



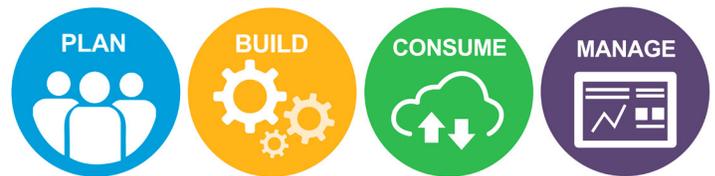
HYBRID CLOUD ECOSYSTEM

Unique mission needs - unique cloud solutions

Though each IT mission is unique, many have similar fundamental needs: reducing costs, increasing usability and accessibility to end-users, maintaining data sovereignty and security, and adhering to relevant regulations. Cloud computing has proven to meet these mission needs. Specifically, many organizations find the most effective solution is a hybrid cloud system due to the inherent flexibility gained by utilizing a combination of on-premises, off-premises, and commercial cloud environments. Importantly, these organizations must consider the necessity of establishing a holistic strategy for adopting and managing the multi-cloud system. It is imperative to follow a disciplined process that considers the opportunities and impacts of combining cloud technologies with existing IT environments.

Northrop Grumman's Hybrid Cloud Ecosystem internal research and development (IRAD) project developed a cloud adoption framework built on four core concepts - Plan, Build, Consume, Manage (PBCM) - that accounts for the full ecosystem lifecycle. The framework uses mission requirements to develop a strategy for

constructing cloud capabilities and addressing potential impacts to existing infrastructure and applications, challenges securing the ecosystem, and organizational management of the solution. Northrop Grumman's mission-focused approach to hybrid cloud adoption emphasizes the development of solutions based on organizational requirements and expectations.



Hybrid cloud - integrating distinct technologies

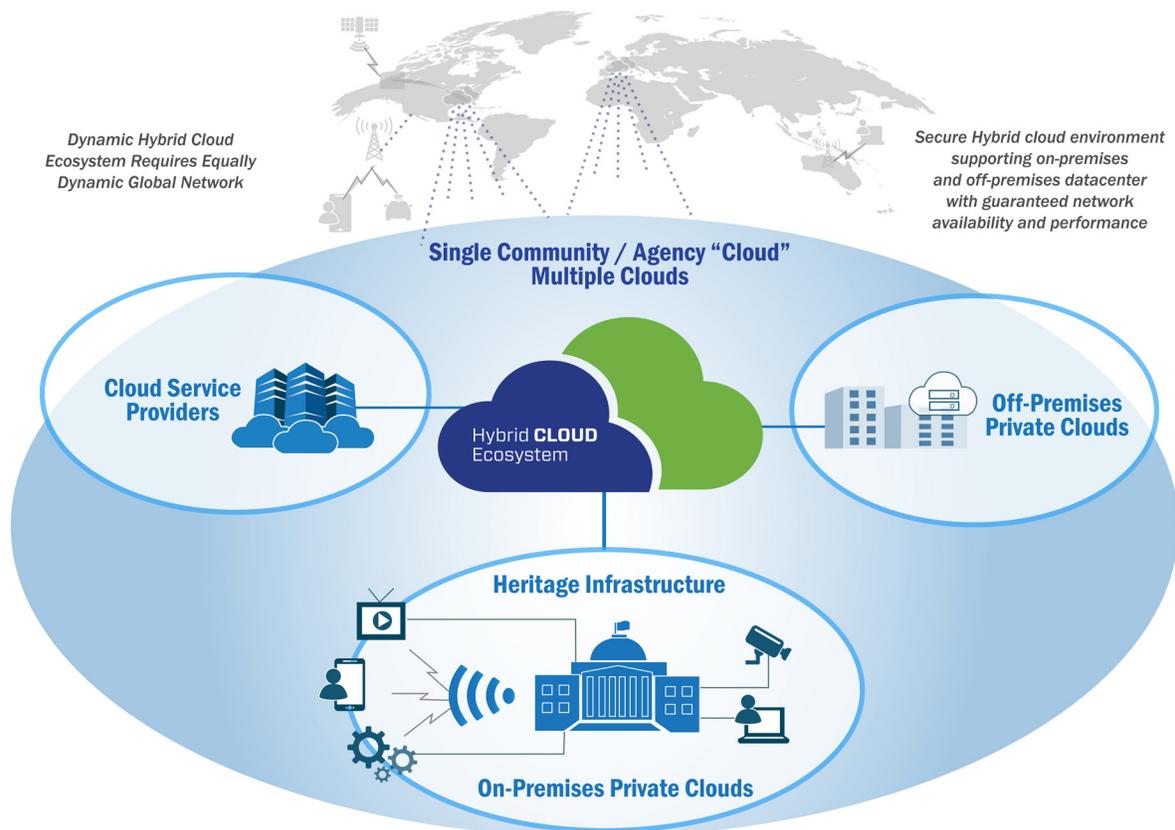
Northrop Grumman has implemented a reference hybrid cloud ecosystem that integrates legacy infrastructure, on-premises and off-premises private clouds, and multiple commercial clouds. The reference implementation incorporates cloud technologies and services into a managed ecosystem that provides a platform for research, concept validation, and customer demonstration. Key technologies and services integrated into the ecosystem include: cloud service providers,

cloud management platforms, infrastructure and platforms as a service, software-defined networking, hyper-converged infrastructure, data and environmental security mechanisms, and Northrop Grumman’s application migration toolkit.

To effectively exploit private and public clouds, reduce costs, and ensure security, organizations must utilize sophisticated cloud management and orchestration techniques. This is particularly relevant to cloud-bursting – running mission-critical or sensitive applications on a private cloud while utilizing public clouds for high volume workloads that must scale on-demand. Northrop Grumman’s hybrid cloud reference implementation leverages a cloud management platform to provide a “single pane of glass” for centralized governance

and management of capacity and workloads spanning multiple cloud environments. The flexible self-service portal can be easily configured to meet mission requirements.

The PBCM framework emphasizes developing a security strategy and incorporating it throughout the life-cycle of the reference implementation. This cloud security architecture identifies myriad components within cloud environments that must be secured, managed, and monitored. Key components of the security design include leveraging DevSecOps methodologies, integration with security, information, and event management tools; compliance monitoring, and holistic identity, credential, and access management capabilities to serve as the foundation for zero-trust network environments.



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