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Towards A Comprehensive Cloud Decision Framework with Financial Viability Assessment

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Completed Research Paper

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Abstract

Most organizations moving their legacy systems to the cloud base their decisions on the naïve assumption that the public cloud provides cost savings. However, this is not always true. Sometimes the migration complexity of certain applications outweighs the benefits to be had from a public cloud. Moreover, the total cost of ownership does not necessarily decrease by moving to a public cloud. Therefore, there is a need for a disciplined approach for choosing the right cloud platform for application migration. In this paper, we propose a comprehensive cloud decision framework that includes an extensible decision criteria set, associated usage guidelines, a decision model for cloud platform recommendation, and a cost calculator to compute the total cost of ownership (TCO). The decision process works as follows. It begins with the ordering of relevant criteria, either according to industry best practice or the enterprise's specific requirements and preferences. A technical recommendation is made on the basis of the criteria classification, which is then assessed for financial viability. By providing traceability of the cost items in the public/private TCO calculators to the decision criteria, the framework enables users to iterate through the decision process, determining and eliminating (if possible) the main cost drivers until a right balance is found between the desirable criteria and the available budget. We illustrate the need, benefits and value of our proposed framework through three different real-world use case scenarios.

Keywords: Cloud Computing Adoption, Cloud Migration, Private Cloud, Public Cloud, TCO Calculator, Decision Support Tool, Financial Viability Assessment

Introduction

The cloud offers a great deal of flexibility for application creation and deployment; yet doing so without a planned and deliberate approach and governance model for application placement can lead to the cloud migration complexity (Linthwait, 2017) and technical debt (Ganly, 2017). While the growing prevalence of agile methodologies is making it increasingly important for organizations to identify a suitable cloud platform early on in the project lifecycle (Younas, M., et al, 2016), the frequent release of new cloud features and services is making cloud selection an increasingly complex task (Crandell et.al., 2017). Market research states that cloud computing adoption can be stifled or delayed without a clear and concise decision framework with associated set of criteria and guidelines for selecting '*fit for* *purpose*' cloud infrastructure platforms (Nelson, Betz, 2018), with up to 90% of the effort being spent on the planning phase of cloud migration (Rakowski, 2018).

A review of recent literature on cloud decision frameworks shows that there have been several efforts at designing decision models for cloud adoption. Some have focused on *cloud platform selection* (Gonçalves et al., 2015, Habryn, F., 2015) while others have focused on *cloud cost estimation* (Juan-Verdejo et al, 2013; Microsoft, 2018; Amazon, 2017). Yet others have proposed models for *identifying non-functional requirements* that influence the decision on cloud platform for different application architectures (Juan-Verdejo et al, 2013). However, none of these approaches provides a comprehensive framework and decision support tool that not only enables enterprise users to review a set of criteria to make a technical recommendation, but also allows them to assess its financial viability, and, where infeasible, iterate through the process to try and find one that is financially viable. Furthermore, none of the cloud cost calculators directly compares the 'rental model' in a commercial public cloud (buying virtual machines and storage by the hour) with 'leasing model' (multiple year set term rental) in a commercial private cloud.

Therefore, in this paper, we present a comprehensive cloud decision framework with an extensible set of decision criteria, associated guidelines, a decision model and a Total Cost of Ownership (TCO) calculator to help enterprises choose between public and private cloud for deployment of their applications. The decision-making process is summarized as follows. The *first* step is to select and classify the relevant decision criteria as 'Required' or 'Optional'. Support for criteria filtering and classification enables coverage of many enterprise scenarios with users (of the framework) having the flexibility to either tailor the decision criteria according to their unique requirements and preferences or follow an industry-based shortcut approach (IBM Enterprise Cloud, 2013) if constrained by time. The *second* step is to feed the shortlisted and classified criteria to the decision model to obtain a technical recommendation, which might either be public, private or hybrid cloud. The *third* step is to use the TCO calculator to assess the financial viability of the technical recommendation. The calculator uses a more complete set of cost items for TCO calculation, compared to those provided by public cloud providers (who have their own vested interests), and provides three different cost estimates including for Public Cloud, Private Cloud and Do It Yourself (DIY) options. The process terminates at the end of the third step if the technical recommendation is financially viable. However, if the business sponsor cannot support or justify the estimated costs, the whole process can be iterated, starting with a reclassification of the criteria, until the right balance is found between the 'Required' criteria and the associated cost items resulting in a financially viable recommendation. Traceability of the cost items in the TCO calculators to the decision criteria enables users to determine and where possible eliminate the main cost drivers, thereby simplifying the reclassification process.

Our framework is suitable for use in cloud migration scenarios that involve sufficiently large and complex enterprise applications, and require a decision in the initial requirements gathering phase of the project lifecycle. In particular, it allows enterprises to assess their applications, one at a time. If the framework is used for low complexity, small-sized applications, then the total number of virtual machines required, and storage sizes and associated speeds will need to be established for the application portfolio before going through the financial viability assessment. The key benefit for enterprises is that they can use the framework to make *more informed decisions* on the choice between public and private cloud, instead of relying on implied assumptions. Using the framework, Subject Matter Experts (SMEs) can work through the critical decision criteria and understand their potential impact on end-user experience as well as the cost implications. The consideration of non-functional criteria in the decision process helps mitigate the risks associated with cloud migration, particularly performance and end user experience, because application components are typically distributed when delivering services (Rakowski, 2018). We validate our proposed framework using three real-world scenarios that cover three different outcomes (a) private cloud recommendation and endorsement, (b) public cloud recommendation and endorsement, (c) private cloud recommendation with no financial endorsement leading to a review of the classification.

The rest of the paper is organized as follows. Section 2 presents related work on cloud decision frameworks. Section 3 presents our proposed framework that includes a detailed architectural decision process coupled with the financial viability assessment. Section 4 illustrates the framework's suitability by providing three sample scenarios. The sample scenarios underpin the motivation and need for technical decision support and associated financial viability assessment through an iterative process to find the right balance between the technical decision criteria and associated costs. Section 5 concludes the paper by providing a summary of the completed work and identifying areas of future work.

Related Research

The majority of research so far identifies cost savings as the primary reason for moving enterprise applications to cloud. In fact, most research reviewed so far assumes that public cloud is less expensive than the legacy environment hosting the applications (Kavis 2014; Maresova et al., 2017). However, this is not always true. Private cloud is typically more economical when the service is purchased as a managed service under a leased arrangement for a duration of 5 years, and after the number of virtual machines increases beyond a break-even point (Garrett, 2016). Alternatively, if seeking to migrate small and low complexity applications, then the total number of virtual machines required, storage sizes and associated speeds will need to be established for the application portfolio before reaching a technical decision between public and private cloud and going through the financial viability assessment.

The regularity of cloud adoption seen with cloud-native architectures is currently missing in legacy or monolithic architectures. A primary reason for this is that service quality assurance can be at risk in a multi-tenanted environment where resources are shared and legacy means of offering application redundancy are not supported. In a cloud-native architecture of a 'shared nothing' principle, this has less of an impact if the application is able to create new instances when it reaches processing thresholds (Chorofas 2010; Holami et al., 2010). Also, most assessments of public cloud do not include the cost implications of moving data into and out, except for calculators for public cloud pricing and identification of non-quantifiable costs of cloud computing (Maresova et al., 2017). Thus, there is still a significant need for guidance when adopting and using the public cloud computing models including IaaS, PaaS and SaaS (Kavis 2014).

As correctly identified in (Gholami et al., 2017; Reza et al., 2017), cloud migration is not simply a matter of replicating functionality in the cloud or porting an application to the cloud – it is also about ensuring that the associated non-functional requirements will be matched or exceeded. The authors in (Gholamai et al., 2017) report that comparing an application's current environment to a 'standardized' cloud environment can be significantly complex when environments have not been kept up-to-date. Alternatively, (Mudaliar, 2015) states that large enterprises value data residency and predictable costs, which will continue to drive private cloud spending.

As enterprises adopt multiple cloud platforms, multiple technical, non-functional and commercial considerations arise regarding vendor lock-in. In Yangon et al. (2016), the authors recommend avoiding vendor lock-in when choosing a public cloud provider, hence, a focus on application portability is encouraged during the engineering of the application. They also recommend that enterprises should have a multi-cloud service strategy of public and private cloud models. Similarly, Lewis (2011) and Famideh et al. (2016) identify a number of considerations for the placement of functionality in a cloud platform, including cloud resource management, user authentication, performance, and security. Fruehe (2017) also identifies the set of decision criteria associated with the deployment of applications on the Azure public and private cloud. Our research aims to extend, elaborate and incorporate these considerations in a decision support tool.

Having gathered a set of decision criteria, it is important to have a framework to guide the cloud platform decision. The Open Group's Cloud Buyers Decision Tree (Harding et al, 2011) provides a decision tree to enable a business or technical SME to identify the appropriate Cloud platform for an application. The limitation of this approach is that it asks questions typically found in a business process assessment and cloud application readiness assessment, without focusing on a clear set of criteria for making the decision as to which cloud platform is appropriate. IBM's Designing Your Cloud Decision assist in arriving at a technical recommendation, which has a reasonable degree of commonality with our approach. It emphasizes that each scenario will have its own set of criteria, which we have taken into consideration by augmenting our approach with Gartner's process (Gartner, 2017) for assessing which criteria are required and applicable or not for a given scenario. However, unlike our approach, it does not provide any support for testing the financial viability of the technical recommendation.

Another frequent focus of the literature review is identifying the complexity of application migration while maintaining independence from a cloud provider. Although compute and storage are available to create a new service, features above this, often lead to cloud provider lock-in (Nelson, Betz, 2018). Moreover, builders of technology solutions that may use cloud services as part of a managed service will require guidance to make the architectural decision. Typically, these are service-based offerings that do not declare which platform underpins the service (Ochs, 2012).

Cloud Decision Framework and Process

In this section, we present our cloud architectural decision framework. The aim of the proposed framework is to support business users, business analysts and/or solution leads in choosing between public or private cloud for their enterprise application, from both a technical perspective and a financial perspective. The framework (as shown in Figure 1) was originally presented in (Ramchand et. al., 2017) and can be summarized as follows. To begin with, the business SME is presented with a business case for cloud migration and is required to make a choice between multiple alternatives – traditional IT, private cloud, public cloud or combinations of them. Depending upon the degree of confidence required in the recommendation, our framework offers two alternative decision processes to choose from – a *streamlined* decision process that relies on the basic use case model (BUCM) and associated high-level guidelines, and an *elaborate* decision process that uses the detailed use case model (DUCM) and associated detailed guidelines. The SME should use the detailed decision process if a high level of confidence is required in the decision-making.

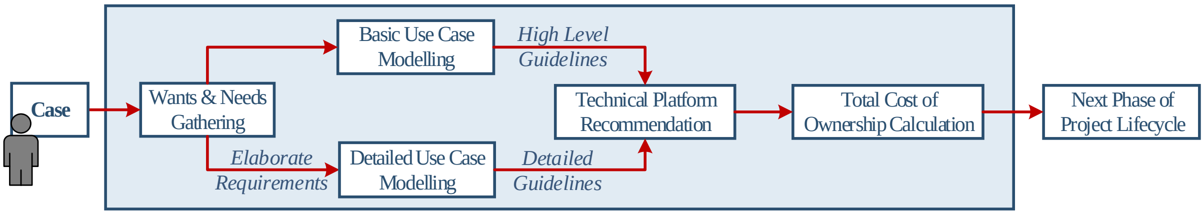


Figure 1 Cloud Platform Architectural Decision Framework

In this paper, we extend the elaborate decision process by introducing an intermediate step *of criteria classification* (cf. Figure 2) to classify the decision criteria as *Required* or *Optional*. The benefits that arise from this 'simple' classification are as follows: it allows the introduction of a minimum fee in the *financial viability assessment* stage that reflects the amounts allocated to the 'Required' criteria, providing a necessary delineation between costs associated with 'Required' and 'Optimal' criteria, thereby focusing on the 'Required' criteria for making the technical recommendation.

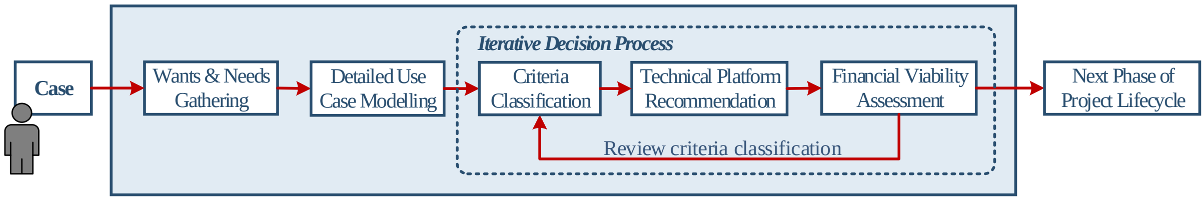


Figure 2 Enhanced Cloud Platform Architectural Decision Framework

Based on the criteria classification, the Decision Model outputs a platform recommendation, which is then evaluated for its financial viability using the cost calculator. If the technical recommendation is infeasible due to budgetary constraints, the SME has the flexibility to iterate through the decision process by re-assessing and re-classifying the decision criteria from 'Required' to 'Optional'.

Criteria Selection & Classification

Table 1 lists the main criteria that the SME should consider when making the cloud platform choice. This list has been determined by examining The Open Group's "The Cloud Buyers Decision Tree"

(Harding et al, 2011), IBM's "Cloud Industry Point of View" (IBM Enterprise Cloud, 2013), IBM's "Designing Your Own Cloud Decision Framework", MOOR Insight and Strategy's "Lenovo Brings Azure Stack On-Premises", and incorporation of research that dealt with decision models (Gonçalves et al., 2015) or non-functional requirements (Juan-Verdejo et al, 2013) that influenced the cloud platform decision. Table 1 also lists the guidelines for classifying each criteria.

Criteria selection for decision-making can be done in two ways. The SME can either consider the full set of criteria for decision making and use the associated guidelines to classify them as 'Required' or 'Optional', or use a sub-set of the criteria, for example, by using the Gartner Framework (Gartner, 2017) and then apply classification to derive a technical recommendation.

Table 1. Detailed criteria for building Elaborate Use Case Model

Criteria	Guidelines for Assigning Weight
Availability	An application's criticality to an enterprise is typically captured in the availability – for example, an application deployed to a single data centre will provide an availability of 99.9% measured monthly while that deployed over two data centres will provide an availability of 99.95%. An availability over 99.95% typically requires a private cloud that can be tailored to meet the requirement.
Business Service Availability	The business process availability is the hours of service for which the business process must be available to the customers. Typically, a Recovery Point Objective (RPO) and a Recovery Time Objective (RTO) provide guidance upon potential data loss and outage durations. Typically, RPO 4hrs-RTO 0 hrs up to RPO 8hrs-RTO 2 hrs are suited to private cloud. If the requirements are less strict than this - it is suited to public cloud because distance between data centres or availability zones may not be released by public cloud providers or with a cloud native architecture the time taken to spawn new virtual machines and re-establish data will typically take more than two hours for enterprise applications in a disaster recovery event.
Long running business process (Application Usage)	Is the business process associated with the application a long running one that is required to maintain state, or does it support short running synchronous business process? If the application must support long running business processes, have a monolithic application architecture and maintain state, then private cloud platform is more suitable.
Application Usage	Do volumes increase seasonally or at predictable times of the year? If yes, public cloud deployment is suitable, else private cloud deployments are likely to be suitable.
Regulatory requirements	From a regulatory perspective, is the application and associated business process subject to regulatory standards that must be tested with a public cloud provider or data centre and IT operations team. Typically, applications with regulatory requirements are implemented on private cloud.
Operating Costs	When marketing campaigns or incentives are released, do they generate more than 20% of traffic over and above business as usual demand. If so, the application is typically suited to public cloud if operating costs are substantially higher for peak periods of the year.
Performance	Consideration should be provided to either the 'average of peak transaction rate' or the 'peak of peak transaction rate' to determine the bandwidth required to maintain a desired performance (Arianyan, Taheri, Sharifian, 2016). Typically for enterprise applications with a monolithic application architecture, the desired platform is private cloud with dedicated bandwidth (Juan-Verdejo and Henning Baars, 2013) on a private network versus a multi-tenanted, contended public cloud.
Application architecture & Associated Constraints	The application architecture will be a key consideration as to which cloud platform is most suitable with a minimum of re-work in the migration process. Implicit in this will be determining if any components within the application have constraints such as bare metal compute platform, minimum storage speed (Juan-Verdejo and Henning Baars, 2013) and minimum network (Juan-Verdejo and Henning Baars, 2013).

Security	Ascertain if the security components will require physical appliances or are virtual appliance appropriate and cost-effective.
Data Security Classification	If the data is classified as either protected, confidential, secret or top secret, then it will typically require a private cloud. Alternatively, if the data is unclassified, then it will be deployed in public cloud.
Network Global Load Balancing	When it comes to supporting high availability through redundancy then Network Global Load Balancing can be a requirement. This is where a hybrid cloud solution is typical due to the hardware being in co-location and the application components being deployed across two locations in private cloud or two public cloud availability zones.
Connectivity to a private MPLS network or internet VPN	Access to the load balancer will be either through connectivity to a private MPLS network or internet Virtual Private Network. If data cannot go outside an Enterprise's trusted zone, then typically private cloud is the chosen platform; however, if data is permitted to exit the trusted zone, public cloud is typically a preferred choice.
Hypervisor	Applications when distributed by Independent Software Vendors will typically have preferred Hypervisor support. If a version of a hypervisor is required that may not be the latest on the market – to have certainty of support of the application private cloud is typical. On the other hand, if the application is custom developed using hypervisors supported in public cloud (typically latest version), then public cloud is the typical cloud platform preferred.
Enterprise Control	Enterprises, particularly with mission critical applications, prefer Enterprise Control. This means that typically those enterprises that prefer to keep them in-house will deploy to private cloud. Alternatively, if the application has been created with a cloud native architecture, enterprise is likely to select public cloud.
Data Classification	If the data classification given to the data is 'publically available' public cloud would be an acceptable platform. If however, the data cannot leave the enterprise, then private cloud is a preferable platform.
Technology Standardisation	Consideration is required to whether or not the application is suited to a standardised technology environment or whether there are unique or non-standard application requirements or constraints. If the application is suited to a standardised environment, then public cloud is typically preferred (Juan-Verdejo and Henning Baars, 2013); however, if there are any non-standard requirements or constraints, private cloud is better positioned to accommodate them.

Similarly, *criteria classification* for decision-making can be applied in two ways. If the SME has sufficient knowledge and wants to classify each criterion individually, then he/she can choose to do so using the provided guidelines. Alternatively, if the use case belongs to a specific industry, then the SME can leverage IBM's Point of View of 'Cloud Requirements by Industry' (IBM, 2013) as described below to generate a technical recommendation. Using this approach, the requirements (that translate to criteria) can be assessed using the detailed guidelines in Table 1 where applicable, by industry. Each of the requirements are negotiable, *hence an assessment of the trade-off between requirements and associated cost is encouraged*. Table 2 lists six broad industries and the technical recommendation based on the analysis of industry-specific requirements.

Table 2. Industry specific technical recommendation (IBM Enterprise Cloud, (2013)

Australian Government
Requirements: • Data residency and local content, requiring that data remains within the geographical boundaries of the state or entity concerned • Australian Government requires control of the target platform *Analysis:* Both of these requirements require private cloud platforms that are single tenanted and remain in Australian data centres. *Recommendation:* Private Cloud
Automotive Industry
Requirements:

- Leveraging cloud automation capabilities to repeatedly deploy complex IT environments efficiently to shorten operation cycles and decrease the Total Cost of Ownership of solutions
- Enabling clients to optimize computing resources based on demand without over investing in infrastructure that may otherwise lay idle
- Develop and Deploy Cloud Applications
- Capitalize on services opportunities for intelligent connected vehicles (IoT)
- Rapidly launch increasingly complex sustainable vehicles and e-mobility services

Analysis: All of these requirements lend themselves well to public cloud because of the 'on-demand' need to infrastructure and the cloud-native architecture of the applications.

Recommendation: Public Cloud

Insurance Industry

Requirements:

- Achieve regulatory compliance and make better decisions through managing the business risk.
- Speed up the deployment of solutions and lower the operational costs during their life cycle
- Provide additional investment capacity by adjusting the resource utilization to the demand

Analysis: The technical decision comes down to priority of these requirements: if achieving regulatory compliance is greater than being able to provide additional resources on demand, then *private cloud is recommended*. The next best option if this is unaffordable is *public cloud* in a cloud provider that meets as many regulatory requirements as possible. A risk assessment of any requirements will be necessary to determine if they are acceptable; alternatively, additional funding will be required to mitigate this risk(s).

Recommendation: Private Cloud for production environment; Public Cloud for development environments.

Retail Banking

***Requirements*:**

- Drive innovation by quickly accessing a broader ecosystem of data, developers, partners, SME's and intellectuals
- Use cloud-based business models to quickly monetize evolving plays in social media and mobile computing
- Lower operating cost through internally extending best practices within the enterprise to quickly leverage efficiency and scale

***Analysis*:** Each of these requirements is underpinned by the cloud enabled infrastructure.

***Recommendation*:** Public Cloud. Where PCI requirements exist for an application - private cloud is recommended, otherwise, leverage public cloud to achieve these requirements

Education

***Requirements*:**

- Scale and shrink compute & analytical workloads for periodic and/or unpredictable usage depending on class scheduling
- Speed up the deployment of solutions while limiting risk to enable learning outcomes
- Improve teaching effectiveness by gaining insight into student performance, attendance and use of course literature

***Analysis*:** The first two requirements are key features of public cloud infrastructures. While gaining insights can be applicable to both platforms and would ideally be placed in public cloud given the first two requirements because of data gravity

***Recommendation*:** Public Cloud

Healthcare

***Requirements*:**

- The deployment of clinical applications should currently be made in private clouds because such applications require the highest level of security, privacy and availability as well as conformance to government and industry regulations.
- Non clinical applications such as such as revenue cycle management, billing, claims or HR management are a better fit for public clouds

***Analysis*:** The user group of the application can dictate which platform is suitable, hence a mix of public and private cloud would be suitable.

***Recommendation*:** Hybrid Cloud.

Financial Viability Assessment

Subsequent to making the technical decision, it is necessary to evaluate its financial implications. The last step in our decision process is to evaluate the cost effectiveness of the recommended cloud choice. The intent of the TCO calculator is to derive a minimum and maximum cost range based on the allocation of 'Required' and 'Optional' criteria. Essentially, the lower bound of the platform cost is obtained by aggregating the cost items attributed to the 'Required' criteria. Similarly, the upper bound is obtained by adding the cost items associated with the 'Optional' criteria. If the range is not feasible, then the business SME can re-assess the classification assigned to the criteria and re-calculate the range.

For the private cloud calculator, we use the VCE calculator (Forrester, 2016) and add additional costs that directly affect the enterprise, notably data network connectivity to a private network from a data centre facility, monitoring and maintenance, and backup. We do not capture Data Centre costs, as these are relative for DIY and Private Cloud. Similarly, for public cloud, we use the calculators provided by public cloud providers such as Amazon (AWS, 2017) and Microsoft Azure (Azure, 2018) and augment them with costs associated with High Level and Detailed Design of the infrastructure solution, data network connectivity to public cloud from a data centre facility, ingress charges and backup.

Table 3 shows the traceability of the costs to criteria in the Private and Public Cloud Calculators with the exception being 'project costs' that are required regardless of which option is recommended. It should be noted that infrastructure costs exist across both platforms and are captured in the 'Compute & Storage' item for 'Prod' and 'DR' regardless of deployment platform. However, the cost item 'Design & Implement' is only included in the private cloud costs since it is not required in the public cloud due to the number of architectural decisions being reduced (i.e. taken out of your hands) by the service provider). Hence, in public clouds, this cost is covered in an overarching Design phase.

Table 3 Traceability of Public and Private Cloud Costs to Decision Criteria

Cloud Calculator Input Items	Applicable to Private Cloud	Applicable to Public Cloud	Trace to Criteria
Architecture & PM			
Solution Architecture	N	Y	Project costs
Project Management	N	Y	Project costs
Connectivity	N	Y	Assume connectivity already available in enterprise data centre
Design & Implement (PROD)	Y	Y	Project Costs
Design & Implement (DR)	Y	Y	Project Costs
Compute & Storage (PROD)			
Vblock 350 Frame	Y	N	Availability, BSA, Long Running Business Process
Virtual Servers	N	Y	Availability, BSA, Long Running Business Process, Hypervisor version, Application Requirements
Physical Blades	Y	Y	Availability, BSA, Long Running Business Process
Storage	Y	Y	Availability, BSA, Long Running Business Process, Application Requirements
Compute & Storage (DR)			
Vblock 350 Frame	Y	N	Availability, BSA, Long Running Business Process
Virtual Blades	N	Y	Availability, BSA, Long Running Business Process, Hypervisor version, Application Requirements

Physical Blades	Y	Y	Availability, BSA, Long Running Business Process
Storage	Y	Y	Availability, BSA, Long Running Business Process, Application Requirements
Ingress & Egress Fees	N	Y	Connectivity usage
Monitoring & Management	Y	Y	Project Costs
Data centre			
Power	Y	N	For Public Cloud, it is included in blade or virtual server costs, Regulatory
Cooling	Y	N	For Public Cloud, it is included in blade or virtual server costs, Regulatory
Floor space	Y	N	For Public Cloud, it is included in blade or virtual server costs, Regulatory
Lifecycle Management			
Platform engineering	Y	Y	Project Costs
Incident management & remediation	Y	Y	Project Costs
Platform migration			Project Costs
Predeployment validation lab	N	Y	Project Costs
Backup	Y	Y	Project Costs
Contract Administration	Y	Y	Project Costs
Audit	Y	Y	Project Costs

The TCO calculator captures the quantities of each of the components or project services for each deployment option. The assumption here is that all deployment options (Public Cloud, DIY, Private Cloud) have the same potential inputs but those that do not apply are blanked out. For example, ingress/egress fees are inappropriate for DIY and Private Cloud. The pricing analysis is performed using publicly available information. TCO addresses all of the costs of providing a cloud environment however, it does not account for application and operating system level requirements as these will be the same for each option. Each of the different cost items are populated with pre-filled values (with fixed unit rates) but variable quantities while the design work requires a vendor's Request For Service quote or an internal IT team's quote.

The key items (per month) that require input from the business SME to complete the picture are quantities of the following:

- Storage price (Per TB)
- Compute price (Per server)
- Management/VM (Per VM)
- management/bare metal server (Per bare metal server)
- VMware licensing (Per VM)
- Red Hat Operating System licensing (Per VM)
- Professional services to rack & stack (per application S/M/L)
- Ever Green Managed Service cost (compute, storage, network, OS and VMware)
- Request For Service/ Quote timelines (vendor quoting)
- Project timeline until released into production (time to have environment operational) and
- Infrastructure Monitoring charges (Per VM/ Device).

Framework Illustration

In this Section, we present three real-world use case scenarios to demonstrate how our proposed framework helps with the cloud architectural decision. We provide a summary of the decision-making process for each of the scenarios.

Scenario 1 – Contact Centre

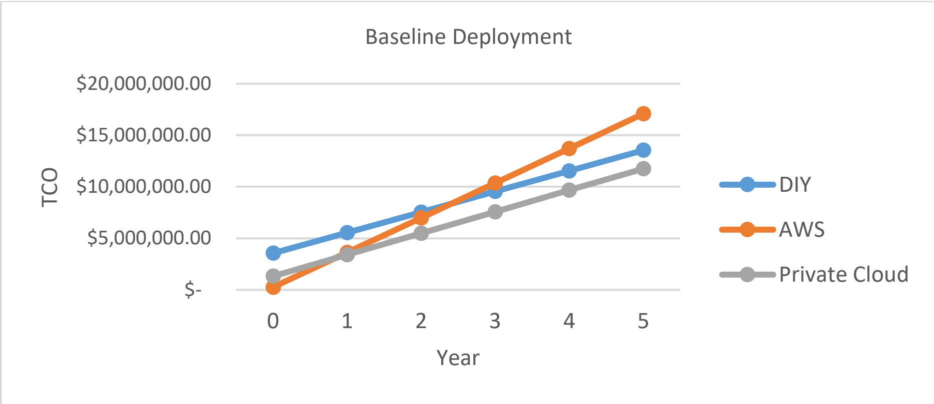
Table 5 presents the DUCM for a scenario involving a Contact Centre application.

Table 4. Scenario 1 - Contact Centre

<table>
<tr><td>Scenario 1</td><td>Avaya Contact Centre</td></tr>
<tr><td>Business Requirements</td><td>A Contact Centre platform facilitates customer interactions providing customers with a wide range of devices and methods they can use to interact with their suppliers. Contact centres can be either multi-channel (multiple technology providers) or omni-channel (single vendor technology). Customer contact centres support inbound and outbound voice calls, SMS, web-chat, email and smart applications. Around 15% of agent calls are recorded and stored (a higher number can lead to extra storage requirements pretty quickly). Retention of information can vary but typically, most companies retain information for 7 years.</td></tr>
<tr><td>Actor(s)</td><td>Customer, Agent, Customer Service Team Leaders, Supervisors and Managers, Rostering and Scheduling staff.</td></tr>
<tr><td>Use Case Overview</td><td>A customer contact centre is effectively a company's "store front". The service availability end to end is required to be 99.97% per month with critical integration transactions to be executed successfully in less than 3 seconds. For enterprises required to conform to adopt and adhere to PCI-DSS guidelines this adds another set of disciplines to be stringently adhered in relation to the taking, storing and accessing of customer credit card details.</td></tr>
<tr><td>Preconditions</td><td>The Telephony Software – Avaya requires a computing platform that supports a mix of virtualisation, bare metal and physical appliances.</td></tr>
<tr><td>Constraints</td><td>The Contact Centre service is to support all Australian time zones and remain on the current software platform. Due to the critical nature of the service a consolidated network and IT assurance Manager of Managers (MoM) tier is required.</td></tr>
<tr><td>Cloud Decision Criteria</td><td><table>
<tr><th>Criteria</th><th>Classification</th></tr>
<tr><td>Availability</td><td>Required</td></tr>
<tr><td>Business Service Availability</td><td>Required</td></tr>
<tr><td>Long running business process</td><td>Required</td></tr>
<tr><td>Application Usage</td><td>Optional</td></tr>
<tr><td>Regulatory requirements</td><td>Required</td></tr>
<tr><td>Operating Costs</td><td>Optional</td></tr>
<tr><td>Performance</td><td>Optional</td></tr>
<tr><td>Application architecture</td><td>Required</td></tr>
<tr><td>Application constraints</td><td>Required</td></tr>
<tr><td>Security</td><td>Required</td></tr>
<tr><td>Data Security Classification</td><td>Optional</td></tr>
<tr><td>Network Global Load Balancing</td><td>Optional</td></tr>
<tr><td>Connectivity to private MPLS network or internet VPN</td><td>Optional</td></tr>
<tr><td>Hypervisor</td><td>Required</td></tr>
<tr><td>Enterprise Control</td><td>Required</td></tr>
<tr><td>Data Classification</td><td>Required</td></tr>
<tr><td>Technology Standardisation</td><td>Required</td></tr>
</table></td></tr>
<tr><td>Cloud Platform Options</td><td>• Public Cloud and Private Cloud
• Public Cloud, Private Cloud and outsourced PCI Compliance Payments Service
• Private Cloud</td></tr>
</table>

Our framework recommends the private cloud for this scenario since the availability requirement (availability higher than 99.95% with commercial ramifications for non-conformance) is extremely stringent. Typically, the private cloud is the preferred platform for applications that require such stringent QoS level. The operating costs being static, together with technology not being commodity make private cloud the preferred platform with co-location for physical appliances and security. As the next step, the technical recommendation is validated using the cost calculator, which shows that it is financially viable over a 5-year period (cf. Figure 3). Based on the outcome of the financial viability assessment, the **final decision for this scenario is to recommend private cloud** due to it being substantially less expensive that the alternatives.

Figure 3 – Scenario 1 Financial Viability Assessment



Scenario 2 - Teradata off-load & Further Data Acquisition

Table 6 presents the DUCM for a scenario of migrating Teradata to a Big Data platform on the cloud.

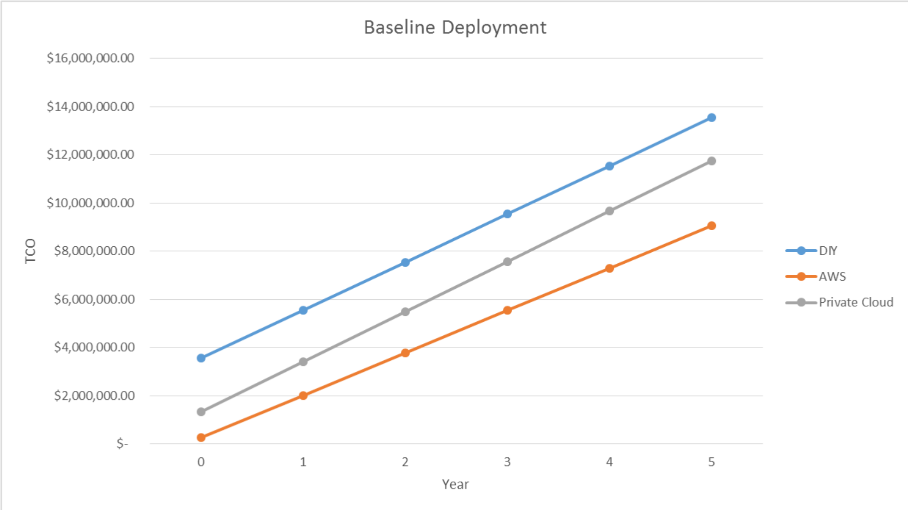
Table 5 Teradata off-load & Further Data Acquisition

Scenario 2	*Teradata off-load & Further Data Acquisition*	
Business Requirements	The legacy capabilities and high cost license fees of the Enterprise Data Warehouse (EDW) Teradata, mean that a modern Big Data platform is a more attractive option. Significant savings in licence and hardware expenses are possible by migrating from Teradata to a Big Data platform using commodity (white label) infrastructure.	
Actor(s)	Customer, Data Scientists, Web Site, Contact Centre, Consumer Banking Products (e.g. personal banking, home loans, insurance)	
Use Case Overview	The use case validates the potential to shift from an EDW to lower cost BDP analytics ecosystem. Then gradually other data sets will be ingested onto the platform to allow data scientists to validate the analytics or forecasting models.	
Cloud Platform Options	• Hybrid Cloud • Public Cloud • Private Cloud	
Analysis of criteria	*Criteria*	*Classification*
	Availability	Optional
	Business Service Availability	Optional
	Long running business process	Optional
	Application Usage	Optional
	Regulatory requirements	Optional
	Operating Costs	Optional
	Performance	Optional
	Application architecture	Optional
	Application constraints	Optional
	Security	Optional
	Data Security Classification	Optional
	Network Global Load Balancing	Optional
	Connectivity to a private MPLS network or internet VPN	Optional
	Hypervisor	Optional

	Enterprise Control	Optional
	Data Classification	Optional
	Technology Standardisation	Optional

The technical recommendation for this scenario is the public cloud platform. The financial viability assessment also shows that the **public cloud is a more cost effective option** as shown in Figure 2. The public cloud has a better economic outcome because the Big Data Platform is able to start relatively small and add extra capacity as required compared with the private cloud, where, to make economic sense, a much larger capacity upfront is required.

Figure 4 – Scenario 2 Financial Viability Assessment



Scenario 3 – On Farm Data Collection

Table 7 presents the DUCM for the scenario of an application that collects data on a sheep farm.

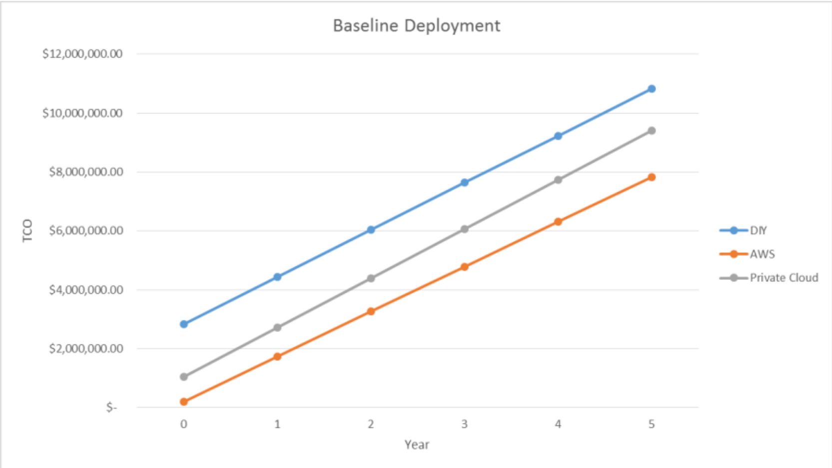
Table 6 Scenario 3 - On Farm Data Collection

Scenario 3	On Farm Data Collection	
Business Requirements	Sheep producers often have to make decisions about the management and selection of their sheep without quantitative information about the flock, management group or individual animals. Most management and selection decisions are made on a subjective basis relying on 'stockmanship'.	
Actor(s)	Sheep, Genetics, Weather, Producer, Agriculture software vendors	
Use Case Overview	In its simplest form an application could be developed on the back of the data captured on the farm to rank sheep within a flock every time a selection or management decision is needed (culling to reduce numbers, animal health action needed or supplementary feeding). The ranking can be based on productivity and/or wellbeing criteria.	
Constraints	Cellular network coverage	
Cloud Platform Options	Hybrid Cloud or Public Cloud or Private Cloud	
Analysis of criteria	*Criteria*	*Classification*
	Availability	Optional
	Business Service Availability	Optional
	Long running business process	Optional
	Application Usage	Optional
	Regulatory requirements	Optional
	Operating Costs	Optional
	Performance	Optional

	Application architecture	Optional
	Application constraints	Optional
	Security	Optional
	Data Security Classification	Required
	Network Global Load Balancing	Optional
	Connectivity to a private MPLS network or internet VPN	Optional
	Hypervisor	Optional
	Enterprise Control	Optional
	Data Classification	Optional
	Technology Standardisation	Optional

The **private cloud is recommended** given all criteria are 'Optional' except for Data Security Classification. However, the public cloud has a better economic outcome because the Big Data Platform is able to start relatively small and add extra capacity as required compared with the private cloud, where, to make economic sense, a much larger capacity upfront is required. The **public cloud remains a financially viable option** as the platform never reaches a point where the infrastructure required by the application is above the sweet spot for private cloud as seen in the graph below. This leads to a review of the platform endorsement and therefore the criteria.

Figure 5 – Scenario 3 Financial Viability Assessment



Conclusion

In this paper, we have presented a comprehensive cloud decision framework that provides an extensible set of decision criteria, associated guidelines, a decision model and a TCO calculator to assist key decision makers within enterprises make more informed decisions on the choice between public and private cloud. While the decision criteria capture those that impact user experience, the TCO calculator captures associated costs, and the process itself helps mitigate risk by making an "informed" decision early on in the project lifecycle. A key benefit of the presented framework is that it provides users the flexibility to iterate through the decision process until a best "fit for purpose" cloud solution is found that is both technically and financially viable. Providing traceability of the cost items in the Public/Private TCO calculators to the decision criteria enables users to determine and eliminate (if possible) the main cost drivers, thereby finding the right balance between the desirable criteria and the available budget. We used three different scenarios to illustrate the need, benefits and value of our proposed framework.

As future work, we intend to extend the criteria classification process to allow the *Optional* criteria to be preferentially ordered. The intent is to use *automated preference-based reasoning* to provide the user with the 'next best option' that meets the financial constraints based on the preferences assigned to the *Optional* criteria. We also intend to add support for cloud platform selection for application portfolios as opposed to individual applications.

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