Netflix’s Journey to the Cloud:
Lessons Learned from Netflix’s Migration to the Public Cloud

Jason Chan, Cloud Security Architect
In-Depth Seminars Track – D1

Agenda

- Background
- Key decisions
  - Why cloud?
  - Which cloud, and how?
- Cloud security @ Netflix
  - Basic approach
  - Implementation specifics
- Lessons learned

BACKGROUND

Netflix Inc.

With more than 27 million streaming members in the United States, Canada, Latin America, the United Kingdom and Ireland, Netflix, Inc. is the world's leading internet subscription service for enjoying movies and TV programs . . .

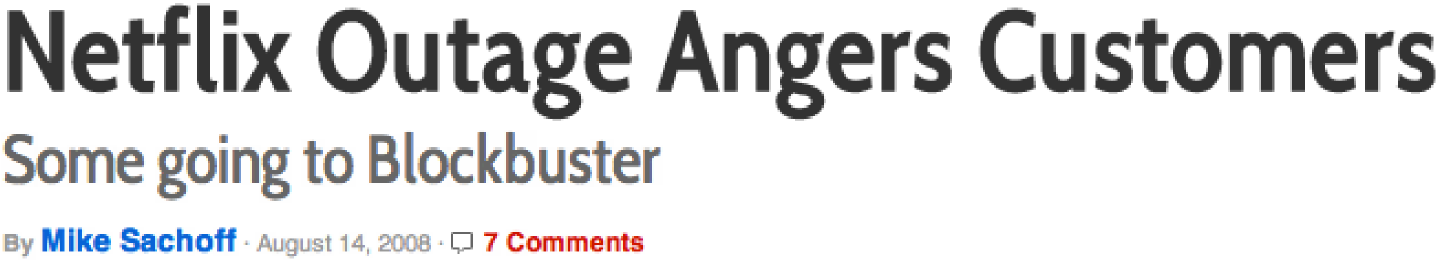
Source: http://ir.netflix.com

Me

- Cloud Security Architect @ Netflix
- Responsible for:
  - Cloud app, product, and operational security
- Previously:
  - Led security team at VMware
  - Previously, primarily security consulting at @stake, iSEC Partners
- ISACA
  - CISM, CISA

WHY CLOUD?

Outages and Availability



Netflix Outage Angers Customers

Some going to Blockbuster

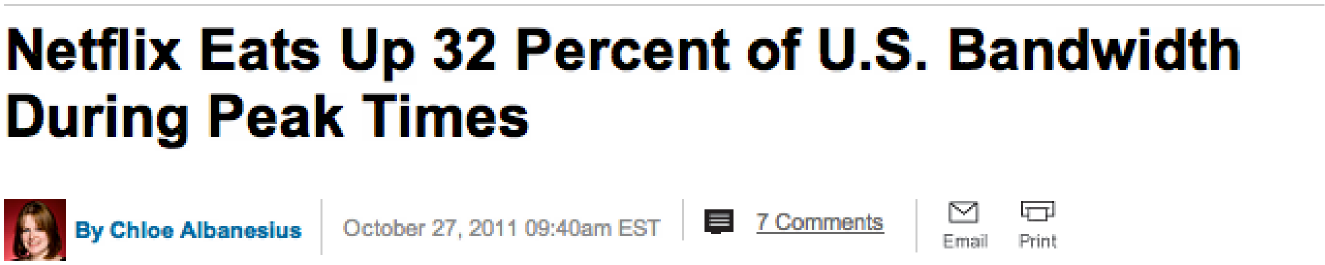
By Mike Sachoff · August 14, 2008 · 7 Comments

- Large-scale outage of data center systems
- Roughly 3 days of DVD shipping outage
- During initial stages of streaming service

http://www.webpronews.com/netflix-outage-angers-customers-2008-08
http://www.reuters.com/article/2008/08/15/netflix-outage-idUSN1539639720080815

Streaming Service

- Goal is a global streaming service
  - – DVD is US only
- Availability becomes much more critical
  - – DVD involves a more predictable pattern
- Capacity and usage

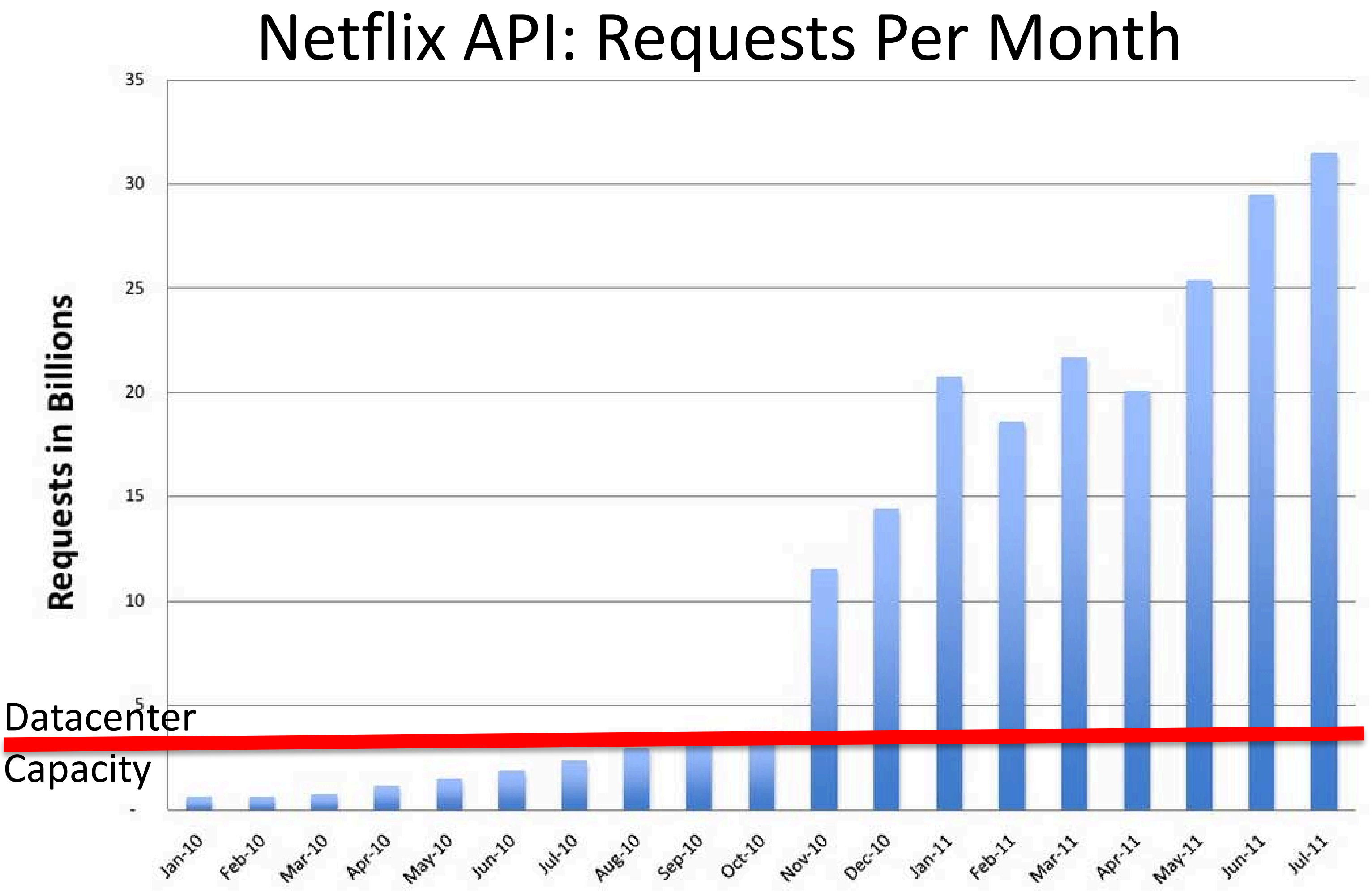


Netflix Eats Up 32 Percent of U.S. Bandwidth During Peak Times

By Chloe Albanesius | October 27, 2011 09:40am EST | 7 Comments | Email | Print

http://www.pcmag.com/article2/0,2817,2395372,00.asp

Outgrowing the Data Center


Netflix API: Requests Per Month

Datacenter Capacity

Seven Aspects of Netflix Culture

- Values are what we value
- High Performance
- **Freedom & Responsibility**
- **Context, not Control**
- **Highly Aligned, Loosely Coupled**
- Pay Top of Market
- Promotions & Development

http://www.slideshare.net/netflix

Get stuck with wrong config

Wait

Wait

File tickets

Ask permission

Wait

Wait

Things We Don't Do

Wait

Run out of space/power

Plan capacity in advance

Have meetings with IT

Wait

Why Cloud? A Summary

- Needed
  - Better availability
  - Support a fast-growing, global service
  - Technical agility to match company culture
- Textbook use case for cloud

WHICH CLOUD?

Public cloud – why?

- We want to use clouds,
  we don't have time to build them
  - Public cloud for agility and scale
  - Undifferentiated heavy lifting (Bezos, Vogels)
- Netflix choice was AWS with our own platform and tools
  - Unique platform requirements and extreme scale, agility and flexibility

AWS and Alternatives

- Public Cloud Alternatives to AWS
  - Far fewer features, much smaller scale
  - Less mature APIs, many variants of APIs
  - Some have additional features or performance
- Private Cloud Alternatives
  - Often harder to build and run than you think
  - Much higher costs w/o scale and multi-tenancy
  - Often driven by IT-Ops needs rather than developers

What about other PaaS?

- CloudFoundry – Open Source by VMware
  - Developer-friendly, easy to get started
  - Missing scale and some enterprise features
- Rightscale
  - Widely used to abstract away from AWS
  - Creates its own lock-in problem
- AWS is growing into this space
  - We didn’t want a vendor between us and AWS
  - We wanted to build a thin PaaS, that gets thinner

HOW?

Netflix PaaS Principles

- Maximum functionality
  - Developer productivity and agility
- Leverage as much of AWS as possible
  - AWS is making huge investments in features/scale
- Interfaces that isolate apps from AWS
  - Avoid lock-in to specific AWS API details
- Portability is a long term goal
  - Gets easier as other vendors catch up with AWS

Build a global PaaS on AWS IaaS

- Supports all AWS regions and availability zones
- Supports multiple AWS accounts
- One-click deployment and balancing across three data centers
- Cross-region and account data replication and archive
- Dynamic and fine-grained security
- Automatic scaling to thousands of instances
- Monitoring for millions of metrics
- I18n, L10n, geo IP routing

Organization Rearchitecture

- Cloud is run by developer organization
  - Our IT department is the AWS API
  - We have no IT staff working on cloud (they do corp IT)
- Cloud capacity is 10x bigger than Datacenter
  - Datacenter oriented IT staffing is flat
  - We have moved a few people out of IT to write code
- Traditional IT Roles are going away
  - Less need for SA, DBA, Storage, Network admins
  - Developers deploy and run what they wrote in production

Cloud and Platform Engineering

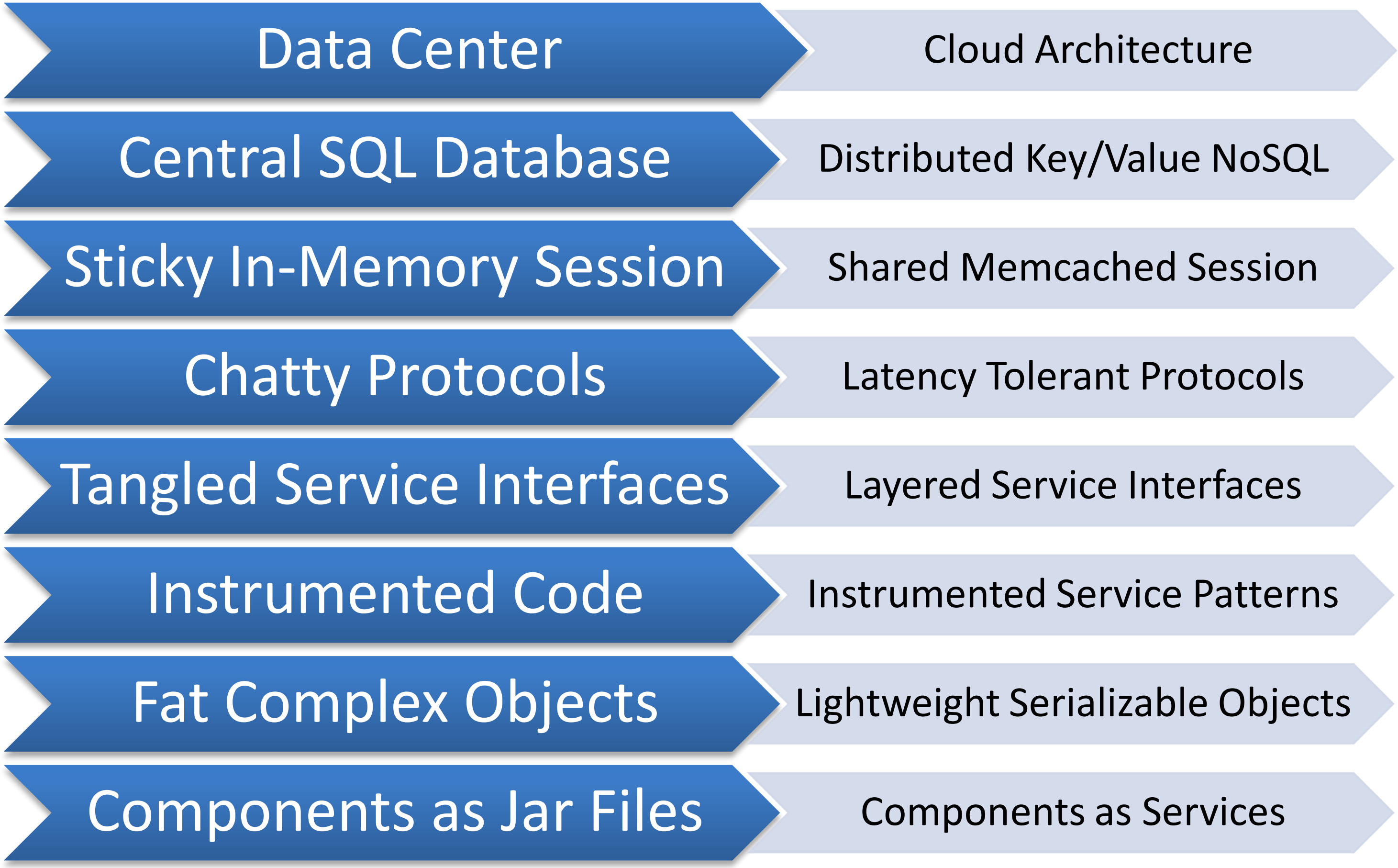
- Build an engineering organization focused on facilitating and optimizing cloud usage

Engineering Tools	• Orchestration, build and deployment
Cloud Solutions	• Monitoring, consulting, Simian Army
CORE	• 24/7 site reliability
Platform Engineering	• Core shared components and libraries
Security	• Application, engineering, and operational
Cloud Persistence Engineering	• Cassandra, SDB, RDS, S3
Cloud Performance	• Testing, optimization, cost
Cloud Architecture	• Overall design patterns

Netflix Cloud Camp

- For developers – one day orientation
- ½ presentations, ½ hands-on
- Build “Hello World” using NFLX PaaS
- Build and security integration, monitoring
- Cassandra read/writes

Service Rearchitecture



Data Center — Cloud Architecture

Central SQL Database — Distributed Key/Value NoSQL

Sticky In-Memory Session — Shared Memcached Session

Chatty Protocols — Latency Tolerant Protocols

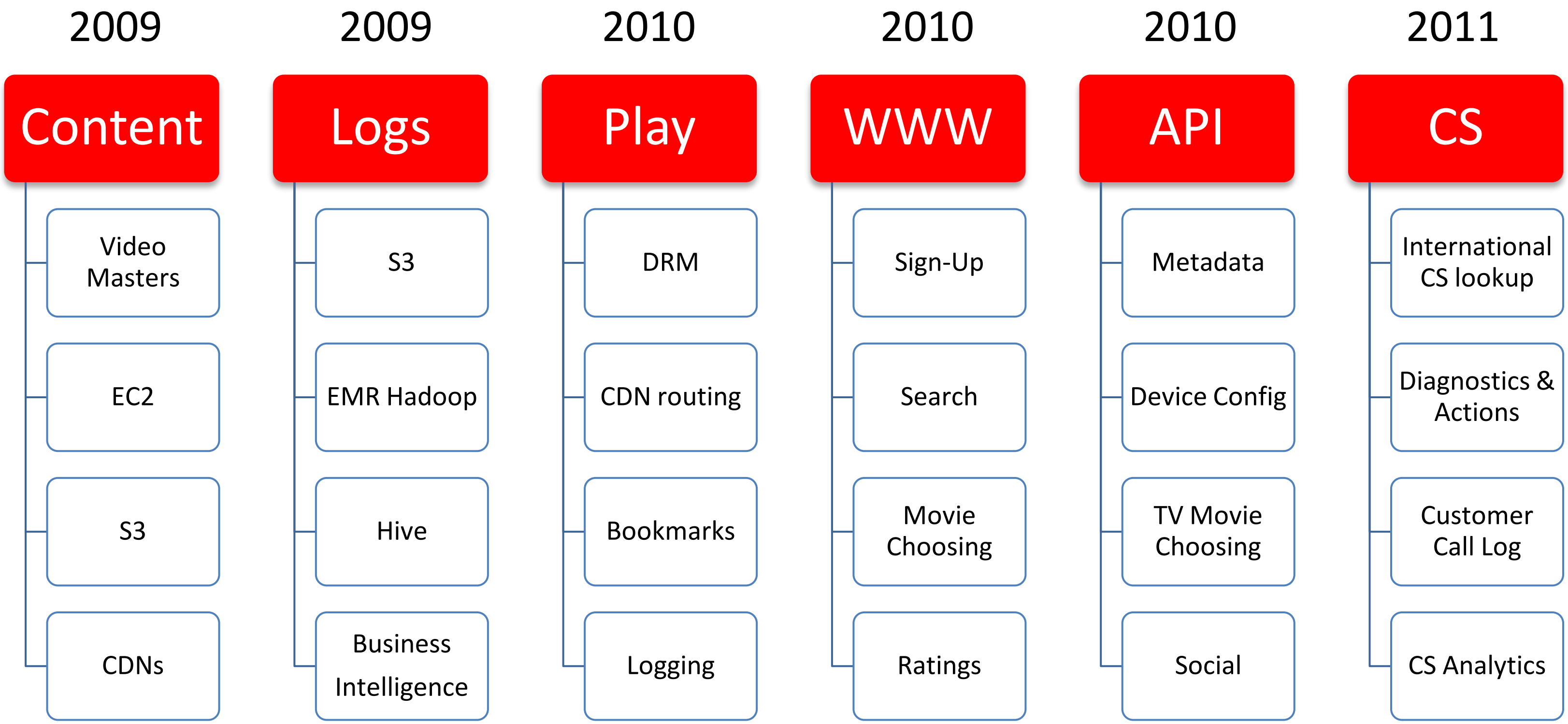
Tangled Service Interfaces — Layered Service Interfaces

Instrumented Code — Instrumented Service Patterns

Fat Complex Objects — Lightweight Serializable Objects

Components as Jar Files — Components as Services

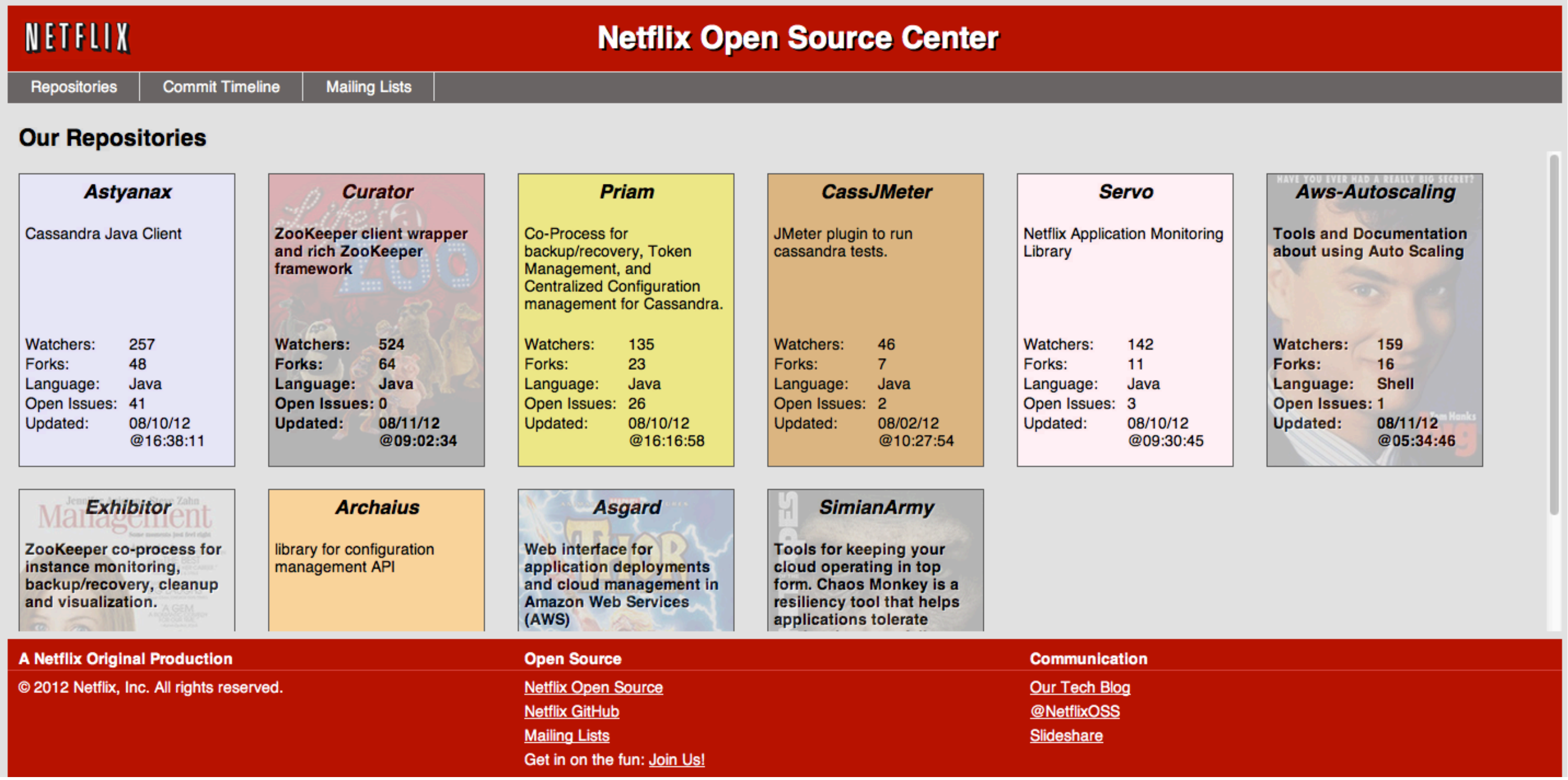
Progression: Netflix Deployed on AWS



2009	2009	2010	2010	2010	2011
Content	Logs	Play	WWW	API	CS
Video Masters	S3	DRM	Sign-Up	Metadata	International CS lookup
EC2	EMR Hadoop	CDN routing	Search	Device Config	Diagnostics & Actions
S3	Hive	Bookmarks	Movie Choosing	TV Movie Choosing	Customer Call Log
CDNs	Business Intelligence	Logging	Ratings	Social	CS Analytics

Netflix OSS

- Open source components to drive innovation



NETFLIX

Netflix Open Source Center

Repositories | Commit Timeline | Mailing Lists

Our Repositories

Astyanax

Cassandra Java Client

Watchers: 257
Forks: 48
Language: Java
Open Issues: 41
Updated: 08/10/12 @16:38:11

Curator

ZooKeeper client wrapper and rich ZooKeeper framework

Watchers: 524
Forks: 64
Language: Java
Open Issues: 0
Updated: 08/11/12 @09:02:34

Priam

Co-Process for backup/recovery, Token Management, and Centralized Configuration management for Cassandra.

Watchers: 135
Forks: 23
Language: Java
Open Issues: 26
Updated: 08/10/12 @16:16:58

CassJMeter

JMeter plugin to run cassandra tests.

Watchers: 46
Forks: 7
Language: Java
Open Issues: 2
Updated: 08/02/12 @10:27:54

Servo

Netflix Application Monitoring Library

Watchers: 142
Forks: 11
Language: Java
Open Issues: 3
Updated: 08/10/12 @09:30:45

Aws-Autoscaling

Tools and Documentation about using Auto Scaling

Watchers: 159
Forks: 16
Language: Shell
Open Issues: 1
Updated: 08/11/12 @05:34:46

Exhibitor

ZooKeeper co-process for instance monitoring, backup/recovery, cleanup and visualization.

Archaius

library for configuration management API

Asgard

Web interface for application deployments and cloud management in Amazon Web Services (AWS)

SimianArmy

Tools for keeping your cloud operating in top form. Chaos Monkey is a resiliency tool that helps applications tolerate

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Open Source

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Our Tech Blog
@NetflixOSS
Slideshare

CLOUD SECURITY @ NETFLIX: BASIC APPROACH

First, some notes on scale

- Thousands of:
  - Instances
- Hundreds of:
  - Developers
  - Applications
- Dozens of:
  - Engineering teams
  - Deployments per day
- Zero of:
  - Architectural review committees
  - Change review boards

Word Association

Cloud

- Freedom
- Agility
- Self-service
- Scale
- Automation

Security

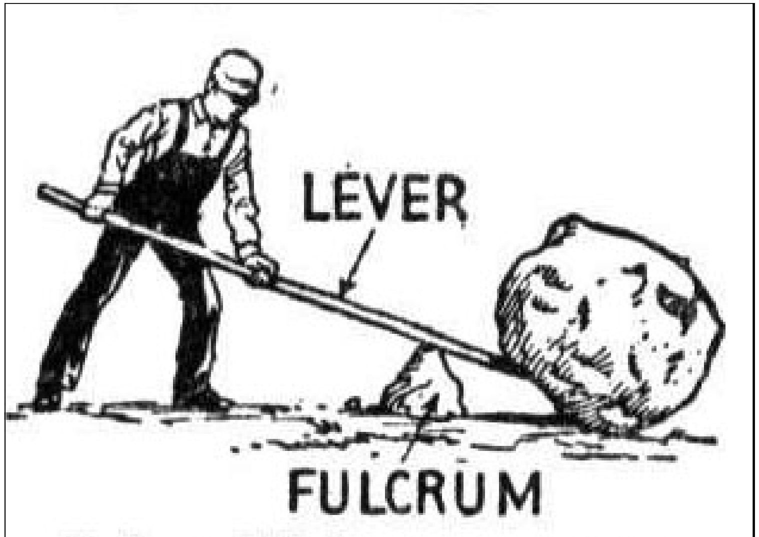
- Pain
- Gatekeeper
- Standards
- Control
- Centralized

Risk-Based Approach

- Understand organization’s risk appetite
- Not everything is equal value
- Understand what’s important and prioritize appropriately

Integrate with and Leverage Tooling

- Build and deployment pipeline is a key point for security integration
- Security uses the same tools as developers
- Think integration vs. separation



Man lifting a stone with a lever

Make Doing the Right Thing Easy

- Developers are lazy
- Operational model incentivizes robust code
- Sensible defaults
- Libraries for common, but difficult, security tasks
- Publish and evangelize patterns

Embrace Self-Service, with Exceptions

- IMHO, self-service is the breakthrough characteristic of the cloud
- Put security configuration in the hands of end-users, with some exceptions:
  - SSL certificate management
  - Some firewall rules
  - User and permissions management

CLOUD SECURITY @ NETFLIX: PROGRAMMABLE INFRASTRUCTURE AND THE SECURITY MONKEY

Common Challenges for Security Engineers

- Lots of data from different sources, in different formats
- Too many administrative interfaces and disconnected systems
- **Too few options for scalable automation**

How do you . . .

- Add a user account?
- Inventory systems?
- Change a firewall config?
- Snapshot a drive for forensic analysis?
- Disable a multi-factor authentication token?

- CreateUser()
- DescribeInstances()
- AuthorizeSecurityGroupIngress()
- CreateSnapshot()
- DeactivateMFADevice()

Security Monkey

- Designed to support culture of freedom and responsibility
- Centralized framework for cloud security monitoring and analysis
- Certificate and cipher monitoring
- Firewall configuration checks and cleanup (with Janitor Monkey)
- User/group/policy monitoring

CLOUD SECURITY @ NETFLIX: MODEL-DRIVEN ARCHITECTURE

Data Center Patterns

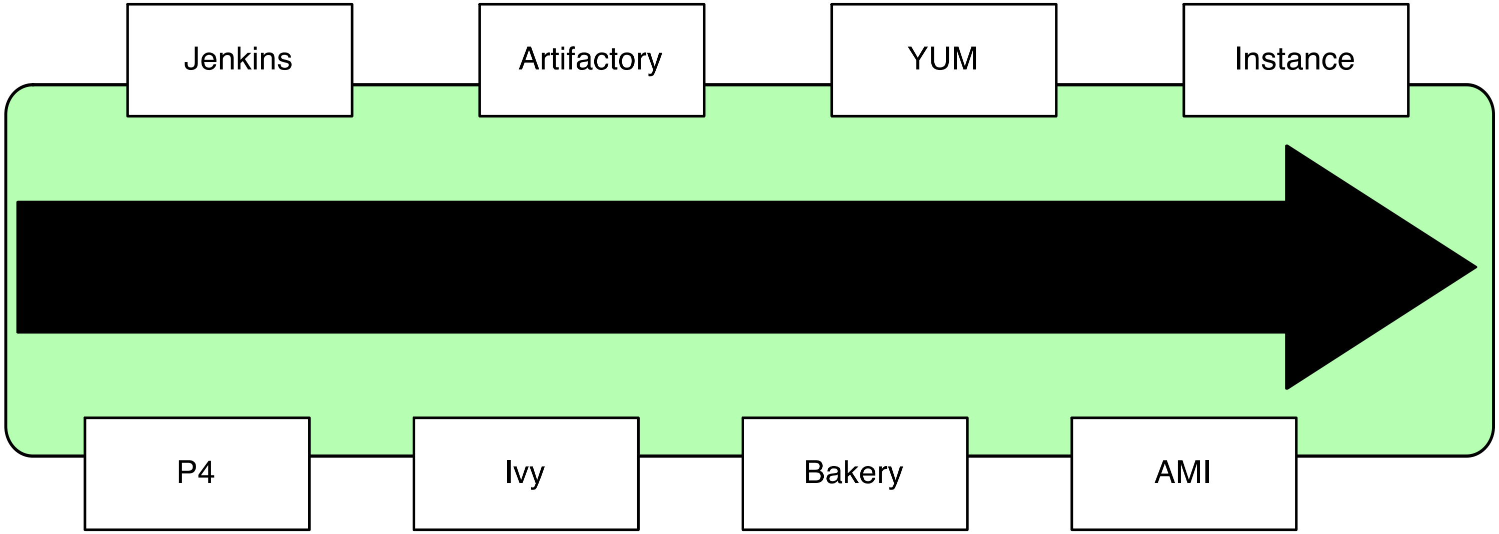
- Long-lived, non-elastic systems
- Push code and config to running systems
- Tech-specific deployment processes
- ‘Snowflake phenomenon’
- Difficult to sync or reproduce environments (e.g. test and prod)

Cloud Patterns

- Ephemeral nodes
- Dynamic scaling
- Hardware is abstracted
- Programmable infrastructure
- Cloud primitives support common deployment patterns

Netflix Build and Deploy

http://techblog.netflix.com/2011/08/building-with-legos.html



Jenkins

Artifactory

YUM

Instance

P4

Ivy

Bakery

AMI

Autoscaling Deployments

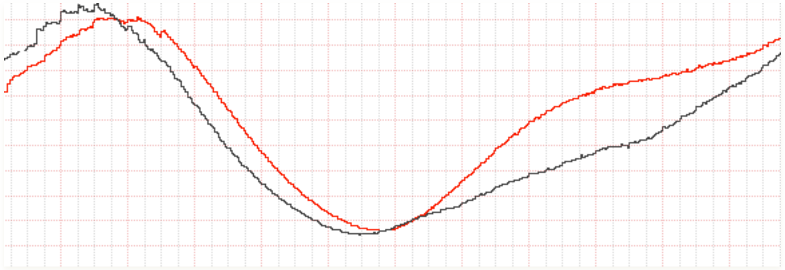
Baked AMI + Launch Config + Autoscaling Group

- Base Linux
- App code
- App dependencies
- App-specific config

- Instance type
- Security group config

- Target data centers
- Cluster min/max

Netflix Web App X



Autoscaling Results and Ramifications

- Goals:
  - # of systems matches load requirements
  - Load per server remains constant
- Continuously adding and removing nodes
  - Based on demand, system health
- **New nodes must mirror existing**

Every change is a new push

Operational Impact

- No changes to running systems
- No CMDB
- No systems management infrastructure
- No snowflakes
- Fewer logins to prod systems
- Trivial “rollback”
- **No room for dev vs. ops argument!**

Security Impact

- File integrity monitoring
- User activity monitoring
- Vulnerability management
- Patch management

CLOUD SECURITY @ NETFLIX: LESSONS LEARNED

Tools and Vendors

- Many data center oriented tools don’t travel to the cloud well
- Drive security vendors/tool makers to:
  - Scale
  - Handle dynamic environments
  - Make everything API-accessible/driven

Organizational and Operational

- Understand the personnel you need for this kind of environment
  - Security staff must be able to write code
  - Need familiarity with engineering processes to efficiently integrate
- Monitor and instrument the events and elements you care about
  - Automated alerting and escalation vs. NOC/SOC staring at multi-displays

Regulatory Compliance

- **Pathfinders beware!**
- Security, auditors, and regulators are still in early stages of defining adequate, secure, and compliant cloud operations
- Be prepared for a knowledge/experience/comfort gap:
  - N-tier vs. distributed systems
  - SOD vs. DevOps
  - QA/UAT vs. CI/CD

Questions?

- chan@netflix.com
- http://techblog.netflix.com