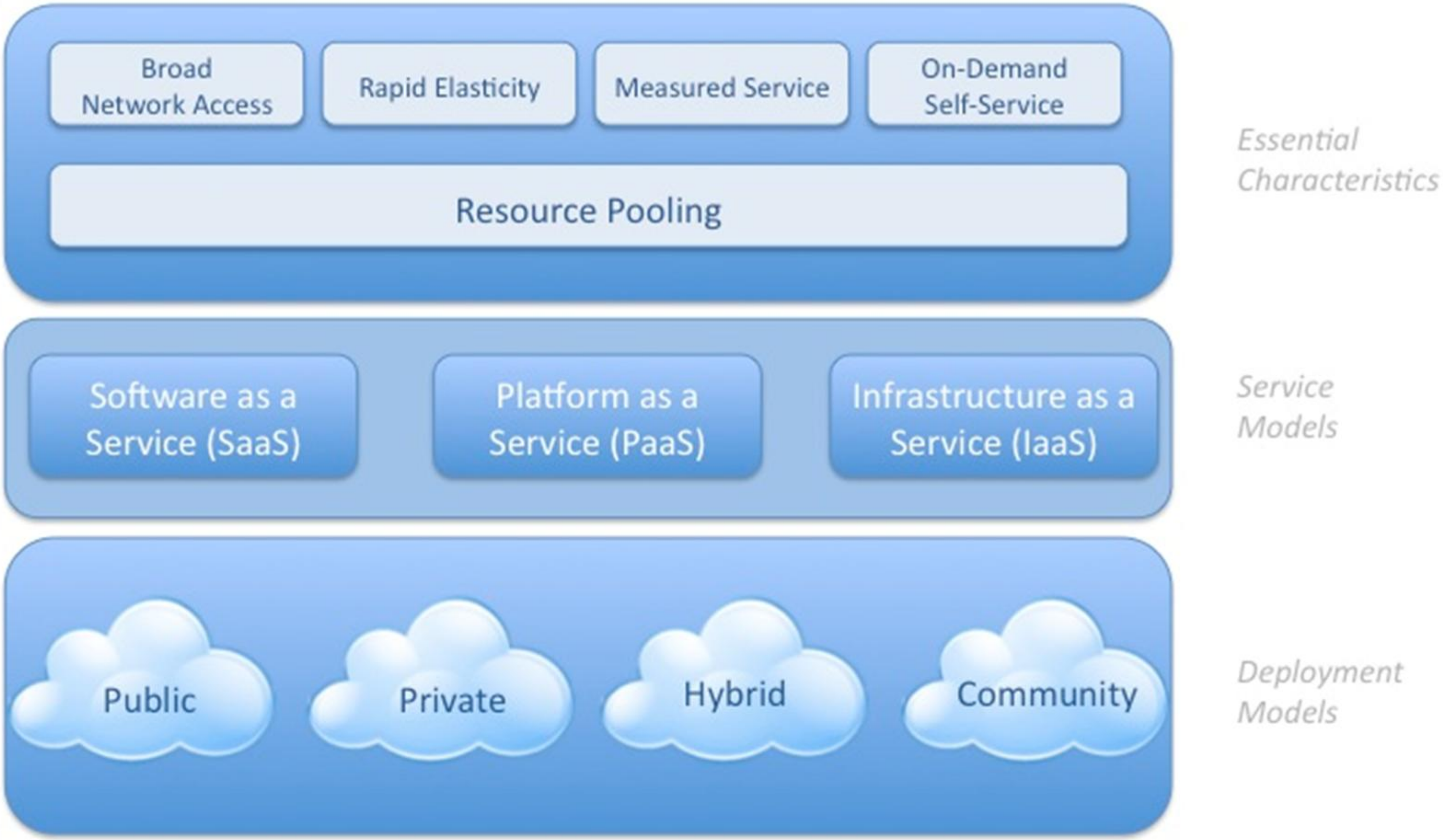
Terminology and Concepts

CLOUD COMPUTING

NIST Cloud Definition Framework

Visual Model Of NIST Working Definition Of Cloud Computing

http://www.csrc.nist.gov/groups/SNS/cloud-computing/index.html



Broad Network Access

Rapid Elasticity

Measured Service

On-Demand Self-Service

Resource Pooling

Essential Characteristics

Software as a Service (SaaS)

Platform as a Service (PaaS)

Infrastructure as a Service (IaaS)

Service Models

Public

Private

Hybrid

Community

Deployment Models

Cloud Applications Are Subtly Different

- Cloud platforms (PaaS and IaaS) change application design as designers leverage platform strengths
- Security for applications written on these platforms requires understanding the application architectures emerging from these designs and identifying their inherent weakness
- Threat Modeling is an effective method for understanding how/where/what security implications arise from cloud-based applications

Security Design Analysis

THREAT MODELING BASICS

What is a Threat Model

- A model of the a software system that depicts
  - The system structure: its components and the flow of control relationships
  - The assets (data and function) in the system
  - The security controls protecting the assets
- This model of the system is juxtaposed against
  - A list of potential "Doomsday Scenarios"
  - A list of potential attackers

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Use Threat Modeling to Identify…

- Where potential attackers exist relative to the architecture
- How attackers escalate privilege
  - …become more formidable
- Specific vectors of attack
- Components and assets needing additional protection

… Ties technical risk & business assets to application design;

…Ties attacks to role, privilege, and capability;

…Drives security analysis, testing.

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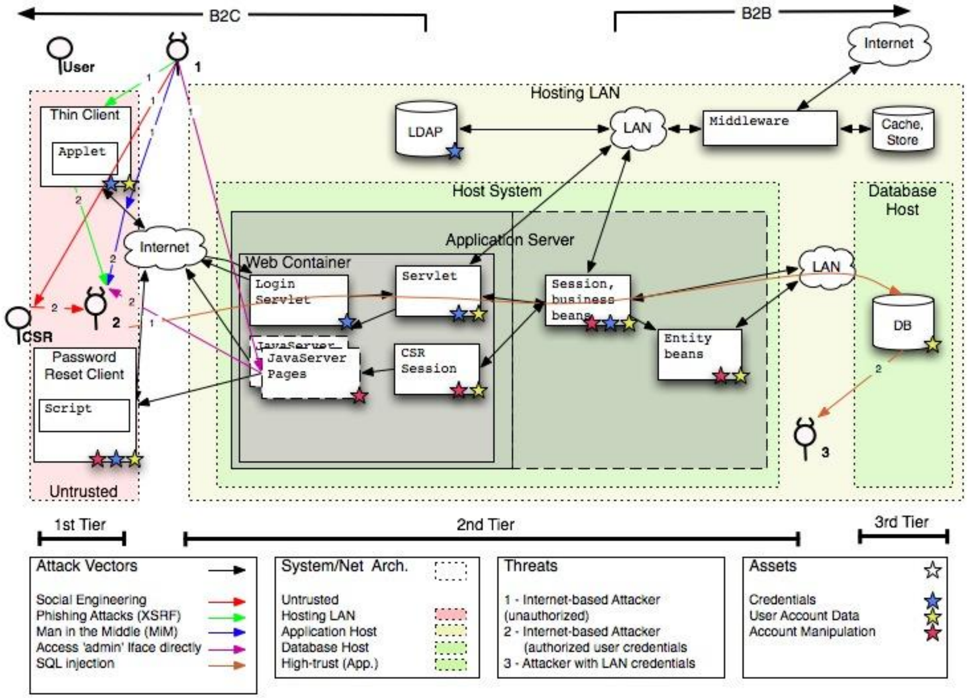
Elements of a Threat Model



- System Structure
- Assets
- Security Controls

- Doomsday scenarios
- Attackers

Threat Modeling – High-level process

1 Diagram the System Structure
2 Identify Assets and Security Controls

3 Enumerate Doomsday Scenarios
4 Identify Attackers

5 Derive misuse/abuse cases

6 Integrate with Risk Management
7 Iterate

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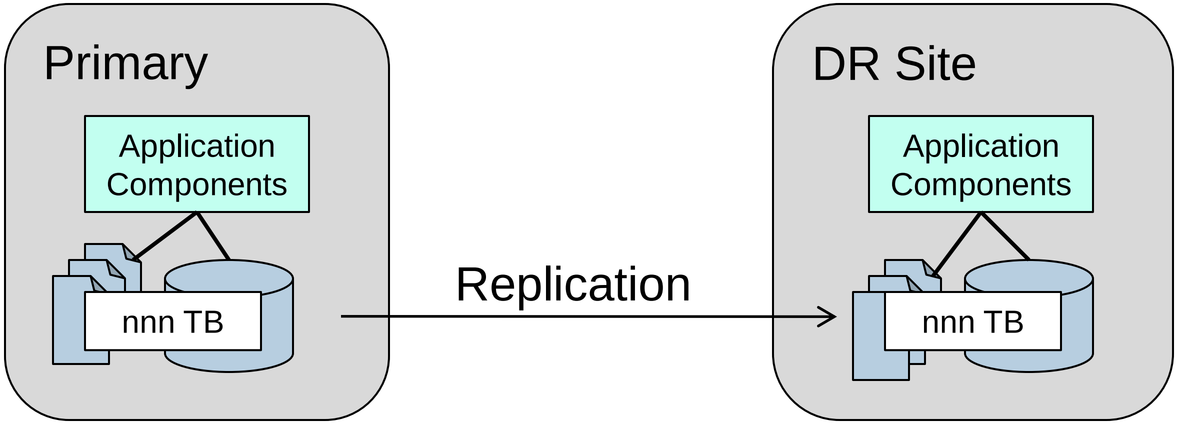
Use Case: Leveraging S3 Storage

A HYBRID, IAAS THREAT MODEL

Using S3 Storage Use Case

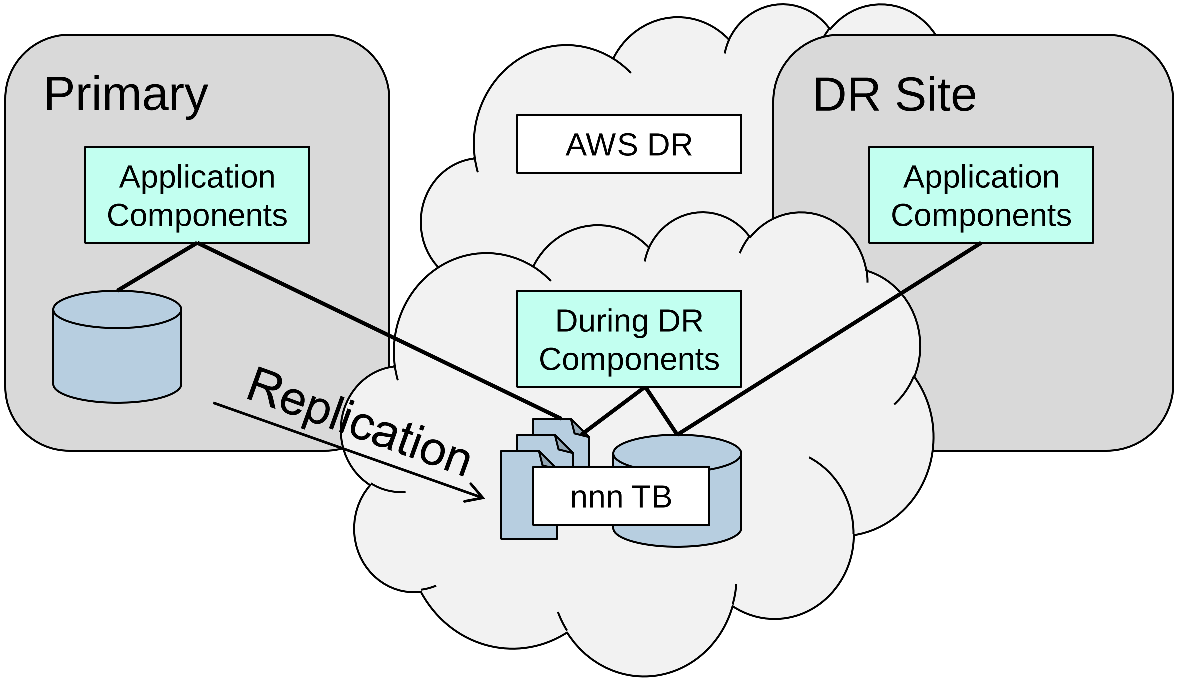
- Use Case:
  - Use S3 Storage for long term storage rather than self hosted storage
  - Data items are large and unstructured
  - Require immediate access
- S3 Advantages:
  - No up-front capital expenditure
  - Disaster Recovery is built into the S3 service
- Examples:
  - Medical Images
  - Large media files

Classic Architecture: Primary with DR Site



- The traditional solution is having a Disaster Recovery site that is a mirror of the primary site
- Data replication is needed for persistent data
  - Pay for un-used capacity even for DR

Cloud Architecture: Augment DR with AWS



- Provide immediate, limited DR capabilities
- Maintain data needing 99.99 availability in S3
- Pay only for the storage that's needed

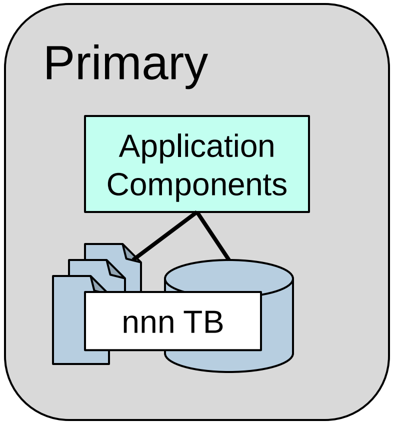
It's Really a New Application

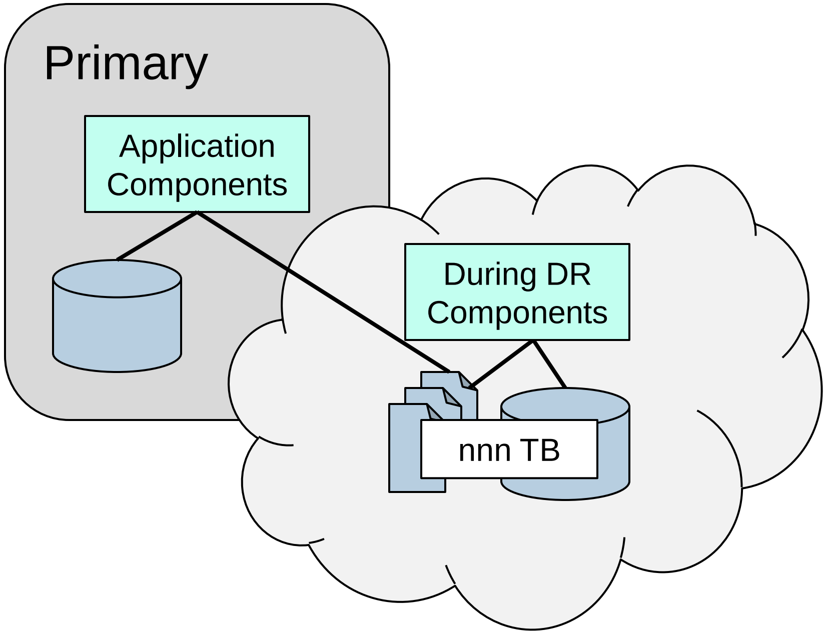
Original App

- Traditional enterprise application (assume n-Tier for this example)

New App

- Multiple applications interacting across two network zones





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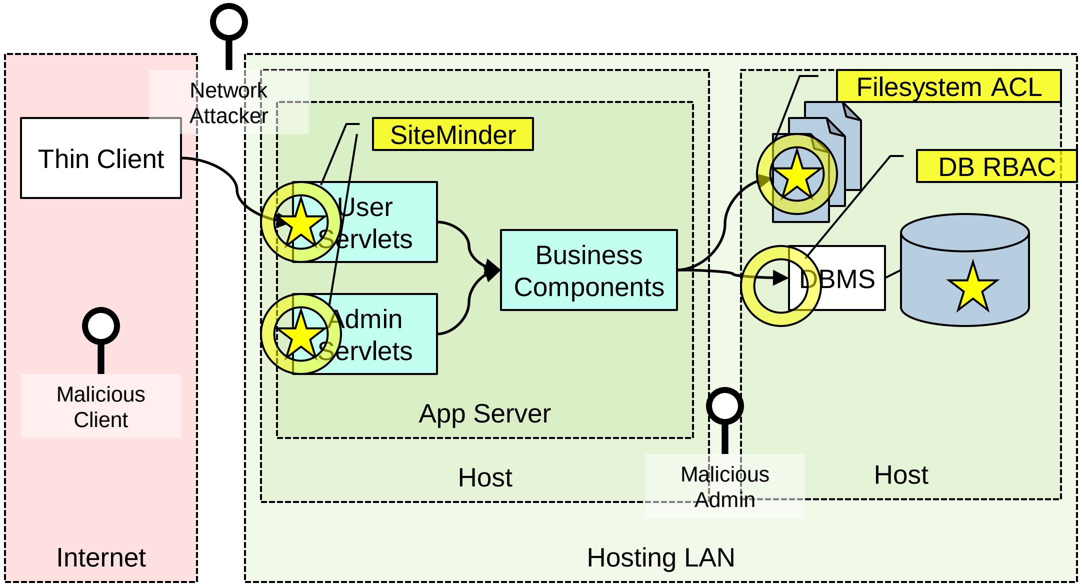
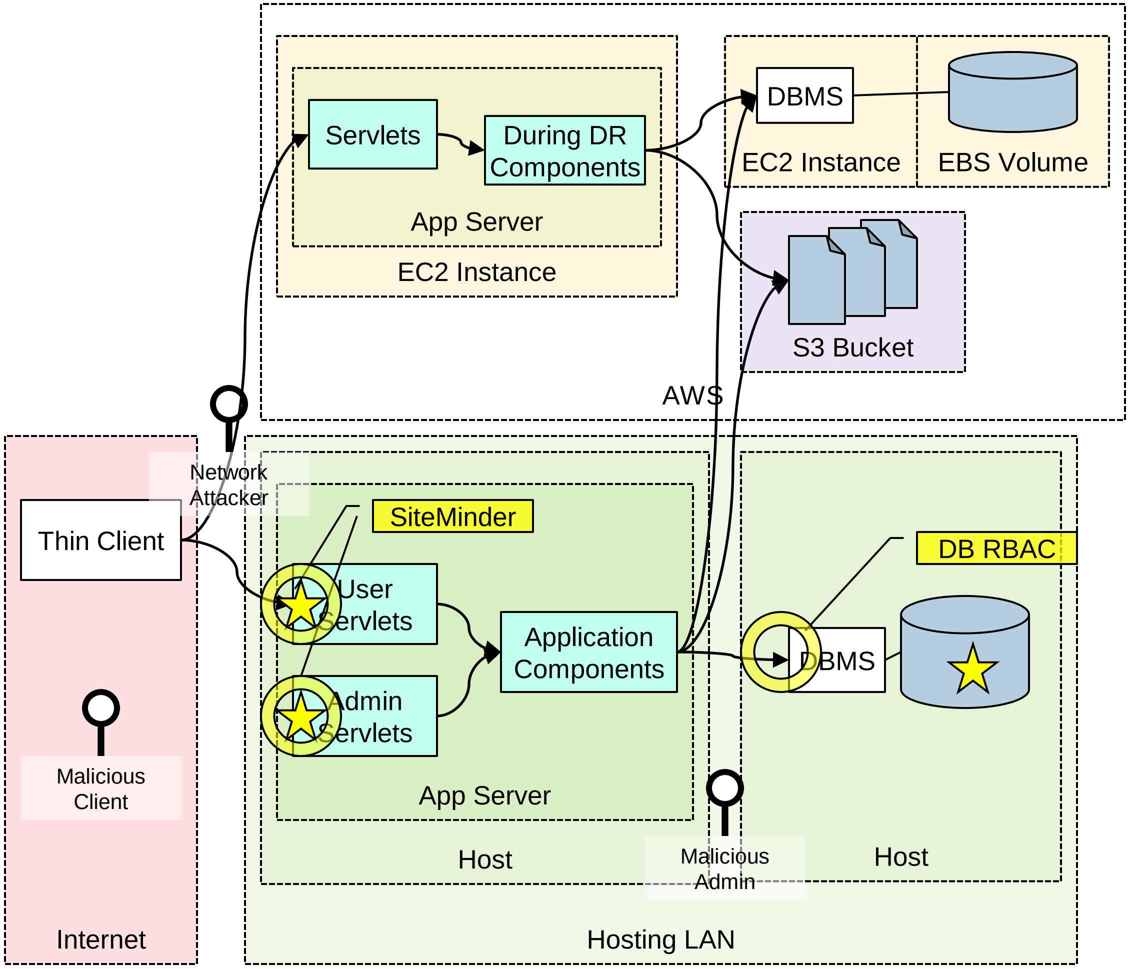
What Does Cloud Do to Our Threat Model?



- For an n-Tier application, the canonical OWASP-ish threat model applies

To the Cloud – New Application Structure



- System structure reflects the AWS framework

Who, What, When, Where, Why, How…

Who	What	How	Impact	Risk
<external>		Web-application …		
<external>		Multi-tenant res,…		
<internal> & <external>	Disclosure of PCI data from the database			
<external>	Gaining access to administrative functions			

- The Threat Modeling Process Builds a sparse matrix
- Start with the obvious and derive the interesting
  - Postulate what bad things can happen without knowing "How".
  - Postulate “Hows” without knowing “Whats”

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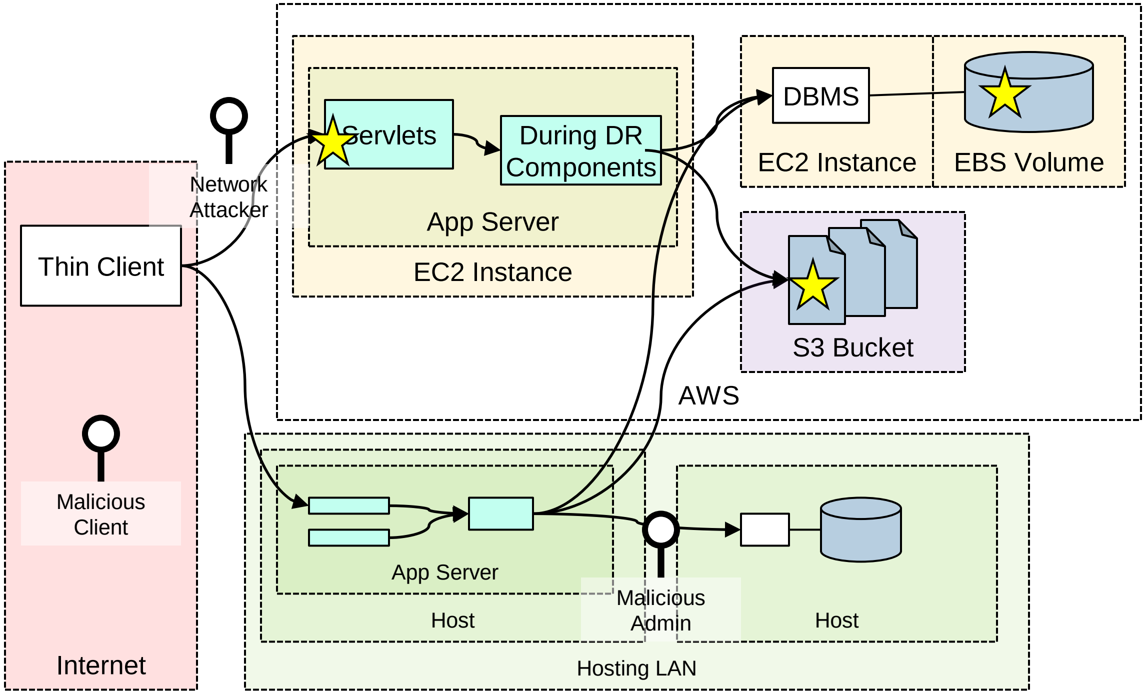
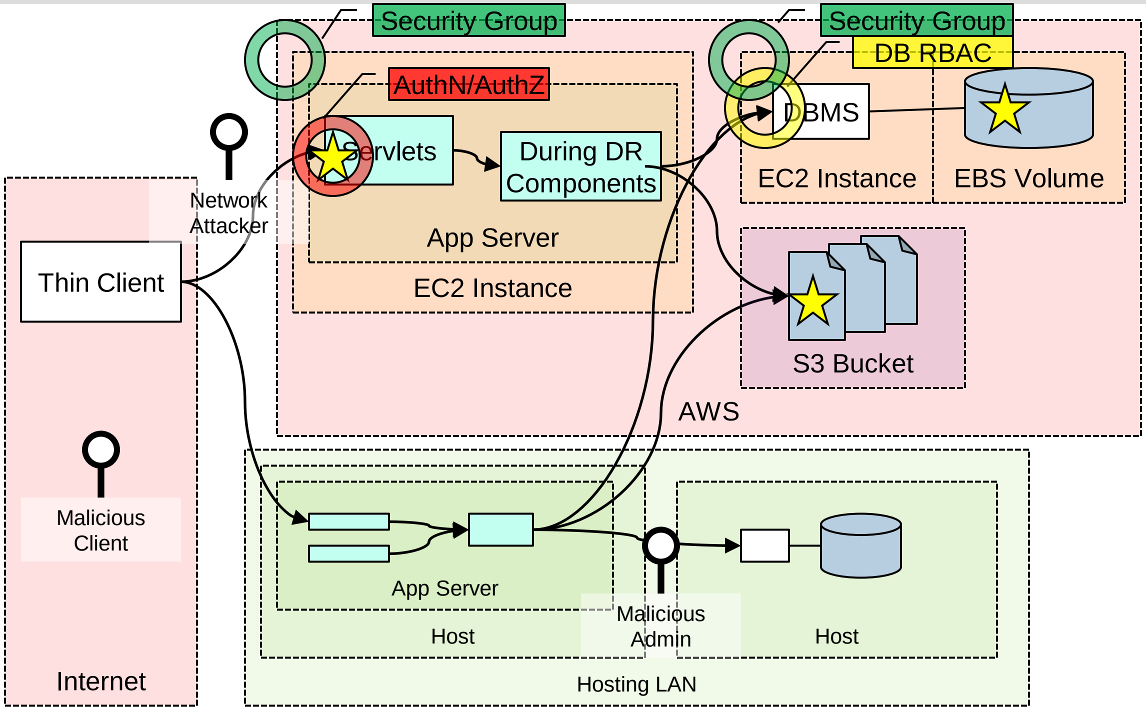
Identify the Assets and Security Controls



- Data assets move with the new design
- Additional functional assets exist with new features
- The AWS Security Controls are different

AWS Security Control Differences



- AWS and the Internet are equivalent network zones; user AWS Security Groups
- Enterprise infrastructure, e.g. SiteMinder, probably won't extend into AWS. What is the replacement?

EC2 Security Groups

- An EC2 Security Group is a set of ACCEPT firewall rules
  - Protocol: tcp, udp, icmp
  - Port Range
  - From:
    - Set of IP addresses (generally external hosts)
    - Security Group
- An EC2 instance can reside in one or more Security Groups
  - Use a Security Group is a "role"
  - Associate permissions with the Security Group ("role")

Integration with Enterprise Authentication

- Stand alone application mechanism means that the user store must be provisioned
- Integration with the enterprise user store implies
  - Connection from AWS back into the data center
  - Federated Identity mechanism
- The Threat Model depends on the actual control
- For this particular example, assume a SAML assertion passed through the browser

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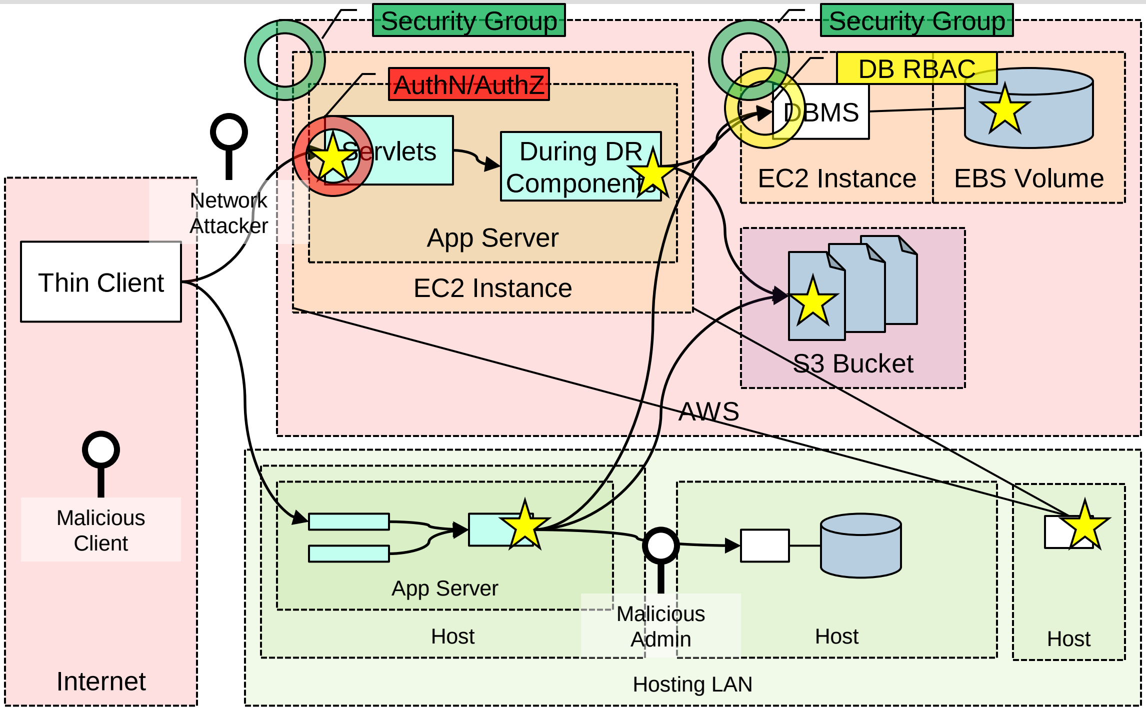
Elasticity Drives Change



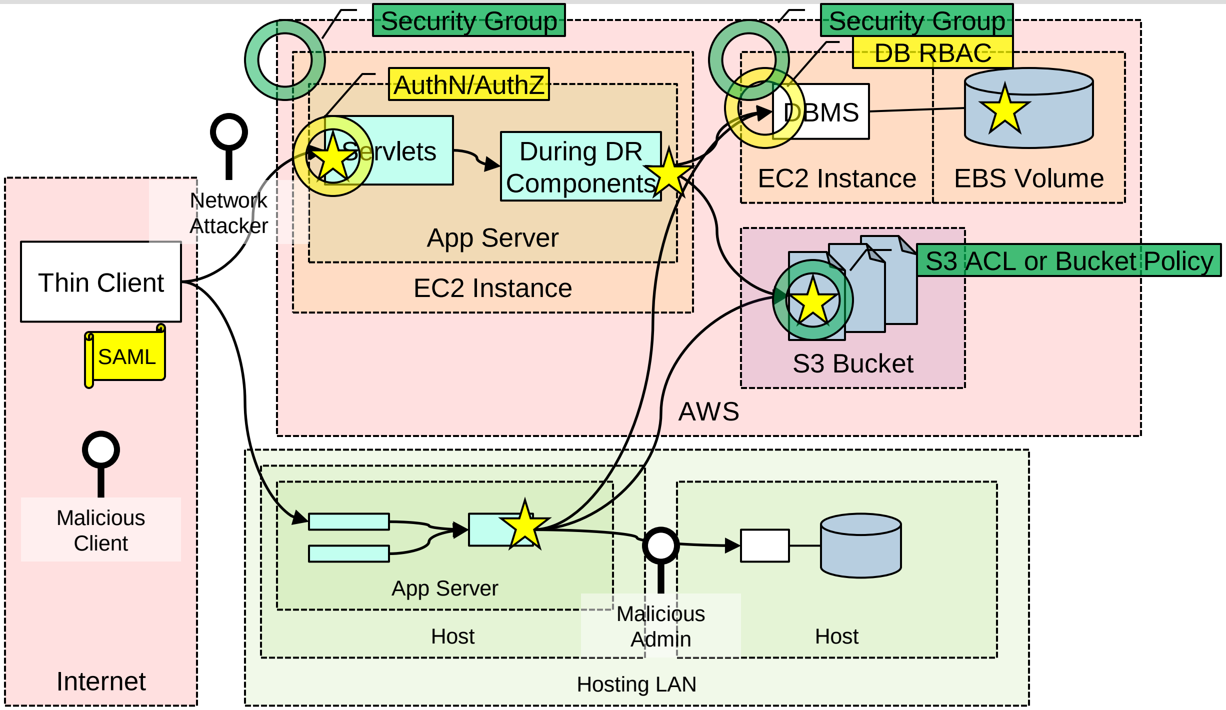
- Will the During DR site be up 100% of the time and costing the company for CPU time? No.
- An EC2 Key Pair is required to launch an instance
- AWS Access Keys are required to access S3

Most Common AWS Security Credentials

Type	Usage	Purpose
Sign-In Credentials	Enter email-address and password to access secure pages	Access AWS Security Credentials Page
User	Use AWS IAM API or interface	Authentication and Authorization for AWS Management Console and AWS Credentials
Access Keys * Access Key ID * Secret Access Key	**Access Key ID** identifies your AWS Account **Secret Access Key** is used to digitally sign the request	AWS SOAP and REST API requests
Key Pairs * Key pair name * Private Key * Public Key	The **Key pair name** is specified when an instance is launched. The Public-Private key is used for SSH root access.	Admin access to the running instance

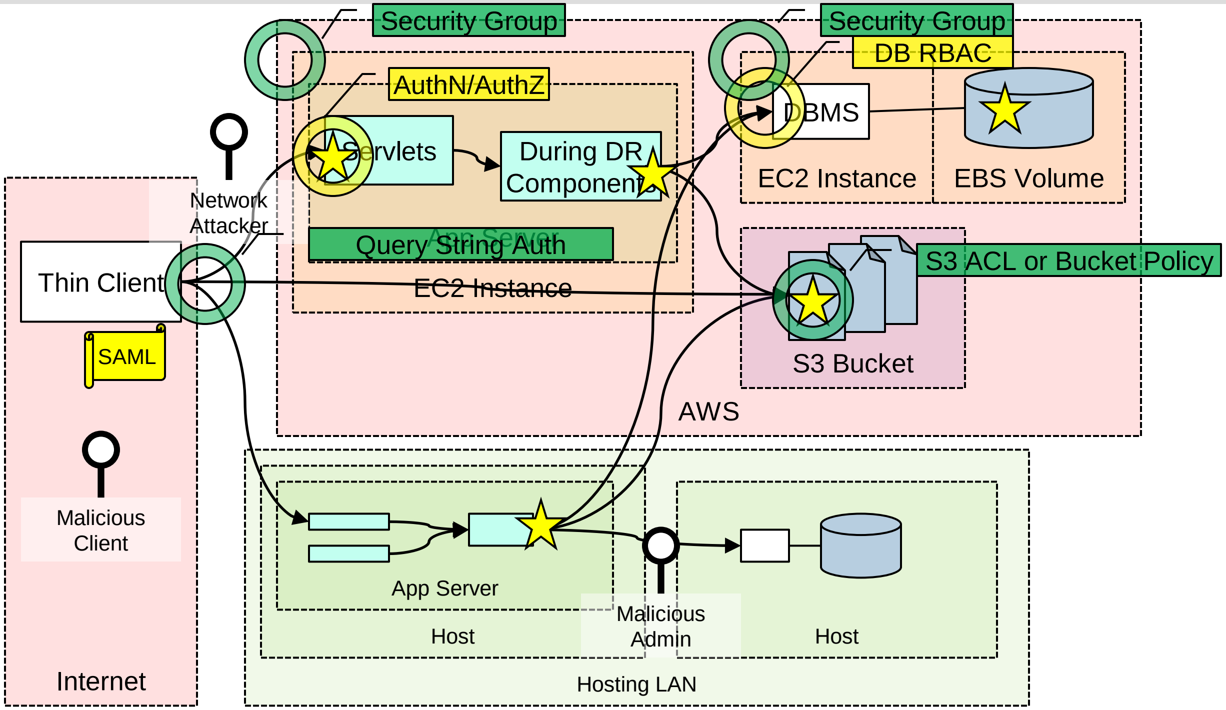
- Authorization is handled through the Access Policy Language

S3 ACLs and Bucket Policies



- Buckets and Objects have separate ACLs or Policies
- User identity is an Amazon S3 user/account
- Policies are more flexible and expressive
  - Define access rules for sets of object
  - Restrict by IP address, date, etc.

Using S3 Drives Design Changes



- Deliver content directly from S3 to the user
  - More efficient bandwidth usage
  - How do you handle S3 ACL or Bucket Policy?
- S3 provides for "query string authentication"
  - A time limited URL signed with your Access Key

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Cloud "Doomsday" Scenarios to Consider

Reprioritized or Changed by Cloud

- Malicious Insider
- Data In Transit
- Management interface compromise
- Infrastructure supply chain stability
- DDoS - direct attacks and attacks against other tenants

Unique to Cloud

- Cloud termination
- Changes in jurisdiction
- Subpoena and e-Discovery of another tenant
- Multi-tenant violation of isolation

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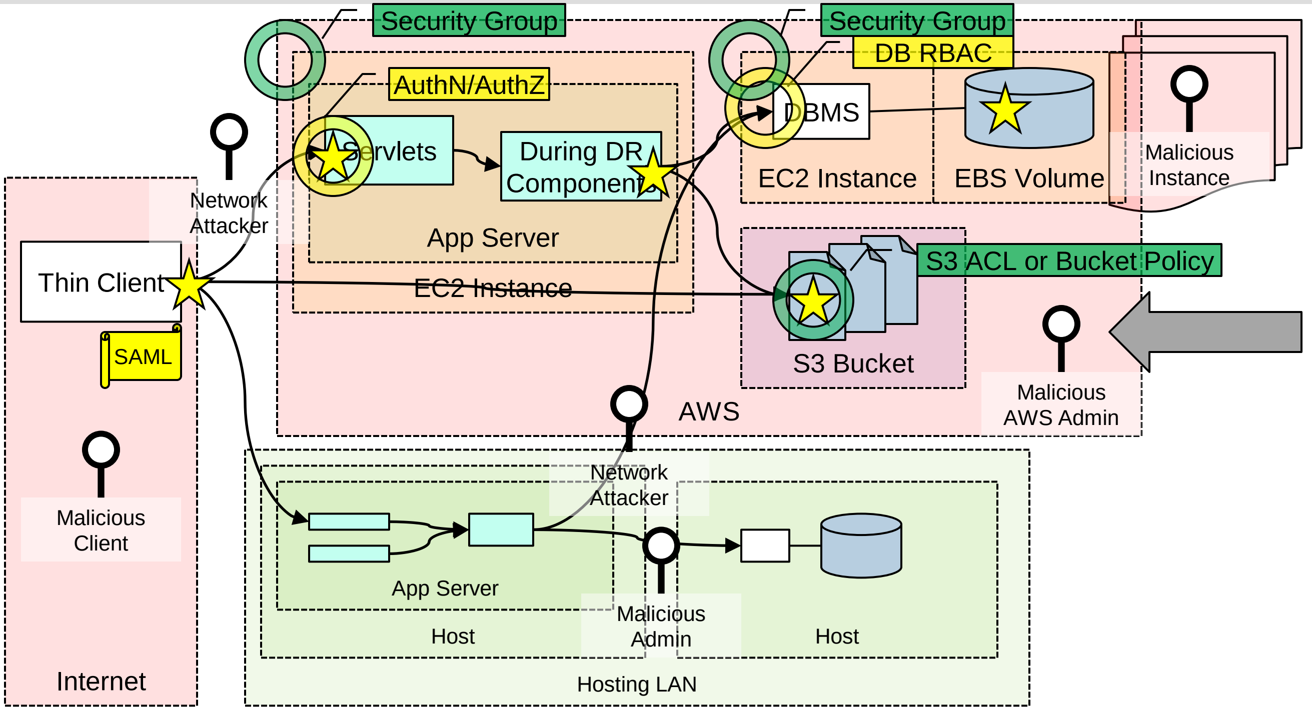
Additional Attackers



Is the AWS Admin someone to worry about?

- Additional attackers are network, AWS Admin and malicious instances
- The multi-document shape indicates multi-tenant

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Enumeration and Risk Management

Who	What	How	Impact	Risk
Hacker	Read all stored data Access a patients … …	Web-application …	Failure to certify with HIPAA audit Failure to certify with PCI audit	
Hacker	Cause system to ..	Known Tomcat,…	Failure to comply with customer SLA	
Admin & Hacker	Disclosure of PCI …	Access DB cred…	Failure to certify with PCI audit	
Hacker	Gaining access to…	Intercept AWS cred	Breach of all application assets	
Admin, Staff & Hacker	Viewing patient inf…	Direct access to…	Failure to certify with HIPAA audit	
			Failure to comply with customer SLA	
			Failure to certify with PCI audit	
			Failure to certify with HIPAA audit	

- Risk management must be done in conjunction with the business

Conclusion

- Cloud application security is platform specific
    - Application design will exploit platform features and constraints
    - Platform security controls are an important consideration in the threat model
- Threat Modeling is an effective way to move from cloud security FUD to a specific set of technical security requirements for applications

Thank you for your time

Questions?

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