



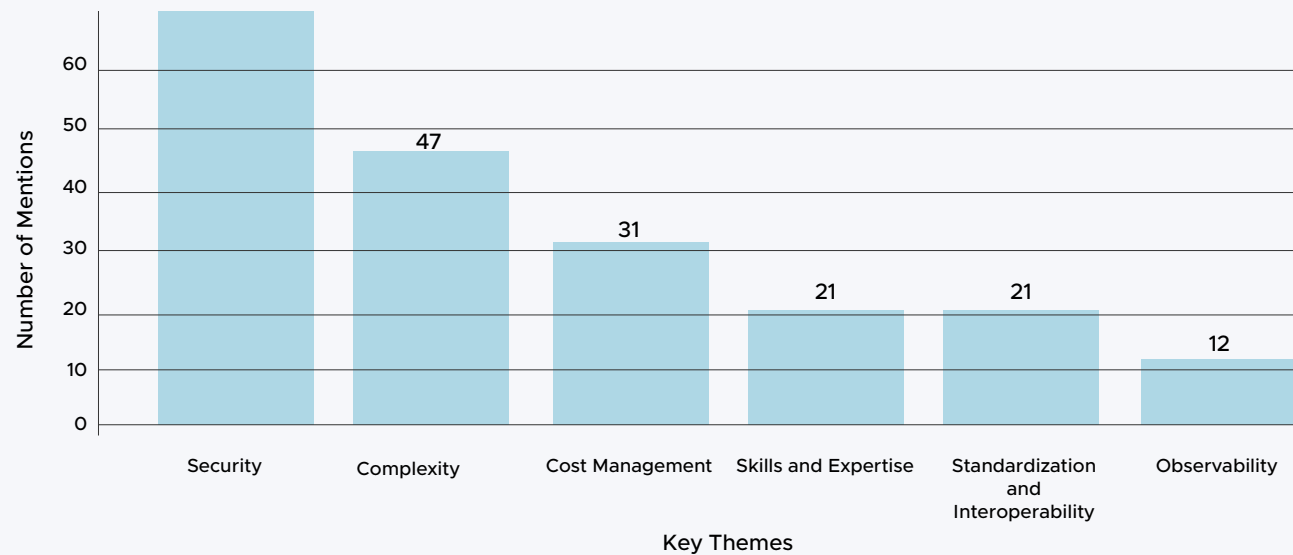
CNCF Ecosystem Gaps

November 2024

Cloud native technologies have revolutionized how organizations build and deploy applications, but this transformation also presents challenges. In our [Q3 2024 CNCF Radar survey](#), which over 300 cloud native developers responded to, we asked for input on gaps and limitations in the cloud native ecosystem. Responses highlighted challenges and concerns across six areas: security, cost management, skills & expertise, complexity, standardization & interoperability, and observability. These findings validate some known pain points and also reveal insights about emerging challenges in cloud native that point us toward potential solutions.

The frequency of key themes in the survey responses is displayed in the following table:

CLASSIFICATION OF RESPONSES BY THEMES





Security

Gaps and Challenges

Not surprisingly, data security and privacy risks associated with distributed applications and third-party providers were the most often cited concern by the cloud native developers surveyed. Traditional security approaches aren't sufficient for complex infrastructure topologies like multi-cluster and multi-cloud environments. Security policies and controls are typically designed for a particular system; developing policies and controls that will function across multiple clouds and environments is challenging.

Existing Resources

CNCF has several security-focused projects, including [Falco](#), [OPA](#), and [TUF](#). CNCF also offers security-focused training & certifications, including the Kubernetes and Cloud Security Associate (KCSA) and Certified Kubernetes Security Specialist (CKS). The [TAG Security Whitepapers](#) are also a rich resource.

Opportunities for New Solutions

When it comes to security, creating more resources and tools for implementing security controls across diverse cloud native environments, such as standardized security frameworks for multi-cloud and multi-cluster environments, would be beneficial.

Cost Management

Gaps and Challenges

Survey respondents reported multiple cost-related challenges in cloud native environments. The consumption-based model across multiple platforms creates complex billing scenarios that are difficult to track and optimize. Right-sizing containers in Kubernetes deployments is a common difficulty, alongside the challenges of predicting costs across cloud providers. Organizations find it difficult to manage spending spikes during auto-scaling events and accurately attribute costs in shared infrastructure environments. These cost management difficulties increase as organizations scale their cloud native infrastructure.

Existing Resources

Current CNCF cost management projects include [OpenCost](#) and [Cloud Custodian](#).

Opportunities for New Solutions

Challenges around cost could be lessened by developing more advanced cost optimization tools for containerized environments that work across cloud providers.



Skills and Expertise

Gaps and Challenges

At a time when developers are in short supply worldwide, finding and retaining experienced cloud native professionals can be an enormous challenge for organizations. It's also an ongoing issue to continually uplevel skills for existing staff in response to new developments in cloud native.

Existing Resources

CNCF offers an extensive library of training modules and several certification programs (e.g., [CKA](#), [CKAD](#)), which are continually updated. New offerings are regularly added.

Complexity

Gaps and Challenges

Distributed applications present multiple layers of complexity that survey respondents consistently highlighted as pain points, including complexity of:

- Service mesh configuration and management when coordinating multi-cluster deployments across environments
- Handling dependencies between microservices
- Version control and update strategies across distributed systems

These complexities often compound, creating cascading challenges for development and operations teams.

Existing Resources

Tools that help simplify cloud native adoption currently offered by CNCF projects include [Helm](#) for package management and multiple cluster management tools provided by [Armada](#), [KubeEdge](#), and [KubeStellar](#). Additionally, a Multicloud Services API and Cluster Inventory API to simplify common multicloud design patterns is currently under development by Kubernetes' SIG-Multicloud.

Opportunities for New Solutions

Solutions that could help reduce complexity-related pain points include "cloud provider aware" policy tooling to help simplify multi-cluster and multi-cloud management, reference architectures and best practices for managing multi-cloud systems and large-scale deployments, and robust and flexible cross-project management tools.



Standardization and Interoperability

Gaps and Challenges

Lack of standardization and interoperability across cloud providers and tools creates friction, presenting security and cost management challenges. These challenges feed into concerns about high switching costs when transitioning between vendors or between projects, and difficulty integrating different systems.

Existing Resources

Many CNCF projects conform to open standards, including OCI. CNCF projects publish interoperability specifications, including [CNI](#), [TUF](#), [in-toto](#), and [CSI](#). Interoperability is one of the factors the TOC considers when reviewing new projects applying for Sandbox.

Opportunities for New Solutions

Challenges with integration and interoperability can be eased with comprehensive standards for cross-cloud and cross-project integration along with certification programs to validate conformance.

Observability

Gaps and Challenges

Adopters reported difficulties managing observability across distributed systems and multiple cloud providers. Observability challenges are primarily due to the complexity of managing distributed systems, lack of visibility, and difficulty integrating security measures. Survey respondents reported friction and a need for clearer documentation, switching from one observability library or stack to another, or aggregating data from multiple vendors into a single dashboard.

Existing Resources

CNCF's existing observability projects include [OpenTelemetry](#) and [Prometheus](#).

Opportunities for New Solutions

Observability, an inherently complicated effort, could be aided by enhancing integration between different observability tools in the CNCF landscape. It would also be helpful to publish more best practices and reference architectures for end-to-end observability in complex cloud native systems.




Industry Validation

Our survey findings align with experiences reported in other channels. A recent CIO article, “[CIOs recalibrate multicloud strategies as challenges remain](#),” reflects the mixed blessings of multi-cloud flexibility. “IT leaders are making a point of reaping the benefits of intentional multi-cloud flexibility, but this makes [for] a much heavier lift,” the article explains. “The ability to dynamically move compute from cloud-to-cloud and/or throttle up/down compute is overhyped,” given that “Interoperability and connectivity are key issues for more than 80% of enterprises that have adopted a multi-cloud model.”


These industry insights validate our survey findings and underscore the importance of addressing these challenges through the continued evolution of the cloud native ecosystem. As the CNCF community works to fill these gaps, collaboration between projects, end users, and vendors will be crucial in creating more integrated, secure, and manageable cloud native solutions.





Cloud native computing leverages an open-source software stack to deploy applications as microservices, where each component is packaged into its own container and orchestrated dynamically to optimize resource utilization. **The Cloud Native Computing Foundation** (CNCF) hosts key projects within the cloud native ecosystem, including Kubernetes, Envoy, Prometheus, and many others. CNCF serves as a neutral hub for collaboration, bringing together leading developers, end users, and vendors—from the world's largest public cloud providers and enterprise software companies to innovative startups. As part of The Linux Foundation, a nonprofit organization, CNCF fosters the growth and adoption of cloud-native technologies across industries. For more information, visit www.cncf.io.

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