

Innovation Insight for Continuous Infrastructure Automation

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Initiatives: [Infrastructure, Operations and Cloud Management](#)

Continuous infrastructure automation extends the agile and DevOps practices used in software development to infrastructure engineering. I&O leaders must rapidly and safely deploy infrastructure, using a continuous delivery pipeline to improve business agility and reliability.

Additional Perspectives

- [Summary Translation: Innovation Insight for Continuous Infrastructure Automation](#) (12 May 2021)

Overview

Key Findings

- Traditional methods of infrastructure automation make it difficult to manage the increasing scale and complexity of modern, distributed infrastructures.
- Cloud-native infrastructure requires infrastructure and operations personnel to adopt agile software development practices, such as version control and automated testing. Agile practices are essential for improving infrastructure agility and reliability.
- I&O leaders are under pressure to continuously optimize infrastructure utilization, enhance service reliability and reduce technical debt; however, I&O staff often fail to apply the right practices or tools to achieve these goals.
- Continuous infrastructure automation requires changes to policies, processes, skills and roles, including the integration of workflows with application development teams.

Recommendations

I&O leaders responsible for infrastructure automation should:

- Support increasingly complex infrastructure at scale by applying continuous delivery principles of version control, continuous testing and integration to infrastructure deployments.
- Enable rapid delivery of cloud-native applications by building a continuous infrastructure automation pipeline to apply agile development practices to infrastructure.
- Optimize infrastructure utilization and service reliability by applying a software engineering mindset, as well as software engineering practices and tools to infrastructure engineering.
- Deliver infrastructure with a product-centric approach by sharing performance metrics with software engineering teams and fostering end-to-end accountability for achieving business goals.

Strategic Planning Assumption

By 2025, 70% of organizations will complement continuous delivery of applications with continuous infrastructure automation to improve business agility, which is a significant increase from fewer than 20% in 2021.

Introduction

Organizations adopt continuous integration/continuous delivery (CI/CD) practices for applications to realize faster business value and increase customer satisfaction. Continuous infrastructure automation (CIA) makes it possible to apply these practices to I&O, enabling them to design and deploy infrastructure faster, reduce cycle times and align more closely with application delivery teams. As I&O and application teams converge to form platform and product teams, CIA will serve as the foundation for delivering high-reliability, high-availability infrastructures.

Continuous infrastructure automation extends agile software development techniques to infrastructure engineering, including practices such as version control, automated testing and CI/CD.

CIA provides an automation blueprint to realize the full benefits of infrastructure as code. It involves taking an agile software development life cycle (SDLC) approach to plan, build, test, secure, deploy and monitor infrastructure. This approach provides two immediate benefits from seemingly opposing vantage points:

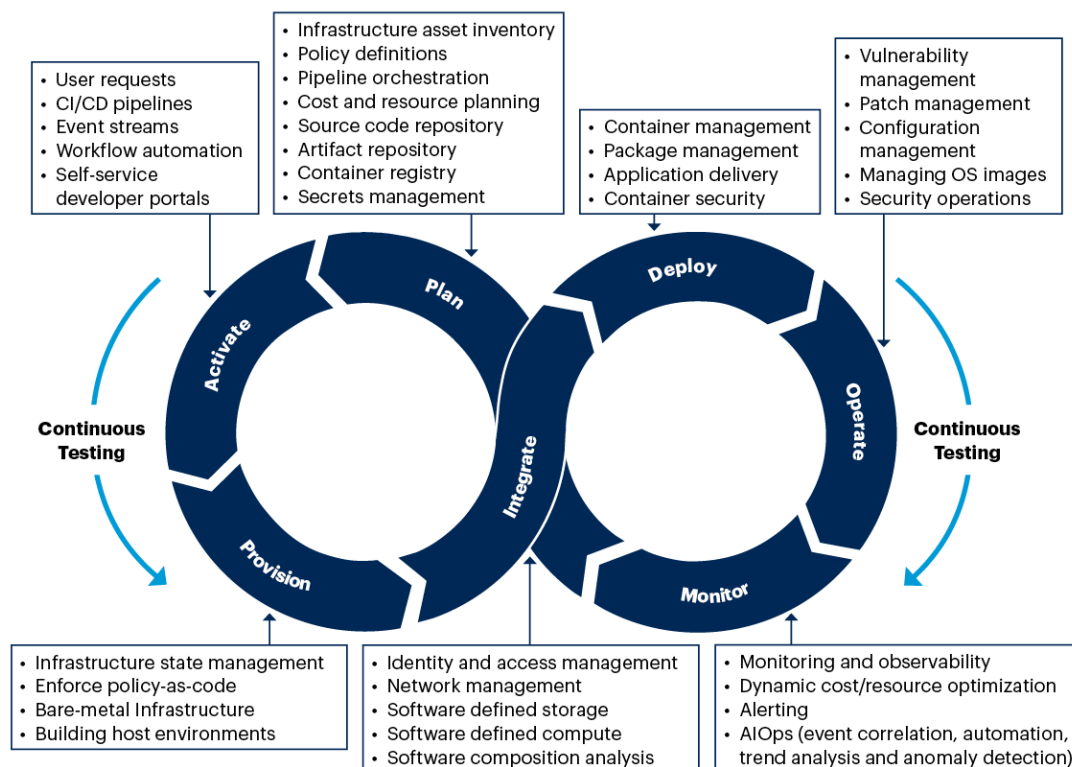
1. Improved agility by using infrastructure automation pipelines
2. Improved reliability, security and compliance by automating validation tests, and integrating security and compliance policies into the infrastructure delivery pipeline

"It is a deep-seated biological impulse to slow down when we feel cautious. For humans, slow is safety. Problem is, software physics are different. Speed is safety. It's more like ice skating, or riding a bicycle: The slower you go, the more dangerously you wobble." — Charity Majors, CTO, [Honeycomb.io](https://honeycomb.io)

Figure 1 depicts the different phases of CIA. For a selection of CIA vendors and tools that map onto these phases, see Table 1 in the Representative Providers section.

Figure 1: Continuous Infrastructure Automation Pipeline

Continuous Infrastructure Automation Pipeline



Source: Gartner
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Gartner

Description

CIA extends agile software development practices to infrastructure, including version control, test automation and CI/CD. The goal is to automate the end-to-end delivery of infrastructure, much like continuous delivery of applications. DevOps teams must build an infrastructure automation pipeline for continuous delivery of infrastructure similar to using a CI/CD pipeline for continuous delivery of applications.

CIA enables I&O teams to deploy any change to production rapidly, but safely. The CIA pipeline comprises a sequence of automated actions and automated verification tests. I&O teams can rapidly deploy changes, because all work is completely automated and does not require human judgment or manual intervention. The pipeline deploys all changes safely because each stage in the pipeline is tested for completeness and correct operation.

I&O leaders should take six steps to build an effective CIA pipeline:

Step 1. Pework. Before beginning to work on the pipeline, I&O leaders must establish objectives and prerequisites. These prework tasks include:

- Defining production environment characteristics (i.e., cloud, edge or on-premises).
- Creating test environments and test harnesses with test data management.
- Planning for the needs of mutable and immutable infrastructure. With mutable infrastructure, changes are made on live production systems; whereas immutable infrastructure is never updated once instantiated (when changes are required, the infrastructure is simply replaced).
- Designing for state-based (or declarative) automation over behavior-based (or procedural) automation. Procedural definitions, also called scripts, are an ordered sequence of instructions to accomplish a specific task. Declarative definitions specify a desired state of a system without explicitly specifying the required steps.
- Implementing a version control system to store infrastructure pipeline definitions. This also requires training and education on version control practices for I&O teams.
- Creating a staged pipeline strategy for secure, compliant and reliable infrastructure delivery.

Step 2. Activation: Establish pipeline activation triggers to initiate the infrastructure automation workflow. For example, I&O teams can trigger infrastructure automation using a service catalog that accepts user requests, CI/CD pipelines, source control commits, event streams and cloud management platforms. During the activation phase of the CIA pipeline, data is collected and made available for subsequent phases.

Step 3: Build Actions: The specific actions in this step will depend on the target infrastructure. Build actions can be scheduled to run periodically or can be invoked by a CI orchestrator. Infrastructure automation tools, shell scripts, cloud provisioning tools or configuration management tools can perform the desired actions.

Step 4: Build Validations: Validations answer the question, “How can I prove that this action has worked?” Each action must have a corresponding automated test suite to verify it is correct (for example, calling APIs to check if cloud resources were provisioned correctly). Just as development teams scan application code for security vulnerabilities and policy violations, infrastructure teams can do the same for infrastructure code. Examples of open source tools for policy enforcement include [checkov](#), [driftctl](#), [terrascan](#) and [open policy agent](#).

Step 5. Deploy: The specifics of a target environment will determine the precise workflow for deployment. With infrastructure as code and using Git as the version control system, I&O leaders should apply the same trunk-based Git deployment model that is used for applications. For example, [GitHub flow](#) offers one such pattern and advocates that any artifact in the main branch is always deployable.

Step 6. Instrument, Monitor and Alert: Instrument the pipeline to get telemetry from pipeline runs. Monitor the processes that affect or change deployed infrastructure. Monitoring is the second line of defense (after validation) to ensure that infrastructure is meeting availability performance objectives. Establish notification mechanisms and procedures to automate incident response.

Benefits and Uses

CIA Improves Infrastructure Agility and Reliability

CIA applies a structured, software engineering-driven approach to I&O automation. This consistent approach increases infrastructure agility, improves reliability and reduces time to value. The benefits of CIA to I&O are identical to the impact of agile and DevOps practices on application development.

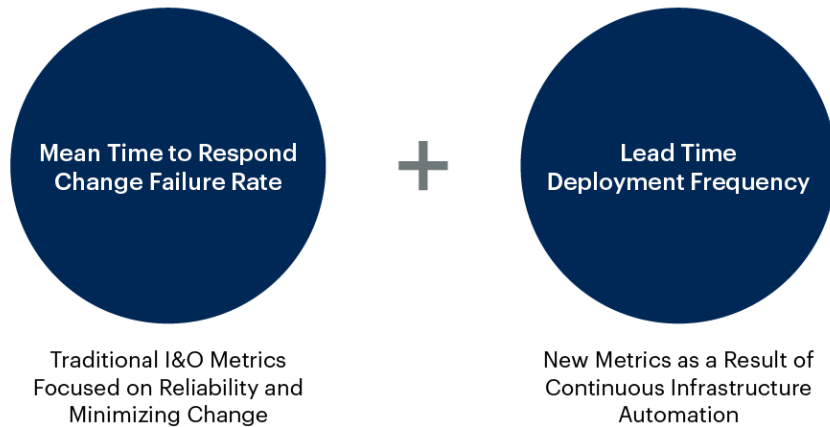
For example, test automation is often ignored in the infrastructure delivery life cycle. By integrating and automating tests at every step in the pipeline, teams can fail fast and fix errors early in the cycle. Continuous testing and verification both ensure consistent, repeatable infrastructure delivery.

CIA Enables I&O Teams to Share Speed and Agility Metrics

CIA enables I&O leaders to match the cadence of infrastructure delivery with that of application delivery. In Gartner's 2020 Adapt I&O Processes Survey, 76% of top-performing I&O leaders responded that they share success metrics with application teams. ¹ Top performers take accountability for both agility metrics, such as lead time and deployment frequency, and stability metrics, such as time to response and change failure rate (see Figure 2). Using CIA can enable I&O leaders to improve their infrastructure delivery cadence — reducing tensions between the priorities of I&O and application development teams and simplifying the transition to DevOps.

Figure 2: Continuous Infrastructure Automation Enables I&O Leaders to Deliver on Both Reliability and Agility Objectives

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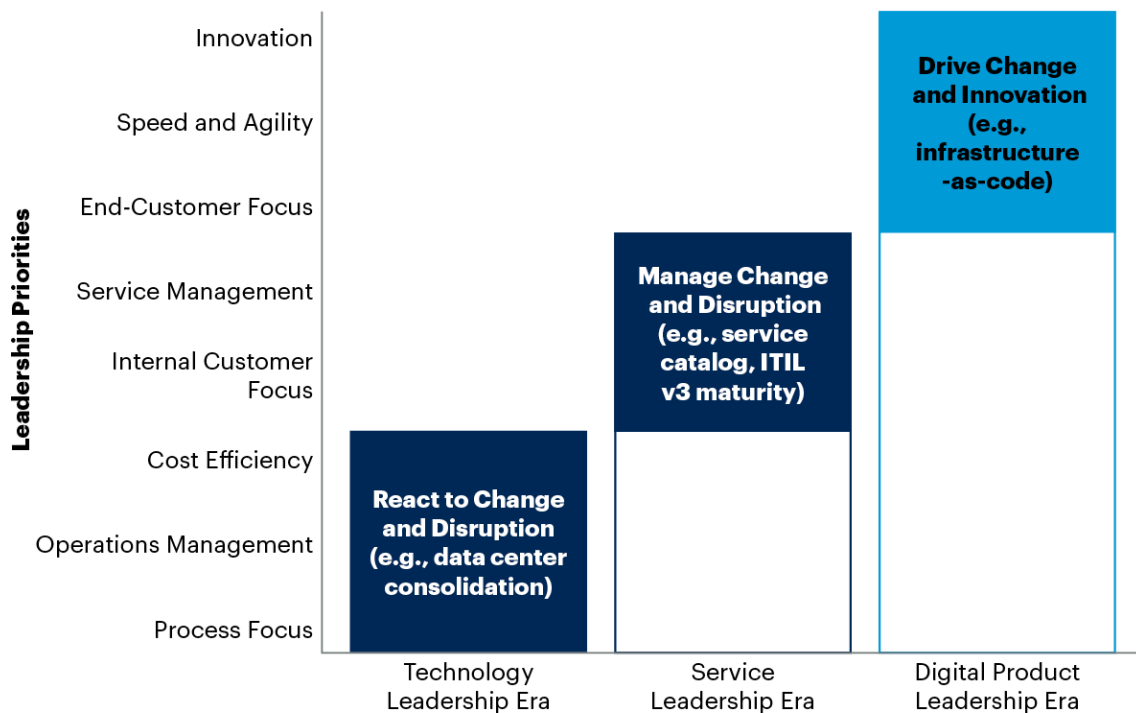
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Gartner's 2020 Adapt I&O Processes Survey shows that 76% of top-performing I&O leaders share success metrics with application teams.

CIA Encourages a Product Leadership Mindset

CIA enables I&O leaders to transition from technology-centric or service-oriented mindset to a product leadership mindset. As organizations build digital products and explore new business models, the continuous delivery of infrastructure helps I&O leaders support rapid product innovation. Infrastructure platform teams can use CIA as a force multiplier to improve agility of infrastructure teams (see Figure 3).

Figure 3: Drive Change and Innovation With a Product Leadership Mindset

Drive Change and Innovation With a Product Leadership Mindset

Source: Gartner
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Gartner

Risks

Infrastructure automation that focuses on tools (rather than end-to-end processes) leads to tool sprawl and fragmented silos of automation. This complexity impedes infrastructure agility. Therefore, I&O leaders must map out the infrastructure delivery process and implement an integrated pipeline that is easier to manage.

CIA demands a software engineering mindset to infrastructure delivery. This requires new skills, practices and tools. In many organizations, infrastructure automation is treated as synonymous with configuration management. The risk is a piecemeal approach to introducing tools without adequate consideration of prerequisite practices, such as version control and continuous testing. The lack of these practices and skills will reduce quality and destroy confidence in the CIA approach.

Another limiting mindset is that infrastructure must not change often and that any change is highly risky. This mindset creates inherent friction between CIA principles and existing styles of change management, such as ITIL. CIA eliminates the need for manual supervision and human approval decisions, because the CD pipeline documents, automates and verifies all infrastructure changes.

As organizations implement infrastructure as code, the biggest risk is not applying the lessons and practices of continuous application delivery to infrastructure delivery.

Adoption Rate

Based on Gartner client conversations, we believe that fewer than 20% of our clients leverage CIA. Traditional infrastructure automation approaches — using configuration management tools to provision resources and automate configuration — are mature and widely prevalent. However, the idea of continuous delivery of infrastructure by applying software development practices is still new and far from mainstream adoption.

We expect the following trends will drive increased adoption of CIA:

1. Cloud adoption and cloud-native architecture, such as immutable infrastructure and container management
2. Implementing GitOps best practices using open-source software (OSS) tools, such as Argo CD and Flux CD
3. The transition from monolithic to microservices application architecture patterns, driving the need for infrastructure agility
4. Product and platform teams unifying software engineering expertise and infrastructure management with shared incentives and objectives
5. Increased adoption of site reliability engineering, which brings a software engineering mindset to I&O

Recommendations

I&O leaders responsible for infrastructure engineering and modernization should:

- Manage the increasing scale and complexity of infrastructure automation by applying continuous delivery principles of version control, continuous testing and integration.
- Support rapid delivery of applications by building a CIA pipeline to apply agile development practices to infrastructure.
- Apply a software engineering mindset to enhance infrastructure resilience and reduce technical debt by continuously building and verifying infrastructure changes across the pipeline.
- Deliver infrastructure with a product-centric approach by sharing performance metrics with software engineering teams and fostering end-to-end accountability for achieving business goals.

Representative Providers

Table 1 highlights a representative sample of providers that offer CIA tools across the delivery pipeline.

Table 1: Platforms and Tools That Map to Different Phases of the CIA Pipeline

(Enlarged table in Appendix)

Automation Activity ↓	Platforms and Tools ↓
Plan	
Infrastructure asset inventory	BMC Helix, ManageEngine ServiceDesk Plus, ServiceNow ITOM
Policy definitions	Market Guide for Compliance Automation Tools in DevOps
Pipeline orchestration	Market Guide for DevOps Value Stream Delivery Platforms and Market Guide for DevOps Value Stream Management Platforms
Cost planning and analytics	Magic Quadrant for Cloud Management Tooling
Source code repository	BitBucket, GitHub, GitLab
Artifact repository	JFrog Artifactory, Sonatype Nexus, Inedo ProGet, Tidelfit Catalogs
Container registry	Harbor, Red Hat Quay, JFrog Container Registry, Amazon ECR, Azure Container Registry, Google Container Registry
Secrets management	HashiCorp Vault, Docker Secrets, Thycotic Secret Server, CyberArk Privileged Access, AWS Secrets Manager, Azure Key Vault, Google Secret Manager
Activate	
User requests	Magic Quadrant for Cloud Management Tooling
DevOps pipelines	Market Guide for DevOps Value Stream Delivery Platforms and Market Guide for DevOps Value Stream Management Platforms
Event streams	Apache Spark and Kafka, AWS Lambda, Google Cloud Functions, Microsoft Azure Functions, Confluent, IBM Streams, Apache Storm
Workflow automation	Market Guide for Service Orchestration and Automation Platforms
Self-service developer portals	Backstage.io, Crossplane, Mia-Platform
Provision	
Infrastructure state management	Market Guide for Infrastructure Automation Tools
Enforce policy as code	Market Guide for Compliance Automation Tools in DevOps
Bare-metal configuration	Liquid, RackN, Canonical MAAS, HPE iLO, HPE Synergy, Dell iDRAC, Lenovo IMM, Intel Rack Scale Design
Building host environments	Market Guide for Infrastructure Automation Tools
Integrate	
Identity and access management (IAM)	Magic Quadrant for Access Management and Market Guide for Identity Governance and Administration
Network management	Market Guide for Network Automation and Orchestration Tools
Software-defined storage (SDS)	Hyperconverged (VMware vSAN, Nutanix Acropolis, Cisco HyperFlex, HPE SimpliVity), NetApp ONTAP
Software-defined computing (SDC)	Virtual machines (VMware ESX), Microsoft Hyper-V, Nutanix AHV, Linux KVM, AWS EC2, Azure VMs, Google Cloud instances and containers (Docker)
Software composition analysis (SCA)	Market Guide for Software Composition Analysis
Deploy	
Container management	Market Guide for Container Management
Package management	YUM, APT, Helm, npm, Chocolatey, NuGet, ProGet
Application delivery	Market Guide for DevOps Value Stream Delivery Platforms
Container security	Aqua Security, Palo Alto Networks Prisma Cloud, Red Hat (StackRox), Snyk, Sysdig
Operate	
Vulnerability management	Rapid7, Tenable, Qualys
Patch management	Configuration automation tools and stand-alone patch managers (IBM BigFix, Quest KACE, Kaseya VSA, Tanium, SolarWinds, Microsoft SCCM and Ivanti)
Configuration management	Configuration automation tools (see Market Guide for Infrastructure Automation Tools)
Managing OS images	Packet, Vagrant, Docker, Buildpacks
Security Operations	Innovation Insight for Cloud Security Posture Management (Control plane) and Market Guide for Cloud Workload Protection Platforms (Data plane)
Monitor	
Monitoring and observability	Market Guide for IT Infrastructure Monitoring Tools and Innovation Insight for Observability
Dynamic cost/resource optimization	Magic Quadrant for Cloud Management Tooling
Alerting	Atlassian Opsgenie, Everbridge IT Alerting, PagerDuty, Splunk VictorOps, xMatters
AIOps	Market Guide for AIOps Platforms

Source: Gartner (April 2021)

Evidence

¹ Gartner's 2020 Adapt I&O Processes Survey asked questions on how the I&O functions are adapting existing processes to support continuous delivery, agile, cloud and DevOps. The survey consisted of questions that covered the adoption of a range of IT operations frameworks, investments in automation and metrics used to measure I&O performance.

Two hundred eighty I&O leaders responded to the survey, and this data was analyzed to formulate the analysis of this paper. Based on the analysis, the survey respondents were segregated into two categories — the top performers and the rest. Top performers were defined as those organizations that self-reported to have exceeded CIO expectations against the top CIO goals for the I&O function. These organizations have specific practices in place to achieve high performance, compared with the rest.

Recommended by the Authors

Some documents may not be available as part of your current Gartner subscription.

[How to Build Agile Infrastructure Platforms That Enable Rapid Product Innovation](#)

[Visualizing the Infrastructure Automation Pipeline](#)

[To Automate Your Automation, Apply Agile and DevOps Practices to Infrastructure and Operations](#)

[Market Guide for Infrastructure Automation Tools](#)

[Using Platform Ops to Scale and Accelerate DevOps Adoption](#)

[New Roles and Skills for I&O Professionals in DevOps](#)

[Essential Skills for Automation Architects](#)

[Essential Skills for Automation Engineers](#)

[Extend Agile With DevOps for Continuous Delivery](#)

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