OPEN DATA CENTER ALLIANCE℠ USAGE MODEL

Cloud Maturity Model Rev. 3.0

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v1.1

TABLE OF CONTENTS

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EXECUTIVE SUMMARY

A cloud maturity model (CMM) helps to answer the question "What should our journey to cloud and hybrid IT look like?" With a CMM, an organization can analyze its current state and plan the implementation of cloud technologies. With business objectives as a parameter, the CMM defines a target state and then provides the keys to performing a gap analysis. When ODCA first introduced the CMM, many organizations adopted it quickly. Feedback from early adopters indicated that they sometimes found the CMM difficult to use to implement cloud solutions effectively, obtain meaningful implementable results, and outline future plans. These early adopters wanted more guidance on specific areas that affect cloud services, as well as clear steps toward transformation. To address these needs, ODCA updated the CMM to make it more outcome driven.

Revision 3.0 of the CMM includes more detailed explanations of the analysis and planning process and addresses specific domains that affect cloud services. The objective of the CMM is to help enterprise IT maximize the potential of hybrid IT through development of a targeted road map, a set of plans and changes necessary to achieve appropriate business objectives through the use of cloud services and hybrid IT integration. The CMM helps enterprises to:

1. Understand the different dimensions that constitute cloud maturity from the perspectives of the consumers and providers of cloud services.
2. Define goals to be achieved with hybrid IT and develop a corresponding cloud strategy.
3. Determine the target maturity levels required for enabling specific use cases for cloud that the business may have, and thereby achieving their defined goals.
4. Develop a roadmap of projects to accomplish the changes that will raise maturity levels for each cloud capability and domain so as to enable the achievement of the desired use case or cases.
5. Develop focused investment initiatives that move selected cloud capabilities and domains, targeting maturity levels that enable the business to achieve targeted capabilities and use case enablement.
6. Steer priorities relating to enabling cloud service usage and adoption.

7. Leverage the ODCA publications to identify characteristics and artifacts that enable an organization to increase their cloud maturity and service success through cloud service adoption.
8. Maximize the potential to achieve the expected benefits of cloud.

Traditional environments will not go away, and traditional IT investments have delivered value for many years. Even with the value of a traditional environment, organizations should develop a cohesive, effective cloud road map and strategy. Developing a cloud road map will help realize the financial and organizational benefits of cloud maturity.

> **Hybrid IT** is the use of traditional internal IT systems integrated with cloud environments. This includes the participation of external partners, systems, and services simultaneous with the participation of traditional internal IT processes and systems.

The CMM considers the multiple layers of people, process, and technology across enterprise IT in the context of the different operating models driven by IT service type and internal and external delivery models.

The CMM analyzes maturity from two key perspectives

The ODCA Cloud Maturity Model helps build this road map by analyzing cloud maturity from two key perspectives: (1) nontechnical enabling capabilities in specific domains and (2) technical enabling capabilities in specific domains. These groupings include maturity levels for the individual cloud service models such as SaaS, PaaS, IaaS, DBaaS, Platform Integration-as-a-Service and Information-as-a-Service, among others. Each domain within a capability is considered from the viewpoints of people, process, and technology.

The **nontechnical capability** addressed in the CMM provides a comprehensive view of the maturity model's stages through the lens of

"business use of the cloud." Across business categories, this perspective includes cloud service models, cloud deployment models, and capabilities for each cloud domain.

The **technical capability** perspective of the CMM provides a similar view of cloud capability maturity through the lens of cloud and information and communications technology (ICT).

These perspectives on cloud maturity offer a way for an enterprise to plot its maturity level in the context of a number of possible use cases. This enables an enterprise to select the use cases that are most aligned with its business needs. Some enterprises are organized or targeted toward business models, where one or more of the cloud service models are of little value or produce an inverse total cost of ownership. Each enterprise can assess its maturity across the cloud service model that is applicable to its enterprise, without the added complexity of the service models that do not apply.

Outcomes in each domain guide the answer to the question for each maturity level: "What does the desired result look like?"

Notes on the ODCA Cloud Maturity Model

1. The CMM provides a framework for identifying specific solutions to enterprise adoption of cloud/hybrid IT. The CMM thereby seeds a road map to cloud adoption, pointing to potential gaps and possible frameworks and solutions to consider, as well as helping to identify capabilities required to achieve specific levels of maturity and to address targeted use cases.
2. It is important to consider internal IT as a service broker or provider rather than as a consumer of services, so as to gain consistency in CMM assessment results (as compared with internal IT being a consumer).
3. Outcomes in each domain guide the answer to the question for each maturity level: "What does the desired result look like?"
4. The CMM provides a portfolio of domains from which the user can select appropriate ones to address the specific use cases critical to the user's enterprise—that is, all domains may not be required, nor optimal, for all enterprises to pursue.
5. Hybrid IT establishment represents many paths to a journey—it has to be taken as a set of defined steps and does not necessarily include the whole enterprise at once.

In cases where an enterprise will use two or three cloud service models in combination, the CMM offers an opportunity to plot maturity across SaaS, PaaS, IaaS, and Info-aaS, among others, independently. This helps strategists chart cloud maturity in the context of the specific technologies and service approaches, the enterprise ability to use them, and the enterprise ability to operate a diverse set of IT platforms (i.e., hybrid IT).

The objective of the CMM is to ensure that the necessary elements are identified on an actionable road map to support the achievement of the expected cloud benefits where the elements are missing. For example, if an enterprise is striving to achieve "speed," then a certain amount of automation and process integration needs to be in place between the consumer and provider—the CMM addresses these areas. Some of the anticipated benefits arising from the use of a mature implementation/integration of cloud technology include:

- Increased capability in domains—New features and functions for the business that don't have to be self-developed
- Efficiency—Reusable, cost-effective standard designs and solutions with cooperative development, operations, and support
- Velocity—Ability to change and deploy services in near real time
- Flexibility—Ability to scale and change services to align to dynamic business needs
- Quality—Increased focus on standardized services engineered, operated and supported consistently across the enterprise

When using the CMM, it is important to note that there are significant differences between enterprise types. For instance, public and private enterprises have different motives. The aim of the public sector is generally to provide goods and services to the people they serve, but private sector enterprises are generally established by market share and placement with primary motives around profitability.

- Public sector enterprise objectives—Political value, financial value, quality of service, public trust
- Private sector enterprise objectives—Revenue generation, operating margin improvement, asset efficiency, market and customer satisfaction

Therefore, stated benefits and objectives in the cloud maturity model consider both enterprise types and need to be applied individually.

The CMM identifies five levels of cloud maturity, but it is not necessary for an enterprise to aspire to CMM Level 5 in all cases. Different levels in the different domain capability areas may also be quite acceptable when they adequately meet enterprise requirements. It is up to each enterprise to determine for itself where it wants to be and what actions and enablers will take it there, per domain capability.

In addition, it is possible to provide IaaS, PaaS, or SaaS through a combination of legacy systems, vested environments, and private and hybrid clouds. CMM Level 5 does not dictate pure public or SaaS-based systems. It describes a managed set of controls, processes, and systems to consistently manage cloud services in line with business priorities, with processes integrated and aligned across the enterprise.

As an enterprise progresses through introspection in regard to the above, it is common to identify islands of excellence within the enterprise, in contrast to other areas that may have lower cloud maturity. This is normal and an indication of being at a level that is “Ad Hoc” (Level 1) or “Repeatable/ Opportunistic” (Level 2). A consolidated, cohesive enterprise-aligned cloud strategy will enable consistent CMM measurement and rating of the entire enterprise against the CMM. In turn, this will aid in developing a clearly defined road map that will deliver on enablement and capabilities.

Traditional IT environments will continue to add value for many years and should not detract the enterprise from developing a cohesive and effective cloud road map and strategy as well as a strong cloud maturity achievement. Not everything has to be on a federated cloud for an enterprise to achieve a more mature rating level. An enterprise could achieve a high CMM rating by:

1. Identifying consistent frameworks and controls
2. Enabling selected business systems according to a defined set of categorization
3. Running according to a defined strategy in the cloud
4. Representing the characteristics and artifacts identified in the CMM model

The following chapters highlight some of the key sections and concepts of the CMM.

OVERVIEW OF THE CLOUD MATURITY MODEL

The CMM helps to establish a methodical and efficient journey to the cloud, aligned with business objectives and likely cost-effective and comprehensive. It also shows how the enterprise can increase its organizational ability to adopt cloud-based services within defined objectives, governance, and control parameters.

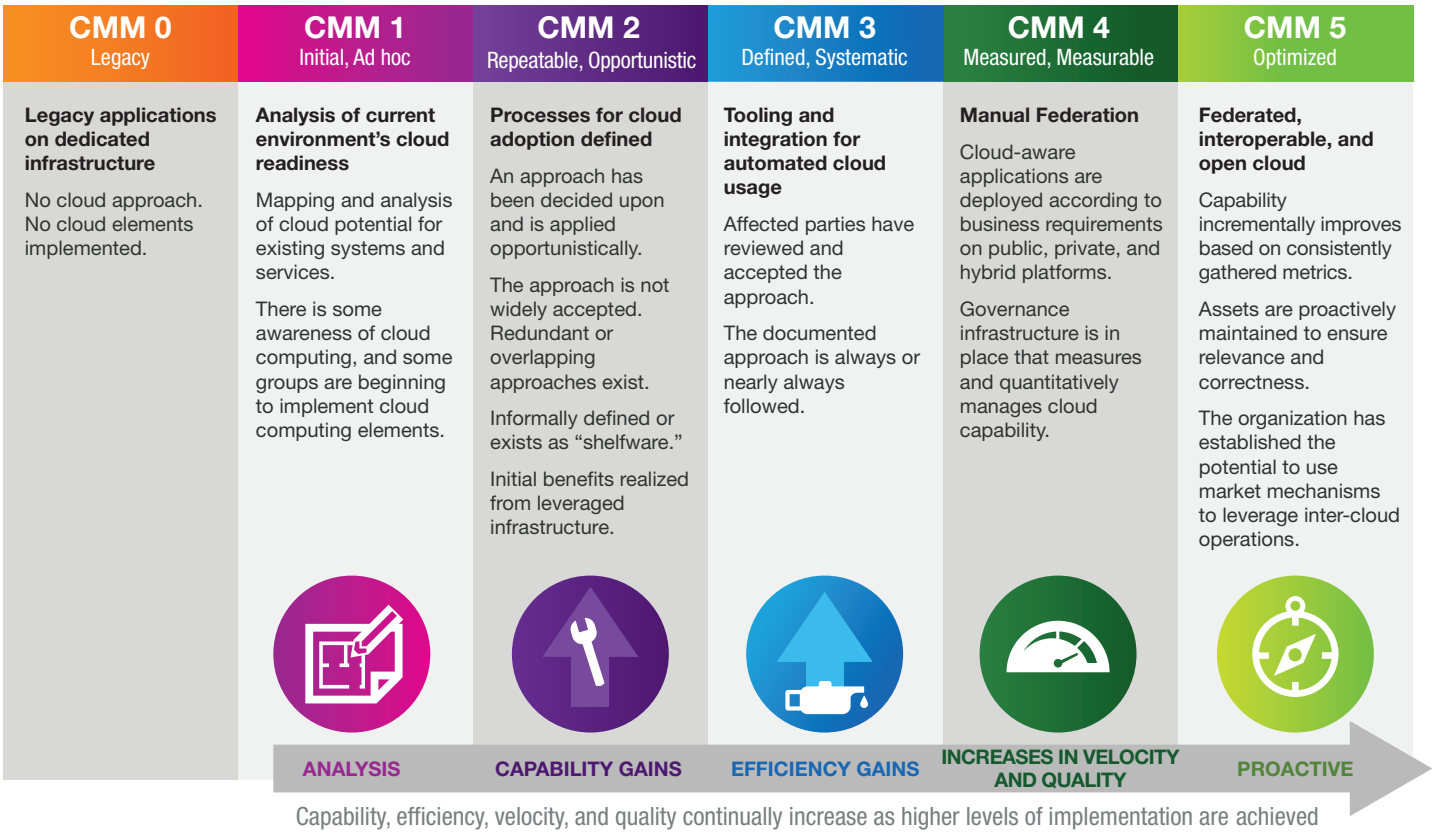
As an organization matures, the use of cloud-based services becomes more sophisticated, comprehensive, and optimized. The CMM plots the progression of structured cloud service integration from a baseline, at which point no cloud solutions are used, through five progressive levels of maturity, as shown in Figure 1.

Figure 1: The cloud maturity model has five progressive levels of maturity.

DESCRIPTION OF THE CLOUD MATURITY MODEL

Figure 2 provides a summary description of each maturity level. It does not differentiate among the various types of cloud technology, cloud methodologies, or cloud deployment models. Each of these factors will be taken into account as the progressive levels of cloud maturity are explored in detail.

Figure 2: These are descriptions of each level of the cloud maturity model.



DESCRIPTION OF THE CLOUD MATURITY MODEL

Progression through the maturity levels defined in the CMM is based on the analysis of parallel specific domains, which are grouped into capabilities represented in Table 2 and Table 3. At a high level, each of the CMM maturity levels may be understood as follows:

CMM 0: None
Systems are a mixture of physical and virtualized that are managed by platform operations teams in silos. Processes are highly manual with the use of some tools for isolated activities. Automation does not exist. There is little to no knowledge of cloud.

CMM 1: Initial/Ad Hoc
The existing environment is analyzed and documented for initial cloud potential. Pockets of virtualized systems exist, for limited systems, without automation tooling, operated under the traditional IT and procurement processes. Most of the landscape still runs on physical infrastructure. The focus is on the private cloud, although the public cloud is used for niche applications.

CMM 2: Repeatable/Opportunistic
IT and procurement processes and controls are updated specifically to deal with the cloud. It is defined who may order services and service elements and how this is done. Private cloud is fully embraced with physical-to-virtual movement of apps and the emergence of cloud-aware apps.

CMM 3: Defined/Systematic
Tooling is introduced and updated to facilitate the ordering, control, and management of cloud services. Risk and governance controls are integrated into this control layer, ensuring adherence to corporate requirements and local regulation. Complementary service management interfaces are operational. More sophisticated use of SaaS is evident, and private PaaS emerges.

CMM 4: Measured/Measurable
Online controls exist to manage federated system landscapes, distributed data and data movement, distributed application transactions, and cross-boundary interactions. Defined partners and integration exist, enabling dynamic movement of systems and data, with supporting tool layer integration (e.g., service desk, alerting, commercial systems, and governance). Cloud-aware apps are the norm, and PaaS is pervasive. Hybrid apps develop across cloud delivery models.

CMM 5: Optimized
All service and application deployments are automated, with orchestration systems automatically locating data and applications in the appropriate cloud location and migrating them according to business requirements, transparently (e.g., to take advantage of carbon targets, cost opportunities, quality, or functionality).

Moving through the CMM levels allows an organization to achieve several key characteristics in its cloud solution: federated, interoperable, and open standards.

Moving through the CMM levels allows an organization to achieve several key characteristics in its cloud solution: federated, interoperable, and open standards. When these characteristics area achieved, the organization enables new business functionality and benefits. These benefits are the recommended results of positioning domain capabilities within the various CMM levels: functional capability gains, efficiency gains, quality gains, and velocity gains. Attaining these benefits ultimately results in powerful business strategy enablement.

Key Characteristics for Cloud Integration

Federated. Federation refers to the ability of identity and access management software to securely share user identities and permissions. This ability allows users to utilize resources located in multiple clouds without having to generate separate credentials in each cloud. IT is able to manage one set of identities, authorizations, and set of security review processes. From the user perspective, this enables seamless integration with systems and applications.

Interoperable. There are two key concepts of interoperability: (1) the ability to connect two systems that are concurrently running in cloud environments, and (2) the ability to easily port a system from one cloud or external system to another. Both involve the use of standard mechanisms for service orchestration and management, enabling elastic operation and flexibility for dynamic business models, while minimizing vendor lock-in.

Open Standards. The term "open" refers to both software and standards. Open source software operates at a fast rate of change supported by diverse, vibrant community updates. These frequent update cycles provide access to the latest features and functional capabilities, including performance and efficiency improvements. The use of common application programming interfaces (APIs) or abstraction layers makes it easier for end users to rapidly consume cloud services from different providers to meet business requirements. Even if the software is not open source, it should adhere to open standards, in order to maximize the benefits of cloud deployment.

Maturity Level Outcomes

In order to effectively steer the control sets for the various domains, a set of outcomes for each domain are defined. These can also be used to help enterprises determine their target state for that domain. Many of the domains are interdependent—that is, one cannot be at a certain maturity level without the other being at a supporting maturity level, but not all domains are interdependent.

The ODCA offers Excel-based analysis materials separate from but introduced by this usage model. These materials address domains and their associated outcomes in greater detail.

Table 1: Example Domain Outcomes

DOMAIN	CMM 0 (None, n/a)	CMM 1 (Initial, ad hoc)	CMM 2 (Repeatable, opportunistic)	CMM 3 (Defined, systematic)	CMM 4 (Managed, measurable)
Control Question	Expected Outcome at CMM Level 0 (People, Process & Technology aspects)	Expected Outcome at CMM Level 1 (People, Process & Technology aspects)	Expected Outcome at CMM Level 2 (People, Process & Technology aspects)	Expected Outcome at CMM Level 3 (People, Process & Technology aspects)	Expected Outcome at CMM Level 4 (People, Process & Technology aspects)

CMM DOMAINS

In order to create an effective road map and priority plan using the CMM, avoid reviewing too many domains at once.

The CMM domains are divided into two primary capability areas: technical and nontechnical. Each capability area encompasses a set of appropriate domains such as finance, governance, and portfolio management. A consultant or auditor can select and review the capability areas and domains that best apply to an organization's use case. In order to create an effective road map and priority plan using the CMM, avoid reviewing too many domains at once.

A detailed description of the capabilities of each domain can be found in appendix V.

Cloud Maturity Model—Nontechnical Capability

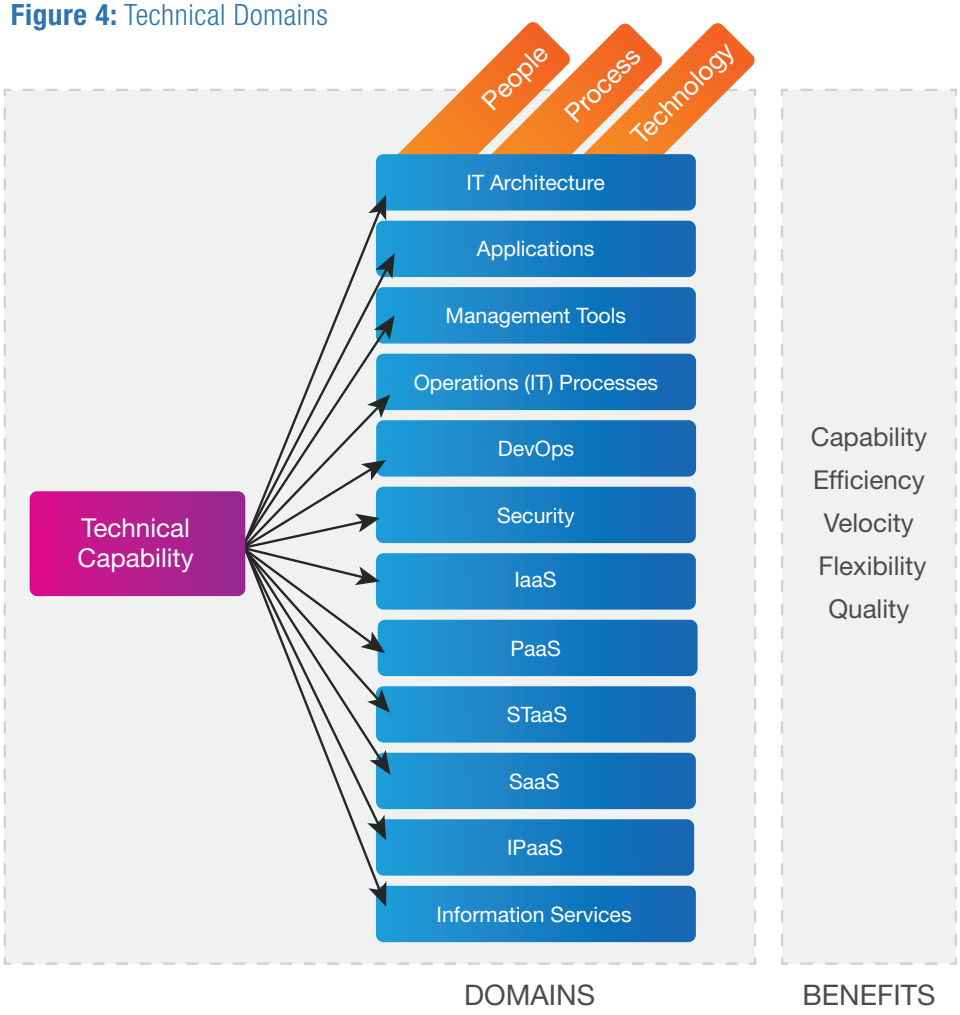
The nontechnical capability and the associated business domains and benefits are depicted in the figure below.

Figure 3: Business Domains

Cloud Maturity Model—Technical Capability

The technical capability and the associated business domains and benefits are depicted in the image below.

Figure 4: Technical Domains



Each of the capability areas has many domains, but not all of them are appropriate in every use case or enterprise. Based on the appropriate use case, one can select just the domains that should be considered.

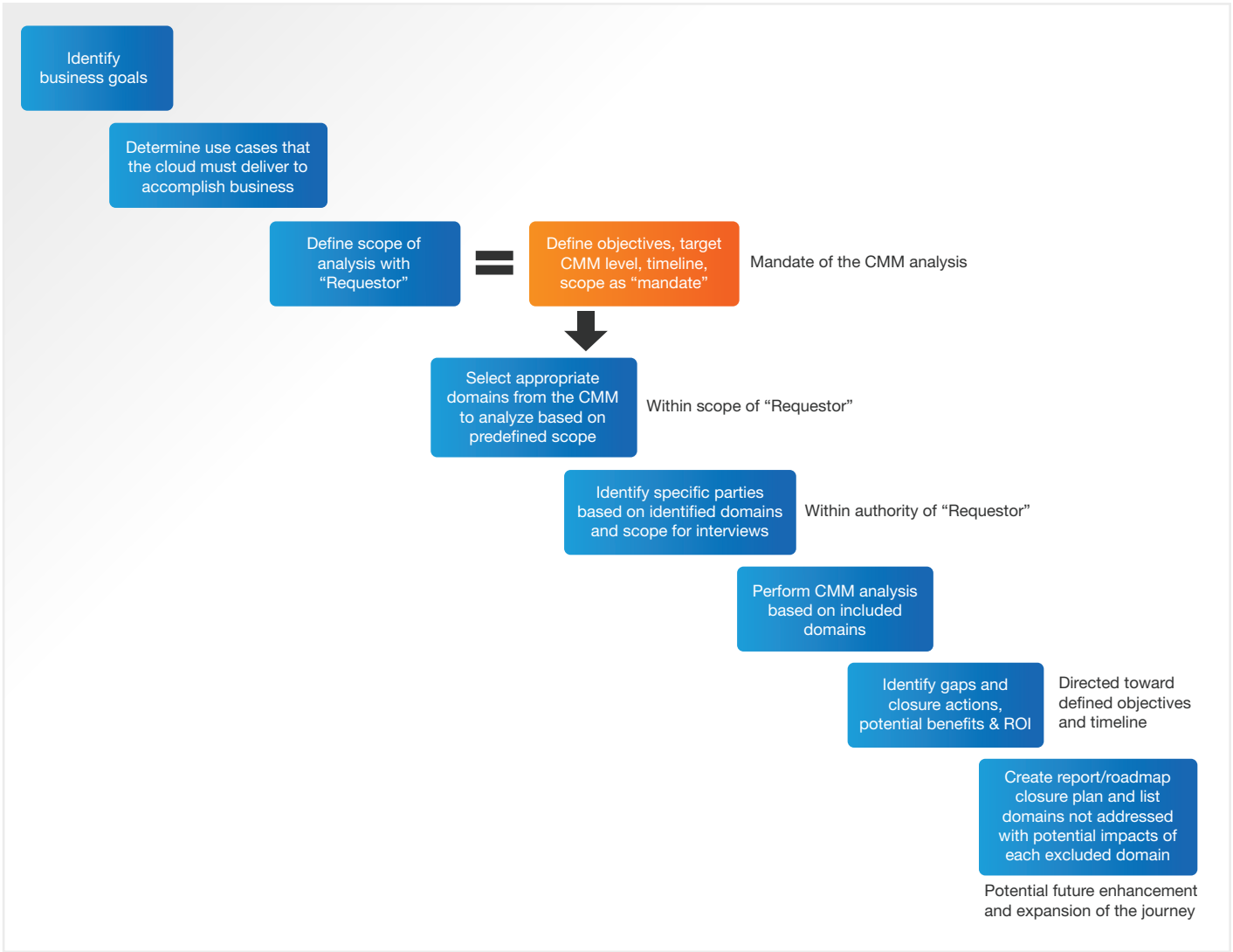
Try to keep the number of domains in a single analysis limited to only those necessary for a particular selected use case.

TIP: Try to keep the number of domains in a single analysis limited to only those necessary for a particular selected use case in order to drive the exercise to deliver results quickly. If a larger analysis is appropriate, it can be broken down into subanalysis sprints, with each sprint delivering a result after a few weeks.

OVERVIEW OF THE CMM ASSESSMENT PROCESS

There are several steps to the CMM assessment process. Figure 5 gives an overview of the flow of the assessment process.

Figure 5: Overview of the CMM Assessment Process



STEP 1—IDENTIFY BUSINESS GOALS

The assessment process starts by understanding the goals that the enterprise must achieve. These goals will be used to identify the use cases that the hybrid IT environment will need to deliver, as depicted in the table below:

Table 2: Example Business Goals and Responses

BUSINESS GOALS	TYPICAL RESPONSES TO BUSINESS CONTEXT
Growing **OR** Maintaining a flat business line but preparing new products to innovate past the competition	Identify new opportunities and existing problems. Adopt innovative new services and solutions to address these. Services may be contracted with external providers or adopted through mergers and acquisitions. Create additional capacity for new business and products by investing in additional infrastructure. This is typically achieved through adding CAPEX. Create additional capacity for new business and products by using existing infrastructure. This improves OPEX.
Maintaining a flat business line	Reduce costs by optimizing existing systems, thereby reducing existing operational costs. Decide to maintain all systems and operational costs as is, which is rare.
Losing business	Reduce costs by optimizing existing systems and thereby reducing existing operational costs. Identify non-core systems and consolidate or optimize them. Also reduce nonessential functionality as needed to reduce operational and infrastructure costs. Outsource non-core systems and convert to a pay-as-you-go system, with flexibility for rapid up-or-down capacity changes.
Selling assets to reinvent and get out of a downward spiral	Identify non-core systems and consolidate or optimize them. Also reduce nonessential functionality as necessary to reduce operational and infrastructure costs. Outsource non-core systems and convert to a pay-as-you-go system, with flexibility for rapid up-or-down capacity changes. Eliminate all spare unused capacity. Modularize non-core functionality into sellable or outsourceable units. Test company rules or restrictions against using alternative pay-as-you-go options such as public cloud for email and web services. Refinance assets for a short-term CAPEX injection through an outsource or lease-back arrangement.

STEP 2—DEFINE USE CASES FOR CMM

The commencement of an assessment would need to be performed by determining the enterprises' objectives. These are often more easily identified in context of a number of use cases, which can be compared to the enterprises current planning. Some typical use cases based on typical initiatives are provided below as examples of how to initiate CMM assessments.

Table 3: Use Cases for CMM Analysis

USE CASE	DESCRIPTION	POTENTIAL APPLICABILITY	POTENTIAL ACTORS	CMM RANGE	TIMELINE (months)				
					6	8	12	18	24
1	Ability to rapidly provision infrastructure and platform services for development and test systems from private, public, or community clouds **Description:** A team is able to access IaaS or PaaS services through a portal, directly procuring and configuring infrastructure and services for developing and testing applications, apps, services, or platforms.	Dev/Test Iaas/PaaS, Private Internal/ External Cloud, Public External Cloud, Internal or External Community Cloud	Dev/ Engineering, DevOps, Test, Integration or Build/Deploy Teams and Systems, Procurement, Commercial, Security & Risk Mgt, Architecture	1–2	●	●	●		
2	Ability to integrate SaaS with back-office systems **Description:** The ability to share files and data with seamless networking, monitoring, and workflow between an organization's back-office systems and an application offered through a SaaS model, without resorting to manual or human driven tasks. Back-office systems may include reporting, analytics, ERP, legal, procurement, finance, human resources systems, or other systems.	SaaS Back-Office Integration, SaaS	SA (System Administrator), Network Team, Business Team, Finance, PMO, HR, and other back-office teams, Procurement, Finance, Security, Compliance, Enterprise Architecture	1-3	●	●	●	●	

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USE CASE	DESCRIPTION	POTENTIAL APPLICABILITY	POTENTIAL ACTORS	CMM RANGE	TIMELINE (months)				
					6	8	12	18	24
3	Ability to provide on-premises data residency for SaaS implementations **Description:** The ability to store data within an organization, based on organizational or regulatory requirements. The ability to provide evidence of data storage and compliance with corporate and regulatory policies.	SaaS Data Residency, SaaS	(Master & Transaction) Data Management, SA (System Administrator), Network and Security Teams, Governance, Risk and Compliance, Legal/Privacy	2-4	●	●	●	●	
4	Ability to deliver and/or consume DaaS (Data as a Service) data stores (e.g., relational, object, KV, graph, file, etc.) from a private, public, or community cloud for development and test applications **Description:** Delivering or consuming private internal or external, public external, or community data stores and data management services may include databases such as Hadoop, Cassandra, Hbase, and other forms of data storage, each offered as a service.	Dev/Test Data Stores, Information as a Service, Data as a Service, Platform as a Service	SA (System Administrator), DBA (Database Administrator), Dev/ Engineering or DevOps, Test/QA Team, Procurement, Finance, Security, Compliance, Enterprise Architecture	2-4			●	●	
5	Ability to deliver and/or consume middleware and similar platforms (e.g., JBoss, .NET, Apache, Tomcat, Citrix, IIS) from a private, public, or community cloud or via Integration-as-a-Service or Integration-Platforms-as-a-Service for development and test applications **Description:** Providing standard middleware through an as-a-service model or taking a developer-centric approach via Integration-as-a-Service or Integration-Platforms-as-a-Service model.	Dev/Test Middleware, PaaS, SaaS	SA (System Administrator), Dev/ Engineering or DevOps, Test/ QA, Integration, Build Teams and Systems, Commercial, Security, Compliance, Enterprise Architecture	2-4			●	●	●

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USE CASE	DESCRIPTION	POTENTIAL APPLICABILITY	POTENTIAL ACTORS	CMM RANGE	TIMELINE (months)				
					6	8	12	18	24
6	Ability to begin experimenting with cloud-native applications (e.g., running on OpenStack or Cloud Foundry) **Description:** Experimenting and developing cloud-native applications, including proof of concept, but short of production applications. Built specifically to utilize cloud frameworks like OpenStack or Cloud Foundry. Often using containers, loosely coupled services, multiservice designs with geographic independence (i.e., services that can run in any location without manual configuration) and that are horizontally scalable and have built-in redundancy, automatic IP remapping, and other cloud-native characteristics.	Experimenting with Cloud-Native Apps, SaaS, PaaS, IaaS	Dev/ Engineering, DevOps, Architect, Procurement, Security, Compliance, Enterprise Architecture	3–5			●	●	●
7	Ability to rapidly provision IaaS and PaaS from a private, public, or community cloud for production applications with full operations support and integration with service and operational management systems and processes **Description:** A team is able to access IaaS or PaaS services through a portal, directly procuring and configuring infrastructure or platform services for support of production applications and systems. Integration with operational systems including monitoring, DNS, load balancing and with service management processes and systems (e.g., configuration, incident, change, etc.) is required.	Production Iaas/PaaS	Dev/Engineering, DevOps, Test/ QA, Integration or Build/ Deploy Teams and Systems, Ops, Service Management (configuration, incident, change, problem), Procurement, Finance, Security, Compliance, Enterprise Architecture	3-5	●	●	●	●	

Continued >

USE CASE	DESCRIPTION	POTENTIAL APPLICABILITY	POTENTIAL ACTORS	CMM RANGE	TIMELINE (months)				
					6	8	12	18	24
8	Ability to deliver and/or consume DaaS data stores (relational, object, KV, graph, file, etc.) from a private, public, or community cloud for production applications with full production support and integration with service and operational management systems and processes **Description:** The ability to deliver or consume private internal or external, public external, or community data stores and data-management services through an as-a-service model may include relational and nonrelational databases, file-based systems (e.g., Hadoop, KV stores like Cassandra), SQL-big data hybrids (e.g., Hbase, or other data technologies). Integration with operational systems including monitoring, DNS, load balancing and with service management processes and systems (e.g., configuration, incident, change, etc.) is required.	Production Data Stores, Information-as-a-Service, Data-as-a-Service, Platform-as-a-Service	SA (System Administrator), DBA (Database Administrator), Dev/ Engineering or DevOps, Test/ QA Team, Ops and Service Management, Compliance, Finance, Security, Enterprise Architecture	3-5			●	●	●
9	Ability to deliver and/or consume middleware and similar platforms (e.g., JBoss, .NET, Apache, Tomcat, Citrix, IIS) from a private, public or community cloud, or via Integration-as-a-Service or Integration-Platforms-as-a-Service for production applications with full operations support and integration with service and operational management systems and processes **Description:** The ability to provide standard middleware-similar platforms (e.g., Jboss, .net, Apache, Tomcat, Citrix, IIS) or take a developer-centric approach via Integration-as-a-Service or Integration-Platforms-as-a-Service must include full integration with production-level operational systems, including monitoring, DNS, load balancing, standard service management processes (incident, problem, change, knowledge, etc.)	Production Middleware, SaaS, PaaS, IaaS	SA (System Administrator), Dev/ Engineering or DevOps, Test/ QA, Integration, Build Teams and Systems, Ops and Service Management, Strategy, Commercial, Security, Compliance, Enterprise Architecture	3-5	●	●	●	●	●

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USE CASE	DESCRIPTION	POTENTIAL APPLICABILITY	POTENTIAL ACTORS	CMM RANGE	TIMELINE (months)				
					6	8	12	18	24
10	Ability to migrate production workloads from a private, public or community cloud to a separate private, public or community cloud provider on demand based on SLA, peak load, or financial factors **Description:** Provide automated processes for workload migration that monitor migration requirements against performance objectives and cost thresholds, migrating workloads when trigger conditions are met. Prior to workload migration, take inventory of workflows and monitor yield utilization data to insure capacity for peak computational loads and understand peak demand requirements prior to any migration.	SaaS, PaaS, IaaS, DaaS, PI-aaS, Information-aaS	Business Teams, Ops, Service Management Team, DevOps, DBA (Database Administrator), Procurement, Finance, Security, Compliance, Enterprise Architecture	4-5			●	●	●
11	Ability to develop and deploy production-ready cloud native applications (e.g., running on OpenStack and Cloud Foundry) **Description:** The ability to develop cloud native applications for production workloads, with full integration into an organization's production operational environment. Cloud native apps are specifically architected and developed for cloud/distributed computing models or built specifically to utilize cloud frameworks like OpenStack or Cloud Foundry. They often use containers, loosely coupled services, multiservice designs with geographic independence (i.e., services that can run in any location without manual configuration) and that are horizontally scalable and have built-in redundancy, automatic IP remapping, and other cloud native characteristics. These applications should be able to leverage an elastic infrastructure in order to provision instances of themselves, scaling up and down as needed, with the ability to detect and work around failures.	Production Cloud Native Apps, SaaS, PaaS, IaaS	Ops, SA (System Administrator), Build, Deploy (Integration) Teams, Strategy, Security, Compliance, Enterprise Architecture	4-5			●	●	●

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USE CASE	DESCRIPTION	POTENTIAL APPLICABILITY	POTENTIAL ACTORS	CMM RANGE	TIMELINE (months)				
					6	8	12	18	24
12	Ability to dynamically manage production workloads with a combination of legacy and cloud native applications, associated middleware, and infrastructure; provide geographic redundancy while maintaining SLAs for a peak business event; utilize internal private cloud, and two or more public or community cloud providers **Description:** The ability to manage production workloads with a high degree of automation, SLA-driven, highly agile and dynamically scalable. Seamlessly integrate legacy/traditional applications with cloud native applications. Deliver to consumers via multiple endpoint channels: mobile, web, TV, smart devices. Utilize IaaS, PaaS, SaaS, Information-as-a-Service and Integration-as-a-Service (e.g., a software-defined stack). Require dynamic workload allocation and optimization. Business rules should be implemented in accordance with regulation and legislation restrictions. Must leverage multiple cloud providers for redundancy and geodistribution. People, process, and technology must be well integrated. The system should proactively respond to threat and risk with a high degree of automation.	Multisite Elastic Computing, SaaS, PaaS, IaaS	Ops, SA (System Administrator), Build, Deploy (Integration) Teams, Business Teams, Service Management, DevOps, DBA (Database Administrator), Integration Teams, Build Teams, Service Management Teams (config, incident, change, problem), Architect, Data Management, Network Teams, Finance Teams, HR Teams, Other Back-Office Teams, PMO, Security, Compliance, Enterprise Architecture	5	●	●	●	●	●

Note: Uncover use cases by conducting a cloud value proposition session or an innovation session.

STEP 2.1—DEFINE SERVICES TO BE DELIVERED (OPTIONAL)

The use cases define what cloud capability requirements of the business unit. The services definition identifies what IT needs to deliver in order to accomplish the use cases. Some CMM users have found it valuable to capture the IT services they expect to use when determining the CMM ratings.

Table 4: Check the service portfolio and capability you wish to support by your cloud implementation

CLOUD SERVICE CAPABILITY DESIRED STATE DESCRIPTION	REQUIRED
Infrastructure as a Service	
Physical Server Provision (bare metal)	
RHEL 6.3 Application Server(Virtual Machine with Vanilla OS)	
Windows 2008 R2 SP1 Application Server	
Windows 2012 & Windows 2012 R2(Virtual Machine with Vanilla OS)	
Open Stack Distro (Helion Openstack)	
Create, delete and configure load balancers	
Object Storage	
Block Storage	
File Storage	
Hypervisor Support	
VMware ESX	
KVM	
Hyper-V	
Integration Platform as a Service	
Informatica	
Dell Boomi	
Mulesoft	
SAP	
Snap Logic	
IBM	

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CLOUD SERVICE CAPABILITY DESIRED STATE DESCRIPTION	REQUIRED
Platform as a Service	
IIS 8.0 on WIN2012 R2	
Apache 2.2 on RHEL 6.0	
Tomcat	
JBoss	
Window Azure	
Amazon Web Services	
Cloud Foundry (Helion Development Platform)	
Docker container	
Database as a Service	
Oracle	
MS-SQL	
Cassandra	
MongoDB	
Maria	
Software as a Service	
Sales Force.Com	
Force.com	
Workday	
Etc.	
Storage as a Service	
Elastic Object storage	
Elastic Block storage	
Elastic File storage	
Private/public cloud drop box services	
One location for all data across the enterprise using a global file system	
Ability to sync files across any device, PC, server	
Backup services for applications, services and PCs	
Data Archiving services	
Deduplication services	
Record Retention Management services	
Data Encryption at rest and in transit	

Continued >

CLOUD SERVICE CAPABILITY DESIRED STATE DESCRIPTION	REQUIRED
Application Eco System Provisioning	
Ability to provision complete 3-tier application/infrastructure/platform/database/network in one provisioning activity	
Management Services	
Replication service	
Server Management: Service Request/Ordering, Power features (reboot, reset, shutdown, off, on),Snapshot, Restore snapshot (restore data and state of the last snapshot), Edit server - edit CPU, MEM, disk configuration, Rebuild Server - rebuild OS, wipes all data, Contract Mgmt.	
Application monitoring	
Backup Services	
Cloud Native application Development	
Openstack Management tools (Chef, Heat, Puppet)	

STEP 3—CONDUCT CMM ASSESSMENT

There must be a consistent process in order to effectively assess an enterprise and develop a road map. To assist in this process, the CMM includes a series of use cases and control questions that can be used to select appropriate domains and develop an interview agenda.

The team of stakeholders should be composed of individuals from multiple disciplines and led by an executive.

Stakeholders must be identified for the selected domains. The team of stakeholders should be composed of individuals from multiple disciplines and led by an executive at a level high enough to provide strategic guidance and, if needed, to arbitrate any disputes that might arise. Stakeholders are likely to come from the ranks of architecture, IT operations, compliance, legal, security, applications, business, and elsewhere.

Conduct interviews with these stakeholders using the control questions. Use separate interview sheets for each interview and note the name of the interviewee. Use the interview answers to the questions to determine maturity levels. The table below outlines the recommended process for: a self-assessment leading to a contracted external assessment, a full self-assessment, or an external assessment.

Table 5: Example CMM Assessment

STEP	ACTIVITIES	RESULTS
1. Define analysis scope: The first step in defining an analysis scope is defining the use cases that have to be enabled for the enterprise. Some example use cases are discussed in this document.	Define the target scope, including, for example: • Overall intended scope and objectives for cloud services • Specific target use cases required and the enabling cloud service models • Domains relevant to each use case • Target CMM levels for each use case • Timeline and milestones or quality gates for each use case • Basic conditions and project risks	**Analysis charter:** A clear mandate, scope statement including target use cases to enable, the timeline in which those use cases should be delivered, and a list of overall objectives that the analysis should address.

Continued >

STEP	ACTIVITIES	RESULTS
2. Identify stakeholders: Based on the identified use cases, identify interested, impacted, and participating parties for each domain pertinent to each use case.	Identify relevant stakeholders and personnel to interview. Agree to the interview schedule.	**Interview schedule:** Based on the selected use cases, relevant domains are selected, and the appropriate stakeholders for each domain can be identified. This schedule should list the stakeholders to be interviewed, as well what information needs to be obtained from each one.
3. Perform assessment: Assess the environment based on the defined use case for each domain relevant to that use case. This will be in the context of people, process, and technology. The CMM Excel-based domain questions and outcomes provide a good foundation for this analysis. By answering the key questions, an initial pass of all 25 domains can by done by the management team. The more in-depth questions will require subject matter experts. In the spreadsheet, key questions are in bold.	Conduct interviews. Review existing documentation, processes, methods, strategies, and problems.	**Resulting preparation:** The following documents will normally be created in preparation for the analysis: 1. A list of questions and possible outcomes per domain, specifically appropriate to the selected use cases, compiled into a single audit document 2. A short slide overview to introduce the stakeholders to the audit, providing objectives for the audit and timeline and setting feedback expectations 3. A statement of the desired target state per domain, based on executive input, against which the current state will be audited

Continued >

STEP	ACTIVITIES	RESULTS
4. Identify barriers: When planning a road map to enable hybrid IT, experienced analysts also consider which barriers they will have to overcome. There are a few common ones in this area, which should be considered per domain during the analysis: 1. Do cloud skills exist? 2. Are there unique applications in the environment that inhibit cloud use? 3. Is there a perception of entitlement? 4. Are there union-driven job classifications? 5. Does leadership provide a mandate to move to cloud? 6. Is there a compensation scheme supporting cloud adoption? For each of these, a solution will need to be found, taking into consideration the organization's hierarchy, culture, structure, and business strategy.	Consolidate barriers. The process of consolidating barriers into a Pareto chart requires the assessor to make a judgment call on the unstructured comments that are collected into categories. Below is a list of common categories of barriers. While these provide a good starting point, you may find very unique categories in your enterprise when performing the assessment. 1. Process design, ownership (accountability), or handoff (inter-process accountability) problem 2. Management or measurement system problem 3. Policy, rule, value, or belief conflict 4. Job description, skills, or organizational problem 5. Information system: application system is inadequate or nonexistent 6. Information system: data are not collected or available 7. Information system: infrastructure is inadequate or nonexistent 8. Information system: service or service levels are inadequate or nonexistent 9. Physical layout or location problem 10. Service delivery technology problem 11. Corporate culture issue 12. IT governance 13. Lack of leadership problem	**Resulting documentation:** Produce a Pareto chart of barriers and identify the most common barriers that will need to be eliminated.
5. Consolidate results: Review the results of the analysis in the context of the desired state. Consider the real impacts and priorities of any gaps or changes required in each domain. Also consider which frameworks, standards, tools, or methods would best be applied to help close the defined gaps for each domain.	Consolidate result documentation. Reconcile draft results with stakeholders and interviewees, if required.	**Resulting documentation:** The following documentation will normally be outputs of the analysis: 1. Statement of current state of the selected domains, as well as identification of key problems that may prevent achievement of the selected use cases and company objectives

Continued >

STEP	ACTIVITIES	RESULTS
6. Identify gaps between current and target maturity levels and develop closure actions: Based on the result of the analysis per selected domain, create a practical implementation plan of change actions (from the previous step) that groups and synchronizes any changes and actions into logical bundles. This should result in a project plan of some sort.	Identify potential gaps between assessment results and targeted maturity level. Develop closure requirements/actions between current and target maturity levels per domain. Provide high-level resource estimation and action timing.	**Road map for maturity level achievement and hybrid IT establishment:** Define a set of steps needed to move each domain from current state to target state, including suggested reference models, recommended frameworks, and standards, as well as actions needed in the process and people layers per domain. Produce a logical grouping of actions across the involved domains to increase project efficiency, simplify the tasks overall, and maximize sharing/single efforts at once between domains.
7. Create a report including assessment results, suggested road map, and actions: Create a management-level report that identifies the key gaps and the impacts of these on the organizational objectives. Indicate the proposed closure actions, proposed timelines, and the amount of estimated effort required to perform these actions. Within the context of the business objectives and defined use case, identify a set of proposed measures to quantify progress through the changes.	Create report including: • Assessment results • Road map of actions • Gap closure plan between current and target maturity levels • Draft project charter • Barrier elimination projects	**Resulting report:** The following documents are the suggested outputs of the analysis and hybrid IT road map: 1. A written gap analysis between current and target state for each domain, including impacts of each gap and recommended frameworks, standards, and models to incorporate to close the gaps. Include a benefit summary of each. This represents the road map to hybrid IT enablement at the required levels 2. A draft project plan for closing the gaps with timing and logical grouping of activities 3. An executive overview presentation showing what needs to change, as well as the resource requirements needed to make the changes within the desired timeline, mapped to the overall resulting benefits

Selecting Domains for Each Use Case—Nontechnical Domains

The table below identifies candidate nontechnical domains that the analyst may select for a particular use case. The actual domain selection depends upon the details of the organizations and its objectives in conducting this analysis. An explanation of the domains can be found in appendix V.

Table 6: Example of Nontechnical Domains

Use Case	Finance	Enterprise Strategy	Structure	Culture	Skills	Compliance	Business Process	Procurement	Commercial	Portfolio Mgt	Projects
1					●			●			●
2		●			●			●	●		●
3					●	●	●	●	●		
4					●	●	●	●	●		
5		●			●			●	●		●
6	●	●	●		●	●	●		●	●	●
7	●	●	●	●	●	●	●	●	●	●	
8		●	●		●	●	●		●		●
9				●	●	●	●		●		●
10	●	●	●	●	●	●		●	●		●
11		●	●	●	●	●	●			●	●
12	●		●	●	●	●	●	●	●	●	●

Selecting Domains for Each Use Case—Technical Domains

The table below identifies candidate technical domains that the analyst may select for their particular use case. The actual domain selection depends upon the details of the organizations and its objectives in conducting this analysis. An explanation of the domains can be found in appendix V.

Table 7: Example of Technical Domains

Use Case	IT Architecture	Applications	Management Tools	Operations (IT)	Security	IaaS	PaaS	STaaS	SaaS	IPaaS	Data	Data Life Cycle Mgt
1	●	●				●	●			●	●	
2	●	●	●		●				●		●	●
3	●		●		●	●		●			●	●
4	●		●		●	●		●		●	●	●
5	●	●	●	●	●		●			●		
6	●	●	●	●	●	●	●	●		●	●	●
7	●		●	●	●	●	●				●	●
8	●	●	●	●	●	●		●			●	●
9	●	●	●	●	●	●	●			●		
10	●	●	●	●	●	●	●	●		●	●	●
11	●	●	●	●	●	●	●	●		●	●	●
12	●	●	●	●	●	●	●	●	●	●	●	●

Using Excel for Domain Analysis

Step 1: Once the relevant domains for the target use case have been identified, investigate each selected domain and identify the minimum target maturity level necessary for that domain in order to achieve the identified use case.

> **Example:** The information systems domain is selected as a domain target use case. When the information systems domain is selected, you must identify the target maturity level of the domain within the organization. The domain maturity may need to be elevated in order to achieve the capabilities needed to enable services that will align with business requirements.

NOTE: It is not necessary to try and target the highest maturity level. Select the minimum maturity level necessary to achieve the identified use case.

Each domain includes control questions that address the layers of people, process, and technology as they apply to the domain.

Step Two: Identify the appropriate control questions from the domain. Not all of the control questions may be appropriate. Identify the outcomes for each maturity level that best align to the ability to deliver on the target use case.

Example: Leveraging selected control questions from the information services domain (CMM3)

	Control Question	CMM 0 (None, n/a)	CMM 1 (Initial, ad hoc)	CMM 2 (Repeatable, opportunistic)	CMM 3 (Defined, systematic)	CMM 4 (Managed, measurable)	CMM 5 (Optimized)
People	Describe your current state of people skills on Big Data technologies (HP)	No Big Data skills	Big Data awareness	Trained on Big Data tools such as Hadoop, Vertica, Cloudera, Autonomy	Building applications using Big Data tools such as Hadoop, Vertica, Cloudera, Autonomy	Trained in canonical data messages, API accessibility, data encryption technology, private and public cloud storage repositories, trained on integration methods, SaaS using integrated data stores	Trained in API service brokerage technology
Process	Describe your current state of governance of ILM processes, policies, data (SNIA)		Unaware of business data governance practices	Aware of business data governance practices but following inconsistently	Follows business data governance practices consistently	Automated ILM consistent with business data governance practices	Feedback loop for continuous improvement of ILM alignment with business data governance practices
Technology	How is your information organized, accessed, available, and managed (SNIA)?		Information stored by each app separately, creating data duplication	Enterprise data management implemented and key master data sources identified	Multiple business intelligence Big Data systems Implemented; Open source Database technologies in use to support a scale out database architecture	Canonical messages implemented, Data types and files accessible via API	Single company-wide logical data repository implemented for structured and unstructured data, data accessible via API service brokerage catalog

Table 8: Example Domain with Target Maturity Level Identified

TIP: Multiple use cases may be built upon the initial use case, but it is not advised to try and achieve them all at once.

TIP: There are technical base and nontechnical base domains—these should always be included together with the selected domains for the use case.

For each outcome, you should be able to determine the frameworks, processes, tools, skills, and capabilities that are needed to achieve that outcome. Each higher maturity level builds on the foundation of the previous maturity levels and assumes that they have already been achieved. Through the stakeholder interview process, the analyst will be able to determine which elements do and do not exist for that domain at the target maturity levels. If there are elements that are necessary but do not exist for that domain, you must build the establishment of those elements into the hybrid IT road map based on the target timeline for the use case. Once each relevant domain has been analyzed in this way, the results may be combined into a single representation of the necessary road map to achieve the use case—the road map to hybrid IT. An example road map is illustrated in appendix III.

Assessing selected business units individually, single support units, or the IT department independently does not indicate the detailed and complete state of the enterprises' cloud maturity. Some complexity lies in analyzing how and why the business units collaborate to use cloud services. This includes identifying the various departments involved and assessing them using appropriate questions from the questionnaire.

BUILDING A ROAD MAP TO HYBRID IT ENABLEMENT FROM A CMM ASSESSMENT

To create a detailed roadmap, define a series of projects for each domain. These projects should accomplish the outcomes defined by the desired maturity level. Link the project charters to the defined outcomes in the CMM assessment. Note that there are also dependencies between domains. For example, it is not recommended that IT management tools are implemented until IT processes are defined. In all cases, people skills for each domain have to be achieved before process and technology changes are implemented. Every project plan will be different. An example of a high level roadmap is in Appendix III.

The output of a CMM assessment is most valuable when it is represented in the form of a road map of tasks, objectives, and answers that need to be defined. The ODCA recommends the following approach to building the road map.

1. Analyze the objectives through the potential or existing use of cloud services. Why is the enterprise considering the use of cloud services?

2. Analyzing each selected use case, determine the CMM level that accurately describes the current state for each of the domains covering both technical and nontechnical capabilities.
3. Analyzing each selected use case, determine the CMM level that describes the desired target state for each of the domains for the in the technical and nontechnical capabilities.
4. Determine a list of elements that need to be addressed using the outcomes identified in the assessment per CMM maturity level. Higher maturity level layers build upon the previous layers, so start at CMM 1 and build upward.
5. Analyzing each of the elements in the people, process, and technology layers per domain, determine what will help close the gap—for example, the incorporation of a methodology or framework, a process update, any tooling updates, and any education and skills development or augmentation.
6. Build a practical timeline for addressing these gap items within the environment. Often, the implementation of technology elements should follow process and skill related updates. Consider instantiating a Cloud adoption program office or cloud adoption center of excellence (CoE) composed of champions and transformation processes/tools to drive specific road map projects.
7. Perform ongoing measurement of the resulting benefits after each milestone is completed. Use these measurements to shape the resulting road map of changes and updates for each domain to ensure that the business objectives and cloud benefits being sought are realized.
8. Review and group appropriate tasks together. Determine estimated resource requirements in order to integrate the planning with daily business operations. This effort may be led by the cloud adoption program office.
9. Create draft project plans for each domain, taking into consideration any cross-domain dependencies or prerequisites or corequisites.
10. Determine appropriate key performance indicators (KPIs) for measuring progress on the updates and the benefits or enablement that the changes should generate.
11. Consider the CMM model as a methodology for enabling and building effective hybrid IT for an enterprise. Present the results this way.

Consider the CMM model as a methodology for enabling and building effective hybrid IT for an enterprise.

NOTE: An example hybrid IT road map may be found in appendix III.

NOTE: Because it is important to the analyst who conducts the gap assessment to be able to determine what should be done to close identified gaps, several reference frameworks, bodies, and training are listed in appendix II.

INCLUDE BARRIER ELIMINATION PROJECTS TO PROGRESS

When planning a road map to enable hybrid IT, the experienced analyst should also consider which barriers will have to be overcome. There are several common barriers that should be considered for each domain during the analysis:

- Do cloud skills exist?
- Are there unique applications in the environment that inhibit cloud use?
- Is there a perception of entitlement?
- Are there union-driven job classifications?
- Does leadership provide a mandate to move to the cloud?
- Is there a compensation scheme supporting cloud adoption?

For each of these barriers, a solution or project will need to be included in the hybrid IT transformation plan, taking into consideration the organization's hierarchy, culture, structure, and business strategy.

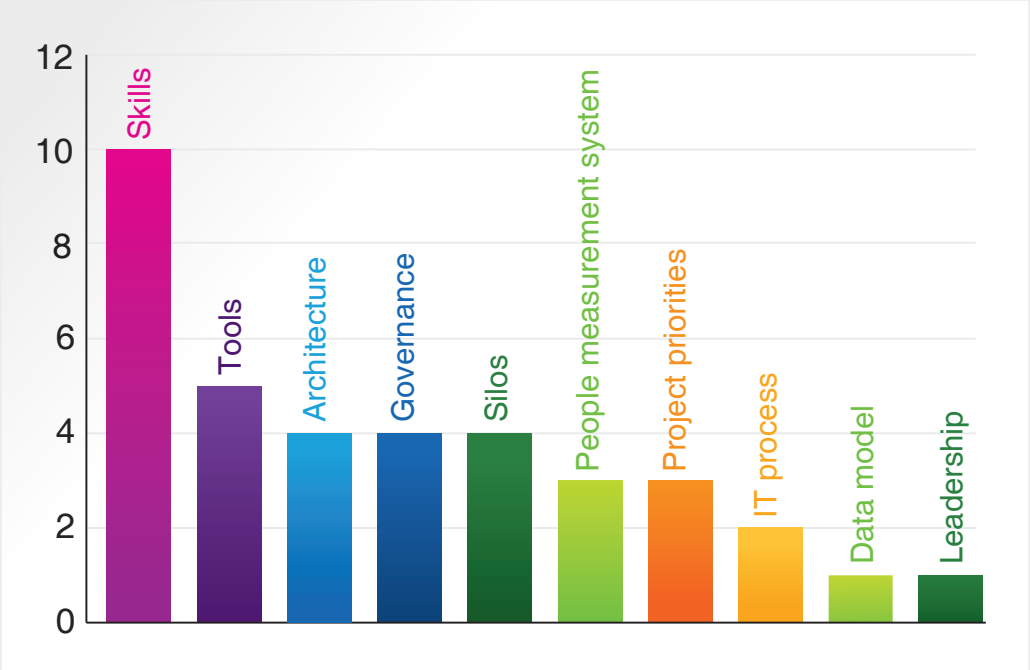


Figure 6: Example Barrier Pareto

MATURITY AND QUALITY

It is important to keep in mind that maturity is different than quality. Increased maturity does not necessarily mean increased quality and vice versa. Organizations should buy products and services that are most appropriate to the business and not waste resources purchasing top-of-the-line products and services unnecessarily. Increased maturity allows organizations to maximize the advantage and benefits gained from appropriate services, no matter what the scope of their features and functions.

Quality and Maturity: What's the Difference?

Maturity relates to an enterprise's processes, governance, integration levels, defined frameworks, and methodologies. These all lead to sustainability and repeatability, as well as effectively achieving what the service was designed to deliver.

Quality relates to features and functions of the service offering without considering the ability and need of the enterprise to take full advantage of the service.

The differences are represented by means of the following table, with bronze, silver, gold, and platinum quality levels representing service quality, which may relate to additional functions and features built into the service or product:

Table 9: Quality and maturity matrix—a dot denotes that there may be some correlation between quality and maturity.

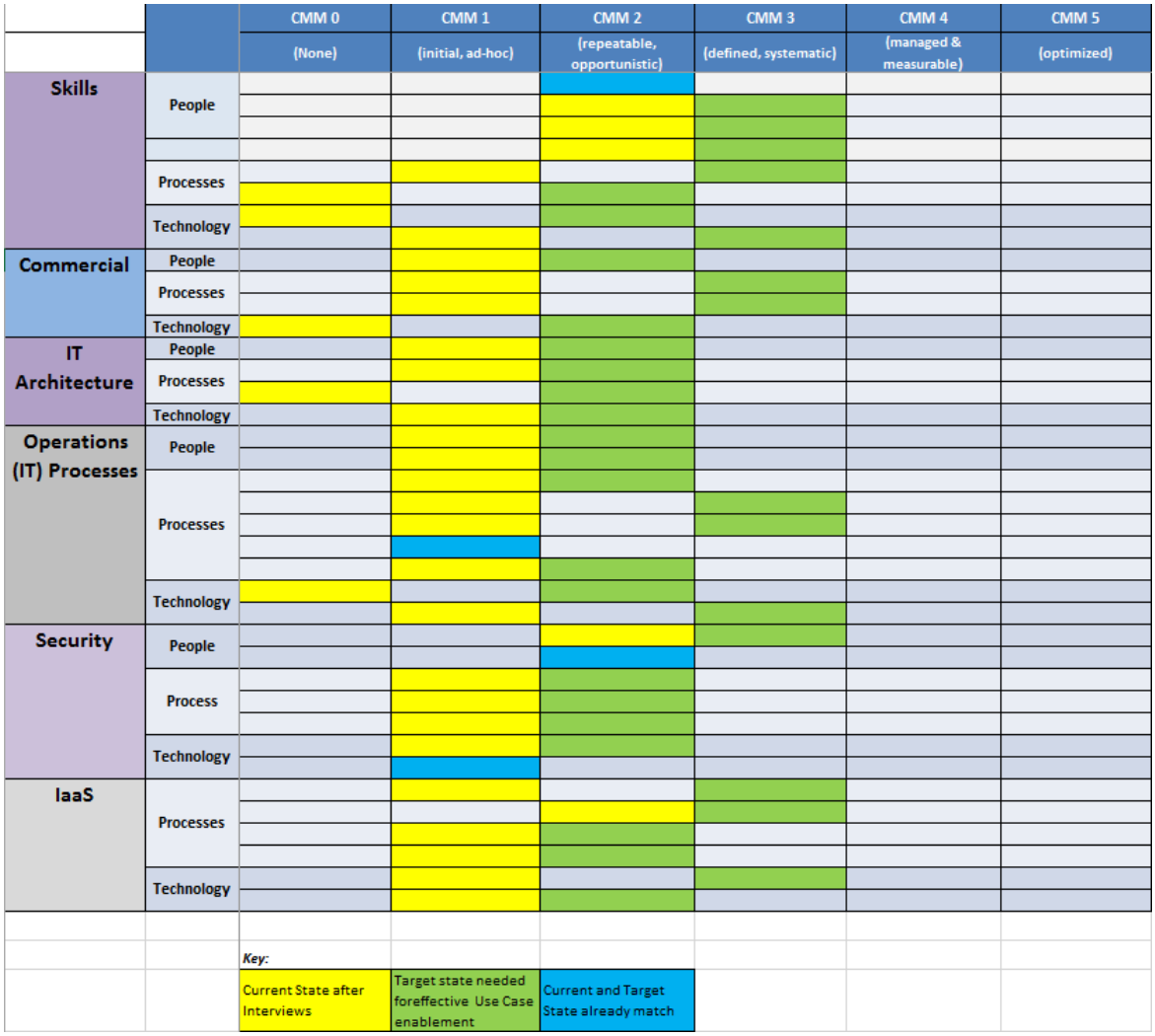
	CMM 1	CMM 2	CMM 3	CMM 4	CMM 5
Bronze	●	●	●	●	
Silver	●	●	●	●	●
Gold		●	●	●	●
Platinum			●	●	●

SELF-ASSESSMENT EXAMPLE

ODCA developed a detailed Microsoft Excel questionnaire to assist enterprises in assessing cloud maturity and identify potential development areas, which in turn lead to potential investments. The questionnaire addresses each of the various domains at the people, process, and technology layers and also addresses potential outcomes and answers for each level.

In the context of the specific business, the questionnaire also identifies appropriate target states for the realization of specific benefits. This gives the enterprise an accurate assessment of its current state and reveals the development gaps where investment of resources is required (e.g., people, processes, technology). An example of an analysis result that leverages a few selected domains is shown below.

Figure 7: Example Analysis Result



An example of a hybrid IT–planning road map arising from a CMM-based assessment may be found in appendix III.

The Excel CMM questionnaire performs several important functions. It supports organizations in performing self-assessments of their cloud readiness levels, assists in the development of a road map of actions to build or improve domain capability, and helps determine how to achieve maximum value from cloud-based services.

CONCLUSION

An organization should reap benefits when technology and business strategies align to reach its optimal cloud maturity level. These benefits should be built upon a federated, interoperable, and open cloud environment that enables the expected business value that cloud services represent to that enterprise. Capability gains, efficiency gains, quality gains, and velocity gains ultimately result in powerful business strategy enablement.

The CMM provides a methodology to achieve the objectives that the enterprise seeks from cloud services and the establishment of a hybrid IT landscape. The CMM helps to identify the different layers that must be considered between the consumer and the provider. It also provides a method for identifying gaps and provides guidance with suggested outcomes, helping to determine what should be done to close gaps in order to improve maturity. The CMM is also useful for both consumers and providers to prepare their requirements and their service offerings in a structured, sustainable way. Using the CMM, an organization can eliminate the risk associated with the approach of moving to the cloud and just hoping for the best, instead developing a road map that enables truly successful cloud adoption.

APPENDIX I—ABBREVIATIONS

Reference Bodies

ATIS	Alliance for Telecommunications Industry Solutions
CEN	Comité Européen de Normalisation
CENELEC	Comité Européen de Normalisation Electrotechnique
CSMIC	Cloud Services Measurement Initiative Consortium
CSA	Cloud Security Alliance
CSCC	Cloud Standards Customer Council
DMTF	Distributed Management Task Force
ENISA	European Union Agency for Network and Information Security
ETSI	European Telecommunications Standards Institute
GICTF	Global Inter-Cloud Technology Forum
IEC	International Electrical Commission
IEEE	Institute for Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
ISO	International Organization for Standardization
ITU	International Telecommunication Union
ITU-T ITU	Telecommunication Standardization Sector
NIST	National Institute of Standards and Technology
OASIS	Organization for the Advancement of Structured Information Standards
ODCA	Open Data Center Alliance
OGF	Open Grid Forum
OSS/BSS	Operations Support System/Business Support System
QuEST	Quality Excellence for Suppliers of Telecommunications
SNIA	Storage Networking Industry Association
TIA	Telecommunications Industry Association
TMF	TeleManagement Forum
TOG	The Open Group

Acronyms

CDMI	Cloud Data Management Interface
CIMI	Cloud Infrastructure Management Interface
CSC	Cloud Standards Coordination
CSP	Cloud Service Provider
ETSI	European Telecommunications Standards Institute
HLUC	High-Level Use Case
IaaS	Infrastructure as a Service
IOP	Interoperability

OCCI	Open Cloud Computing Interface
OSS/BSS	Operational Support System/Business Support System
PaaS	Platform-as-a-Service
SaaS	Software-as-a-Service
SDO	Standards Development Organization
SLA	Service Level Agreement
TGx	Task Group 1 to 3 of CSC
VM	Virtual Machine
VPN	Virtual Private Network

APPENDIX II—USEFUL REFERENCE FRAMEWORKS AND STANDARDS

After an organization has conducted a maturity analysis, it is time to design a road map toward an increased maturity model. There are a number of frameworks and approaches available to guide road map design. The ODCA does not mandate the use of any of these specific models—it is up to each enterprise to determine which frameworks are specifically most appropriate to them and their business needs. The following is a nonexhaustive list:

IT Governance

ITIL (IT Infrastructure Library)

COBIT (Control Objectives for IT)

Cloud Standards

DMTF

- OVF (DSP0243) (Open Virtualisation Framework)
- CIMI (DSP0263 & DSP0264) (Cloud Infrastructure Management Interface)
- CADF

OASIS

- CAMP
- TOSCA (Topology & Orchestration Specific for Cloud Applications)
- ODATA (Open Data Protocol)

Quest

- TL9000 (TL 9000 Measurements & Requirements handbooks)

ATIS

- ATIS-0200003 (CDN Interconnection Specification)
- ATIS-0200004 (CDN Requirements for Multicast-Based Content Distribution)
- ATIS-0200005 (Cloud Framework for Telepresence Service)
- ATIS-0200006 (Virtual Desktop Requirements)
- ATIS-0200008 (Trusted Information Exchange)
- ATIS-0200009 (Cloud Service Lifecycle Checklist)
- ATIS-0200010 (CDN Requirements in a Multi-Party Federation Environment)
- ATIS-I-000001 (Format of ATIS Namespace)
- ATIS-I-000002 (ATIS XML Schema Development Guidelines)

TIA

- ANSI/TIA-942-A (Infrastructure Standards for Data Centers)

NIST

- SP 80-145 (NIST Definition of Cloud Computing)
- SP 500-292 (NIST Cloud Computing Reference Architecture)
- 800-53 Rev4 (Security Controls)

TMF

- GB917 (SLA Management Handbook)
- GB960 (Quick Start Pack for Cloud: Trouble to Resolve)
- GB963 (Cloud SLA Application Note)
- TR174 A, B, C (Enterprise-Grade IaaS Requirements, Bus Models, External Compute, Reference Implementation)
- TR178 (Enabling e2e Cloud SLA Management)
- TR194 (Multi-Cloud Service Management Pack—Introduction)
- GB935 (Multi-Cloud Service Management Pack—Business Guide)
- GB981 (Partnership and B2B2X Best Practices Overview)
- TR211 (Partnership and B2B2X Best Practices Overview—Concepts and Examples)
- TR218 (Partnering Guidebook—A Step-by-Step Guide)
- GB982 (B2B2X Partnering Development Guide)

Interfaces

OGF

- OCCI (Open Cloud Computing Interface)
- GFD.183 (OCCI—Core)
- GFD.184 (OCCI—Infrastructure)
- GFD185 (OCCI—RESTFul HTTP Rendering)
- GFD.192 (Web Services Agreement)
- GFD.193 (WS Agreement Negotiation)

Security

Cloud Security Alliance

- CCM 3.0 (Cloud Control Matrix)
- CTP (Cloud Trust Protocol)
- A6 (Cloud Audit)
- PLA (Privacy Level Agreement)
- TCI (Reference Architecture—Trusted Cloud Initiative)
- OCF (Open Certification Framework)

ITU-T

- X.1600 (Security Framework for Cloud Computing)
- Y.3501 (Cloud Computing Framework and High-Level Requirements)
- Y.3510 (Cloud Computing Infrastructure Requirements)
- Y.3520 (Resource Management Framework for e2e Cloud)

Storage

SNIA

- CDMI (Cloud Data Management Interface)

Applications

- ODCA Cloud Native App Blueprints

  Architecting Cloud-Aware Applications Best Practices Rev 1.0
  http://opendatacenteralliance.org/article/open-data-center-alliance-best-practices-architecting-cloud-aware-applications-rev-1-0-2/

- "Architectural Patterns for High Availability"
  www.infoq.com/presentations/Netflix-Architecture

- *Cloud Architecture Patterns*
  www.amazon.com/Cloud-Architecture-Patterns-Using-Microsoft-ebook/dp/B009G8PYY4/

- "Cloud Characteristics, Principles and Design Patterns"
  www.gartner.com/document/2081915

- "Cloud Design Patterns: Prescriptive Architecture Guidance for Cloud Applications"
  http://msdn.microsoft.com/en-us/library/dn568099.aspx

- "Building Cloud-Aware Applications"
  www.slideshare.net/cobiacomm/building-cloudaware-applications
  [slides 17, 18, 19, 31]

- "Searching for Cloud Architecture…"
  http://blog.cobia.net/cobiacomm/2011/11/25/searching-for-cloud-architecture/

- "Maximizing Cloud Advantages through Cloud-Aware Applications"
  http://www.intel.co.za/content/dam/www/public/us/en/documents/white-papers/maximizing-cloud-advantages-through-cloud-aware-applications-paper.pdf

- Network Latency between U.S. Cities (AT&T)
  http://ipnetwork.bgtmo.ip.att.net/pws/network_delay.html

- "The Fallacies of Distributed Computing Reborn: The Cloud Era —New Relic blog" http://blog.newrelic.com/2011/01/06/the-fallacies-of-distributed-computing-reborn-the-cloud-era/
- "5 Lessons We've Learned Using AWS"—Netflix Tech Blog http://techblog.netflix.com/2010/12/5-lessons-weve-learned-using-aws.html
- "Optimizing the Netflix API" —Ben Christensen https://speakerdeck.com/benjchristensen/evolution-of-the-netflix-api-qcon-sf-2013
- "Architecting Applications for the Cloud: Best Practices" —Jinesh Varia, Amazon Technical Evangelist http://media.amazonwebservices.com/AWS_Cloud_Best_Practices.pdf
- "Lessons from Distill" —Michael Forhan, AppFirst www.appfirst.com/blog/lessons-from-distill/
- "Understanding Security with Patterns" – Prof. Peter Sommerlad, Tutorial T39 @ OOpsLA 2006 http://wiki.hsr.ch/PeterSommerlad/files/T39-Sommerlad.pdf
- "How it Works" (Circuit Breaker implementation in Hysterix open source library) —Netflix https://github.com/Netflix/Hystrix/wiki/How-it-Works
- Netflix Shares Cloud Load Balancing and Failover Tool: Eureka! —Netflix Tech Blog http://techblog.netflix.com/2012/09/eureka.html
- "Dystopia as a Service" —Adrian Cockcroft, Netflix www.slideshare.net/adrianco/dystopia-as-a-service
- "Netflix and Open Source" www.eiseverywhere.com/file_uploads/c6b285b64a18cc2742c0fb20061d6530_OBC_BreakoutSession_AdrianCockcroft_1pm.pdf

Standards, Terminology, and Metrics

ISO/IEC

- ISO/IEC 19086
- ISO/IEC 27001 (Information Security Management Systems)
- ISO/IEC 27002 (Code of Practice for Information Security Controls)
- ISO/IEC 17203 (Open Virtualisation Framework)
- ISO/IEC 20000-1 (Service Management System Requirements)

Training Certifications for Cloud

Service Layer

Amazon AWS—Amazon AWS has offers five certifications and is working toward offering additional certification. Currently, Amazon offers certifications at the associate level for architects, developers and SysOps admins. Professional-level certifications are offered for architects and DevOps admins.

- AWS Certified Solutions Architect—Associate Level
- AWS Certified Solutions Architect—Professional Level
- AWS Certified Developer—Associate Level
- AWS Certified SysOps Administrator—Associate Level
- AWS Certified DevOps Engineer—Professional

Arcitura Education

Arcitura Education—Arcitura Education created a set of cloud certifications in addition to their SOA certifications.

- Certified Cloud Professional (CCP)
- Certified Cloud Technology Professional
- Certified Cloud Architect
- Certified Cloud Security Specialist
- Certified Cloud Governance Specialist
- Certified Cloud Storage Specialist
- Certified Cloud Virtualization Specialist
- Certified Cloud Capacity Specialist
- Certified Cloud Trainer

CA Technologies

CA Technologies—The CA AppLogic certification program offers instruction and hands-on labs covering the essential elements needed for rapid success in the cloud: basic concepts, advanced technologies, best practices, automation, and business continuity. The programs are accessible to IT professionals who are using the AppLogic cloud computing platform.

- CA AppLogic Certified Cloud Operator
- CA AppLogic Certified Cloud Architect

Cloud Credential Council

Cloud Credential Council is a vendor-neutral cloud computing certifications provider. CCC offers trainings and several certifications from associate to architect level.

- Cloud Technology Associate
- Cloud Business Associate
- Professional Cloud Administrator
- Professional Cloud Developer
- Professional Cloud Security Manager
- Professional Cloud Service Manager
- Professional Cloud Solutions Architect

Cloud Genius

Cloud Genius Certification—Cloud Genius certification is recommended to people who want to learn DevOps skills in a cloud computing environment. Candidates may also receive certifications in the design and architecture of cloud solutions.

- Certificate on Cloud Technologies
- Certificate on Cloud/DevOps: Automating Cloud Infrastructure
- Certificate on Cloud Architecture/Design
- Cloud Genius Certification

Cloud Institute

Cloud Institute—The Cloud Institute is an independent provider of vendor-neutral cloud computing online certification programs. The Cloud Institute offers two online certifications and one free online test.

- Certified Cloud Architect (CCA)
- Certified Cloud Professional (CCP)

CompTIA

CompTIA—CompTIA has cloud certifications targeted at people who want to understand the basic concepts of cloud computing.

- CompTIA Cloud Essentials
- CompTIA Cloud+

Cloud Security Alliance

CCSK—The Cloud Security Alliance's Certificate of Cloud Security Knowledge (CCSK) is the industry's first user certification program for secure cloud computing. Currently, it is the only cloud certification that demonstrates knowledge of cloud security skills.

- Certificate of Cloud Security Knowledge (CCSK)

EXIN

EXIN—EXIN has two cloud certifications in its portfolio.

- EXIN Cloud Computing Foundation
- EXIN Cloud Technologies Advanced

HP

HP—HP has developed several certifications for cloud specialists. These certification programs are generally integrated with software and hardware from HP, but candidates can also find many topics that cover general cloud concepts and applications.

- HP Master ASE—Data Center and Cloud Architect
- HP Master ASE—Software for Cloud Management
- HP ASE—Cloud Integrator
- HP ASE—Data Center and Cloud Architect
- HP ASE—Software for Cloud Management
- HP ATP—Cloud Administrator
- HP ATP—Data Center and Cloud
- HP ATA—Cloud
- HP Master ASE—Data Center and Cloud Architect
- HP ASE—Data Center and Cloud Architect
- HP ATP—Data Center and Cloud
- HP Master ASE—Software for Cloud Management
- HP ASE—Software for Cloud Management
- HP ATP—Cloud Service Automation
- HP Master ASE—Data Center and Cloud Architect
- HP ASE—Data Center and Cloud Architect
- HP ATP—Data Center and Cloud
- HP Technical Certified II—Software for Cloud Automation in SME
- HP Technical Certified I—Implementing SaaS Solutions

IBM

IBM has three certifications for people who want to demonstrate their knowledge of cloud computing infrastructure solutions. One certification is focused on Tivoli systems; two are focused on architectural concepts.

- IBM Certified Solution Advisor—Cloud Computing Architecture
- IBM Certified Solution Architect—Cloud Computing Infrastructure

Microsoft

Microsoft Cloud Certification—Microsoft is one of the largest players in the cloud certification marketplace.

- Microsoft Certified Solutions Expert (MCSE) Private Cloud
- Microsoft Specialist certification in Office 365
- Microsoft Certified Specialist Developing Microsoft Azure Solution
- Microsoft Certified Specialist Implementing Microsoft Azure Infrastructure Solutions

Mirantis

Mirantis Certifications—Mirantis is one of the biggest OpenStack players on the market.

- OpenStack Administrator Certification Exam—Associate Level
- OpenStack Administrator Certification Exam—Professional Level

Oracle

Oracle—In the Oracle portfolio, there are several new certifications for cloud specialists. The most important are OCP Database Cloud Administrator and OCM Database Cloud Administrator.

- Oracle Certified Master, Database Cloud Administrator
- Oracle Certified Professional, Database Cloud Administrator
- Oracle Cloud Application Foundation Certified Implementation Specialist
- Exalogic Elastic Cloud X2-2 Certified Implementation Specialist
- Oracle Exalogic Elastic Cloud 2014 Certified Implementation Specialist

RackSpace Hosting

CloudU—CloudU is a cloud certification designed for IT professionals and business leaders who want to upgrade their knowledge of the fundamentals of cloud computing. CloudU program is sponsored by RackSpace Hosting.

- CloudU Certificate
- Rackspace Certified Technician for OpenStack

Red Hat

Red Hat Certification—Red Hat is one of the biggest companies involved in Linux and cloud solutions (OpenStack).

- Red Hat Certificate of Expertise in Hybrid Cloud Storage
- Red Hat Certified System Administrator in Red Hat OpenStack
- Red Hat Certificate of Expertise in Platform-as-a-Service

Salesforce.com

Salesforce—Salesforce is a cloud computing company. All certifications from the Salesforce portfolio are based on its cloud services. Companies who use certified cloud specialists generally see smoother deployments and better use of Salesforce.

- Salesforce.com Certified Administrator
- Salesforce.com Certified Advanced Administrator
- Salesforce.com Certified Developer
- Salesforce.com Certified Advanced Developer
- Salesforce.com Certified Sales Cloud Consultant
- Salesforce.com Certified Service Cloud Consultant
- Salesforce.com Certified Technical Architect

VMware

VMware Cloud—VMware is still the number one player in the virtualization market, and with vCloud Director, the company has moved into the cloud world. VMware offers several new certifications for cloud experts, some of which are available now and others that will be available soon.

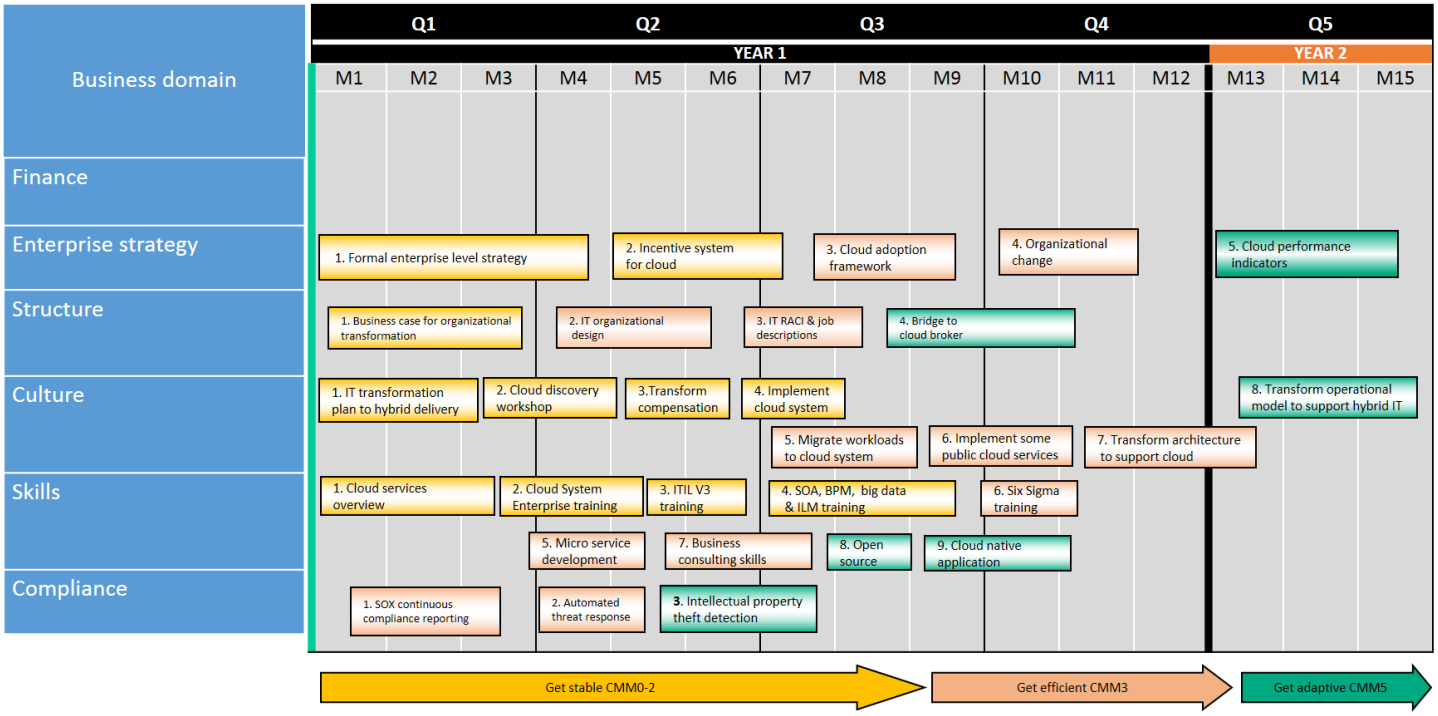
- VMware Certified Associate—Cloud (VCA-Cloud)
- VMware Certified Professional—Cloud (VCP-Cloud)
- VMware Certified Advanced Professional—Cloud Infrastructure Design (VCAP-CID)
- VMware Certified Advanced Professional—Cloud Infrastructure Administration (VCAP-CIA)
- VMware Certified Design Expert—Cloud (VCDX-Cloud)

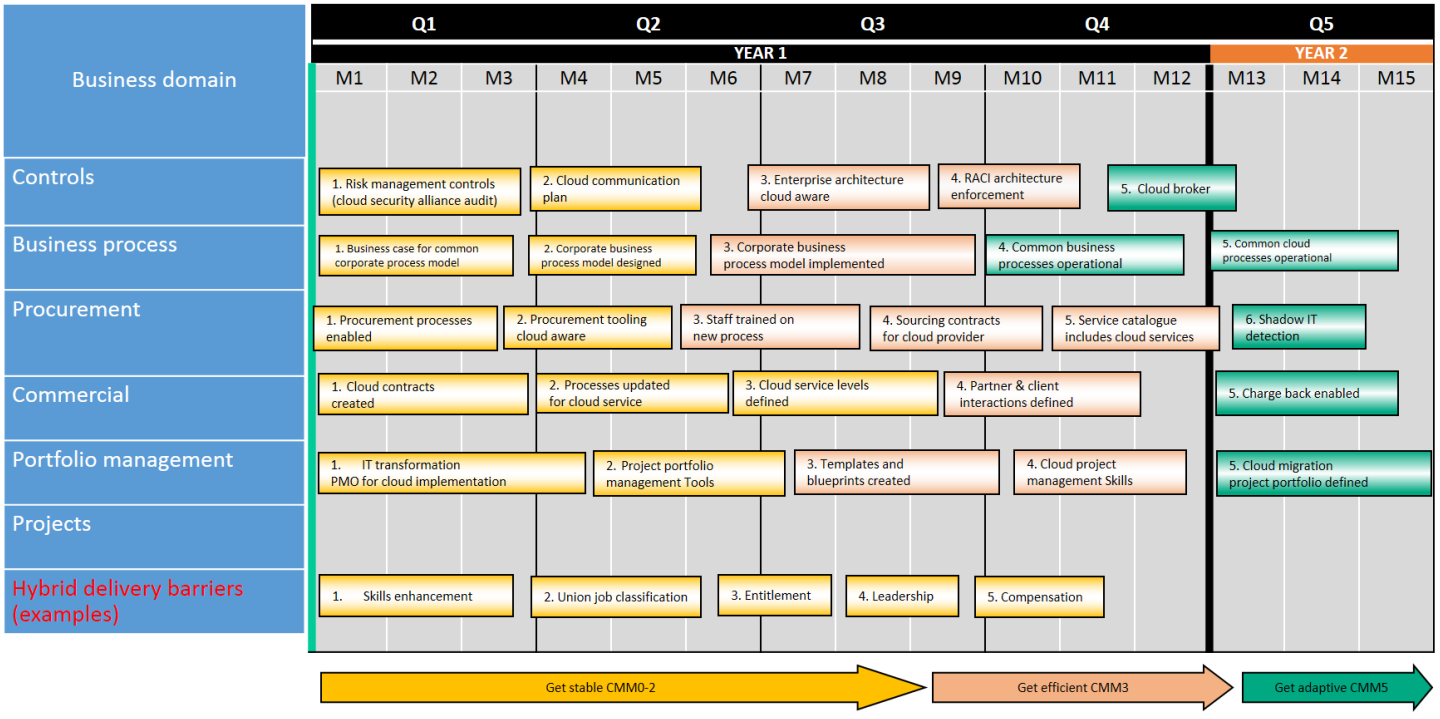
A more comprehensive list of some of the training and certifications for cloud services can be found here:
http://itcertificationmaster.com/it-certifications/cloud-certifications/

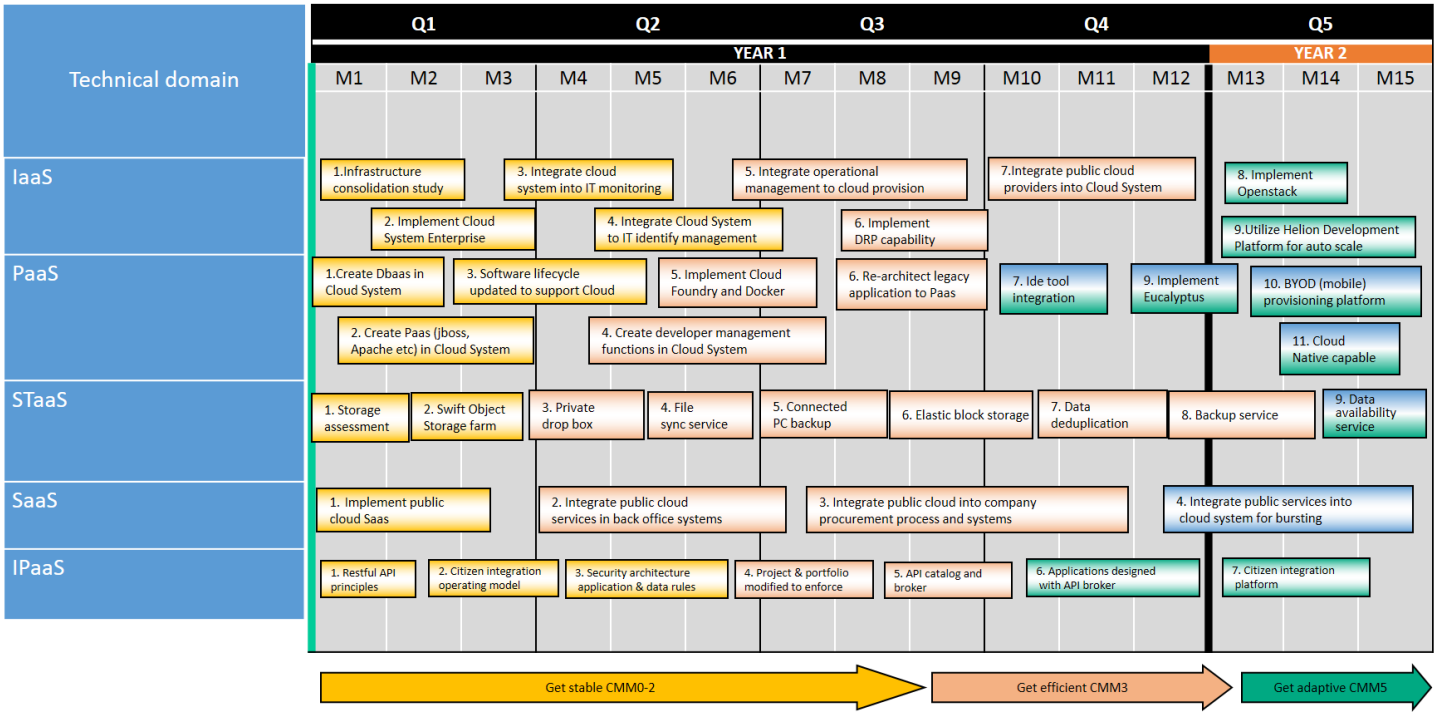
APPENDIX III—EXAMPLE ROAD MAP

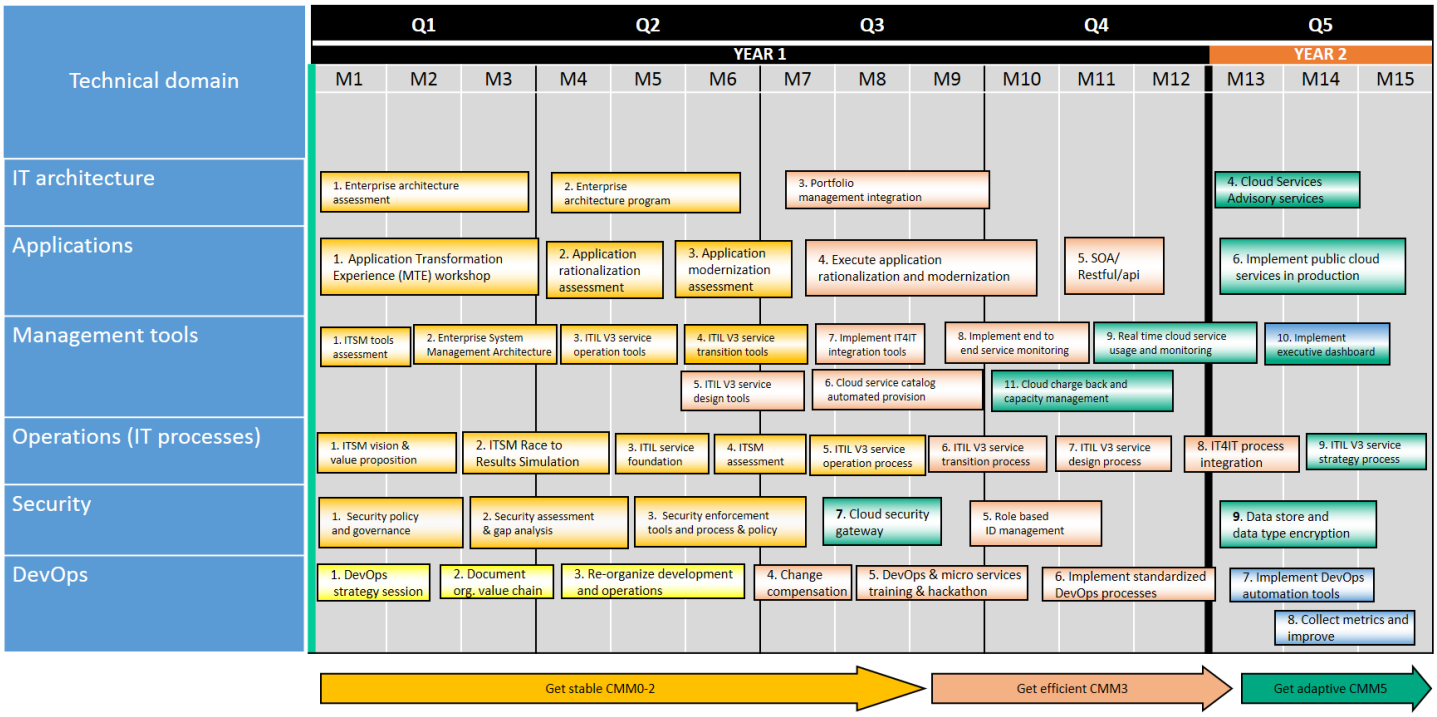
The following is an example road map produced by Hewlett Packard Consulting Services, based on the result of a CMM analysis. The road map brings together all initiatives for execution, coordination, and governance.

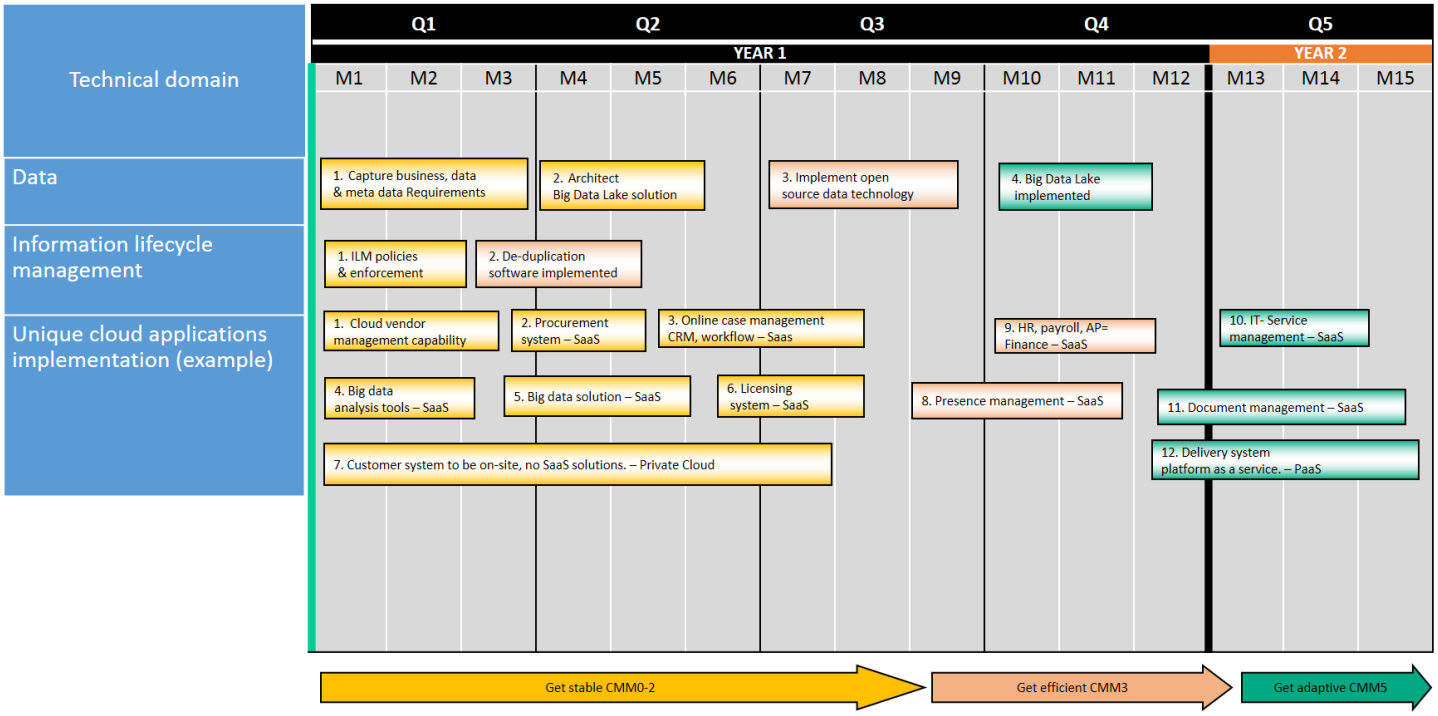
Figure 8: Example Road Map











APPENDIX IV—TERMINOLOGY

Table 9 lists the standard terms and corresponding descriptions that are used in this document.

Table 10: Terms and Descriptions

TERM	BENEFITS	DESCRIPTION
Architecture	Flexibility Compliance	A defined architecture for public and private clouds, through all layers, including business processes. This includes patterns, automation, business requirements, stakeholder maps, rules, specifications, standards, and measures.
Federation	Flexibility	• **Security**—Security domain is structured to include public- and private-based IaaS or PaaS. • **Data**—Organization data is distributed in a structured, consistently managed way across multiple clouds. • **Processes**—Organization data is distributed in a structured, consistently managed way across multiple clouds.
Identity and Access Management	Simplify	Security domain is structured to enable public- and private-based user access in a managed standard way.
Integrated	Simplified	Core design process and standards for all system elements with documented API exposure and usage allow interapplication communication regardless of platform.
Orchestration	Automated	This is a tooling layer for handling service deployments consistently according to patterns, consisting of workflows and work packages.
Policy	Compliance	A governance-driven set of business and IT thresholds, standards, preferences, or metrics against which IT delivery is measured includes a defined set of policies for handling all aspects of cloud usage, including data protection, applications, risks, and requirements.
Process	Compliance	This is a defined set of processes for handling all aspects of cloud usage, including migrations, data life cycle, risks, and exceptions.
Risk Management	Compliance Risk	• **Corporate**—Company-specific requirements are defined in the context of the cloud. • **Country**—Country-specific requirements are defined in the context of the cloud. • **Region**—Sub-country governing bodies, with localized rules and requirements for technology, privacy, and other aspects of cloud service use. • **Industry**—Industry-specific requirements are defined in the context of cloud.

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TERM	BENEFITS	DESCRIPTION
Security	Compliance	Security domain is structured to enable public- and private-based service access in a managed, standard way.
Service Delivery Management	Managed	Human interfaces are appointed, with supporting governance and processes, to manage the interface between business users and cloud providers, taking care of translating service detail and other incidents, handling problems, and reporting between the parties.
Transition and Transformation	Velocity Cost	• **Transition** is the migration from a legacy platform onto the cloud. • **Transformation** is the migration from a legacy design to take advantage of cloud benefits.
Capability	Capability	This is the expression or the articulation of the capacity, materials, and expertise an organization needs in order to perform core functions. It refers to a particular set of intellectual property enabled by people, process, and technology that enables a particular aspect of business to operate, usually grouped according to organizational high-level structures, including a set of interdependencies. In the CMM, it has been further divided into specific enabling domains.
Enterprise	Efficiency	All of the business units that compose an entity in order to deliver defined services to their market, using defined processes, are aligned on their integration and use of on-premises and cloud-based service elements.
Hybrid IT	Capability	In order to operate and manage the entire traditional and cloud-based IT landscape of an enterprise or organization, the different development and operational models combine into one structure, complementing each other and interoperating seamlessly.
Systems / Business Systems	Capability	The different technologies used to process and execute business transactions form systems, which integrate efficiently with each other, enabling the business to handle transactions according to cost and time expectations.
Use Case	Governed	A use case represents a viewpoint or specific scenario against which requirements and capabilities are scoped and specified.
CAPA		Capa stands for Correction and Preventative Actions.

APPENDIX V—DOMAINS

Table 10 lists the descriptions for the domains that are discussed in this document and the supporting Excel questionnaire.

Table 11: Domain Descriptions

DOMAIN	DESCRIPTION
Finance Domain	Considers the financial management, control, and budget processes necessary to enable cloud services when moving from CAPEX to OPEX models
Enterprise Strategy Domain	Contains capabilities such as: • Business motivation • Expected benefits • Guiding principles • Expected costs and funding models • Service selection and service-level agreements (SLAs), which also gain relevance in cloud initiatives
Culture Domain	Contains the mindset and behavior pattern that: • Supports the business with choice (says yes not no), facilitates innovation, and demonstrates flexibility • Transforms from being a supplier to being a business partner • Nurtures innovative practices through self-service and automation • Eliminates technology silos • Is committed to being and efficient, fast and service oriented where a service is measured from a customer point of view, rather than ITs point of view
Structure Domain	Contains capabilities related to: • Development of organizational competency (work) around cloud computing • Organizational structure and new tasks
Governance and Control Domain	Considers the process and technology updates that should be integrated into an existing environment, to deal with and control the cloud and any external dynamic services and solutions
Skills Domain	Contains capabilities related to: • Competency in cloud implementation skills • Business process knowledge • Emerging standards and technology knowledge, such as open source, OpenStack, cloud foundry, and cloud native application development • DevOps methods of continuous integration and deployment • Big Data technology and data lake architecture, Six Sigma, ITIL v3, and IT4IT operational models

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DOMAIN	DESCRIPTION
Compliance Domain	Compliance in general means to fulfill laws and regulatory requirements, specifications, and standards as well as specific demands imposed by other external parties or internal stakeholders; examples from the perspective of a certain enterprise: • Law: Publish yearly financial statements. • Regulatory: Validate computer systems when manufacturing medical devices. • Specifications and standards: Transmitting unit in Wi-Fi devices needs to use certain frequencies including a maximum deviation. • Specific demands of external party: A customer expects a certain interface for data exchange with a system such as an ERP system. • Internal stakeholder: A foreign subsidiary requires a process or IT system to be designed in a certain manner.
Business Process Domain	Contains capabilities related to: • How business processes are structured and designed • Which processes are deemed support or shared and which are unique to the business unit
Procurement Domain	Contains capabilities related to the following: • The procurement processes are cloud aware. • The procurement tooling is cloud aware. • Training and development are performed for supporting organizations. • Sourcing and contracting have been updated to accommodate cloud. • A cloud service catalogue exists. • Reporting is updated to monitor and measure cloud services.
Commercial Domain	Contains capabilities related to: • Cloud contract templates • Processes updated to accommodate cloud service delivery • Key performance indicators for cloud based services • Partner and client Interactions updated for cloud service delivery • Costs of a service billed to the consumer of the service
Portfolio Management Domain	Contains capabilities related to: • Consistent methodology for product and service development at both business and enabling technology layers • Project Initiation updates to enable innovation and “cloud-first” thinking • Standardized online documentation for services and products, which enables effective selection and matching of enabling and underpinning offerings
Projects Domain	Projects are enabled by means of defined processes, blueprints, skills, and governance frameworks; this domain considers some of the key cloud enablers for projects

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DOMAIN	DESCRIPTION
IT Applications Domain	Contains modernized and optimized application ecosystems that: • Are service oriented, API accessible, fully aligned to business needs, and cost-effective • Are able to be migrated to a hybrid cloud delivery model • Contain hybrid cloud application design mechanisms • Support cloud native application design • Utilize RESTful API, micro-services, and container models of application design
Architecture Domain	Contains capabilities related to the following: • The definitions of the overall architecture and guidelines for various practitioners to ensure adherence to the architecture • Capabilities fundamental to cloud architectures such as: » Resource pooling » Interoperability » Self-service • Enterprise architecture program defined: » Policies » Principles » Architecture domains • Technology standards and road maps enforced; cloud native patterns and code samples
Management Tools Domain	Contains capabilities of tools that: • Manage and monitor all technology • Enable ITIL V3 processes, IT4IT value chain models, and end-to-end service monitoring • Provide integrated portfolio management system • Document the enterprise architecture system • Document the service catalog with workflow • Integrate test management and software development environment • Manage IT assets • Document IT automation and cloud service provisioning
Operations (IT) Processes Domain	Contains capabilities related to: • Enabling 24x7, business continuity, and data center failover • ITIL V3, service strategy, design, operations, and continuous improvement processes • Asset management, workforce management, and service design, building and testing development processes • Integrated IT value chain (Open Group IT4IT model); that service life cycle is captured in the four IT value streams: » Plan (Strategy to Portfolio) » Build, (Requirement to Deploy) » Deliver (Request to Fulfill) » Run (Detect to Correct)

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DOMAIN	DESCRIPTION
DevOps Domain	Framework allows development, quality assurance, and operations to meet customer needs, containing capabilities related to: • Integrating development and operations teams to facilitate communication collaboration, and integration to manage today's rapidly changing business demands • Enabling developers to provision, change, and manage their development environments without IT operations involvement • Enabling developers to promote to production cloud native applications without IT operations involvement • Enabling both conventional application development acceleration and cloud native application development techniques
Security Domain	Contains capabilities to enable: • Single sign on access • Role-based identity management • Real time per transaction authentication for SaaS Integration • Detection and auto-response mechanism to all threats at any level of the OSI model
IaaS Domain	Contains capabilities related to: • Provisioning processing, storage, networks, and other fundamental computing resources • Enabling a consumer to be able to deploy and run arbitrary software, which can include operating systems and applications • Providing the subscriber control over operating systems, storage, and deployed applications but not the underlying cloud infrastructure • If necessary, providing the subscriber limited control of select networking components such as host firewalls
PaaS Domain	Contains capabilities related to: • The subscriber can ceploy onto the cloud infrastructure subscriber-created or acquired applications created using programming languages, libraries, services, and tools supported by the provider • The subscriber does not manage or control the underlying cloud infrastructure, including network, servers, operating systems, or storage, but has control over the deployed applications and possibly configuration settings for the application-hosting environment • The provider provides platform services such as Apache Tomcat, JBoss, .NET, and Cloud Foundry to develop applications • The provider provides database-as-a-service (DBaaS) such as Oracle, Microsoft SQL Server, Cassandra, Mongo, Maria, Vertica, et cetera

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DOMAIN	DESCRIPTION
STaaS Domain	Cloud service provides a platform to support users, applications, and data projects with storage, containing capabilities related to: • Storage services include elastic » Object storage » Block storage » File storage » Private/public cloud drop box services • One location for all data across the enterprise using a global file system • Ability to sync files across any device, PC, server • Data encryption at rest and in transit
SaaS Domain	Contains capabilities related to: • The servicer (software) provider's applications running on a service provider's infrastructure • The applications accessible from various client devices through either a thin client interface, such as a web browser (for example, web-based email), or a program interface • Applications integrated with internal applications and data stores
IPaaS Domain	Contains capabilities related to the following: • Integration platform as a service (iPaaS) is a cloud service that provides a platform to support application, data, and process-integration projects, usually involving a combination of cloud-based applications, APIs, and on-premises systems. • IPaaS delivers some combination of capabilities that are typically found in enterprise service buses (ESBs), data integration tools, B2B gateways, managed file transfer products, and API management platforms. • IT departments, line-of-business developers, mobile application development teams, application teams, and even business users (aka citizen integrators) leverage these capabilities to develop, execute, and manage integration interfaces (or integration flows) in the cloud.
Information Lifecycle Management Domain	Contains capabilities to: • Capture, manage, retain, retrieve, and deliver information according to its business relevance and specific industries • Enforce information management life cycle process from creation to disposal • Record retention policy enforcement • Back up and archive policy enforcement • Use efficiently hierarchical storage technology • Go beyond storage management to information management by application, data classification, and business function • Back up services for applications, services, and PCs • Archive data • Offer deduplication services

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DOMAIN	DESCRIPTION
Data Domain	Contains the capability of: • Storing information in data lake architecture or a storage-as-a-service model that is a highly scalable, high performance, easily accessible, cost-effective shared repository • Enables data virtualization of structured and unstructured data • Promotes a shift from ETL (Extract, Transform, Load) to ELT (Extract, Load, Transform) of data • Enables insight and foresight reporting based on aggregated unstructured and structured data versus conventional hindsight reporting based on structured data alone