



# Cloud & DevOps Plan for the Plan

November 2015



**HARVARD UNIVERSITY**  
Information Technology



November 10, 2015

Dear Reader,

In the following package of material, you will find documentation outlining our planning efforts for the HUIT Cloud & DevOps program. The material is intended to provide a high-level, strategic outline of our approaches for the following five areas:

- Overview: The Plan for the Plan
- Current-State Services
- Future-State Services
- Service Transition
- Cloud Migration

In total, these documents explain the “case for the cloud” for HUIT, and review the service, technology, process, and people changes that are necessary for successful implementation. The next step associated with the effort is to develop a coordinated implementation, staffing, and change management plan that maps process, dependencies, and delivery milestones for impacted organizations.

Thank for you taking the time to review our strategy.

Kind Regards,

Cloud & DevOps Working Group and Program Team



HARVARD UNIVERSITY  
Information Technology

# Cloud & DevOps 'Plan for the Plan'

## The Case for Cloud & DevOps

# Agenda

- Purpose and Intended Outcomes
- About Cloud & DevOps
- What is the Cloud?
- Value of the Cloud
- What is DevOps?
- Value of DevOps
- Getting There from Here
- Service Transition: Infrastructure and Application Services
- Migration Approach
- Managing Change

# Purpose and Intended Outcomes

## Purpose

To summarize cloud computing and DevOps methodologies, explain their value, and examine how cloud and DevOps can provide value and efficiencies within HUIT.

## Intended Outcomes

- Knowledge of cloud and DevOps key concepts
- Awareness of the potential for value offered by cloud and DevOps
- Understanding of a migration approach and service transition plan within HUIT, as well as critical aspects of change management

## About Cloud & DevOps

**Cloud computing and DevOps methodologies are two major IT industry-wide transformations that have been underway for many years.**

**These two trends have an impact on the way we build and/or operate applications:**

- This affects the work we do in application groups, such as ATS
- This impacts large portions of our infrastructure services

**We can either ...**

- Embrace these trends and capitalize on the benefits that they offer
- Hang on to our current practices for as long as we can

## About Cloud & DevOps

**Both cloud and DevOps each have value on their own, but the value of the two together is greater than the sum of the individual parts.**

**Ultimately, the value of cloud and DevOps working together lies in:**

- A reduction in operating costs
- Increased speed, flexibility, and reliability

# What is the Cloud?

“The Cloud” incorporates two fundamental ideas:

## “Off-Premise”

- Using others’ data centers, servers, etc.

## Advanced Capabilities

- Access to new technical capabilities not available in traditional data centers that deliver higher value to Harvard

There are two key cloud models to highlight:

## Infrastructure as a Service (IaaS)

- Servers in the cloud (e.g. AWS)

## Software as a Service (SaaS)

- Applications in the cloud (e.g. Facebook, Office 365, Gmail)



## An Analogy: Digital Photography

Cloud computing is to data-center computing as film photography is to digital photography ...

### Film Camera



**The good:** Camera lens, camera functionality

**The bad:** Can't edit, each print costs money, each print takes time

### Digital Camera



**The good:** Camera lens, camera functionality

**The better:** On-the-fly editing, delete bad prints, immediate viewing

... and similarly, the cloud introduces on-demand self-service, rapid elasticity, and improved integration.

# Value of the Cloud

## Cost

- Some reduction in operating cost as part of the transition
- Cloud costs are directly tied to usage — today, we often pay for peak usage rather than actual usage

## Speed

- Ability to meet new or changing needs in minutes or hours, not days or weeks

## Flexibility

- Ability to adjust to changing conditions such as seasonal spikes, or extreme conditions and other disasters

## Reliability

- Ability to create systems that are more resilient, secure, and standardized

# What is DevOps?

**“DevOps” means applying three important concepts that change the way applications are developed and operated.**

## **Agile**

- Deliver value fast and frequently
- Correct the course if necessary
- Understand risk and challenges more quickly
- Reduce wasted efforts

## **Automation**

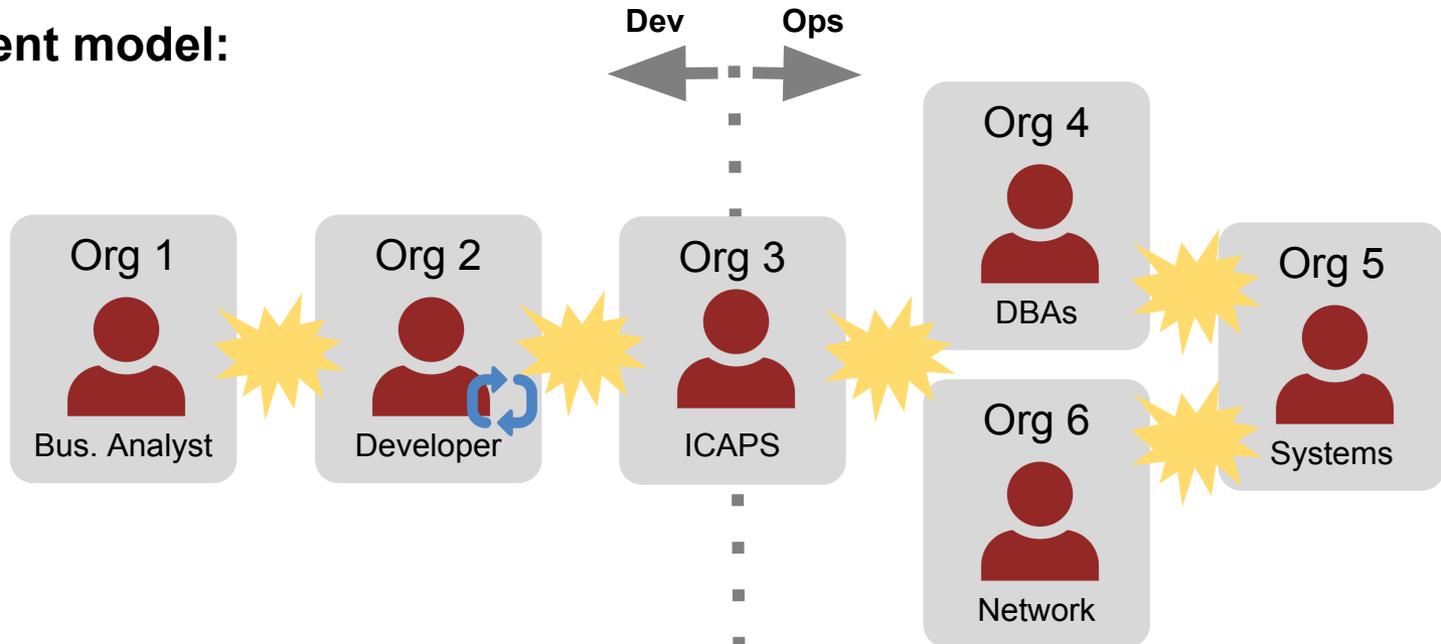
- Use tools in order to remove as much human-factor risk as possible

## **Integrated, multidisciplinary teams**

- Teams structured to include all skills necessary to develop and operate a system

# What is DevOps?

## The current model:



## The DevOps model:



# Value of DevOps

## Cost

- Team integration means less redundant management
- Labor cost goes down as a result of automation

## Speed

- Agile methodologies and automation dramatically increase the speed of delivery
- Integrated teams mean faster and more efficient collaboration

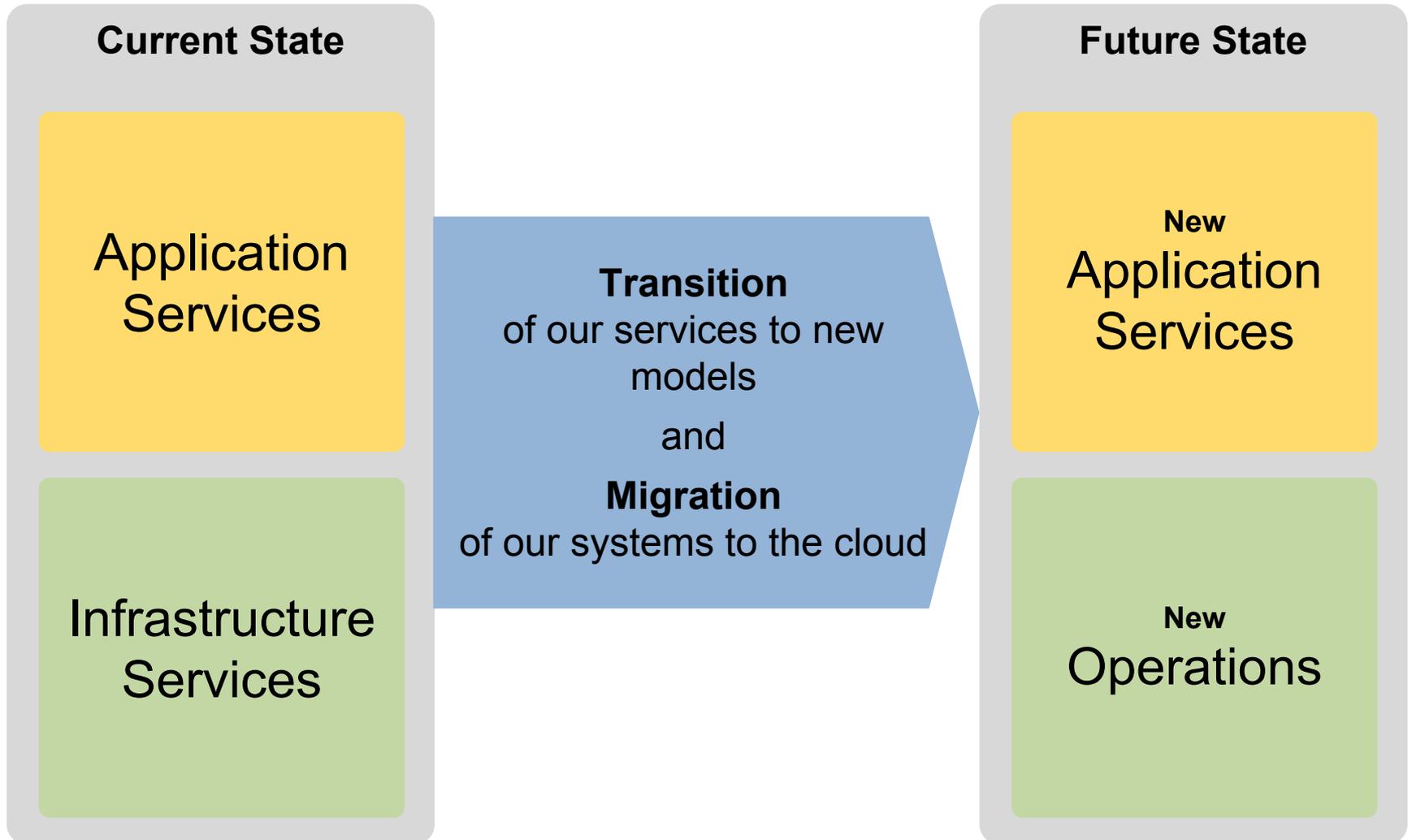
## Flexibility

- Agile methodologies and automation allow for quicker adjustments

## Reliability

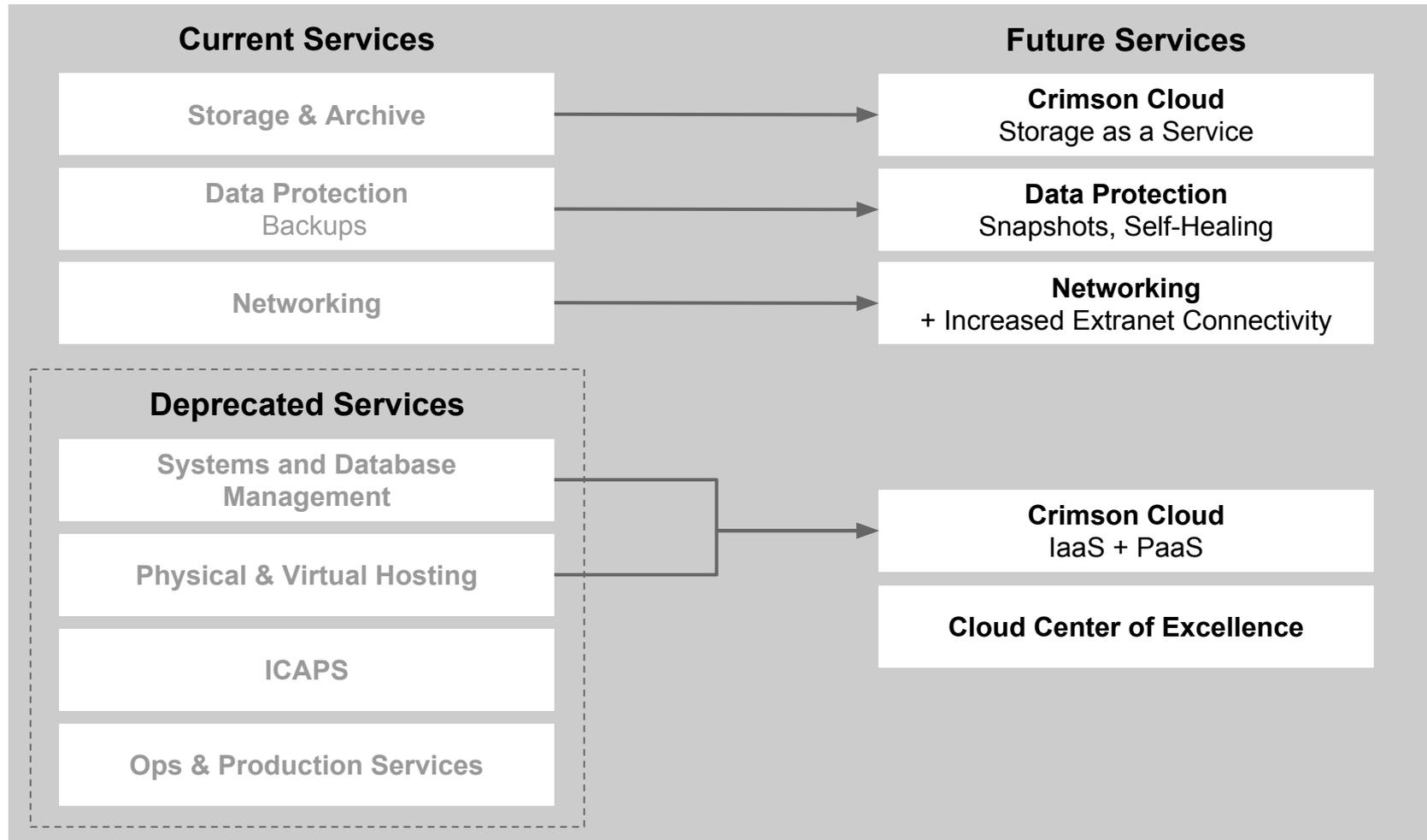
- Automation removes a category of human errors while promoting or even forcing standardization
- Integrated teams are more self-sufficient and accountable

# Getting There from Here



# Service Transition: Infrastructure

Infrastructure services will evolve, remain the same, or be deprecated.



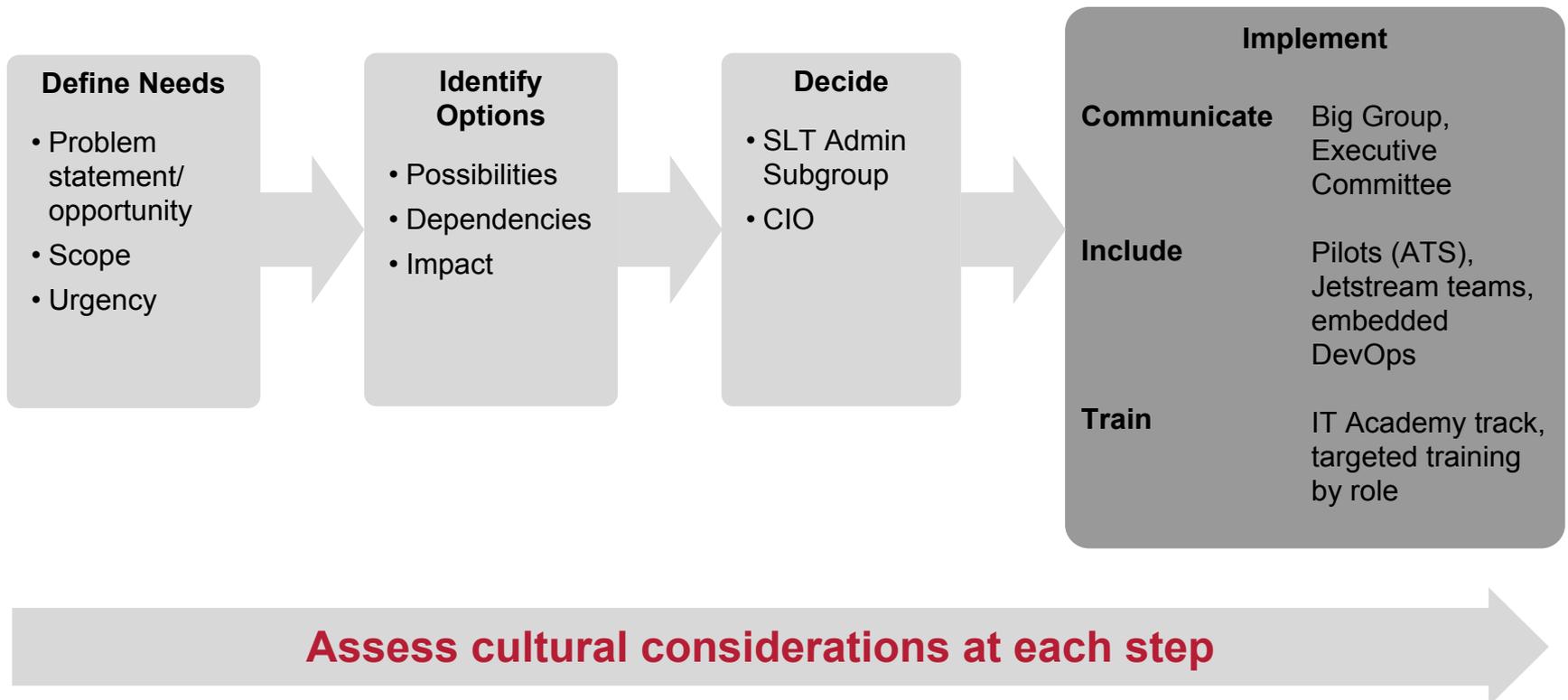
# Migration Approach Summary

There are two methods to migrate an application to the cloud as IaaS: replatforming, or “lift and shift.” HUIT application teams can migrate via one of these options either through the Cloud & DevOps program, or on their own.

Replatform	Lift and Shift
<ul style="list-style-type: none"><li>● Replaces application functionality with cloud services</li><li>● Requires developer commitment and cloud service expertise to implement application changes</li><li>● Operational support model shifts to cloud program team and embedded DevOps resource when staffed</li></ul>	<ul style="list-style-type: none"><li>● Copies the application “as is” to the cloud</li><li>● Requires research on existing connections through discovery process</li><li>● Enables fast migration timelines using a migration toolset</li><li>● Known operational support model leveraging the infrastructure team</li></ul>

# Managing Change

Implementing organizational change of this magnitude without impacting service delivery requires a coordinated approach:





**HARVARD UNIVERSITY**  
Information Technology

# **Cloud & DevOps ‘Plan for the Plan’ SOC, NOC, and ATS Current State**

# Agenda

- Purpose and Intended Outcomes
- ATS Services: Current State
  - FAS and College Systems
  - Central Administration Systems
  - Office of President & Provost Systems
  - ATS Practices
- Infrastructure Services: Current State
  - SOC Services
  - NOC Services

# Purpose and Intended Outcome

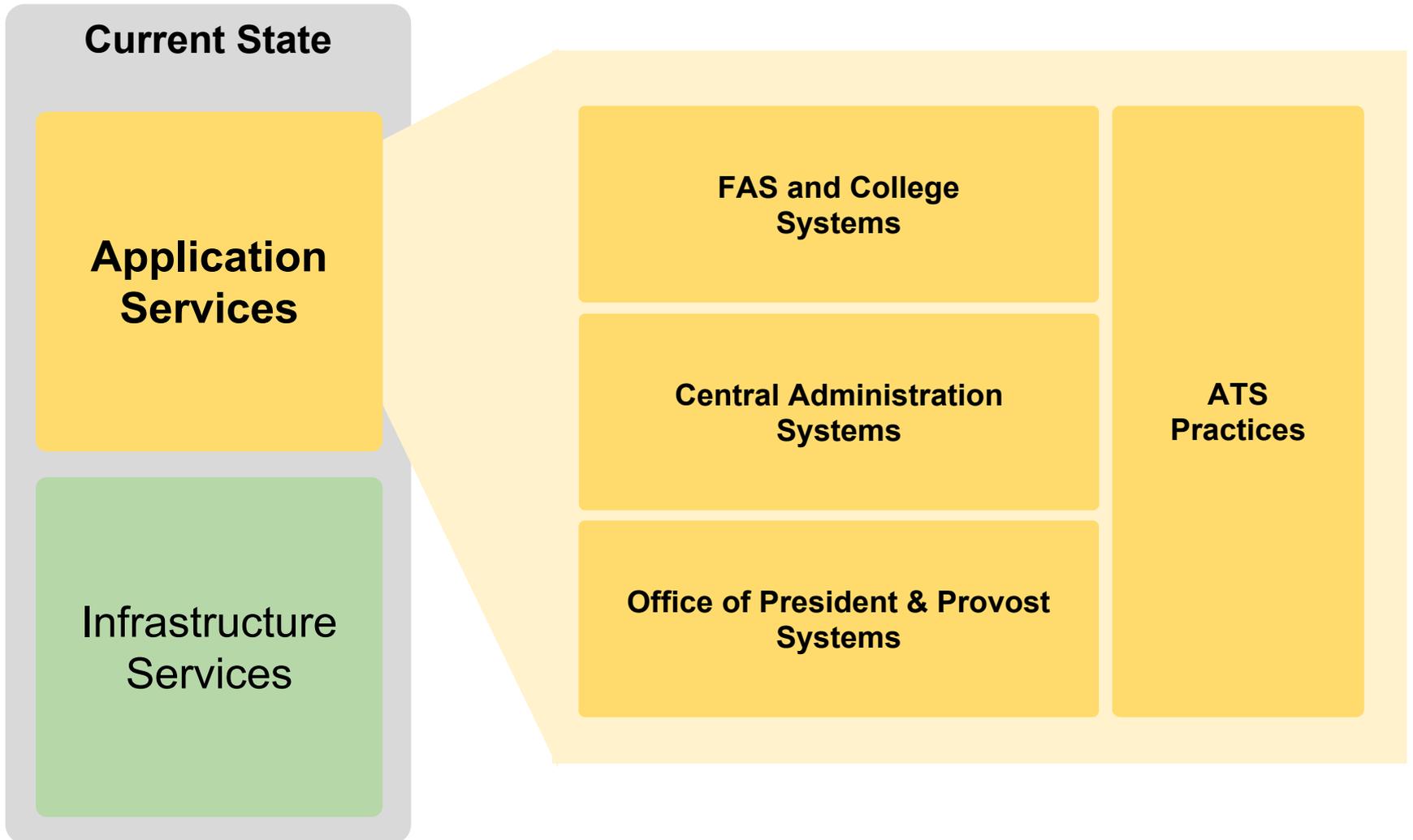
## Purpose

To provide a financial and staffing overview of the current state of the SOC, NOC, and ATS.

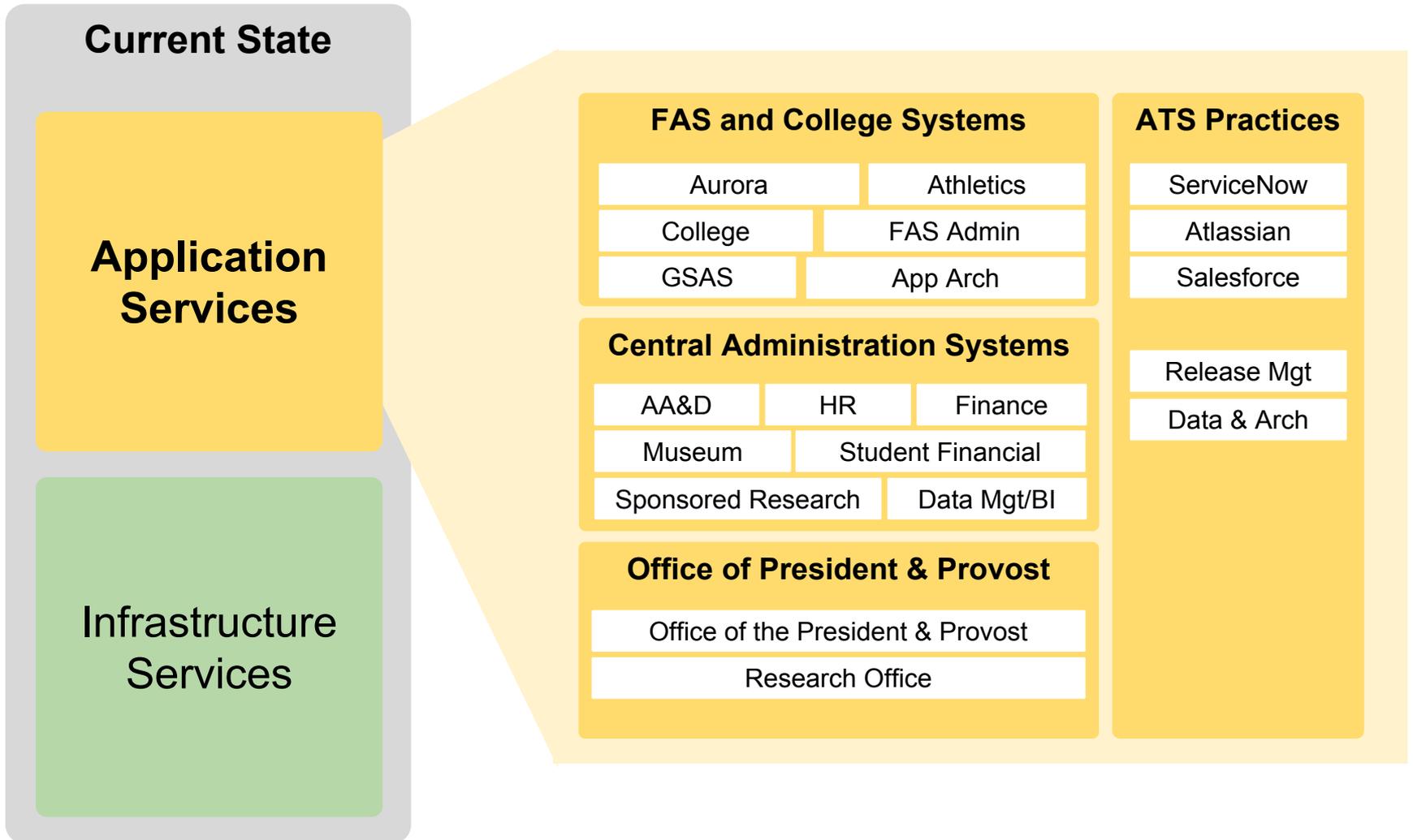
## Intended Outcome

- Understanding of current-state financial and staffing climate for the NOC, SOC, and ATS

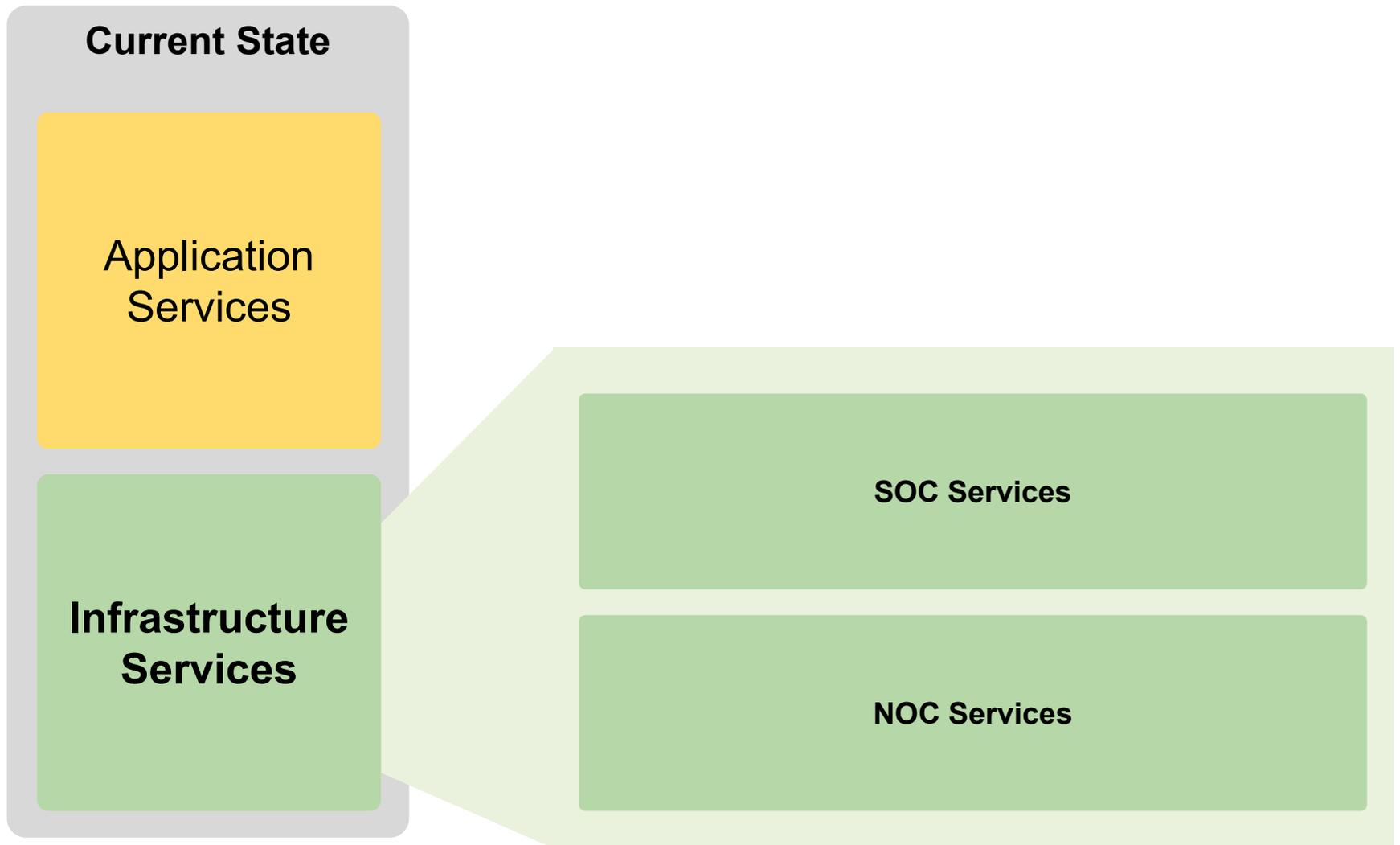
# ATS Services: Current State



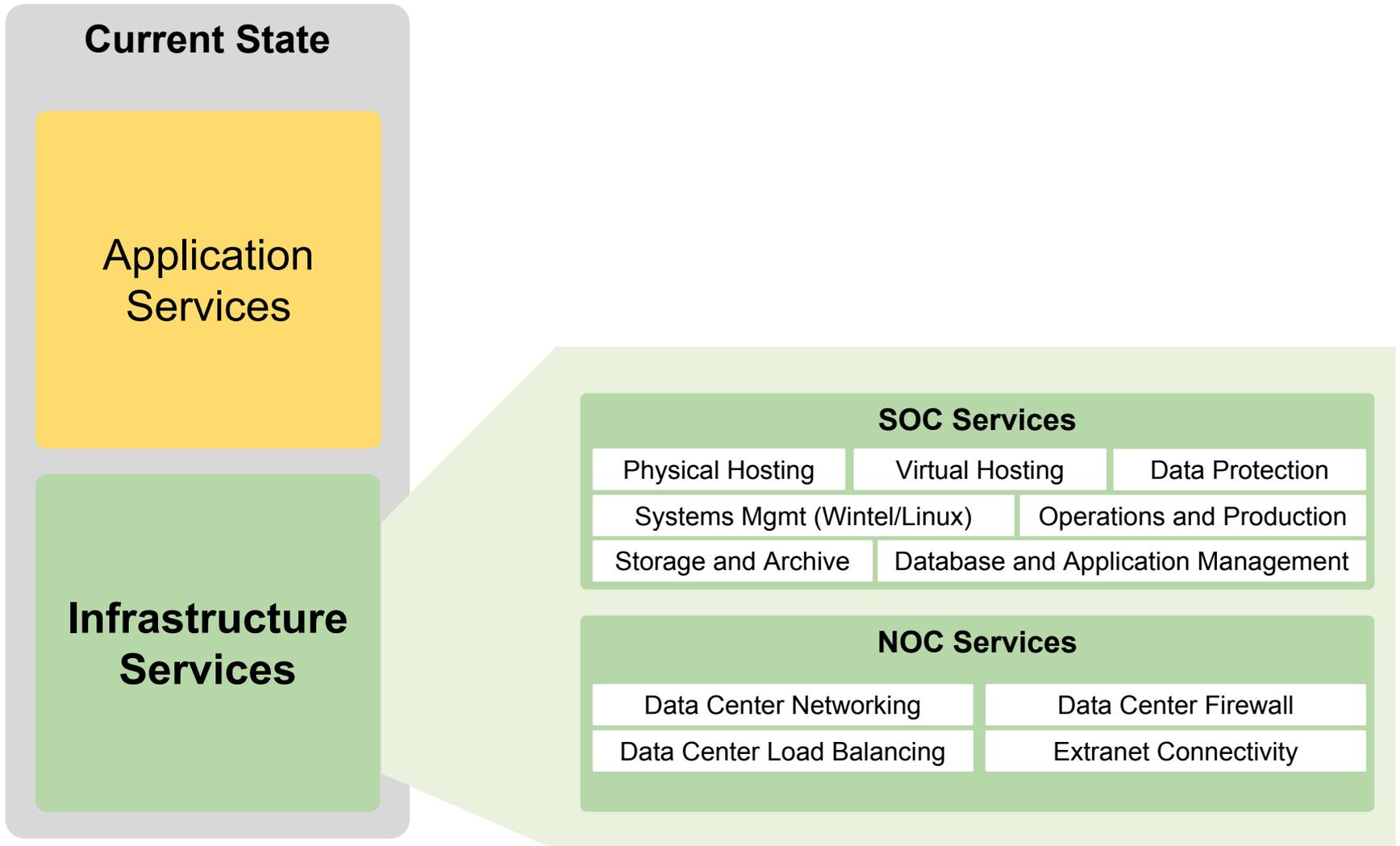
# ATS Services: Current State



# NOC/SOC Services: Current State



# NOC/SOC Services: Current State





HARVARD UNIVERSITY  
Information Technology

# Cloud & DevOps 'Plan for the Plan' Future-State Service Strategy

# Agenda

- Purpose and Intended Outcomes
- Drivers for Cloud Services
- Cloud Services Future State
- User Segments and Requirements
- Crimson Cloud Service: IaaS, PaaS, and SaaS
- Cloud Center of Excellence
- IT Provider Services
  - Network and Security
  - Billing and Account Management
- Cloud Operations Services
  - Operations
  - Disaster Recovery
- Application Team Impact
- ITSM Impact
- End-State Tools

# Purpose and Intended Outcomes

## Purpose

Describe the future state for cloud services within HUIT, including proposed cloud services, the organization tasked with governing these services, and the extension of operations to support cloud services.

## Intended Outcomes

- Understanding of the future state for HUIT cloud services
- Awareness of the oversight organization and model for cloud services
- Knowledge of the infrastructure and operations organization services

# Drivers for Cloud Services

## **Illustrate an understanding of diverse user needs for cloud solutions**

- Create a suite of service offerings that are deliberately crafted based on known user needs and behaviors

## **Provide value differentiation over “direct-to-vendor” offerings**

- Incorporate organizational best practices for security and networking into the delivery process for cloud resources, enabling teams who deploy to the cloud to navigate complex policies
- Introduce automation to empower application teams to deliver functionality without needing in-depth understanding of a specific vendor

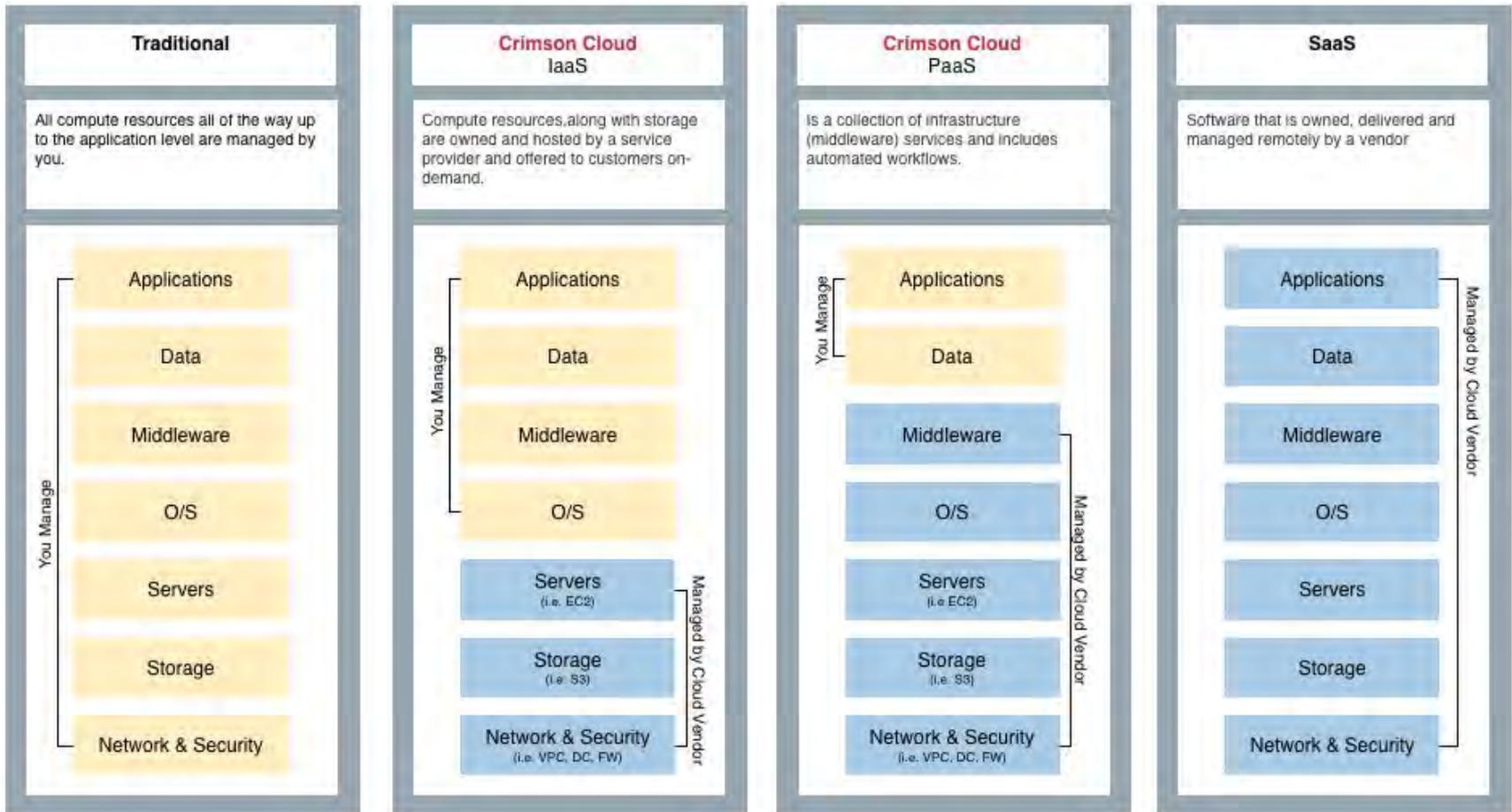
## **Provide a means to estimate, trace, and recover costs in a meaningful way**

- Bundling and mapping costs for specific resources, tools, and technologies to services helps facilitate long-term financial planning and enables the organization understand TCO

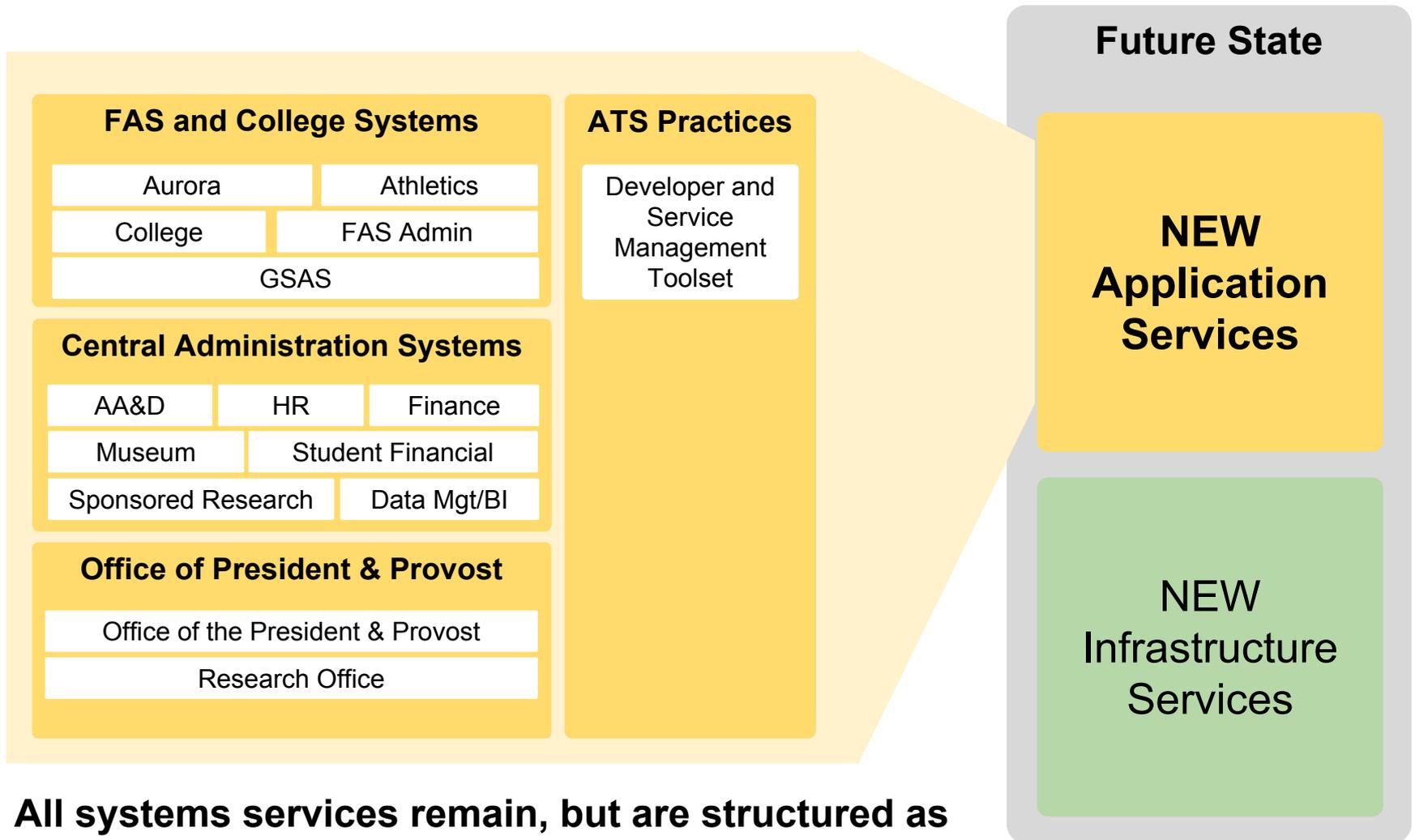
## **Define the transition from current-state services to future-state hosting**

- Clearly define and articulate how infrastructure hosting services will evolve with the introduction of the new cloud hosting delivery model

# Drivers for Cloud Services ... as a Service

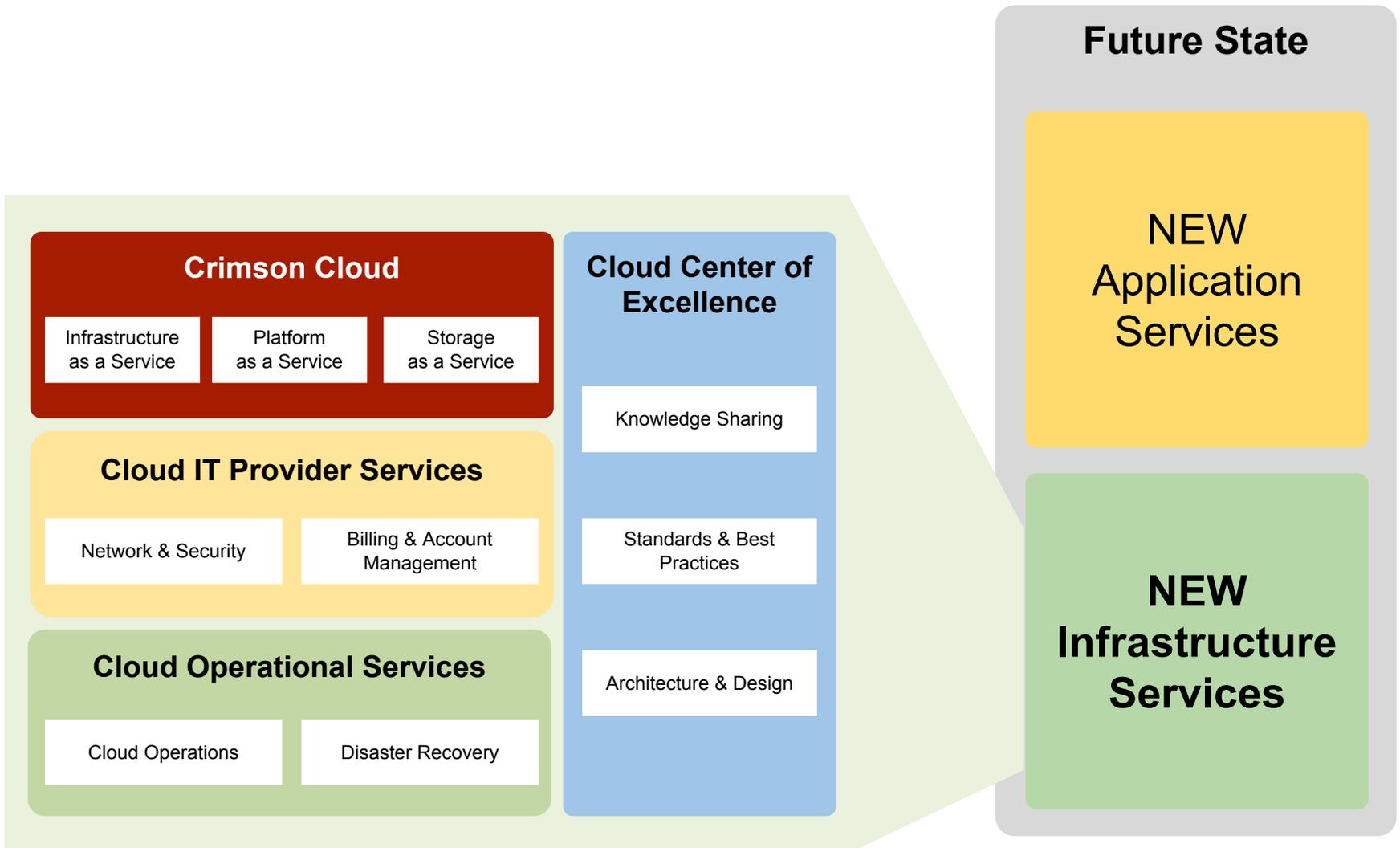


# Future-State Services



**All systems services remain, but are structured as integrated teams with embedded DevOps.**

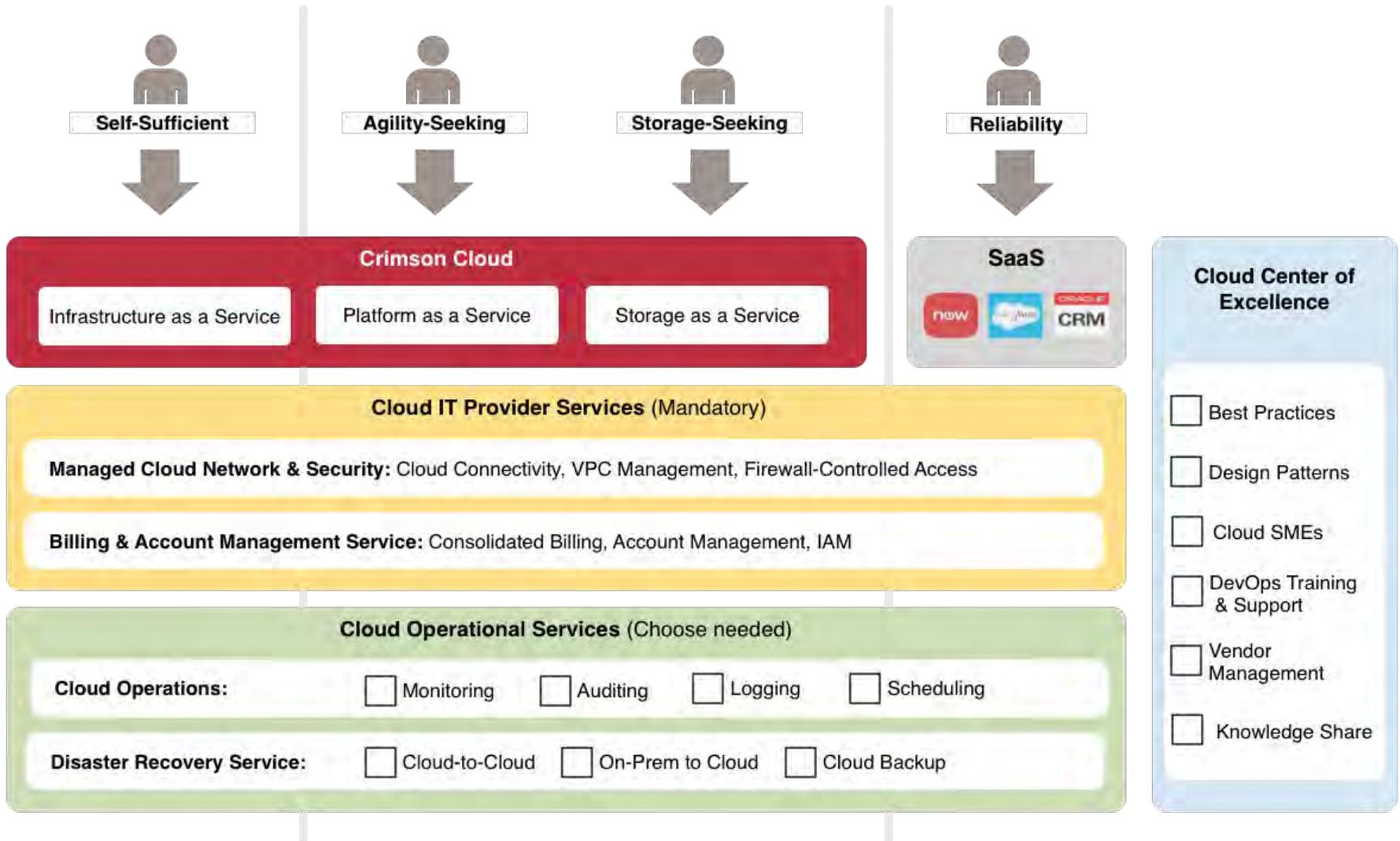
# Future-State Services



# User Segments and Requirements

User	Characteristics	Requirements	Solution
Self-Sufficient	<b>Little to no need for centralized service offerings.</b> Has “full stack” dev team and/or skills to independently support the entire application development lifecycle. Team is familiar with or has potential to implement and support cloud offerings without assistance.	<b>Autonomy</b> in creation, maintenance and support of apps and resources. Prefers <b>access</b> to <b>advisory services</b> and/or information to get reusable artifacts and design validation.	<b>Crimson Cloud</b> IaaS
Agility-Seeking	Motivated by <b>efficiency</b> and quick delivery of resources. Seeks <b>speed</b> above all else and has a low tolerance for complex or cumbersome processes.	Favors <b>automation</b> for provisioning and maintaining cloud resources. Seeks “ <b>ease of use</b> ” and <b>self-service</b> . Favors <b>bundled</b> options that are workflow-enabled and require minimal customization or ongoing support.	<b>Crimson Cloud</b> PaaS
Storage-Seeking	Need to store large amounts of information and share it with others. Wants tiered storage capacity that is flexible and on demand to meet their ever-growing data needs.	Seeks <b>file share</b> options for sharing files across departments or groups. Needs flexible, cost-effective storage.	<b>Crimson Cloud</b> Storage
Reliability-Seeking	Prioritizes application <b>availability</b> . Demands <b>stability</b> and <b>resiliency</b> in the form of uptime, low RTO, and low RPOs. Examples include enterprise and mission-critical applications.	Seek <b>automated recovery</b> options for compute and data. Require <b>disaster recovery</b> to ensure business functions available in a crisis.	SaaS

# Cloud Services by User Segment



# Crimson Cloud: IaaS

**Self-service capabilities enable users to rapidly provision resources; automation and standardized templates improve service quality and reduce time to delivery.**

## Features

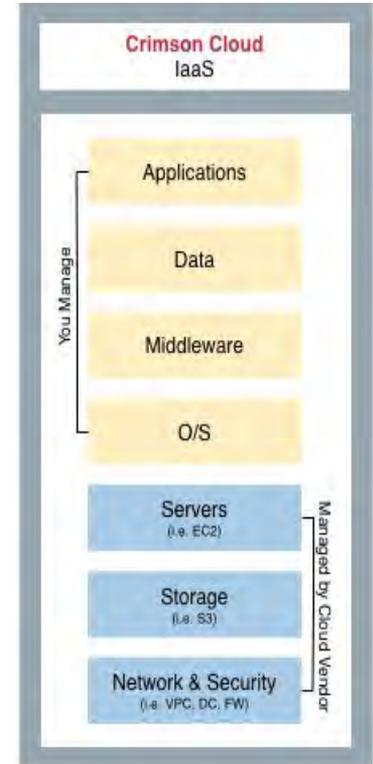
- Fast, automatic resource generation
- Tested templates/scripts from a central knowledge store
- Full self-service access to provision/remove resources

## Target Audiences

- Application development teams
- Students and faculty

## Use Cases

- Faculty member hosting statistical probability app
- Student needing compute resources for class assignment
- Partner org hosting production app with periodic spikes
- App team needing dynamic storage to develop business-critical application



# Crimson Cloud: PaaS

**Users can develop, deploy, and manage end-to-end cloud resources and supporting toolsets with no worry about underlying infrastructure.**

## Features

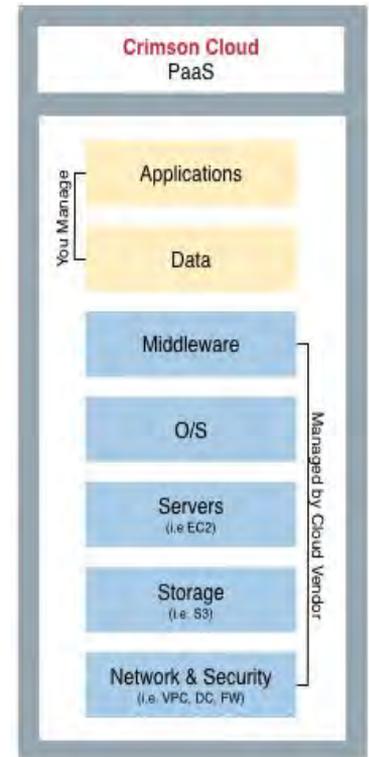
- Self-service access to a fully integrated cloud platform
- SLA provided by direct from selected PaaS vendor
- Centrally negotiated contract lowers costs, standardizes terms/conditions

## Target Audiences

- Partner org with small, development-focused team
- Faculty member hosting information for a class

## Use Cases

- Partner org with app with constantly-changing content
- Student building a website for a class
- Partner org that can hire developers, but has difficulty finding qualified DevOps engineers
- Deadline-driven team needing to reduce deployment time



# Crimson Cloud: STaaS

**From application storage to file shares to archive cold storage, Crimson Cloud's storage service will provide cost-effective, scalable, on-demand storage capabilities.**

## **Features**

- Multi-tier storage (EBS, S3, Glacier, etc.)
- File sharing (NFS/CIFS protocols; Elastic File Share)

## **Target Audiences**

- Business units
- Students and professors
- Application teams

## **Use Cases**

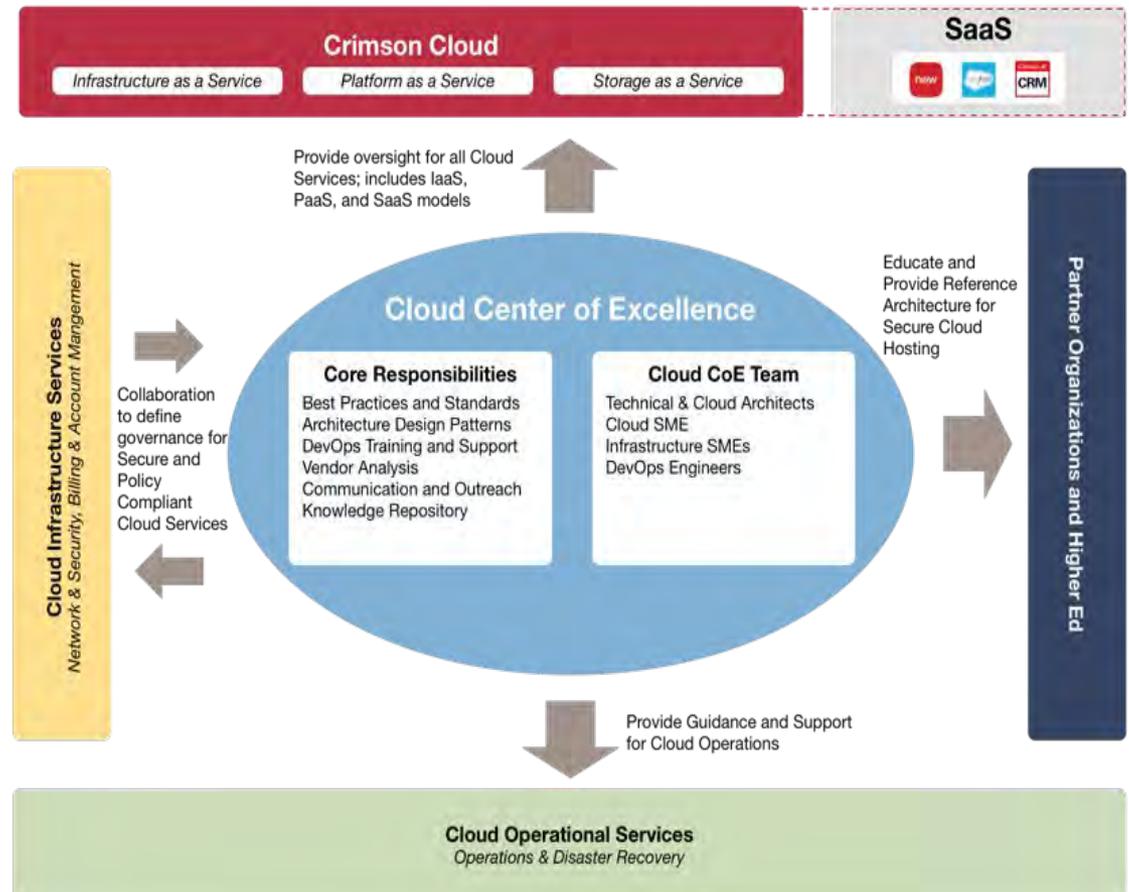
- An application that requires storage for its database
- Business units that need a shared file system for document storage
- Organization requiring secure storage to backup and archive data for compliance

# Crimson Cloud: End-State Staff

Service	Roles	Responsibilities
<b>Crimson Cloud IaaS</b>	<ul style="list-style-type: none"> <li>● Crimson Cloud Product Owner</li> </ul>	Develops and supports establishment of the Crimson Cloud service; provides Tier 3 support for the cloud
<b>Crimson Cloud PaaS</b>	<ul style="list-style-type: none"> <li>● DevOps Engineer</li> <li>● Developers</li> <li>● BA/QA</li> </ul>	Expertise, best practices, and standards for using PaaS will exist within the Cloud Center of Excellence, but there will be no centralized support team
<b>Crimson Cloud STaaS</b>	<ul style="list-style-type: none"> <li>● Cloud Storage Senior Engineer</li> <li>● Cloud Storage Engineer</li> </ul>	Supports multiple storage options; works closely with DR product owner to ensure that storage and data are well designed

# Cloud Center of Excellence

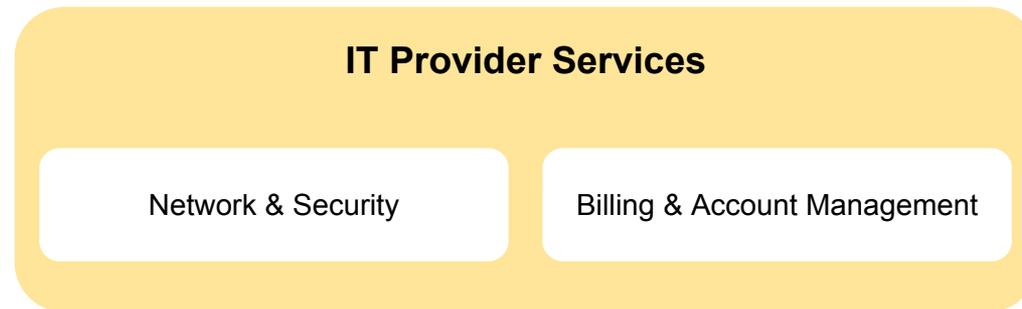
The Cloud Center of Excellence will provide best practices, standards, and technical oversight for all Harvard cloud services. This team of cloud architects and subject matter experts will provide the University with leadership, support, guidance, and training.



# Cloud Services: End-State Staff

Service	Roles	Responsibilities
<b>Cloud Center of Excellence</b>	<ul style="list-style-type: none"><li>• Cloud Architecture Manager</li><li>• Cloud Architect</li><li>• Infrastructure SME — part of Enterprise Architecture</li></ul>	Experienced cloud architects in Harvard's cloud deployments. Infrastructure SMEs are the best technical resources from 60 Oxford who want to remain focused on infrastructure (Windows, Linux, Storage/DB). Provides Tier 3 support for the cloud.

# IT Provider Services



## Network & Security

- Provides the foundational services required for any HUIT cloud application, as well as the core network and infrastructure security required for any application hosted in an external cloud

## Billing & Account Management

- Integrates a partner organization into the consolidated billing process and high-level account management to cloud services provider; service also includes integration with HarvardKey identity and access management

# IT Provider Services: Network & Security

**This service (required for all cloud-hosted production applications) provides foundational services needed for any HUIT cloud app, including the core network required for any application hosted in an external cloud.**

## Features

- Fully-managed network connection to external cloud provider
- High-speed, redundant network connectivity (Direct Connect for AWS)
- Enables connectivity to defined cloud and/or on-premise resources
- Routing and DNS support for cloud network integration

## Target Audiences

- All IaaS and PaaS offerings must use this service
- Project teams with experience implementing and managing cloud infrastructure

## Use Case

- Partner organization hosting applications fully supported by project team, but needing reliable connectivity and the ability to access internal Harvard resources (such as an internal database)

# IT Provider Services: Billing & Account Management

**This service integrates a partner organization into the consolidated billing process and high-level account management to cloud services provider.**

## **Features**

- Consolidated billing to produce greater savings and volume discounts
- Governance over root-level cloud provider access
- Integration with HarvardKey identity services for all accounts
- Guidance on the mandatory tagging of resources to simplify

## **Target Audience**

- All partners using Crimson Cloud services

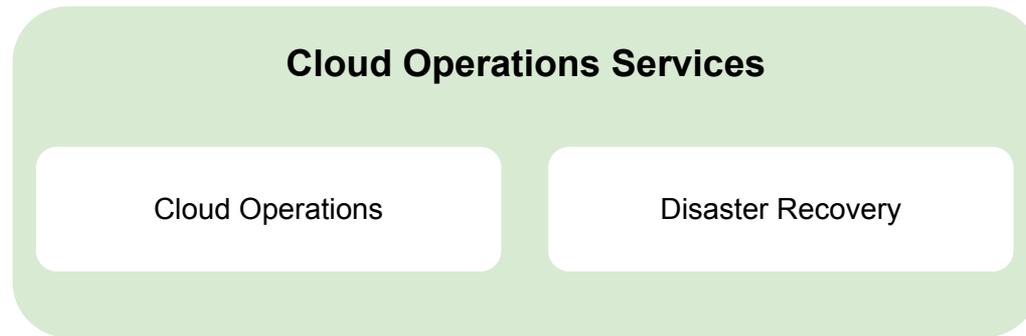
## **Use Case**

- Partner organization using either IaaS or PaaS offerings

# IT Provider Services: End-State Staff

Service	Roles	Responsibilities
<b>Network and Security</b>	<ul style="list-style-type: none"><li>• No impact</li></ul>	Supports DirectConnect and entire security architecture framework for AWS; builds upon current tools
<b>Billing and Account Management</b>	<ul style="list-style-type: none"><li>• Billing Manager</li><li>• Billing Analyst</li></ul>	Supports the billing system, manages the billing process, projects revenue

# Cloud Operations Services



## Cloud Operations

- A suite of next-generation operational services and tools that provide application teams with the ability to manage, optimize, and assess production application workloads; will also extend and enhance on-prem capabilities to cloud resources

## Disaster Recovery

- A suite of service offerings to offer an appropriate level of DR for all applications that require it; primary offerings will be on-premise-to-cloud and cloud-to-cloud DR

# Cloud Operations Services

**Services and tools that enable app teams to manage, optimize, and assess production application workloads. Cloud Operations will extend and enhance on-premise capabilities to cloud resources.**

## Features

- Monitoring
- Auditing
- Logging
- Scheduling

## Target Audiences

- Application teams with compliance requirements
- Production applications with high service levels and on-call requirements
- App teams continuously optimizing for cost and performance

## Use Cases

- An application team needing a means to identify the root cause of a service outage
- An application team that wants to spin up a new environment without creating downtime

# Cloud Operations Services

## Monitoring

Advanced cloud monitoring will expand the current server monitoring service to cloud resources, with application performance and diagnostics information available as an optional service.

## Logging

Current logging service will evolve and become a standard component for all cloud systems; tiered services will provide customers with options to meet their application or compliance requirements.

## Auditing

Cloud auditing will become standard on all cloud systems, and will monitor cloud resources for a wide range of security-related configuration items, including security groups, S3 policies, and IAM users.

## Scheduling

There is currently no known job schedule outside of Maestro that meets requirements; in the future, as new technology for the cloud is developed, we anticipate the service will use a specific cloud job scheduler.

# Disaster Recovery

**Design and support services required to recover applications or services to cloud resources.**

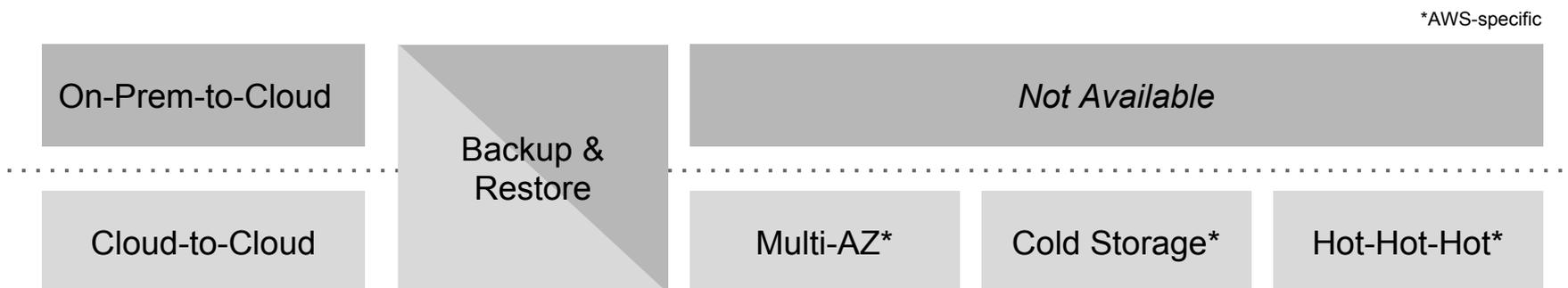
## Features:

- *Cloud-to-Cloud*: Applications already deployed in the cloud can recover within the same cloud provider or across different cloud providers
- *On-Premise-to-Cloud*: Applications remaining on-premise will use CloudEndure to ensure application redundancy

## Target Audiences

- Mission-critical applications
- Enterprise applications

## Service Tiers



# Disaster Recovery

DR Service	Description	Protects Against	Cost	RPO	RTO
<b>Data Protection</b>	Uses CloudEndure to build standby application for reconstitution at remote AWS data center	Disaster at Harvard data center	\$	<24 hr	<1 hr
<b>Multi-AZ Cloud Architecture</b>	Design services to use good cloud design principles for horizontal scaling and data protection using multi-AZ architecture	Individual data center or AZ failure/ degradation	\$	~0	~0
<b>Cold Storage</b>	Copy all data and configuration to secondary region for cold storage (code+config+data)  Full environment build required and data can also be sent to secondary	Extended regional failure	\$\$	<1 hr	<8 hr (staff limited)
<b>Hot-Hot-Hot</b>	Multi-region active production running at full scale	Regional failure or degradation	\$\$\$\$	<15 min	<30 min

# Cloud Operations Services: End-State Staff

Service	Roles	Responsibilities
<b>Disaster Recovery</b>	<ul style="list-style-type: none"><li>• DR Product Owner</li></ul>	Manages DR communication, evaluates ongoing solutions, works with Crimson Cloud and storage product owners to define implementation approaches, manages testing across HUIT service teams
<b>Cloud Operations</b>	<ul style="list-style-type: none"><li>• Cloud Operations Director</li><li>• Cloud Operations Tools Developer</li><li>• Cloud Operations Optimization Engineer</li></ul>	Manages, tracks, and reports on monitoring, auditing, and logging; partners with ITSM team on incidents to ensure that event reporting is appropriate; partners with application teams to meet application needs

## Application Teams: Overview

**This section provides an overview of the service impact associated with application teams or ITSM**, including the impact of both the embedded DevOps engineer and the newly introduced services as part of the cloud. The examples that follow relate to HUIT's ATS program, but in all cases the models work across application teams.

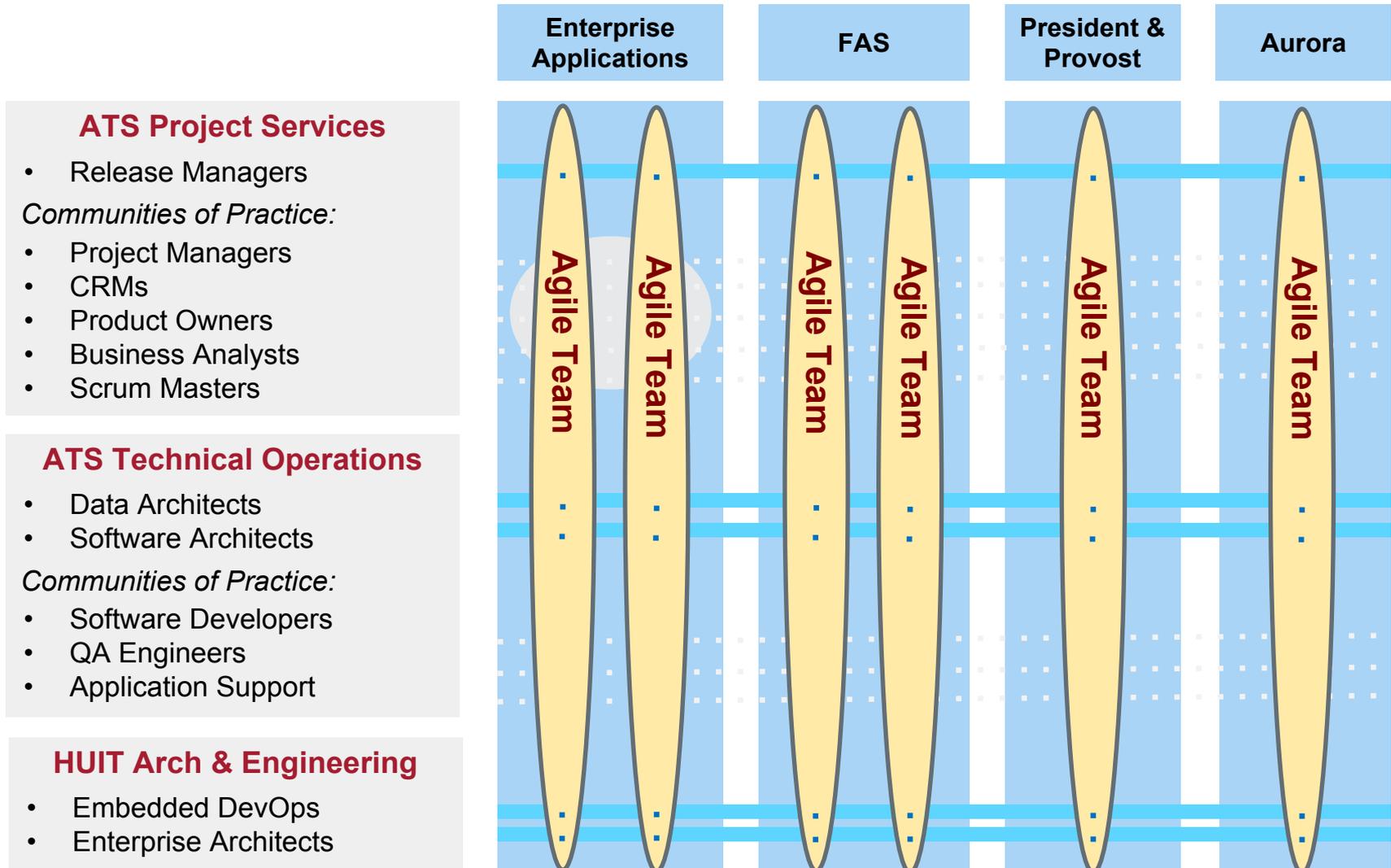
### **Critical concepts for application teams include:**

- Embedded DevOps
- Release management
- Developer toolset
- Application team structure
- ITSM process impact

# Cloud & DevOps Impact on Application Teams

- Embedded DevOps engineers managed and cost-allocated to application teams
- Common cloud services and multi-tenancy established
- Scaled Agile Framework practices incorporated into the establishment of infrastructure
- Embedded architects and the establishment of standard infrastructure patterns
- Defined integration approaches for application connectivity within the cloud
- QA automation and deployment integration
- Automated, continuous deployment and changes to release management
- Defined and published operational support models

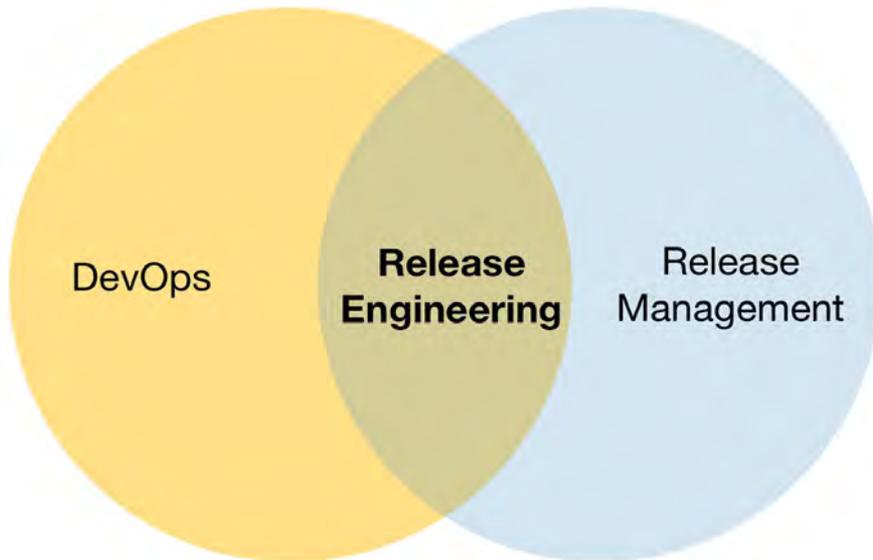
# Sample Application Team: ATS



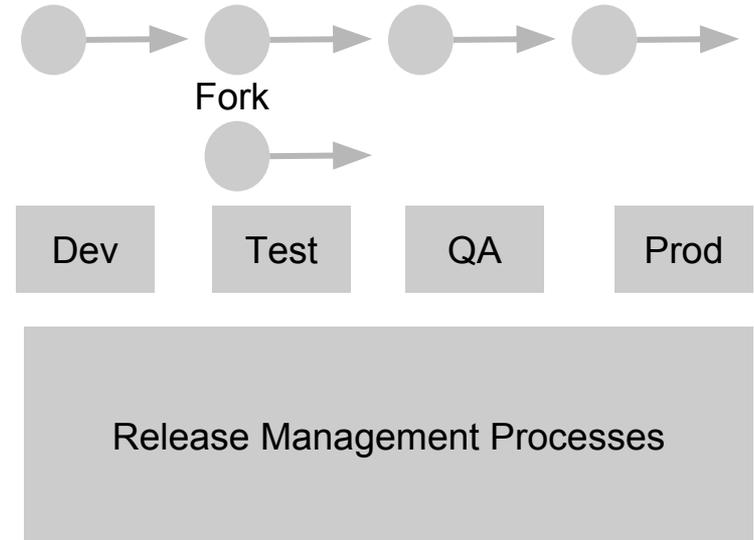
*Communities of Practice are accountable for best practices, with a full-time role and input in team rating*

# ATS: Release Management

**Release management evolves to provide an expansion of services to orchestrate automated release engineering processes.** The auditable release engineering processes replace manual release validation with automated deployment packages.



## Automated Code Promotion



# ATS: Developer and Service Management Toolset Service

**This service provides a set of shared development tools teams across the University can use, including a set of common functions all groups use as part of the application development process.**

## **Features**

- Atlassian suite (JIRA, Confluence, Fisheye, Crucible, HipChat)
- Enterprise GitHub
- Data masking tool
- Automation tools (Puppet, Ansible)
- ServiceNow

## **Target Audiences**

- Development teams

## **Use Cases**

- A development team wishing to create a de-identified copy of production data to securely use in lower environments
- Teams that want to create a wiki for project collaboration
- A developer who wants to create a script to automate a repetitive manual process

# Application Teams: End-State Staff

Service	Roles	Responsibilities
<b>ATS Embedded DevOps</b>	<ul style="list-style-type: none"> <li>• DevOps Engineer</li> </ul>	Teams remain as defined earlier, with the addition of embedded DevOps personnel
<b>Embedded DevOps for Other App Teams</b>	<ul style="list-style-type: none"> <li>• DevOps Engineer</li> </ul>	Teams remain as defined earlier, with the addition of embedded DevOps personnel
<b>ATS Release Management</b>	<ul style="list-style-type: none"> <li>• Release Engineer</li> </ul>	Provides broad release engineering support across ATS, and is integrated into the release management process; trains other release managers in release engineering
<b>ATS Developer and Service Management Toolset</b>	<ul style="list-style-type: none"> <li>• Toolset Lead</li> <li>• Tools Engineer</li> </ul>	Provide HUIT-wide development and service support tools, as well as tool patches and upgrades and operational support; assesses organizational fit and works with Cloud CoE for selection

# ITSM: Cloud Impact

ITIL Lifecycle	Processes	Cloud Impact
<b>Service Strategy</b>	Service portfolio	Assess different cloud providers and their services.
<b>Service Design</b>	Service catalog, service level	Introduce new services identified; establishing new features with these services will occur at fairly rapid pace.
<b>Service Transition</b>	Change management	Breaks the centralized control, but not the centralized repository of information; autoscaling “just happens.”
<b>Service Operation</b>	Event management, incident management, problem management, service requests	Increase pace of activity and response; reduce focus on determination of problem and increase rapid creation for response. Automate process for event and request response from ServiceNow to incite cloud change.
<b>Service Improvement</b>	Service reporting and quality	Improve service metering capabilities.

## End-State Tools (1/2)

Tools are based on the current rapidly-evolving marketplace, and are therefore expected to be subject to change.

Service	Tool	Purpose
DR	CloudEndure	DR purposes only
Account Mgt	Security Monkey	AWS account management
Billing	Cloud Allocation 360	Dynamic cost/billing analysis for both on-premise and cloud
Developer Toolset	Github (Enterprise)	Advanced version control system
Developer Toolset	VictorOps	Automated incident paging
Logging	Splunk	Centralized and consolidated monitoring

## End-State Tools (2/2)

Service	Tool	Purpose
<b>Monitoring</b>	New Relic	App monitoring, including dashboard and transaction introspection, automated alerting, and trend analysis
	Zenoss Service Dynamics, Nagios XI	Event management console
	Nagios	Detailed system monitoring and alerting
<b>Scheduling</b>	IBM Tivoli Workload Scheduler (Maestro)	Automated script scheduling and batch processing
<b>Release Management</b>	Bamboo (Atlassian)	Automated release management



HARVARD UNIVERSITY  
Information Technology

# Cloud & DevOps 'Plan for the Plan' Service Transition Strategy

# Agenda

- Purpose and Intended Outcomes
- Goals for Cloud Service Transition
- Cloud Change Principles
- ATS Services: Current and Future State
- ATS Transition
- Infrastructure Services Current and Future State
- Infrastructure Transition: Staff
- Infrastructure Transition: Project Development

# Purpose and Intended Outcomes

## Purpose

To outline principles and goals for cloud service transition, examine ATS as a case study, and discuss staff and process transitions for infrastructure at Harvard.

## Intended Outcomes

- Understanding of our goals for cloud service transition
- Knowledge of transition as instantiated within ATS
- Awareness of infrastructure transition goals, processes, and options

# Goals for Cloud Service Transition

## Organizational Goals

- Reduce inefficiencies through consolidating redundant roles
- Create and implement a common Agile framework across organizations
- Break down silos by developing common HUIT-wide standards and tools

## Infrastructure Goals

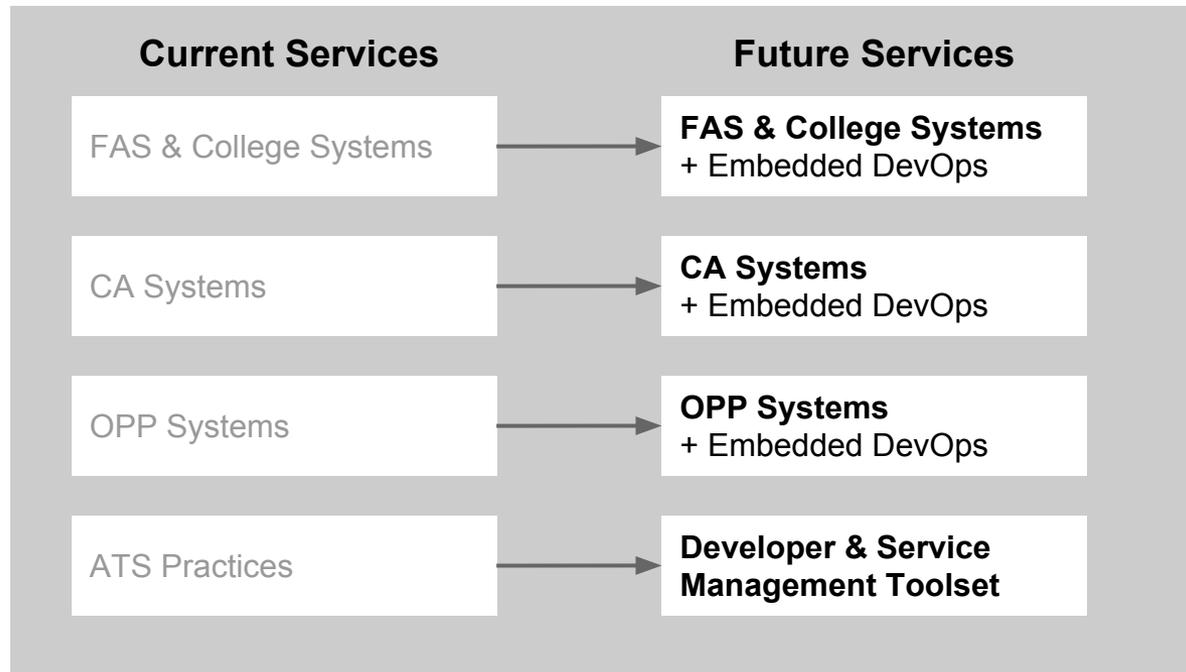
- Decentralize operational support and create T-shaped professionals by implementing embedded architects and DevOps engineers
- Develop cloud service offerings and transition from a traditional data center to the cloud

# Cloud Change Principles

- Use ATS as lead adopters for all application teams
- Define and communicate an embedded DevOps vision and its benefits for the team
- Perform changes in small increments
- Identify owners of organizational change within ATS to drive progress and remove obstacles
- Define owners of process changes within the Cloud & DevOps program team
- Provide training and actively communicate with ATS team members throughout the change process
- Develop a regular, recurring reporting process to capture progress and identify course corrections

# ATS Services: Current and Future State

The future state of ATS relies upon the addition of embedded DevOps resources, as well as close collaboration with data management integration services and the Cloud Center of Excellence.



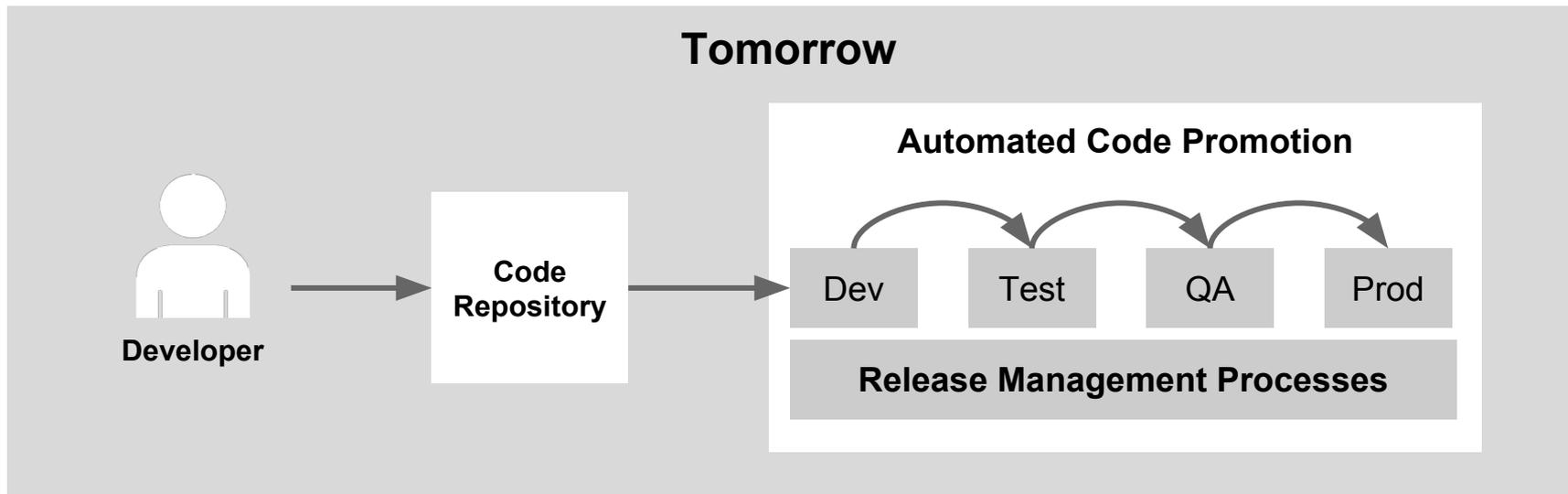
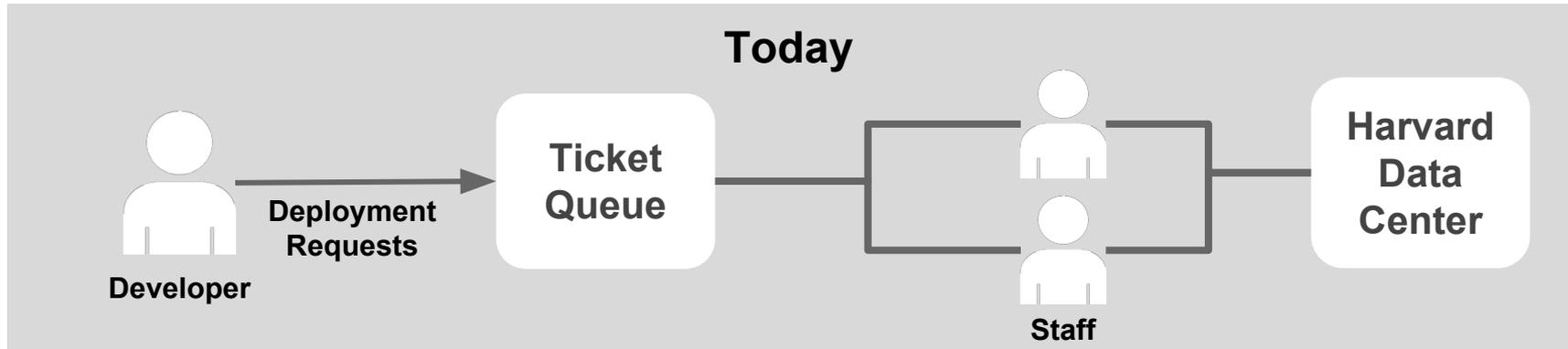
## ATS Transition: Defining an Approach

**Broad process changes are required, but they cannot be implemented all at once across the organization.**

Category	Definition	Expected Outcomes	Lead Adopter
<b>Development Process</b>	Consolidate and optimize ATS development, deploy, and support processes	Create the ability to share resources across ATS	OPP
<b>Embedded DevOps</b>	Introduce new roles and evolve support structures as a result	Create the ability for service teams to be independent service teams	FAS and College Systems

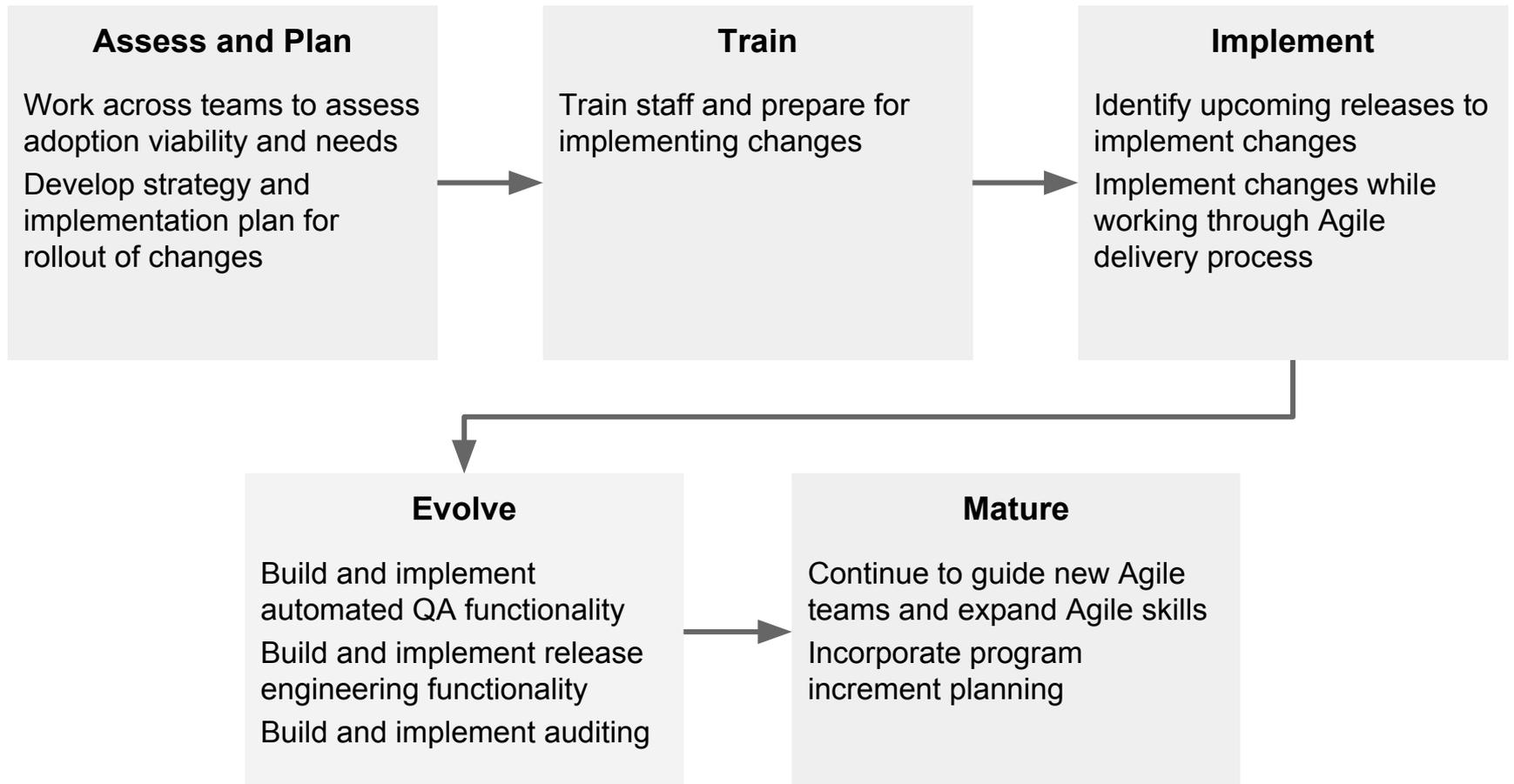
# The Development Process: Today vs. Tomorrow

As a result of this change process, code development will also evolve.



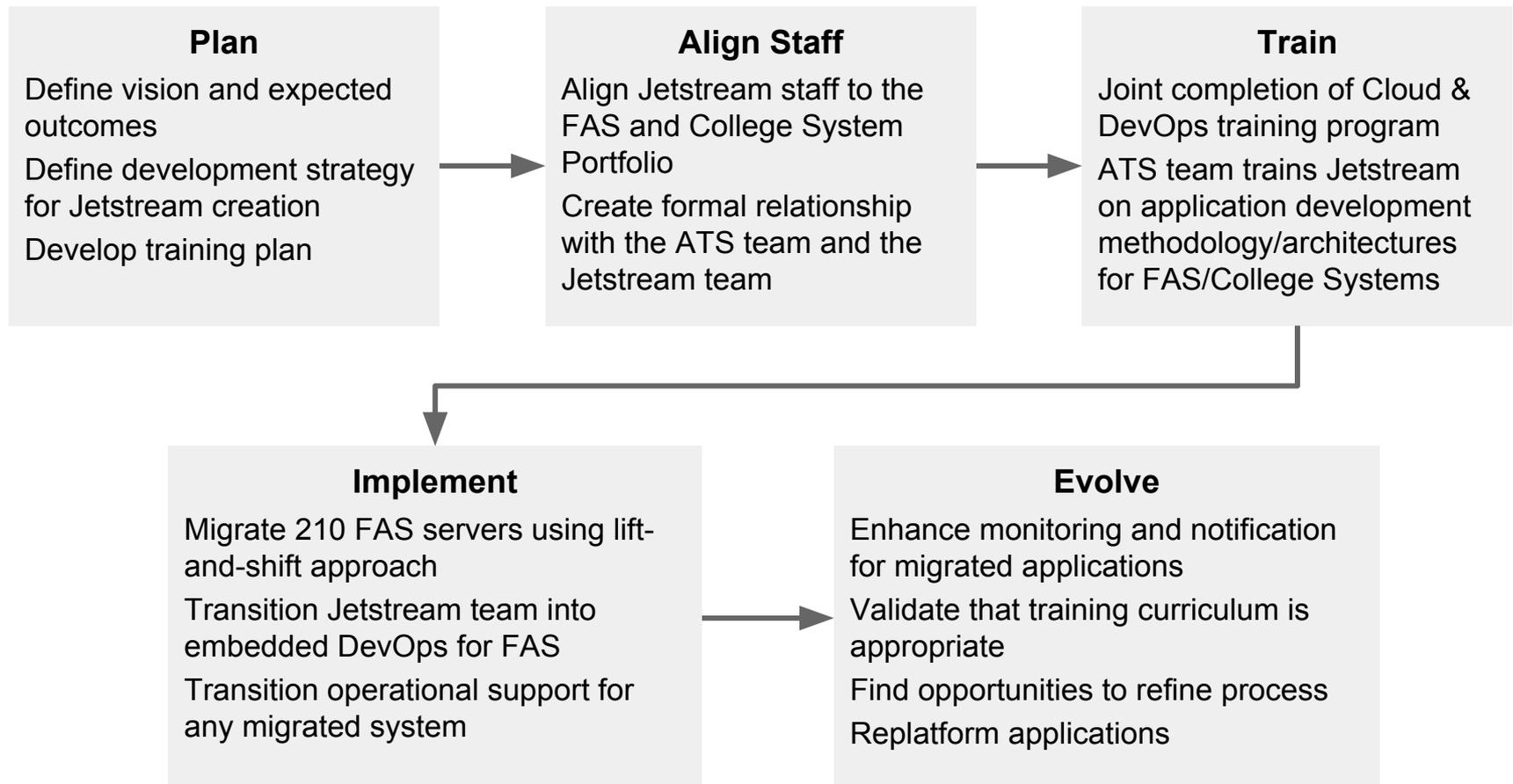
# ATS Transition: Development Process

**Our goal is to develop consistent project management, Agile, QA, and release management processes across HUIT.**



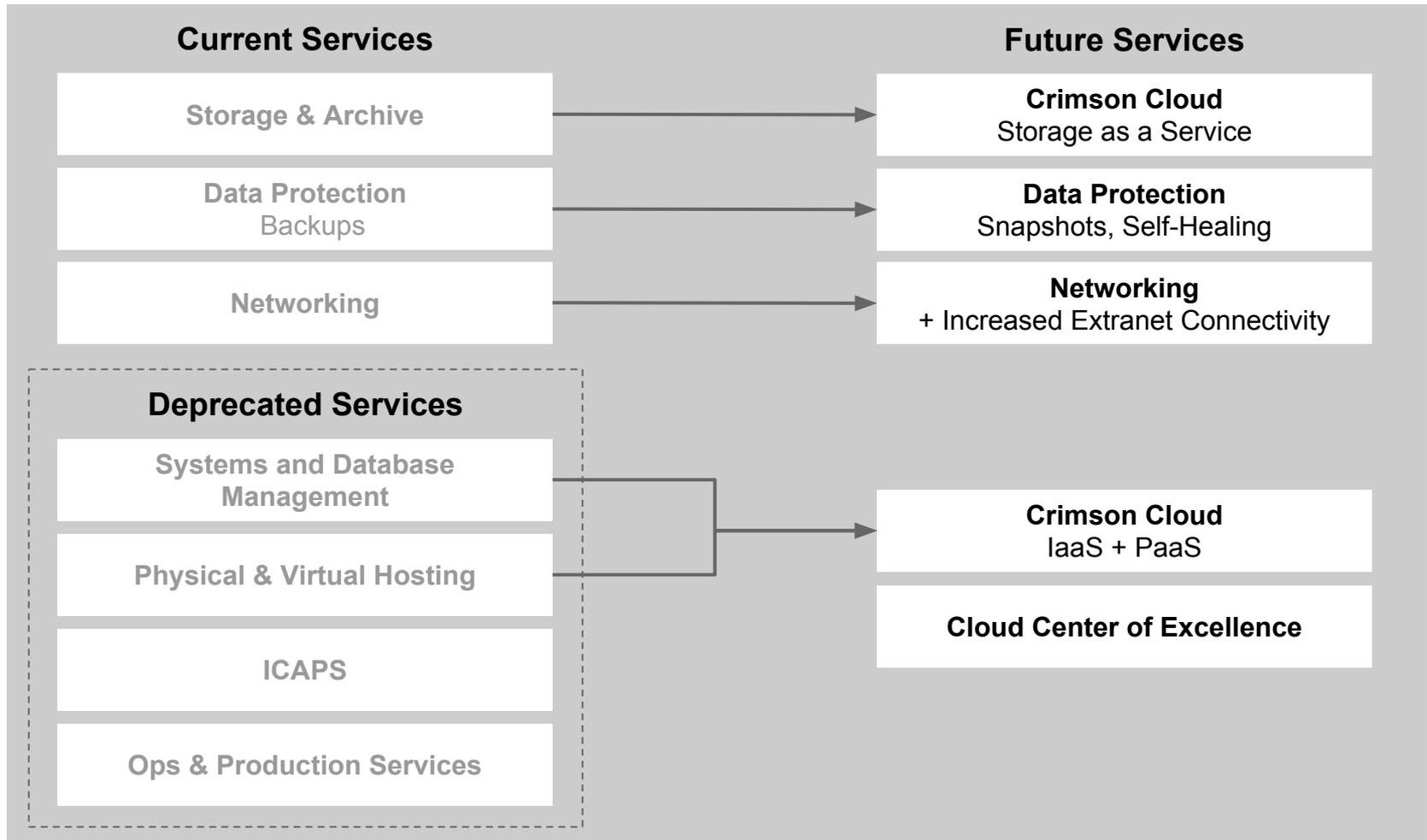
# ATS Transition: Embedded DevOps

**Introduce embedded DevOps and Jetstream teams, accompanied by operational support changes.**



# Infrastructure Services: Impact to the Service Catalog

Infrastructure services will evolve, remain the same, or be deprecated.



## Infrastructure Transition: Defining an Approach

Infrastructure as an organization does not exist in the future state; the overarching goal is to build the skills and supporting services to create the capability to enable DevOps.

Category	Definition	Outcomes	Lead Adopter
<b>Staff</b>	Transition sysadmin staff into new roles needed for the cloud	Build expertise and capability to support cloud services	Jetstream team, Cloud & DevOps program staff
<b>Project Development</b>	Complete associated projects with Infrastructure to enable future cloud services	Completed infrastructure services that utilize the cloud	Infrastructure teams (varies)

# Infrastructure Transition: Staff

## **Create a clearly defined plan for transitioning staff**

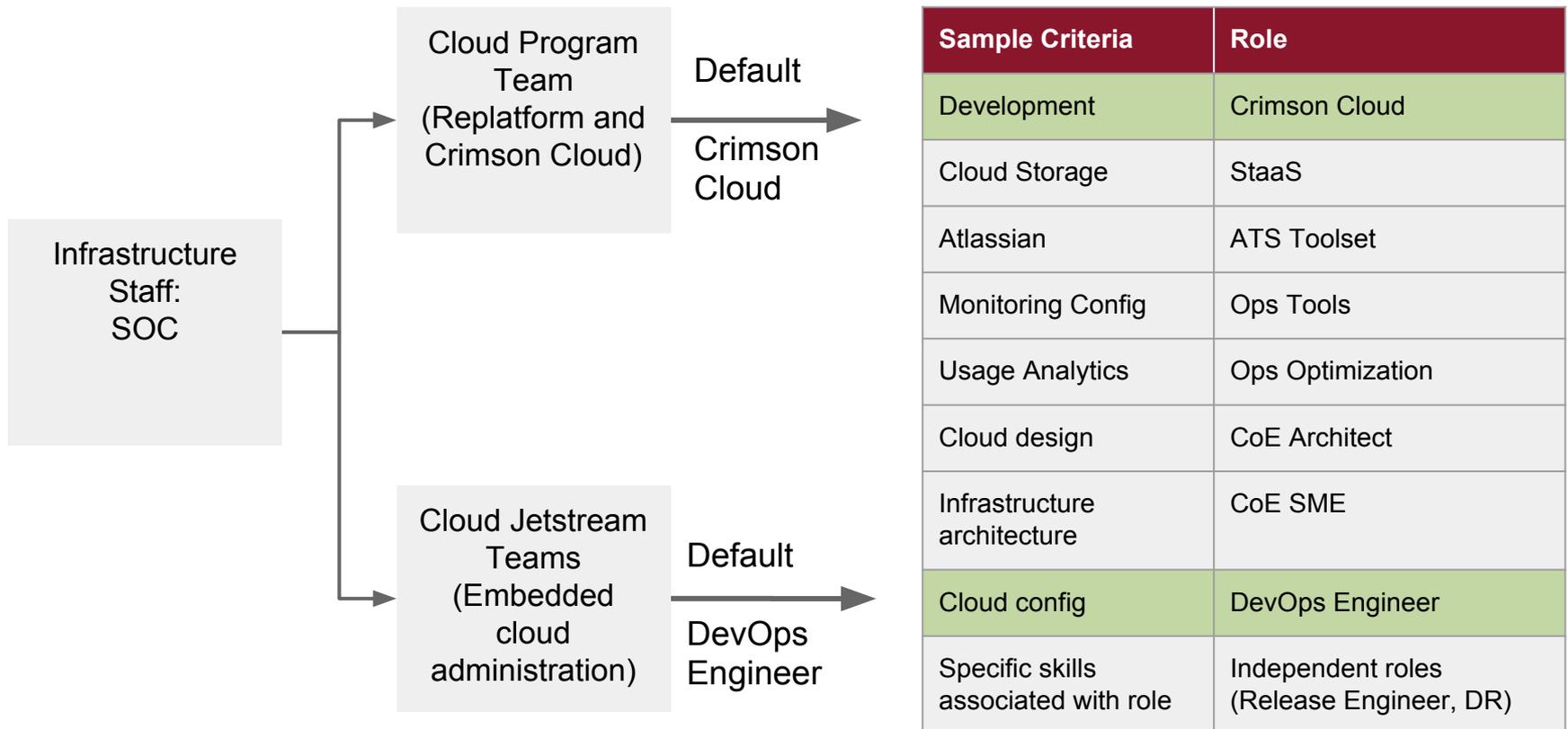
- Incorporate Jetstream transition to app teams as migrations take place
- Include backfill of cloud program staff as they migrate into different roles
- Identify a DR product owner

## **In support of migrations, the Cloud & DevOps program will drive transition of Infrastructure staff to enable cloud skills**

- Lift and shift
  - Skills to transfer existing applications to cloud environments
  - Application awareness
  - Replatforming within application teams
- Replatforming
  - Skills to assess existing application designs
  - Skills to refactor applications to conform to cloud standards
  - Skills to QA revised applications

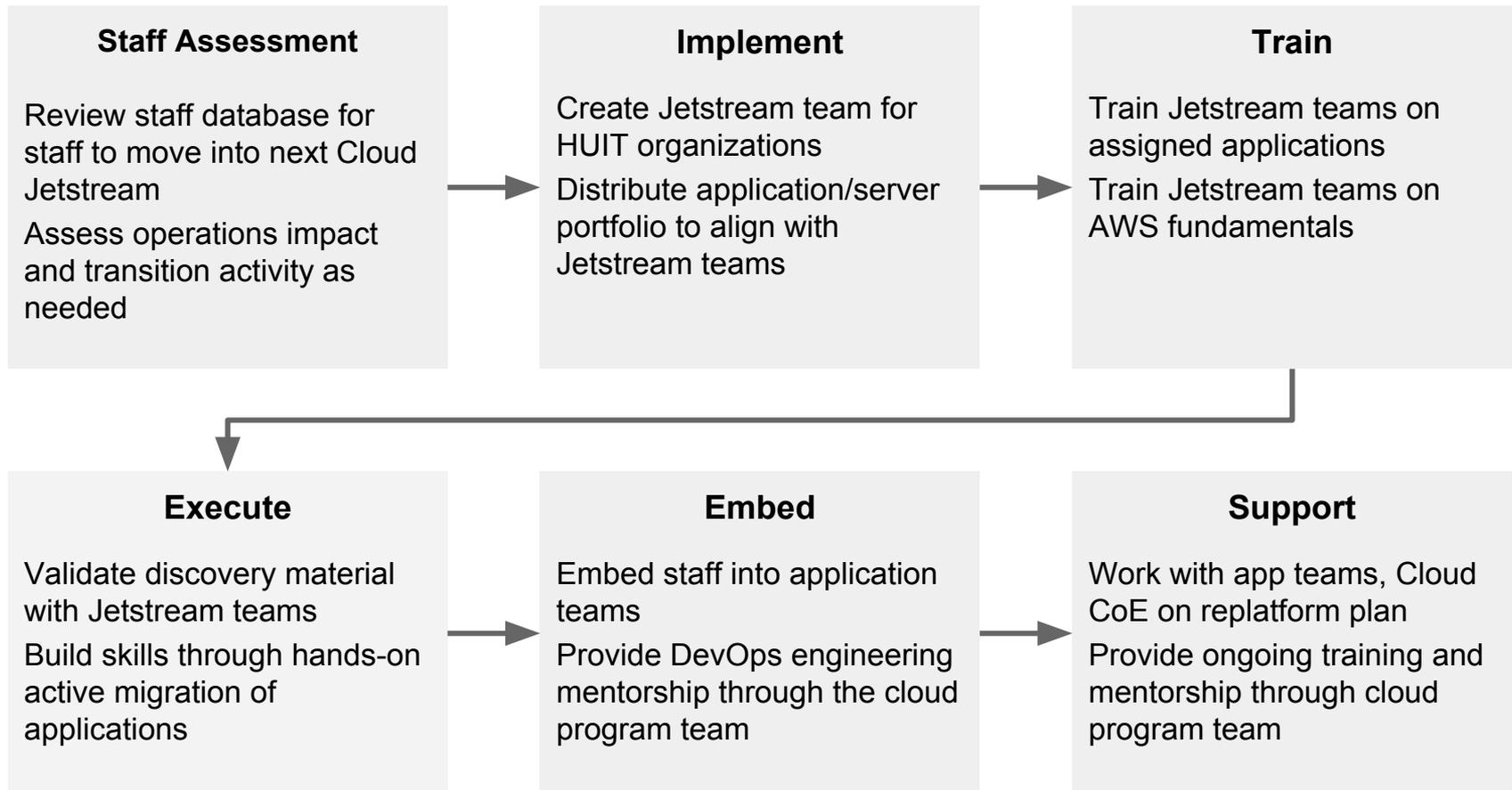
# Infrastructure Transition: Staff

Training paths for Jetstream and program teams have established progressions and criteria for end-state roles. However, team members can also work towards meeting criteria to move into other roles.



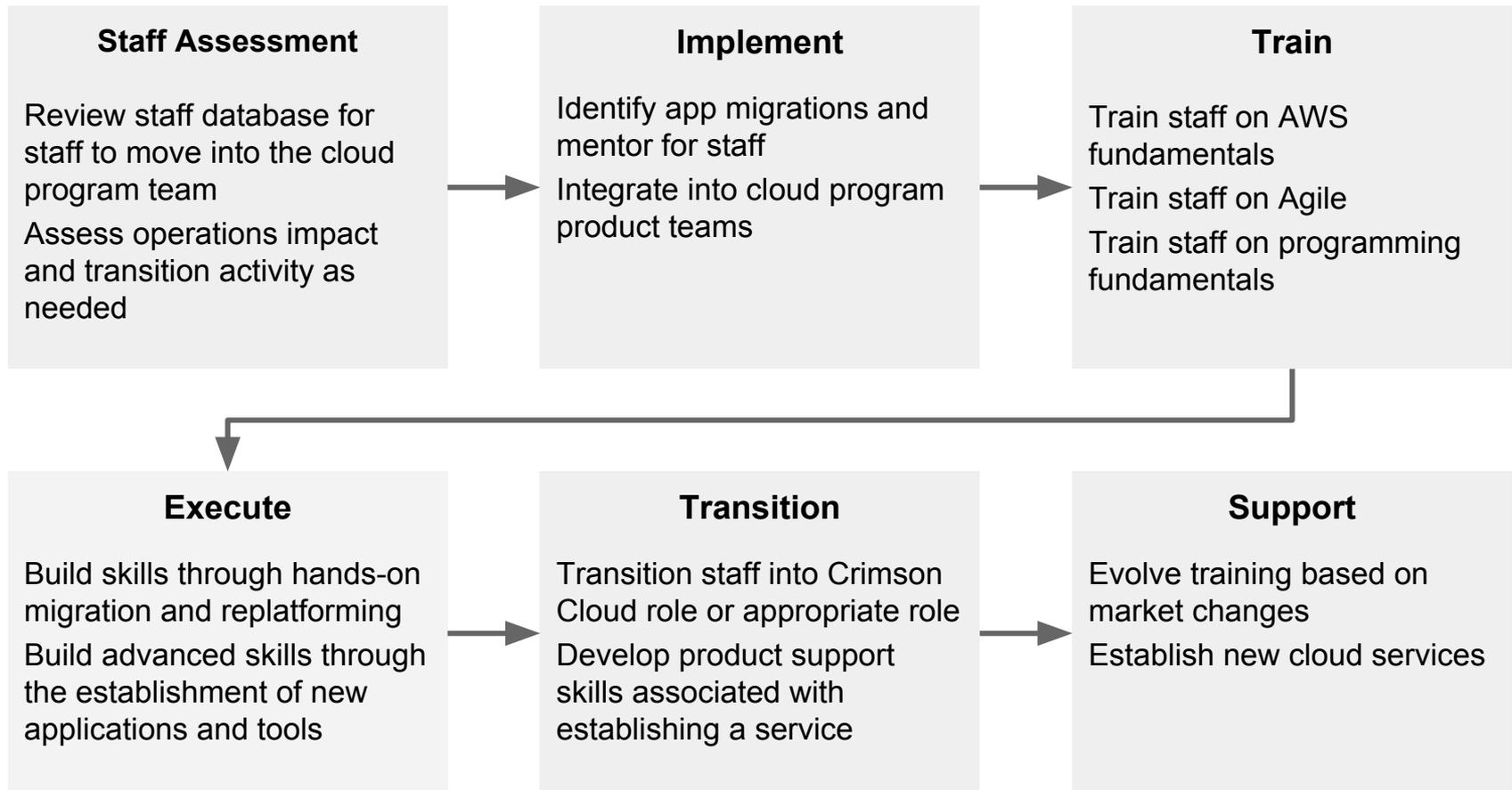
# Infrastructure Transition: Cloud Jetstream Teams

**Create small teams of cross-functional infrastructure teams to embed with application teams to support the portfolio in the cloud.**



# Infrastructure Transition: Cloud Program Team

**Migrate staff into a central cloud migration team to replatform applications and learn development skills.**



# Infrastructure Transition: Crimson Cloud

## Crimson Cloud will be structured as a product development and support team:

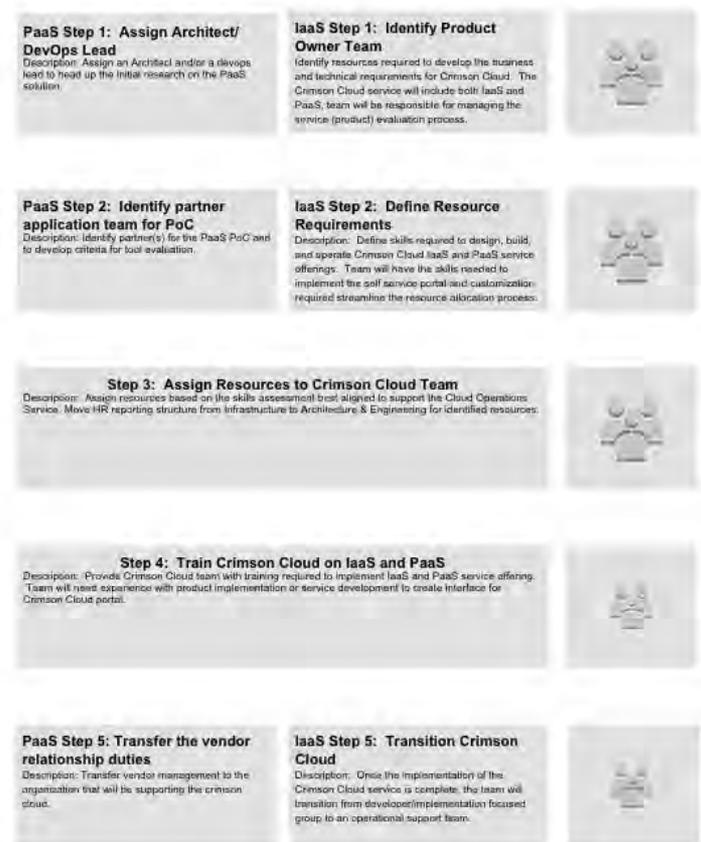
- Strong product owner to define service strategy and manage development
- Development and DevOps engineers to implement self-service capabilities
- Close work with Cloud CoE to ensure services are aligned to best practices and standards

## Why is this important?

Crimson Cloud will own all aspects of the cloud hosting service and be responsible for delivery of cloud services.

## Crimson Cloud Working Group

Regular sessions with user community will gather feedback on features, functionality, issues, and concerns.



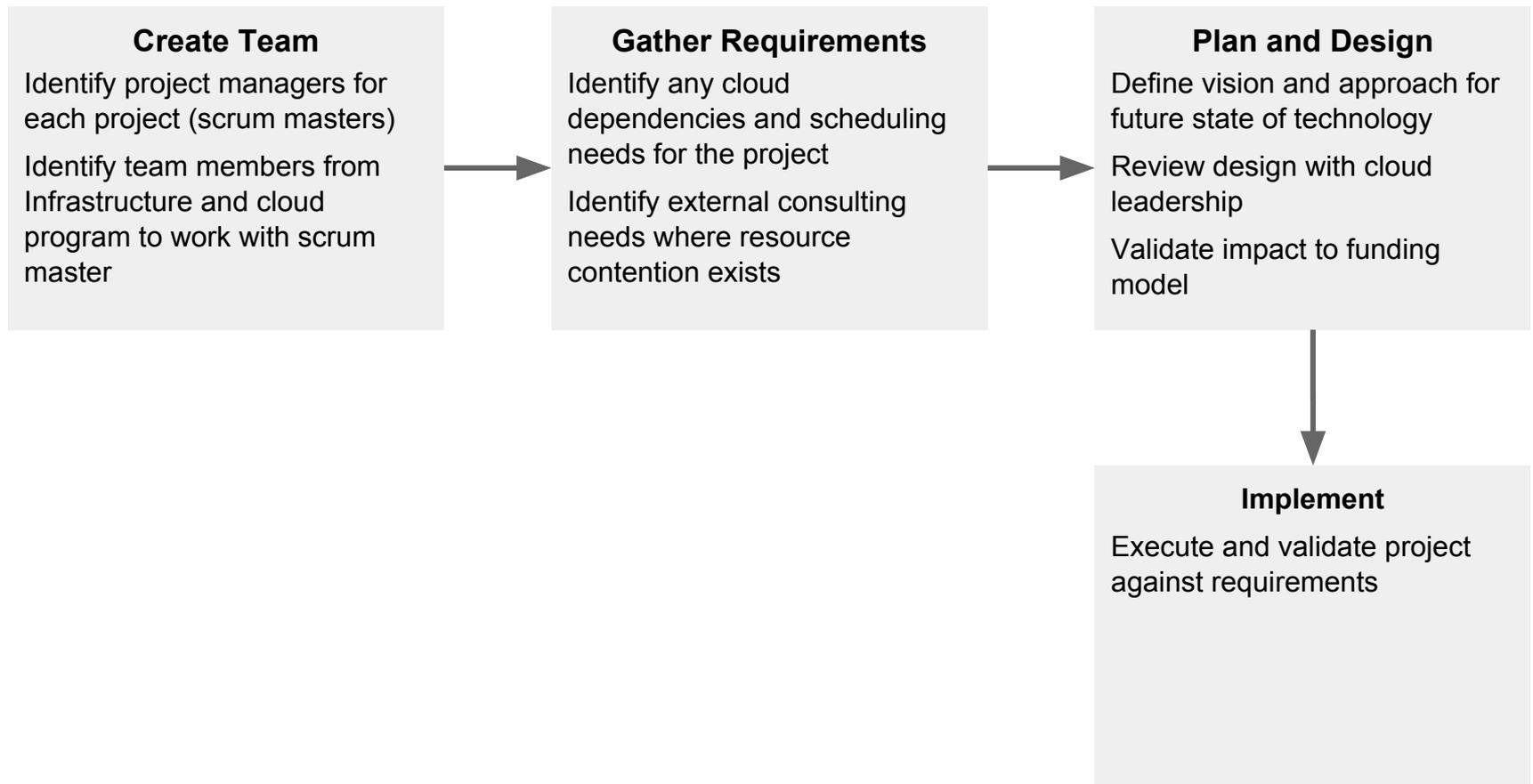
# Infrastructure Transition: Project Development

The projects below require coordination between the cloud and infrastructure teams.

Project	Definition	Outcomes	Leading Team
<b>Scheduler Service</b>	Evaluate Maestro for cloud viability and migrate or replace with cloud alternative	Scheduler service that allows direct application team scheduling updates	Operations
<b>Data Protection</b>	Evaluate risk and approach for providing ongoing protection of Harvard data in the cloud	Document outlining protection methods for Harvard data; establish associated services	Data Protection
<b>Storage Strategy</b>	Integrate storage strategy and cloud StaaS definition into coherent project implementation	Storage strategy document and associated implementation plan	Storage and Archive
<b>Billing</b>	Assess long-term viability of Slash system and either migrate or replace with alternative	Billing solution supported by multiple staff	Cloud and DevOps
<b>Cloud Network Firewall</b>	Establish centralized firewall approach to protect cloud assets	Cloud network firewall that allows Level 4 data to be hosted in the cloud	Extranet Connectivity
<b>GoldenGate</b>	Establish a database integration service	Direct database replication service	Database
<b>Network Simplification</b>	Migrate the existing complex ACL and network layered approach into a simplified approach that takes advantage of cloud technologies	Simplified network structure and associated service updates	Data Center Networking

# Infrastructure Transition: Project Development

All projects should follow standard project methodology. Below are extra steps to coordinate projects with the cloud team and architecture.





HARVARD UNIVERSITY  
Information Technology

# Cloud & DevOps 'Plan for the Plan'

## Cloud Migration Approach

# Agenda

- Purpose and Intended Outcomes
- Current Challenges
- Migration Approach Options
  - Replatforming
  - “Lift and Shift” and Jetstream
  - Cloud Migration Consultants
  - Organic Transition
- Recommendations

# Purpose and Intended Outcomes

## Purpose

To highlight observations from HUIT's current migration approach, describe alternative approach options that were considered, and provide a recommendation for a future migration approach.

## Intended Outcomes

- Understand the current migration constraints
- Describe alternative migration approach options
- Review and compare migration approaches
- Outline recommendations

# Current Challenges

**Replatforming has encountered multiple constraints, impacting our ability to meet program goals.**

## **Velocity of migrations not sufficient to meet the program goals**

- Current process migrates approximately 2-3 apps per two-week sprint
- Speed of migrations has increased as team gains more experience, but still not enough to meet program goals

## **Identifying applications to migrate is challenging**

- Developing a backlog of applications has been difficult

## **Training DevOps engineers takes substantial time**

- A considerable amount of time will be required to train the number of staff necessary to support the end state

## **Currently unable to migrate applications with Level 4 data**

- Infrastructure changes required to support Level 4 data have not yet been implemented

# Migration Approach Options

**There are four identified approaches for migrating code into the cloud environment. Their commonalities and differences are defined below.**

Approach	Codebase	Migration by	Tools	Outcomes
Replatform	Optimized for cloud	Cloud program team	Evolving Crimson Cloud toolset	Crimson Cloud toolset, migrated applications
Lift and Shift	Unchanged	Cloud program team	CloudEndure	Codebase in cloud, ready for independent replatforming efforts
Migration Consultants	Optimized for cloud	Consultants	Proprietary	Codebase in cloud, but ongoing support is dependent upon consulting
Organic	Varied	Application team	Varied	“Have and have not” silos, distributed approaches

# Migration Approach: Replatforming

## The Process

Applications are updated to maximize the utility of cloud features, and are then deployed to the cloud by this team. All new applications follow this process.

## Staffing

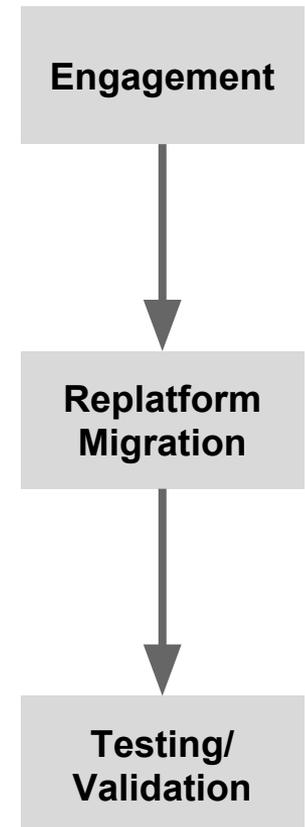
Cloud & DevOps program team platforms all applications

## Benefits

- Applications replatformed for the cloud see improvements in **quality**, improved alerting, and increased **reliability**
- **Crimson Cloud tools** — A library of reusable toolsets to maximize automation abilities of all application teams

## Challenges

- Limited number of DevOps engineers available to support replatforming; currently 8 engineers included in Wave 1
- Changes to the application infrastructure, requires time and work from application and DevOps teams
- Ongoing operations support model is not sustainable



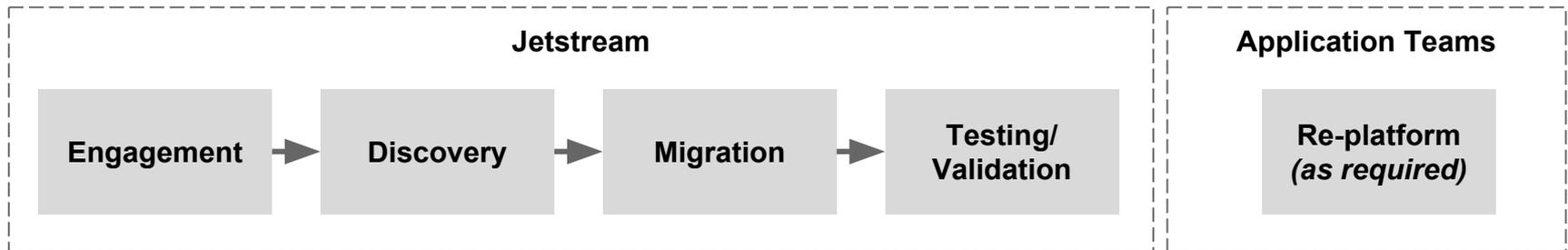
# Migration Approach: Lift and Shift (1/2)

## The Process

The application, infrastructure, and cloud program teams jointly identify dependencies, plan, and migrate apps. Application teams validate the migration was successful; embedded team members provide ongoing support.

## Staffing

Infrastructure team staff will be assessed and split into support teams to drive migrations using CloudEndure.



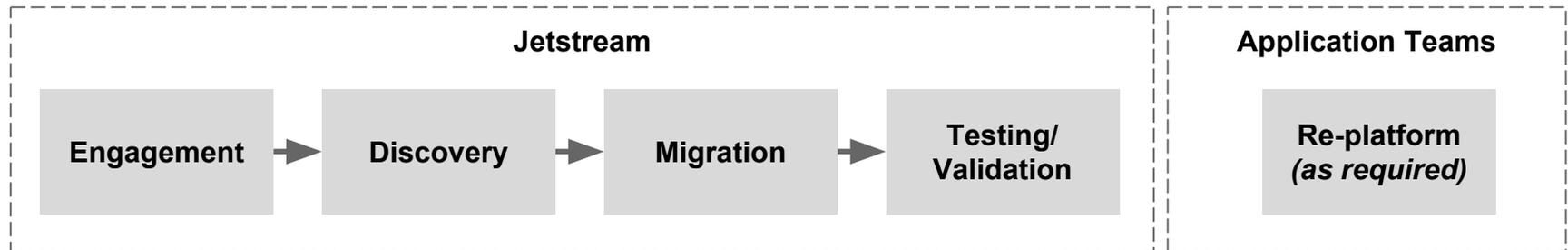
# Migration Approach: Lift and Shift (2/2)

## Benefits

- This approach reduces migration time, allowing us to decommission on-premise servers more quickly and reduce hosting costs
- Allows existing staff to manage migrated servers with limited knowledge of cloud technologies — this accelerates migration but extends timeframe to both train and replatform application

## Challenges

- The discovery process to determine application dependencies is intensive and potentially time-consuming
- Replatforming is dependent upon the application team prioritization and support for embedded infrastructure teams



# Migration Approach: Jetstream

“**Jetstream**” teams are **small, cross-functional groups** made up of sysadmins and DBAs from the SOC. These teams will have all of the skills necessary to support applications while also migrating them to the cloud using “lift and shift” methods. Benefits of Jetstream teams include ...

## Provide app support *and* migrations

- Performed in parallel
- Part of the application team
- Build application culture first

## Increase migration velocity

- “Like for like” migrations

## Cloud exposure to more staff, faster

- Effectively extends our training time

## Gradual expansion of skills

- Teams develop replatforming skills



# Migration Approach: Cloud Migration Consultants

## The Process

Hire a third-party vendor to migrate applications to the cloud. The vendor will define and manage the process based on their best practices and methods.

## Staffing

Migration will be staffed by vendor, but will still require significant help from application teams, network, and security to reconcile dependencies and integration into Harvard's network.

## Benefits

Delivery-focused vendor will accelerate the timeframe.

## Challenges

- HUIT loses in-house skills to support migrated applications, requiring us to rely on the vendor for support until HUIT is able to hire in necessary skillsets
- Overall **increased cost** for migrating applications

**Warning: Vendor-Dependent Process!**

# Migration Approach: Organic Transition (“Do Nothing”)

## The Process

Partner organizations are responsible for migrating on-premise apps and resources, with schedule controlled by partner organizations.

## Staffing

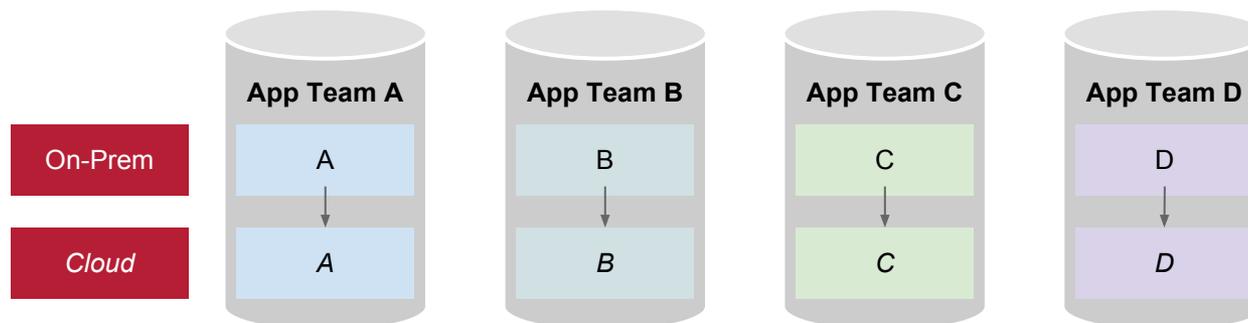
Partner organizations are responsible for staffing.

## Benefits

- No need for a dedicated Cloud & DevOps program

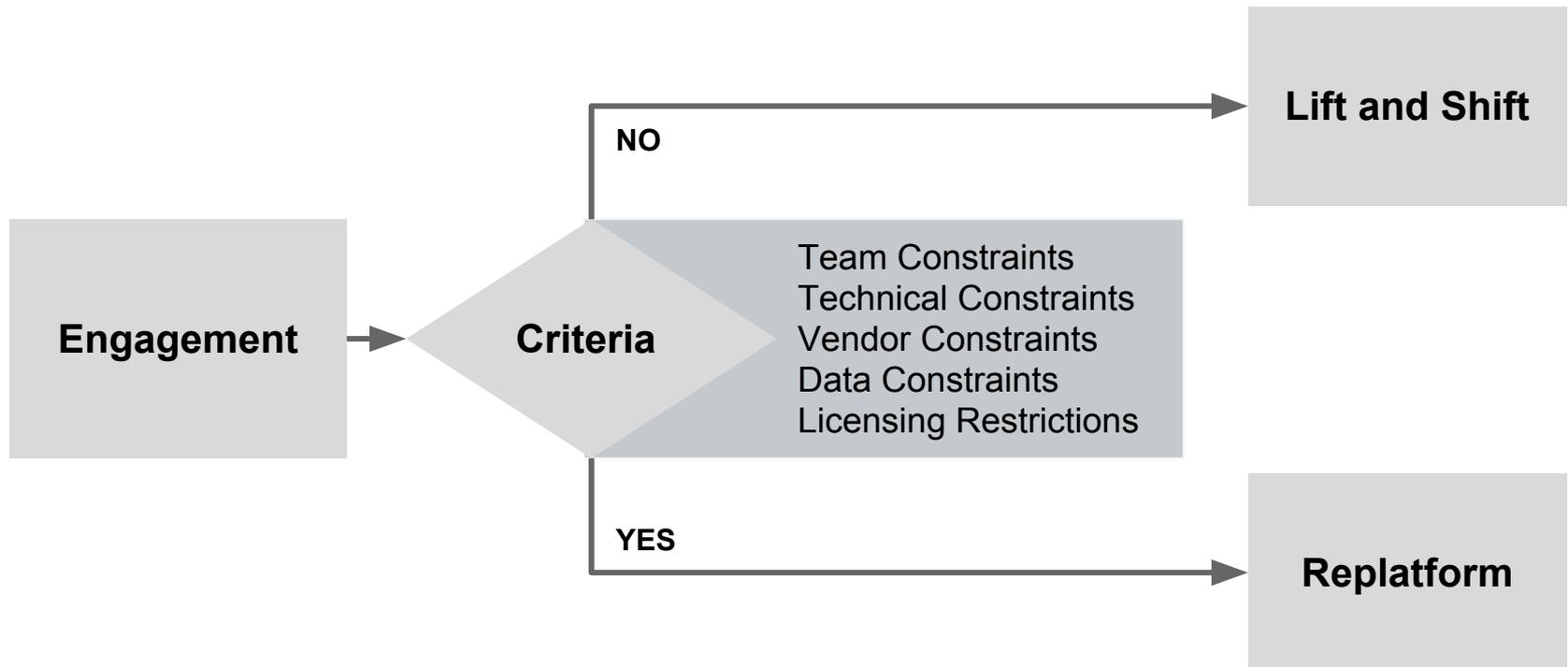
## Challenges

- Inconsistency in app migrations lead to information silos
- Increase in security risk due to inconsistent cloud deployments



## Recommendation: Hybrid Approach

After analyzing these migration approaches' strengths and weaknesses, we have decided to adopt a consolidated approach that offers the increased velocity and collaboration of lift and shift with the flexibility and cloud optimization of replatforming. The default approach is lift and shift, but there are instances where replatforming is appropriate.



# Benefits of a Hybrid Approach

## **Expands the number of staff that participate in the cloud program**

- Lift and shift enables the SOC and application teams to learn and apply basic cloud and AWS technologies
- Program team can focus on reusable artifacts and future-state services

## **Initial lift-and-shift phase provides agility and flexibility to app teams**

- Offers a streamlined approach to provision resources faster in order to address technical debt (e.g. outdated operating systems)
- Provides basic assurance that an application can run “as is” in the cloud; eliminates “too many changes at once”
- Reduces network complexity
- Enables teams to plan for replatforming according to partner timelines and with the support of an embedded resource

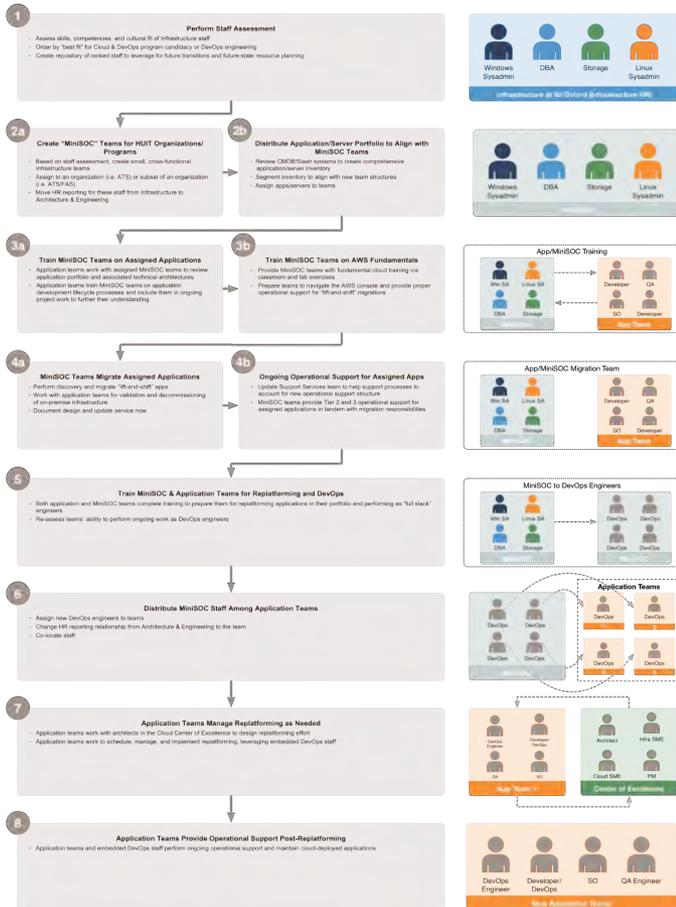
## **HUIT can save costs and meet program goals with current support levels**

- Allows for increased pace of decommissioning on-premise infrastructure
- Application support model remains “as is” until support resources are embedded into the team

# Staff Transitions: Lift and Shift/Replatforming

Please see the handouts for details of the staff transition approach.

## Migrate First ("Lift & Shift") Staff Transition Approach



## CLOUD & DEVOPS Staff Transition Workflow

This guide to the Cloud & DevOps team launch process provides an overview of the full timeline and guidelines for successful staff transitions.

### PHASE A: PLANNING

**Wave 0: Seed Staff**  
 Early January 2020 (ongoing)  
 Name individuals to special assignments. Wave 0 Core Team planning and leadership roles are responsible for driving or selecting foundational migration processes, activities, and techniques needed to migrate apps

**Wave 0: New Hires**  
 January/February 2020 (continuously posted, advertised positions)  
 Recruit new skills and create new positions:

- Senior DevOps Engineer
- Senior Cloud Architect
- ICDR Project Manager
- Senior Applications Administrator
- Cloud Architect

**Additional Effort: Staff Communication and Outreach**  
 January 2020 (in progress)  
 Establish Cloud & DevOps as a formal HJT Program. Produce and distribute notifications, known timelines, and other supporting information for HJT staff regarding the Cloud & DevOps team and staff transition process.

### PHASE B: DESIGN & MIGRATION

**Wave 1: Pilot Tools, Establish Processes, and Migrate Applications**  
 January 2020  
 Name staff to Wave 1 special assignment. These staff will establish foundational migration processes and best practices. The following selection criteria will be used to name this staff. (Note: Wave 1 transition is streamlined due to the wave's shortened 6-month duration.)

- 1. AWS Bootcamp experience
- 2. Experience with IAM, ACE, or HPAC applications
- 3. Skills pertaining to the technology stack associated with applications earmarked for Wave 1
- 4. Scripting skills and/or software development experience
- 5. Primary work can be fully transitioned operationally

**Waves 2-3: Build Skills, Migrate Apps, and Gain Experience**  
 Wave 2 (Hires): March 2020 to June 2020  
 Wave 2: July 2020 to June 2021  
 Wave 3: July 2020 to June 2021  
 Use the repeatable process below to train, recruit, assess, and transition internal staff across HJT from traditional roles to the Cloud & DevOps teams, with staff transitions scheduled across the three remaining waves. Establish and apply a rolling process with continuous cycles.

### Repeatable Process (3-4 Weeks): Assigning Staff to Waves

**Step 1: Create Internal Postings**  
 Wave 1 posting (Starting: Midgy: March 2020)  
 Wave 2 postings: June 2020  
 Wave 3 postings: June 2020  
 Based on the volume of apps to be migrated per wave, management determines the total number of staff positions required to meet objectives. Prepare and publish job descriptions internally at least 1 month prior to the start of each wave. Build short question set (2-3) for applicants.

**Step 2: Apply for Positions**  
 Positions will be posted in HJT for 2 weeks. Interested HJT staff may apply for internal positions by submitting the following to a Cloud & DevOps dedicated application email:  
 • Updated resume  
 • Letter of interest and responses to question set. Letter should clearly candidate's interest, skills/dominant, and career aspirations

**Step 3: Review and Assess HJT Internal Applicants**  
 Duration: 2-3 days  
 Cloud & DevOps and Data Center Service leadership review submissions and apply the following selection criteria to assess willingness, competency, and experience:  
 1. AWS Bootcamp or other AWS training completed (mandatory)  
 If yes, continue; if no, continue only if the candidate has functional skills/experience supporting or developing apps with similar technology stacks to those needed for the wave. Otherwise, only the candidate's top experiential and skills for alignment to future waves  
 2. Demonstrated experience with applications identified in the planned wave (mandatory)  
 If yes, continue; if no, continue only if the candidate has functional skills/experience supporting or developing apps with similar technology stacks to those needed for the wave. Otherwise, only the candidate's top experiential and skills for alignment to future waves  
 3. Scripting or development experience (preferred)  
 If yes, continue; if no, continue if there is need or an adequate number of open positions  
 4. Agile experience or attended Agile training (preferred)  
 If yes, continue; if no, continue if there is need or an adequate number of open positions  
 5. Deep expertise in operational toolsets (preferred)  
 If yes, move to interview with Cloud Ops team; if no, interview with Migration Team  
 Candidates with both mandatory and preferred skills will be considered more strongly. All else equal, preferred skills will be used as a tiebreaker. The process for limited number of non-technical roles (forum masters, sourcing team, etc.) will follow a similar process, but with criteria specific to each role.

**Step 4: Interview HJT Applicants**  
 Duration: 2-3 days  
 For Wave 1, the Cloud & DevOps leadership team and Data Center Service leadership will conduct interviews to assess experience, expertise, alignment to HJT values, and overall cultural fit. For Wave 2-3, the process will also include a group interview with select Cloud & DevOps team members so that candidates can consult with staff already performing cloud work.

**Step 5: Notify Candidates**  
 Duration: 1-3 days  
 Teams work with HR to notify selected individuals. Sponsors and their managers receive letters regarding effective date and HR changes, if any (grade, salary, reporting, etc.). Those not selected for summer wave will receive feedback and/or advice on the wave they may align best with their skill set.

**Step 6: Prepare Transition Documentation**  
 Duration: 1 week  
 Selected individuals work with their managers to create a transition plan, including allowing for any communications with or assistance for other staff impacted by the transition. When considering a transition's impact, the objective is to balance operational and migration needs. Performance management may be a joint activity between former and new supervisors.

**Step 7: Onboard New Staff**  
 Duration: 1 day  
 Selected candidates attend Cloud & DevOps orientation and physically transfer to SO Church St. for assignment.

### PHASE C: TRANSITION

**Ongoing: Transition Prior Waves to Core and/or Service Teams**  
 As each new wave begins, selected individuals from prior waves will transition from SO Church St. to core and/or service teams. To ensure smooth transition between waves, there will be an overlap period during which outboard staff will provide mentorship to incoming resources. Other key activities occurring in connection with waves include:  
 • HR assumption of salary and grade for equity  
 • Space planning activities to accommodate transfers  
 • Assignment of staff to new operating budgets as appropriate

# Migration Workflow: Lift and Shift

