IT CLOUD MANAGEMENT MARKET LANDSCAPE

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In this report, Taneja Group presents an evaluation of the current IT Cloud Management market landscape for enterprise customers. We look at this landscape as an evolution of IT operations management grown up into the cloud era. In addition to increasingly smart and capable operational monitoring and systems management, good cloud management also requires sophisticated capabilities in both automation and orchestration at scale to support end-user provisioning and agility, and detailed financial management services that reveal multi-cloud costs for analysis and chargeback or showback. End users are also seeking management solutions for hybrid cloud and for the development and deployment of cloud-native apps. Our objective is to evaluate cloud management offerings from leading vendors across these five dimensions to enable senior business and technology leaders to decide which vendors offer the best overall solution.

In this study, we evaluated vendors with offerings in one or more of the five fundamental areas. Several well-known vendors (VMware, Microsoft, ServiceNow, Cisco and Red Hat) have solutions in all five areas. Other vendors focus on only two or three areas, and because it's possible to compose a broader solution from parts, we've evaluated popular niche solutions within each area. All companies were required to have solutions that were generally available as of September 2017. To fairly assess the offerings, we looked at a set of differentiating factors in each of the categories that we believe enterprise customers should use to qualify cloud management solutions.

Within each of the five areas—Cloud Orchestration, Operations Management, Hybrid Cloud Management, Cloud Native Apps, and Cloud Costing and Business Management—we've applied categories of factors for scoring as determined by our team of experts, based on customer buying criteria, technical innovation, and market drivers.

The Cloud Management Market: Ranking of Full Suite Solution Vendors
(4 = Highest Score; 0 = Lowest Score. Harvey Ball scores rounded down to nearest whole number.)

Evaluation Scores	VMW	MSFT	SVN	CSCO	RHT
Cloud Orchestration	3.6	3.0	3.0	3.1	2.9
Operations Management	3.8	2.5	1.5	1.4	1.9
Hybrid Cloud Management	3.0	2.8	2.0	2.0	2.0
Cloud Native Apps	1.8	3.3	1.0	1.3	2.0
Cloud Costing & Business Management	3.8	3.5	2.5	2.0	Not Evaluated
Summary Score	**3.2**	**3.0**	**2.0**	**1.9**	***2.2**

Legend: VMW=VMware, MSFT=Microsoft, SVN=ServiceNow, CSCO=Cisco, RHT=Red Hat

Taneja Group Opinion

We show in Figure 1 a visual of our detailed evaluation results for full-suite vendors mapped onto an assessment of Enterprise Maturity versus Cloud Innovation. Enterprise maturity is based on each vendor's ability to address established management requirements, in areas such as cloud orchestration and operations. Cloud innovation is based on emerging management support for new or next-gen native/hybrid scenarios, encompassing areas such as hybrid cloud and the development and deployment of cloud-native applications. This holistic, forward-looking view of the market illustrates that competition is fierce and constantly changing, as these strategic players have delivered significant portfolios to offer complete IT cloud management solutions. Even though most solutions are in or near the top right quadrant and can deliver deep value in many areas, there is still obvious differentiation between offerings.

As IT cloud management matures into a well-defined set of enterprise capabilities, we find VMware is well-positioned with its enterprise grade platform, market-defining innovation, expertise and vision, and a capably deep and broad solution built expressly to simplify IT over an ever growing scope, scale, and level of sophistication. This did not happen in one step; rather it is the result of years of development and acquisition, yet unlike many of its other landscape competitors the VMware vRealize Suite is a coherently focused solution consisting of integrated components addressing automation, operations and business management, along with management support for cloud-native apps and hybrid cloud. Architecturally, unlike many other vendor solutions, it doesn't look like spaghetti thrown up on the wall – and that directly translates into lowered OPEX. VMware has executed effectively towards a common architectural and management framework for the IT admin who, as the data center marches towards an inevitable hybrid cloud future, is required to mature from a silo focus to virtual data center administration and cloud management. VMware is now also aiming to support line of business and developer personas with solutions for DevOps and cloud-native application management.

Many of the solutions evaluated in this report have grown organically over time, and are feeling their legacy weight in this new era of cloud scale automation, hybrid operations, and new economic models. Most of the larger vendors have embarked on a program to build newer, simplifying front-ends, but these are by and large a work in progress, often dragging much legacy wiring and componentry along to fill in all the required functionality. For customers long invested in a particular vendor's management solutions, these efforts may provide some hope of a "layer up" way to add cloud level functionality, but as this evaluation underscores, all complexity and friction at the cloud level of operations needs to be eliminated. Given that data centers are inevitably moving towards even more complex and dynamic hybrid cloud architectures, achieving successful end-to-end operations will soon become a very hard if not impossible task for any management vendors not completely focused on cloud management.
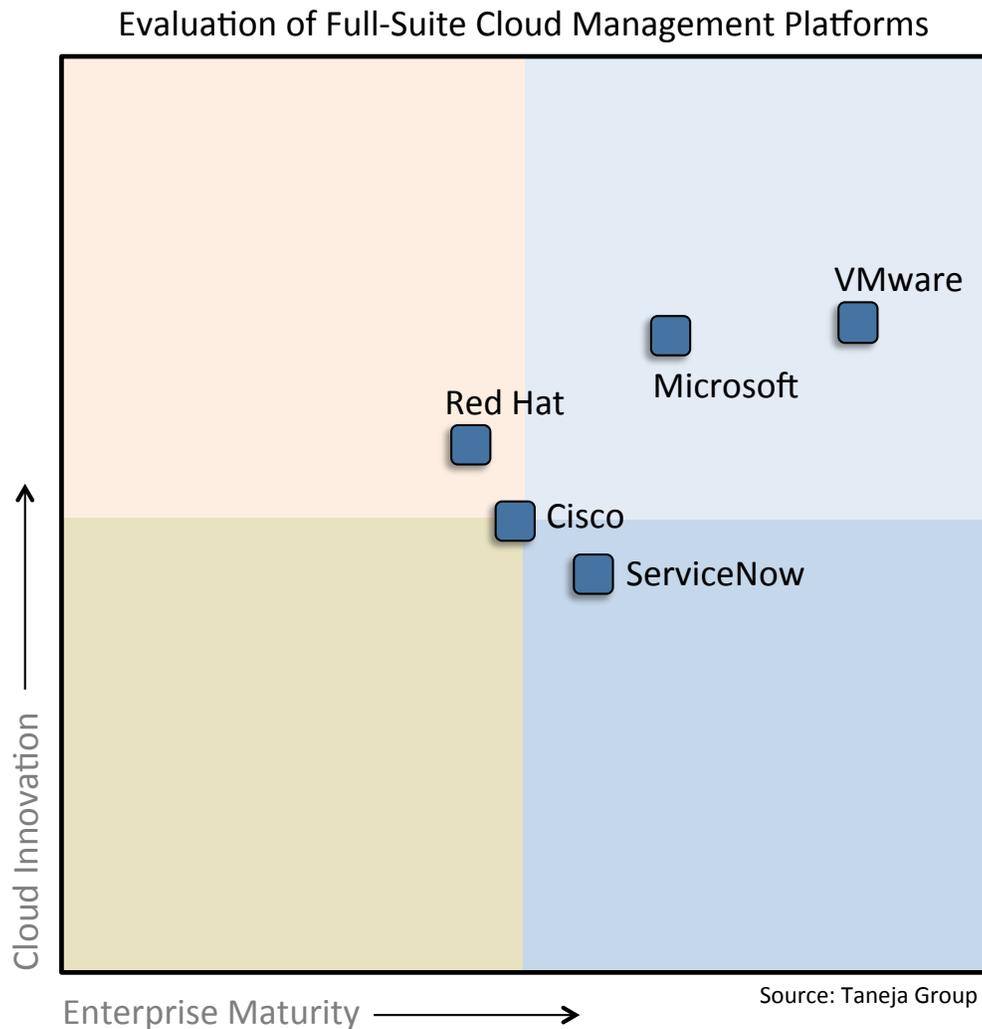
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Evaluation of Full-Suite Cloud Management Platforms

Figure 1: The Cloud Management Market Full-Suite Vendor Landscape: Enterprise Maturity vs. Cloud Innovation

Key Takeaways for IT and Business Leaders

While the detailed sections of this report go into significant depth evaluating the various cloud management offerings, here we present some key findings we've noted during our analysis. There are five overall takeaways, plus three for each functional area of evaluation.

Overall Cloud Management Takeaways

- **Cloud service advancements continue to outpace cloud management.** The growth and sophistication level of both public and private cloud technologies and services has outrun the tools and capabilities available to manage them. Cloud management vendors and service providers are playing catch-up, and given the continuing rate of innovation in IaaS and PaaS capabilities, cloud management functionality will continue to lag user needs for the foreseeable future. Given this reality, look for vendors with a track record of cloud innovation, a strong product portfolio and an overall strategy that will allow them to deliver a cloud management framework capable of meeting the needs of your business over the long term.

- **Comprehensive cloud management platforms are rare.** Look for cloud management solutions that are integrated across operations, automation and business disciplines. This is a rare capability in the market today, but will be critical going forward in providing you with a holistic cloud management solution. Without robust built-in integration and a common look and feel, you will be dealing with a set of fragmented point tools that you'll have to stitch together or simply use independently. Ask vendors to demo their full cloud management suite – if a vendor can't show you how their various solution modules work together, then you probably won't find it easy to deploy and manage their full product suite due to overwhelming complexity.

- **Lack of standards makes cloud interoperability a challenge.** The lack of cloud portability and cross-cloud management standards makes it difficult for vendors (incl. cloud service brokers) to effectively manage resources across multiple flavors of clouds. (OpenStack is an attempt to standardize, but even some different OpenStack cloud implementations cannot effectively interoperate, as vendors add proprietary enterprise functionality to their own OpenStack-based clouds.) Query your vendor/provider on their workload portability and management capability across different clouds to ensure their offerings will meet your needs.

- **Hybrid cloud management is still a work in progress.** In general, hybrid cloud management—even on a single vendor's platform spanning on-premises and external clouds—is still a work in progress and largely unproven in the enterprise. Few offerings enable intelligent workload placement, elastic resource management, and compatible automation frameworks across public and private cloud boundaries. Focus on vendors that can deliver these capabilities today and into the future.

- **Prioritize offerings that enable cloud-native development without compromising operational control.** The shape of cloud management is largely driven by the applications that run in the cloud, and will be especially influenced by the new breed of cloud-architected microservices that are already dominant on the world's leading hyperscale clouds. Given this, prioritize offerings that enable cloud-native development and supporting DevOps capabilities to boost workload agility and mobility, along with the governance and control that IT professionals need to enforce usage and cost policies.

Cloud Orchestration Takeaways

- **Look for vendors that have a comprehensive approach to IT use case support.** When it comes to pre-packaged applications that are easy to consume, look for vendors that complement multi-tier orchestration with marketplaces, intelligent workload placement and digital workspaces. These additional capabilities broaden the range of usage scenarios supported by enabling virtual desktop infrastructure (VDI), multi-cloud orchestration and the ability to select from pre-defined solutions that are shared within a collective community.

- **Insist on template and orchestration functionality that supports both traditional and cloud-native application design.** Given the numerous application types and build scenarios, companies need a visual design canvas and application templates that provide orchestration for traditional application stacks. They also need vendors to support template languages such as JSON and YAML to satisfy developers building cloud-native applications. In addition, orchestration tools should provide integration with third party systems for end-to-end automation and provide access to an extensive library of out-of-the-box components and workflows to fast-track the creation of standard services.

- **Make security, compliance and governance a priority when designing applications.** All the major vendors in this study have recognized the importance of incorporating support for load balancing, virtual network devices and security groups into template design and application orchestration. However, you'll want to pay attention to differences in the granularity level of controls, and you may want to consider microsegmentation frameworks for added flexibility. All vendors provide role-based access control and approval workflows, but the flexibility of security policies can vary. While the vendors in this landscape assessment offer logs for audit trails, you should carefully examine the level of configuration auditing, change tracking and drift analysis, as these capabilities differ from vendor to vendor.

Operations Management Takeaways

- **At cloud scale and speed of IT operations, avoid deploying or making do with mix-and-match solutions.** Every disparate component, every integration required, every vendor in the mix introduces complexity and friction, ultimately increasing OPEX. Beware of touted single panes of glass that are really only lightweight dashboards in front of multiple disparate toolsets. Third party extensions and validated plug-ins are great, but they too add complexity and risk.

- **Automated analysis of configuration files, performance data, and hybrid-spanning logs are a "must have".** Comprehensive logfile indexing and search solutions accelerate numerous IT investigative and reporting based tasks, provide immediate drill-down insight from the more structured event management components, and generate sophisticated query-based proactive alerts/events. Look for advanced machine learning analytics over both historical and real-time data streams designed specifically to ease IT operational overhead.

- **Success with cloud operations depends on managing complete lifecycle workflows.** Look for solutions that are fully integrated and share critical information back and forth in-band between operational activities. Data from planning activities should inform operational alerting, and provisioning actions and operational service delivery metrics should feed into costing. The intelligent automation of policies helps drive and scale operations effectively.

Hybrid Cloud Management Takeaways

- **Intelligent workload placement and bi-directional migration capabilities are core to enabling hybridity.** Hybrid clouds extend the scalability, agility and pay-as-you-go benefits of the public cloud to your data center, and at the same time, should open up new deployment choices. To take advantage of this new flexibility, focus on management solutions that enable your workloads to be intelligently placed in the public cloud or on premises, based on policies that seek to optimize cost, compliance, and/or service levels. Platform-agnostic migration capabilities extend this benefit one step further, by enabling your workloads to move between on premises and public cloud as needed to support a range of hybrid cloud use cases.

- **Prioritize solutions that allow you to elastically control resources to optimize utilization and reduce costs.** Many hybrid cloud applications must scale out rapidly to satisfy demand or service level commitments, and continue to consume costly resources once their job is done. These types of use cases require elastic resource management, including auto-scaling to spin up instances upon demand and spin them down when they're no longer needed. Look for policy-driven solutions that optimize resource utilization, by reclaiming inactive resources and dynamically re-balancing workloads along the way.

- **Don't assume that security, compliance and governance are a given.** A networked deployment that spans your data center and public cloud demands extra vigilant security, and not all hybrid cloud management offerings are up to the task. Put your money on solutions that deliver comprehensive, end-to-end security to protect your workloads, along with policy-based frameworks that will help you meet compliance and governance needs.

Cloud Native Apps Takeaways

- **Container management solutions are still evolving.** It's clear that the IT world is moving fast towards increasingly packaged application deployment. However, both best practices and available enterprise-quality implementations of container platforms and container management solutions are still evolving rapidly. While it is necessary to start supporting containerized applications in production, IT should stay flexible – luckily, high agility and portability are core container architecture features.

- **Containers are a method of packaging applications. Developers really want Platform-as-a-Service (PaaS) that automates packaging at a lower level.** While those straddling dev and ops – DevOps – may find containers compelling, many developers would still rather simply hand over their code and not deal with the details of operational packaging. PaaS solutions provide platforms in which developers can more directly program and deploy production code, letting the platform handle operational details automatically at a lower level.

- **Persistent container storage still requires storage experts.** Even as containerized environments evolve better mechanisms to migrate both containers and their data (or at least enable data access), fulfilling enterprise requirements for data security, integrity, protection, backup/recovery, and business continuity still calls for serious storage expertise. These tasks may be compounded for quite some time yet by the sheer potential scale of containerized operations and multi-cloud/hybrid environment challenges.

Cloud Costing and Business Management Takeaways

- **Look for vendors that embrace both cloud and traditional business management.** Enterprises can benefit tremendously from cloud services but many IT resources and services—such as facilities, physical infrastructure, service desks and consulting fees—may not be cloud based. Prioritize business management solutions that embrace both traditional IT resources and private/public cloud services, and deliver a unified cost model and analytics that shed light on and help you to optimize your entire computing landscape.

- **Cloud service brokers may not be optimized for your cloud environment.** Independent cloud service broker companies do some things very well, but their offerings are typically reliant on information from platform vendors' element managers (e.g. VMware vCenter), and they invariably can't be optimized for particular brands of virtualization or cloud platforms. If you consider these vendors, ask them to show you how well their features address your private and public cloud platforms of interest.

- **Focus on cloud management solutions that offer strong decision support.** Most business management solutions offer analytics that provide good cost and consumption visibility, but their intelligent workload placement and financial planning capabilities may fall short of expectations. To optimize resource management in increasingly complex and ever expanding multi-cloud environments, look for cognitive computing solutions that offer self-learning based on data mining and pattern recognition. These techniques can enhance decision

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support by offering insights you would find hard to recognize using customary dashboards and reports.

GUIDE TO THE CLOUD MANAGEMENT LANDSCAPE ASSESSMENT

Our comparative evaluation of the enterprise cloud management market landscape is divided into the following main sections:

- **Market Description and Vendor Landscape.** As a market overview, we describe the Cloud Management market, discuss primary market drivers, and then briefly describe the broader solution vendor landscape covered in our analysis.

- **Vendors and Solutions Evaluated.** In this section we outline each of the solution areas, our vendor selection criteria, and the vendors and solutions we have evaluated within each category.

- **Solution Area Evaluations.** In each solution market space we comparatively score the vendor offerings for each specific evaluation category, and then discuss our rationale for the scores we have given in each category, based on how well each vendor's solutions stacked up against our detailed evaluation factors.

   o **Cloud Orchestration**
   o **Operations Management**
   o **Hybrid Cloud Management**
   o **Cloud Native Applications**
   o **Cloud Costing and Business Management**

- **Cloud Management Market Summary.** We then roll up scores across the five categories and present overall vendor scores in a concluding summary section.

MARKET DESCRIPTION AND VENDOR LANDSCAPE

IT Cloud Management

The IT Cloud Management market has matured well beyond its early days when it was simply considered an extension to existing traditional operational monitoring tools. Management solutions have had to keep up with the modernization of datacenter infrastructure, which has been redefined and re-imagined through waves of virtualization, increasing convergence, and software-defined technologies. The latest breed of cloud management solutions must serve the needs of both developers and end users, enabling more rapid and streamlined development and deployment of cloud apps, while still providing IT with visibility, governance and control over both infrastructure and operations.

When we last surveyed this market landscape in 2016, we focused on three traditional pillars of IT cloud management: automation and orchestration, operations management, and cloud costing and business management. In this year's update, we are adding two categories that have recently come into their own: hybrid cloud management and cloud-native apps.

While still evolving, the hybrid cloud has become a reality in many organizations, which are now running infrastructure and apps both on-premises and across one or more public clouds. Hybrid clouds have management needs that extend beyond IT operations and orchestration, to workload portability, elastic resource control and intelligent workload placement. Hybrid cloud management solutions must effectively balance the business user's needs for self-service and agility with the IT practitioner's requirements for strong security, compliance and governance.

The need for speed, agility and efficiency drives the capabilities for our second new category, focused on management of cloud-native apps. Even as enterprises lift and shift some of their existing business apps to the cloud, developers are increasingly focused on authoring apps that run in containers and a microservices architecture. Solutions that manage cloud-native apps must address DevOps and application lifecycle management needs, spanning the lifetime of an app from creation to implementation, to maintenance and support. Such solutions should embrace PaaS frameworks that facilitate cross-cloud portability and policy-based deployment, and must deliver service assurance to ensure app resiliency and performance. These are among the evaluation factors we considered in our assessment.

As cloud deployments continue to grow in the enterprise, IT staff are well on their way to becoming "internal" service providers to their business "clients". In this new model, IT is transitioning in many companies from cost center to revenue accelerator, and from technology gatekeeper to a true business partner. The best cloud management solutions will help IT to play a transformative role, capitalizing on all that the cloud enables to help their organizations achieve new levels of efficiency, agility and competitiveness, allowing their companies to grow faster and return a greater share of investment to the bottom line.

In other words, IT operations in world-class organizations are rapidly evolving from primarily keeping the lights on to optimizing IT-as-a-service to benefit their businesses. In this evaluation we've therefore looked at IT Cloud Management as a cohesive, and increasingly converged, set of capabilities that includes automation and orchestration, operations management, and cloud costing/business management, as well as management of hybrid clouds and cloud-native apps.

Solution Vendor Landscape

At a high level the IT Cloud Management market landscape divides into two main camps – vendors offering a full end-to-end suite (or platform with a matrix of portfolio products) that can be implemented as a single vendor solution, and niche vendors that offer solutions in only specific areas within cloud management.

The full suite vendors are larger, more mature and have broad IT solutions in their portfolios. Their solutions are battle-tested, are often the result of years of development and best-in-class acquisitions, and have both extensive services support and established partner ecosystems. However, because these solutions have been developed over time there are legitimate concerns with legacy approaches being applied to new IT challenges; increased solution complexity to integrate, deploy, support and operate; and mounting licensing costs.

Compared with full suite vendors, niche vendors are smaller but largely seen as more entrepreneurial and innovative within their respective areas. Some enterprise IT organizations will seek out new disruptive technologies that can give their organizations an edge over their competition. However, the enterprise adoption of niche solutions literally increases the number of vendors IT must deal with, leading to greater costs for support and services, integration complexity, and a need for increased staff training and expertise. Moreover, enterprises are well aware that as startup niche vendors demonstrate success, they are often acquired and folded into the larger full suite vendors, and many will therefore wait for that event before then investing with the more established acquiring vendor.

Cloud Management vendors like Red Hat and Cisco are becoming full suite providers. Red Hat is a vendor with its own Hypervisor/Cloud offerings and is quickly assembling a comprehensive management suite out of the multiplying open source tool space they live within. Cisco has designs on

becoming known more as a Full Stack IT Vendor, with recent acquisitions and partnering extending their networking leadership and UCS servers with storage and hyperconverged solutions.

We also note another interesting division in the cloud management market – that between on-premise deployment and SaaS based management (remote cloud hosted services). ServiceNow, for example, is SaaS based, which provides certain customer advantages in scalability, agility, pace of innovation, and lowered tool support and operations OPEX. Yet SaaS management has some challenges to prove out in terms of reliability, ultimate security, and even long-term cost.

We see many on-premise vendors now offering parts of their cloud management solutions as-a-service. VMware, for example, has this year released at least seven new SaaS system management services (VMware Managed Services). In the broader IT management market, we see multiple startups offering different pieces of IT management as remote cloud services (e.g. asset management, help desk, storage management). We expect that many if not all on-premise solution vendors will come to offer cloud-hosted SaaS management options across most of their portfolios as a SaaS management model becomes more widely accepted by enterprise customers.

VENDORS AND SOLUTIONS EVALUATED

Vendor Comparative Categories

To organize our analysis and facilitate accurate comparisons with various offerings, we have grouped solutions into five main market segments:

- **Cloud Orchestration –** IT Use Case Support; IT-as-a-Service; Template Support; Security, Compliance and Governance; Orchestration and Workload Placement; Resiliency and Elasticity; Discovery, Deployment and Maintenance; Automation Extensibility.

- **Operations Management –** Monitoring Coverage; Performance Management; Capacity Management; Infrastructure Optimization; Workload Hosting Optimization/Placement; Extensibility; Logfile Management; Integration with Third Party Ecosystem; Policy/QoS Based Management; Platform Support; Single Point of Interaction.

- **Hybrid Cloud Management –** Workload Portability; Intelligent Workload Placement; Elastic Resource Control; Unified Management/Monitoring; Security, Compliance, Governance.

- **Cloud-Native Apps** – Agile Application and Performance Management; Container Management; Remote Management-as-a-Service; Platform-as-a-Service Support.

- **Cloud Costing and Business Management –** Cost and Consumption Transparency; Business Management; Data Center Planning; Cloud Cost Optimization.

Vendor Selection Criteria

As a baseline, all selected vendors were required to have at least some solutions in one or more categories that were generally available as of September 2017. We primarily scored factors based on already available solutions in our head-to-head comparisons, though we did consider impending functionality in public beta/field deployment when judging innovation and roadmap related factors. In addition, we took into account significant upcoming offerings in our evaluation of vendor strategy and the key takeaways that we've offered as a result of assessing vendor solutions in each category. We have included popular niche vendors because they offer good feature competition in their respective areas as point solutions (although enterprise IT shops should be cautious about piecing together a heterogeneous cloud management layer).

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Vendors and Solutions Evaluated

In this comparative study, we evaluated the cloud management offerings of 10 vendors. We have listed for each vendor the solutions evaluated across the relevant market segments in the table below.

Vendor	Solution(s) Evaluated		
	Cloud Orchestration	**Operations Management**	**Hybrid Cloud Management**
Full Suite Vendors			
Microsoft (MSFT)	Microsoft Azure Stack, Azure Resource Manager (ARM)	Microsoft Azure Stack Management Pack, Microsoft System Center Operations Manager 2016, Operations Management Suite	Microsoft Azure Stack, Microsoft Azure Resource Manager (ARM), Azure Portal, Azure Monitor, Log Analytics, Microsoft System Center Operations Manager 2016
ServiceNow (SVN)	ServiceNow IT Operations Management, ServiceWatch Suite, Orchestration, Discovery, Cloud Provisioning	ServiceNow IT Operations Management (Event Management, Service Mapping, Operational Intelligence, et.al.)	ServiceNow ServiceWatch Suite, Orchestration, Event Management, Discovery, Cloud Provisioning
VMware (VMW)	VMware vRealize Suite, vRealize Automation, vRealize Orchestrator, VMware Cloud on AWS	vRealize Operations, vRealize Lifecycle Manager, VMware Cloud Managed Services	VMware Cloud on AWS, VMware vRealize Enterprise Suite, vRealize Automation, vRealize Orchestrator, vRealize Operations, vRealize Log Insight, VMware Wavefront
Cisco (CSCO)	Cisco CloudCenter, Cisco UCS Director, Cisco UCS Manager	UCS Director, Performance Manager, Workload Optimization Manager	Cisco CloudCenter, Cisco UCS Director, Cisco ONE Enterprise Cloud Suite
Red Hat (RHT)	Red Hat CloudForms	Red Hat CloudForms	Red Hat Cloud Suite, Red Hat CloudForms, Red Hat Satellite, Red Hat Insights, Ansible Engine/Tower
Single Solution Vendors			
CloudBolt Software (CB)	CloudBolt (cloud management platform), Cross-Cloud Blueprints		CloudBolt (cloud management platform), Cross-Cloud Blueprints
Embotics (EMB)	Embotics vCommander Cloud Management Platform		Embotics vCommander Cloud Management Platform
Morpheus Data (MOR)	Morpheus (Cloud Application Management Platform)		Morpheus (Cloud Application Management Platform)
RightScale (RSC)	RightScale Cloud Management Platform CMP		RightScale Cloud Management Platform (CMP), incl. Self Service (automation), Cloud Management (ops), and Optima (cloud costing)
Turbonomic (TUR)		Turbonomic Operations Manager, Cloud Control Module	Turbonomic Premier Edition, Turbonomic Hybrid Cloud Management Platform, Turbonomic Operations Manager, Turbonomic Cloud Control

Vendor	Solution(s) Evaluated	
	Cloud Native Applications	**Cloud Costing**
Full Suite Vendors		
Microsoft (MSFT)	Microsoft Azure Stack Management Pack, Azure Pack	Microsoft Azure Cost Manager (by Cloudyn), Microsoft System Center 2016 Service Manager
ServiceNow (SVN)	ServiceNow Suite	ServiceNow Financial Management
VMware (VMW)	vSphere Integrated Containers, Pivotal Container Service (PKS)	vRealize Business for Cloud
Cisco (CSCO)	Cisco CloudCenter	Cisco CloudCenter, Cisco UCS Director
Red Hat (RH)	Red Hat OpenShift, Red Hat CloudForms	[not evaluated]
Single Solution Vendors		
CloudBolt Software (CB)		CloudBolt Cloud Costing and Management
Embotics (EMB)		Embotics vCommander Metering and Billing, Resource and Cost Optimization, Cloud Expense Management, Cloud Cost Reporting
Morpheus Data (MOR)		[not evaluated]
RightScale (RSC)		RightScale Optima
Turbonomic (TUR)		Turbonomic Hybrid Cloud Management Platform

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CLOUD ORCHESTRATION LANDSCAPE

In this section we present the category-level scores for cloud orchestration solutions, along with our rationale based on our assessment of the vendors' offerings against evaluation factors. To arrive at overall marks, we computed a weighted average of the 8 category scores, and then adjusted the scores based on our own judgment of each vendor's market position, focus and expertise. The vendors included in this section are VMware (VMW), Microsoft (MSFT), ServiceNow (SVN), Cisco (CSCO), Red Hat (RHT), RightScale (RSC), CloudBolt Software (CB), Embotics (EMB) and Morpheus Data (MOR).

The categories covered in this section are IT Use Case Support; IT-as-a-Service; Template Support; Security, Compliance and Governance; Orchestration and Workload Placement; Resiliency and Elasticity; Discovery, Deployment and Maintenance; and Automation Extensibility. For each category we have provided a summary that discusses the key factors we used to evaluate vendor offerings as well as significant observations.

CLOUD ORCHESTRATION COMPETITIVE LANDSCAPE *(4 = HIGHEST SCORE)*

Cloud Orchestration Factors	VMW	MSFT	SVN	CSCO	RHT	RSC	CB	EMB	MOR
IT Use Case Support	●	◕	◕	●	◑	◕	◑	◑	◔
IT-as-a-Service	●	◕	●	◑	◕	●	◕	◑	◕
Template Support	●	◕	◕	●	◕	◕	◕	◕	◕
Security, Compliance and Governance	●	◕	◕	◕	◕	◑	◑	◑	◔
Orchestration and Workload Placement	●	◕	◕	◕	◕	◕	◕	◕	◑
Resiliency and Elasticity	◕	◕	◕	●	◕	◕	◑	◕	◕
Discovery, Deployment and Maintenance	◕	◕	◕	◕	◕	◕	◕	◑	◕
Automation Extensibility	◕	◕	◑	◑	◕	◕	◕	◑	◑
OVERALL SCORES:	◕ 3.6	◕ 3.0	◕ 3.0	◕ 3.1	◑ 2.9	◕ 3.0	◑ 2.6	◑ 2.4	◑ 2.3

Evaluation of IT Use Case Support

Many companies are on a simplification journey that is affecting how application owners, administrators and developers consume applications and IT infrastructure. It's no longer good enough to automatically provision a single virtual machine or issue a ticket to IT every time administrators want to deploy an application stack. Users want pre-packaged applications and environments that are super easy to consume.

Given this, companies want automated deployment of full application stacks like SQL Server and VDI on virtualized or containerized infrastructure and they want to leverage both private and public cloud instances, e.g., SQL Server-as-a-Service, VDI-as-a-Service, etc. Companies have found that automating these well-known application patterns drives faster time-to-value and allows IT teams to focus on things that improve the business, rather than repetitive tasks.

All vendors we evaluated enable users to automatically deploy entire business services (SAP Financials, PeopleSoft CRM, Securities Lending, etc.) and development environments (Ruby, Python, PHP, etc.) and the associated application stack components (MySQL, DB2, PostgreSQL, web servers, application servers, load balancers, VM or cloud instances, networking, storage, etc.) using catalog items published to a self-service portal. Catalog items are created from templates that automatically provision the entire application and multi-tier stack including all dependencies based on pre-defined rules. A subset of these rules can be modified to re-configure applications to support various needs, such as latency considerations, budget constraints, compliance controls or approval workflows.

We believe the strongest use case support comes from VMware and Cisco. These vendors stand out because they complement multi-tier orchestration with marketplaces, intelligent workload placement and digital workspaces. These additional capabilities broaden the range of usage scenarios supported by enabling virtual desktop infrastructure (VDI), multi-cloud orchestration and the ability to select from pre-defined solutions that are shared within a collective community.

Microsoft deserves special mention as well given their ability to deliver desktop virtualization with Remote Desktop Services (RDS) and to easily provision popular Microsoft collaborative applications, such as SharePoint and Exchange using Microsoft Azure and Microsoft Azure Stack. However, Microsoft Azure Stack only offers basic workload placement with no cost considerations, which inhibits multi-cloud orchestration.

Evaluation of IT-as-a-Service

IT-as-a-Service (ITaaS) can be one of the most visible factors in transforming IT from a cost-center to a strategic partner with the business by driving improvements in productivity and performance. The core components are a common self-service portal and service catalog that provide developers, application administrators and business users with a secure, self-directed experience for finding, requesting, provisioning and managing the application stacks, virtual infrastructure and cloud services they need.

All vendors provide basic self-service and service catalog capabilities, including branding, personalization, policy-based governance, approval workflows, dynamic provisioning, cost transparency, and integrated lifecycle controls. The differences show up in the marketplace support and the ability to provision across multiple cloud providers.

A marketplace is a key value for companies because it provides shared access to out-of-the-box solutions that can considerably shorten the time to value. ServiceNow, RightScale and VMware all maintain their own marketplace communities. For example, the VMware Solutions Exchange markets VMs, virtual and physical appliances and cloud services that have been published by VMware, partners and developers. Other vendors, such as Morpheus Data, don't offer their own marketplace, but they do offer integration with marketplaces provided by cloud vendors, such as the Azure Marketplace.

The ability to provision across multiple clouds is the key area of differentiation. Although all vendors we evaluated provide support for multiple cloud services, most fall short of customer expectations when it comes to having the same architecture, operational tools and seamless workload migration across multi-cloud environments.

Provisioning workloads to multiple cloud services is the first task. Several vendors provide cloud-specific templates that facilitate provisioning to multiple cloud services, such as AWS, Microsoft Azure and the Google Cloud Platform. For example, Red Hat enables deployment of complete multi-tier applications using Ansible Automation with Red Hat CloudForms. With Ansible Automation, users

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access provider-specific templates for cloud resource management, including AWS CloudFormation, Azure Resource Manger (ARM), OpenStack Heat, Google Compute Engine and Cloud-init templates. ServiceNow, CloudBolt, Embotics and Morpheus also offer template-based provisioning across multiple cloud environments.

VMware and Microsoft go a step further by offering the same architecture and operational experience on premises and in the cloud. VMware offers this capability through their VMware Cloud on AWS offering. Microsoft offers this capability between Microsoft Azure and Microsoft Azure Stack. This additional level of compatibility offers the promise of advanced operational functions, such as live migration of running virtual machines (the initial release of VMware Cloud on AWS only supports cold migrations). Cross-cloud vMotion will be available in a future release.

Evaluation of Template Support

Application templates and design tools are considered the core components of cloud orchestration because they provide end-to-end service automation for both simple and multi-tier application stacks. The key benefits of service templates are built-in best practices, greater standardization, efficiency gains, faster updates and rapid customization.

We found there are two approaches to template design. Some vendors, such as Microsoft, Red Hat, CloudBolt and Morpheus optimize template design for developers. Therefore, template building and editing requires knowledge of task automation and configuration languages, such as PowerShell, JSON and YAML. This approach provides a high degree of flexibility, but the programming skills required are more prevalent in IT shops building cloud-native applications.

Companies managing traditional infrastructure have IT administrators that often have a lower implementation skill level. These companies want to modernize and automate existing IT operations, but may also be building cloud-native applications. Given this, they want workflow design tools that can utilize OOTB task libraries and a visual template design canvas that provides assistance and a more guided experience.

Cisco, VMware and Morpheus follow this visual template design approach and enable users to build servers, compose multi-tier application stacks and assemble multi-VM workflows using a graphical canvas and a drag-and-drop interface. Users select components from a palette, assemble the components on the canvas, define build/deployment dependencies and ultimately publish servers and application stacks to a service catalog. Designer components include infrastructure resources, networking, scripts and software components, such as operating systems, front-end load balancers, application servers and backend database services. ServiceNow also offers a visual template designer, but the ServiceNow designer is built for single VM provisioning, automating lifecycle management and routine administrative tasks, such as increasing the size of a home directory or mailbox. Support for more complex workflows requires scripting.

Out-of-the-box workflows are another important part of a strong overall automation capability because pre-defined application templates fast-track the creation of standard services. We found that RightScale, ServiceNow, VMware, Red Hat, Microsoft and Cisco all offer extensive template libraries. However, pre-defined templates often differ from vendor to vendor. For example, Microsoft offers templates geared toward deployment of Microsoft applications, while RightScale offers a variety of different ServerTemplates that have been published by RightScale, ISV partners, and others. For example, server templates are available for several common server types such as a PHP application server, LAMP all-in-one server, Microsoft SQL server, etc.

Resource controls also set vendors apart from the competition. This is an area where VMware, Red Hat, Cisco and ServiceNow shine above the competition by offering extensive storage, data retention, network and container support. For example, VMware recently released a plugin that integrates storage policy-based management (SPBM) into vRealize Automation. The plugin exposes vSphere VM storage policies to the vRealize Automation service catalog allowing the ability to dynamically assign individual VM storage policies to virtual disks based on their storage requirements (performance, availability, security, etc.). Users can manage vSAN, VVol and VMFS datastores.

Microsoft also offers solid data retention, network and container support, but Managed Disks are not yet supported in Azure Stack. Azure Managed Disks simplify disk management by managing the storage accounts associated with the VM disks. With Managed Disks users only have to specify the type (Premium or Standard) and the size of disk needed, and Azure creates and manages the disk for them.

Evaluation of Security, Compliance and Governance

The goal of every cloud management vendor is to provide a unified template design environment that incorporates all resources and components needed to deploy enterprise-ready cloud applications. This streamlines the process of designing application workloads with the proper network connectivity, security, performance, compliance and governance.

Several vendors are packed at the top of this category; they are Microsoft, VMware, Cisco, Red Hat, and ServiceNow. All of these vendors have recognized the importance of incorporating support for load balancing, virtual network devices and security groups into template design and application orchestration. Differences come into play around the availability of granular controls. For example, VMware recently enhanced load balancer controls, such as customizing load balancer algorithms and modifying load balancer policies.

Leading vendors all support virtual networking and security groups, but VMware and Cisco offer the leading microsegmentation frameworks (VMware NSX and Cisco ACI) for secure application deployment. Microsegmentation is used to set up granular network security and achieve application isolation by prohibiting intruders that have compromised one node from directly accessing other nodes on the same VLAN. Also, in the latest vRealize Automation release, VMware introduced NSX controls for day-2 operations, such as adding and deleting security groups to/from an application.

Security is an essential part of automated application delivery. Given this, all vendors provide parameters for security settings, role-based access control and approval workflows. However, users will find that differences can be found in the flexibility of security policies. For example, access and approval policies should be able to be applied to both catalog items and catalog item components, as well as day-2 actions that require entitlements.

With the advent of SOX, HIPAA, PCI, FOIA and soon GDPR, ensuring compliance and proper governance has become essential for all companies. Public cloud adoption is also driving an increased need for data controls, since data inherently becomes more portable once in a public cloud environment, which raises concerns around data locality compliance. To ensure compliance and governance, leading vendors offer segmented user access with approval workflows and automated policy enforcement and remediation. All vendors also offer logs for audit trails, but the level of configuration auditing, change tracking and drift analysis differs from vendor to vendor. As a leading configuration management database (CMDB) vendor, ServiceNow sets the pace in this area. That said, other vendors do provide integration with leading CMDB vendor solutions.

Evaluation Orchestration and Workload Placement

Think of policy-based orchestration as the cloud management control plane that enforces corporate policies, manages resource usage and optimizes workload placement. All the vendors we evaluated support policy-based orchestration and policy-based eventing; however, intelligent automation, workload placement and support for converged infrastructure are still gaps in several vendor offerings.

Looking across vendor capabilities, we see that policy-based orchestration plays an important role in the following areas: controlling which services a user can request, approval guidelines, service cost, lease periods, service options, service level received, type of machine assigned (physical, virtual, container and/or cloud instance) and service placement. Other important policy governance features are the use of templates to standardize offering policies for different groups and the ability to easily configure policies without the need for coding or scripts.

Policy-based eventing enables automated workflows and facilitates integration with external systems. For example, a new service request might trigger an automated workflow for obtaining approval using external systems before a lifecycle action such as deploying a resource offering can occur. Other examples of integration with external systems include making CMDB updates and propagating changes in regulatory and operational compliance rules. Vendors that emphasize policy-based eventing are ServiceNow, Red Hat, VMware, RightScale, CloudBolt, Embotics and Morpheus.

Automated resource reclamation is a capability that is now pervasive as vendors have realized the importance of avoiding VM sprawl to reduce costs and automating VM reclamation to reduce administrative burden. The best capability we found in this area is the use of analytics to identify underutilized resources that can subsequently be reclaimed. Service lease management is another common vendor capability that identifies when services will expire, which creates opportunities for lease renewal or automatically deprovisioning VMs once they are no longer required.

The growth in converged infrastructure (CI) and hyperconverged infrastructure (HCI) has driven vendor adoption of CI/HCI devices to simplify procurement, streamline deployment and improve management of virtual compute, storage and networking resources. Cisco, Red Hat, Microsoft and VMware have all incorporated CI/HCI devices into their cloud management platforms.

Intelligent automation and intelligent workload placement are rapidly evolving capabilities. The goal is to connect analytics and automation to optimize and automate placement of workloads within a multi-cloud environment based on cloud costs, workload requirements and cloud service levels. VMware, Red Hat, Cisco, ServiceNow, RightScale, CloudBolt, Embotics and Microsoft all have varying capabilities in this area. This capability is covered more extensively in the Cloud Costing section.

Evaluation of Resiliency and Elasticity

One of the most important benefits of cloud computing is elasticity, or the ability of the cloud to adapt to workload changes by provisioning and de-provisioning resources in an autonomic way. In the same manner, cloud orchestration should support auto-scaling as well as the ability to automate failover and recovery for overall reliability. The combination of auto-scaling and automated failover enables clouds to move beyond elasticity to being truly resilient in the face of unpredictable conditions and constantly changing usage and demand.

The most basic tenet of resiliency is data center recovery in the event of an outage or other unforeseen disaster. To this end, leading cloud management vendors are focused on simplifying High Availability (HA) and failover through various innovations and integrations. For instance, for

compute, RightScale users can use "MultiCloud Images" that can be launched across regions and hybrid environments. This capability ensures the same implementation of the server in different cloud regions. Users can also automate the process of promoting a slave to master. The process is automated, but decision to run the process is manual.

VMware has also recently simplified HA with NSX Edge High Availability. Leveraging self-service options in VMware vRealize Automation, application tenants can provision and protect workloads without IT involvement. Application owners select the availability and recovery time objective (RTO) and recovery point objective (RPO) options that fit their SLA requirements and budget.

We were pleased to see that all vendors support load balancing and the majority of vendors support auto-scaling. Two exceptions are ServiceNow and Microsoft Azure Stack, which do not support configuring auto-scaling within application design templates.

The final factor we considered when evaluating vendors in this category is the ability to control snapshot sprawl. We found that the vendors with the strongest emphasis in this area are Cisco, Red Hat, ServiceNow, Embotics, Morpheus and VMware. Key capabilities we identified are the ability to manage how long snapshots exist and the ability to manage snapshots in multiple cloud environments. For example, VMware controls how many snapshots a machine can have and how long those snapshots exist through blueprint policies, while Morpheus can manage snapshots in multiple private and public cloud environments, including AWS, VMware and Azure.

Evaluation of Discovery, Deployment and Maintenance

We believe there are a couple of important ways vendors can improve productivity and reduce costs, and it starts with automating resource discovery. We were pleased to see that all vendors we evaluated offer comprehensive resource discovery automation.

We believe ease of solution deployment is important in this category and we were pleased to see that most vendors have improved in this area. Three vendors worth mentioning are Cisco, CloudBolt and VMware. With UCS Director Release 6.5, Cisco introduced an HTML5 compliant user interface and multiple guided setup wizards. CloudBolt also provides a quick setup wizard that creates all the objects that CloudBolt requires to begin provisioning, discovering, and managing VMs. VMware, with the vRealize Automation Release 7.3, made it easier to deploy, upgrade and migrate vRealize Automation. Specifically, vRealize Automation 7.3 adds and exposes APIs to programmatically install, upgrade, and migrate vRealize Automation.

Another valuable cloud management capability that improves productivity is workload migration. Specifically, we believe the ability to migrate workloads seamlessly between private and public clouds and between public clouds is growing in importance as companies more broadly embrace multi-cloud environments. Multi-cloud workload migration is not covered well by any vendor we evaluated as part of this report and this capability appears to still be the realm of specialty vendors, such as Zerto and HotLink.

That said, it should be noted that VMware is moving rapidly down the path towards automated workload migration with VMware Cloud on AWS. Currently, only cold migration to AWS is supported. However, cross-cloud vSphere vMotion migration will be available in future VMware Cloud on AWS releases, as well as per-VM Enhanced vMotion Compatibility, to provide vSphere vMotion compatibility between the in-cloud ESXi host's CPU architecture and the customer's on-premises ESXi host's CPU architecture.

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Evaluation of Automation Extensibility

There are many facets to automation extensibility, but there are four main focus areas. The first area is programmatic access to cloud management functionality through published APIs and all vendors we evaluated in this report publish REST APIs.

The second area is the ability to stand up consistent application configurations in different cloud environments. DevOps teams and application administrators need to be confident they are provisioning the exact same server and application configurations and that the same scripts were run, irrespective of where the workload is placed.

The third area is implementing a common DevOps approach across hybrid cloud environments. All vendors deliver functionality is this area through northbound APIs that provide integration with configuration management tools, such as Puppet and Chef, and increasingly Salt and Ansible; as well as with test automation servers, such as Jenkins; and with continuous integration and continuous development (CI/CD) tools, such as Jenkins CI, GitHub, and DockerHub, which are used by many organizations to build continuous integration pipelines.

Red Hat may have a leg up on the competition in the DevOps area, through their acquisition of Ansible, but VMware has also stepped up their game with vRealize Automation 7.3, which adds native integration with external configuration management tools (starting with Puppet). This enhancement adds the ability to drag-and-drop a Puppet configuration object directly onto a machine component in the VMware Converged Blueprint Designer. Once dropped, a user queries a configured Puppet Master, Environment and Role, and dynamically assigns puppet roles to a blueprint component. The integration also provides day-2 actions to unregister or delete assignments as needed.

The fourth area is having a centralized means of integrating with external management systems that are part of a machine's lifecycle. Common integrations include CMDB platforms, authentication software and service desk solutions.

OPERATIONS MANAGEMENT LANDSCAPE

In this section we present the category-level scores for cloud operations management solutions, along with our rationale, based on our assessment of the vendors' offerings against each of the evaluation factors. To arrive at overall marks, we computed a weighted average of the 11 category scores, and then adjusted the scores based on our own judgment of each vendor's market position, installed base, product strategy, and focus and expertise.

The vendors included in this section are VMware (VMW), Microsoft (MSFT), ServiceNow (SVN), Cisco (CSCO), Red Hat (RHT) and Turbonomic (TUR). For each of the 11 categories we have provided a summary that discusses the key factors we used to evaluate vendor offerings, the importance of the factors and significant observations.

OPERATIONS MANAGEMENT COMPETITIVE LANDSCAPE *(4 = HIGH)*

Operations Management Factors	VMW	MSFT	SVN	CSCO	RHT	TUR
Monitoring Coverage	●	●	◐	◐	◕	○
Performance Management	●	◐	◐	◐	◕	○
Capacity Management	●	◐	○	◔	◔	◐
Infrastructure Optimization	●	◕	◔	○	◐	◕
Workload Hosting Optimization/Placement	◕	◔	○	◔	◔	●
Extensibility	●	●	◕	◕	◕	◐
Logfile Management	◕	◕	○	○	○	○
Integration with Third Party Ecosystem	●	◕	◕	◕	◐	◔
Policy/QoS Based Management	●	○	◔	○	○	◐
Platform Support	◕	◕	◐	◐	◐	◐
Single Point of Interaction	●	◕	◐	◔	◔	◕
OVERALL SCORES:	◕ 3.8	◐ 2.5	◔ 1.5	◔ 1.4	◔ 1.9	◔ 1.7

Evaluation of Monitoring Coverage

The cornerstone of IT operations begins with being able to see what is going on where – one can't manage what one isn't measuring. In pre-virtualization days simple element management ruled with agents installed on every component that forwarded metrics and events to a centralized infrastructure manager console (possibly one for each IT silo). With the evolution of service-oriented management, IT began monitoring virtual machine performance, end-user experiences and transactions, application layer components, databases and middleware. As cloud and hybrid cloud

architectures have become the norm, IT now also requires multi-tenant, cross-cloud perspectives, global and mobile agility, and the huge scale that comes with containerized applications.

Some of the criteria below detail how the best operations management solutions bring all this together and make it feasible, efficient, and affordable for IT to take on an ever broadening, end-to-end span of responsibility. In this category specifically, we evaluate both the depth and breadth of fundamental monitoring coverage. Here the traditional platform management vendors might be thought to have a slight edge simply because over decades their legacy tools have grown larger coverage matrices and incorporated best practices in physical IT silo management. But VMware, Microsoft, Red Hat and Cisco developed core data center platforms in conjunction with intimately engineered management solutions, and while not trying to be large NOC platforms, these vendors are delivering much of what IT operations customers want, especially in virtualized and increasingly highly automated "cloud" architectures.

Note that we have discounted the obvious fact that almost any management solution today can serve as an umbrella console that can be configured to rake in external events and data streams sourced from other layers of management tooling (e.g. the main claim for broad coverage with ServiceNow). While this is seemingly convenient when silo solutions are already deployed in an environment and there is no appetite to undertake transformational changes, every layer of tooling and each additional vendor supplier adds to the complexity of operations and ultimately degrades responsiveness and reliability.

In practice, many large vendors present spaghetti-like wiring diagrams of moving parts that require services to integrate and are eventually confusing to operate. Significantly, we noted that many of these vendors are offering newer, more competitively converged and cloud-friendly front-end solutions that are intended to ultimately replace their legacy portfolio-based approaches (e.g. Cisco Intersight). These efforts can seem not only late to market, but threaten to drag along legacy components of functionality for a long time to come.

Evaluation of Performance Management

Performance management involves reporting and alerting on the status and health of IT components. This involves tracking alerts, events, configurations and streams of metrics, with subsequent analysis and/or escalation capabilities that may range in capability from detailed element-level and reactive to aggregated business service level and predictive. A primary goal of newer generations of solutions is to effectively simplify and focus what is presented at the top level of interaction in favor of helping prioritize staff attention. The goal may not be to hide all complexity as much as to reduce noise (false alerts), provide context (e.g. models, maps, service groupings), improve interpretation (root cause) and accelerate response (reduce MTTR or even enable proactive automatic remediation).

Ultimately IT customers want to reduce the OPEX involved in guaranteeing production-level IT health and performance, even as their world becomes increasingly complex. Recently, we note that many management vendors are beginning to incorporate big data style machine learning algorithms (often presented as Artificial Intelligence) over the growing volume of machine generated data (e.g. logfiles, events, metrics).

While it was beyond this evaluation to lab test and validate the efficacy of each vendor's solutions in actual practice, we note that all these vendors have assembled multiple layers of capabilities in various components that might apply sophisticated correlations and anomaly detection features. The best solutions add value by intelligently learning baselines of the dynamic and seasonal behavior of workloads, resources, and business cycles and then automatically setting "abnormal" alert thresholds. They also group (and reduce) events and alerts to the user, app or service, correlate with

configuration changes, and provide contextual, knowledge-based recommendations. Finally, we think customers prefer solutions that aggregate information to a service map or model, producing multivariate KPI's on health and status, and applying multiple kinds of correlations (e.g. time-based, transaction-based, topology-based).

Notably, VMware vRealize shows sophisticated IT "health" scoring (KPI's) that the traditional vendors in this space (including Microsoft) might analogously produce and display only with multiple layers of components. We should also note that operations balancing solutions like Turbonomic actually avoid offering this type of insight in favor of focusing on dynamic optimization (leaving the actual health of IT to other solutions).

Evaluation of Capacity Management

If performance management is mainly about real-time monitoring, alerting and events, capacity management is about proactively managing the ongoing state of resource utilization. The idea is that with solid capacity management you can avoid running out of resources, which inevitably results in throughput bottlenecks, latency issues, and provisioning shortages, or over-allocation that wastes investment. The hybrid cloud era challenges traditionally slow and static data center planning approaches, enabling potentially elastic supply balanced with additional concerns about utility costs over time.

Some solutions claim predictive capabilities by forecasting a linear trend line on resource utilization history while the best solutions account for both observed trends and committed future plans, and smartly alert on predicted capacity shortfalls. VMware vRealize presents these separately from immediate health problems as "risk" factors in its single dashboard, while the big traditional solution vendors have a variety of legacy components to address capacity. Microsoft SCOM's cloud-based OMS has a plug-in for capacity management, but does not effectively account for future plans in operational use. ServiceNow is relatively orthogonal to all these issues, while Turbonomic does a good job of dynamically assuring effective use of available resources, and has grown to cover cloud infrastructure, but isn't integrated into wider hybrid IT cloud operational concerns or actual application perspective performance.

Evaluation of Infrastructure Optimization

Where capacity management focuses on managing the remaining capacity of a system, infrastructure optimization looks for possible efficiency gains in the reclamation or re-alignment of resources. While we didn't include offline capacity planning solutions in this larger evaluation (e.g. those that involve long-running simulations, non-linear queuing modeling, or actual lab benchmarking), there are a number of capacity planning related optimizations that cloud management operations solutions can automatically produce.

For example, VMware vRealize Operations produces "efficiency" KPI's (again separate from performance "health" and capacity "risk" scores) that highlight where available infrastructure tuning opportunities exist. Microsoft's add-on OMS log analytics (evaluated separately below) can be used to find over-allocated or unused resources, although this isn't rolled up automatically to the top level interface. ServiceNow checks this off with some orchestration processing to help reclaim provisioned assets, but it is a separate unguided task.

Part of our evaluation gave credit for integrated infrastructure utilization forecasting in which both future workload demands (planned growth and other "reservations") and planned infrastructure upgrades can be overlaid. Aligning workloads to infrastructure, both current and future reservations,

is a core strength of Turbonomic's dynamic optimization approach. We note that VMware also supports the future analysis of planned changes. In particular, we note that VMware vRealize Operations automatically feeds committed future plans back into its other KPI's to inform even more intelligent predictive alerting.

Evaluation of Workload Hosting Optimization

If the system is in good health and has sufficient future capacity, then the next task of operations is to best align the currently running workloads with the current infrastructure. While determining the "best alignment" can include functions of performance QoS, meeting committed SLAs, minimizing cost, or even considerations to maximize data protection and security, the evolution into cloud is bringing new opportunities to both maximize performance and broker lower costs.

Turbonomic deserves special mention here as a solution squarely aimed at the dynamics of moving virtual machines around to best fit them into available capacities (however we note modeling VM size placement as a best-fit economics problem isn't sufficient to ensure actual application performance). We did note that VMware now not only provides automatic "within cluster" placement (with the native Distributed Resource Scheduler (DRS)), but can also make intelligent cross-cluster recommendations (with vRealize Operations in conjunction with DRS), and now has an intelligently predictive DRS (pDRS) variant that learns workload profiles over time.

Microsoft also has VM placement recommendation and re-balancing capability. Although most hint at ultimately aiming to provide active cloud brokerage, Red Hat and even Cisco can currently make VM provisioning placement recommendations (or re-provisioning plans) but don't pretend to operate in real-time at the host, cluster, or cloud levels. At the same time, automation solutions (evaluated in this report in a separate category) like Red Hat Ansible can be used to automate reactively triggered re-provisioning tasks.

Evaluation of Extensibility

When providing an operations management solution, it's important to ensure extensibility through the exposure of API's and/or SDK's that allow the larger IT ecosystem to produce or provide appropriate plug-ins. We observed that the larger and more established the vendor, the richer and more complete the catalog of third party plug-ins. All of these vendors are large enough to have a multitude of technical partnerships, though any particular IT shop would be well served to identify any important gaps before investment. In all cases, custom services are also available to help extend or custom-build adapters to just about anything in IT that can produce metrics and/or events (from their own API's, command lines, or machine data logs).

Evaluation of Logfile Management

No current cloud-scale operations management solution is complete without some way to parse and mine value out of the plentitude of logfiles produced by almost every bit of IT infrastructure. This "machine data" may get processed and translated into event and metric streams input into the more structured activities evaluated above, but also deserves its own "unstructured" analysis solution to support just about every IT management activity including configuration and asset management, software license auditing, security management, and detailed feature usage analysis. Logfile analysis solutions collect, store, and index log files from across the IT stack. They must intelligently parse these files at variety and scale, and subsequently provide easy query/search access to IT users. Often logfile collections grow to "big data" sizes, so many solutions apply new big data analytics solutions and are cloud-hosted.

Splunk is perhaps the most recognized solution in this space, focusing on this capability almost exclusively as their core technology. However, Splunk was not included in this year's report as we do not find a standalone machine data/search query solution at all sufficient to meet broader IT cloud management needs.

Evaluation of Integration with Third Party Ecosystem

The flipside of the extensibility category above is outbound (aka northbound) integration with third party ecosystem solutions. A hallmark of truly well thought-out management solutions is that they can become data sources in turn to the broader IT ecosystem by feeding intelligent information into solutions like trouble ticketing, help desk, CMDB's, asset managers, financial management and application business health dashboards. Integrations can take several forms including event forwarding, triggered scripting, exposed reporting API's or CLI's, SDK/libraries, or even stored procedures.

While professional services are available from each vendor or its partners to accommodate custom integrations, the best solutions come with built-in adapters or ready plug-in modules for the most common out-of-the-box integrations (e.g. sending workflow/lifecycle events to BMC Remedy).

The operations management solution first has to be able to generate workflow/lifecycle events. vRealize Operations is notable in that it can initiate cascading actions based in its intelligent KPI's, and some of those KPI's (e.g. certain "risk" factors) in turn account for existing future plans (upgrades and/or reservations), helping close a full cycle loop of IT infrastructure "assurance".

Evaluation of Policy-based/QoS Management

In an increasingly agile and cloud-like IT environment, it's becoming increasingly important to be able to exert proper IT management and governance via policies that can be dynamically implemented by provisioning systems and automatically monitored by operational components. For operational excellence, it's key for IT clients to both demand and be assured of receiving specified QoS levels. At the scale of cloud operations, only policy-driven solutions can deliver on QoS promises.

More solutions across the spectrum today have some element of policy establishment, often to limit or constrain the provisioning of a certain kind of resource to certain groups of users or kinds of applications. The key differences show up in how such policies might be operationally monitored, enforced or reported on downstream. We note that VMware vRealize Suite enables a coherent policy-based approach throughout the lifecycle, whereas many larger platform vendors have, at best, different solution components with various policy implementations.

For example, the monitoring-heavy vendors can apply custom thresholding based on information passed from orchestration tasks as a matter of "policy". This will often be different, again, from what might be reported (e.g. in financial management). ServiceNow, when it comes to QoS assurance, offers only a service level "visualization".

Evaluation of Platform Support

We look for today's management solutions to be able to run on-premise and as a cloud or hybrid service, supporting cross-cloud approaches. With multiple data centers, converging resources, shrinking staff, and hybrid cloud deployments, many enterprises are looking to subscribe to cloud-hosted management services (SaaS) to augment or even replace on-premise management tools.

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Evaluation of Single Point of Interaction

The "single pane of glass" has long been the promise of IT systems management vendors. IT wants to increase admin efficiency and productivity by unifying and integrating multiple interfaces into one coherent point, or UI, of interaction. Furthermore, the intelligent use of rollup, or aggregating KPI's, should extend these efficiencies by distilling much detail down into obvious admin "calls to action". Ultimately the idea is to reduce the number of different tools, unique UI's, complex raw metrics and even disparate workflows into a simpler, and hopefully simplifying point of primary interaction.

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HYBRID CLOUD MANAGEMENT LANDSCAPE

In this section we present the category-level scores for hybrid cloud management solutions, along with our rationale based on our assessment of the vendors' offerings against each of the evaluation factors. To arrive at overall marks, we computed a weighted average of the 5 category scores, and then adjusted the scores based on our own judgment of each vendor's market position, installed base, product strategy, and focus and expertise.

The vendors included in this section are VMware (VMW), Microsoft (MSFT), ServiceNow (SVN), Cisco (CSCO), Red Hat (RHT), RightScale (RSC), Embotics (EMB), CloudBolt Software (CB), Turbonomic (TUR) and Morpheus Data (MOR).

The categories covered in this section are Workload Portability, Intelligent Workload Placement, Elastic Resource Control, Unified Management/Monitoring and Security/Compliance/Governance. For each category we have provided a summary that discusses the key factors we used to evaluate vendor offerings, the importance of the factors and significant observations.

HYBRID CLOUD MANAGEMENT COMPETITIVE LANDSCAPE *(4 = HIGH)*

Hybrid Cloud Management Factors	VMW	MSFT	SVN	CSCO	RHT	RSC	EMB	CB	TUR	MOR
Workload Portability										
Intelligent Workload Placement										
Elastic Resource Control										
Unified Management/Monitoring										
Security, Compliance, Governance										
OVERALL SCORES:	3.0	2.8	2.0	2.0	2.0	2.8	2.0	1.6	2.0	1.8

Evaluation of Workload Portability

One of the keys to making a hybrid cloud work is to provide a simple and streamlined way to move apps and data to and from an on-premises data center and the public cloud. In fact, workload portability helps to enable two of the most fundamental benefits that customers seek in cloud deployments: agility and freedom of choice.

In this category, we evaluated the ease with which vendors allow users to migrate workloads to/from the data center and different clouds, along with the ability to move workloads dynamically based on policy-based triggers. We also looked at vendor support of migration-driven use cases, such as cloud bursting, lifting and shifting of legacy apps, and extension of datacenter infrastructure to the public cloud. The cloud and virtualization platform vendors tended to score better in this category, since they have the native tools, functionality and policy frameworks in place to enable migration to and from their environments.

Red Hat, RightScale and VMware are focusing on enhancing workload portability in their offerings. Red Hat Cloud Suite helps to automate the migration of workloads from a customer's data center to AWS or Azure clouds, and also supports a range of migration-enabled use cases. VMware also has a

strong offering here, supporting workload migration to allow customers to extend on-premises data centers to VMware Cloud on AWS. vRealize Automation and Operations together help to automate workload movement based on policy, and VMware supports a number of migration-driven hybrid use cases. While not a platform vendor, RightScale also earned high scores for workload portability, with its use of Cloud Application Templates to enable policy-based movement and placement.

Microsoft and Cisco also scored well, with each still building their hybrid cloud offerings and presence. Microsoft is still working out the incompatibilities between Gen-1 and Gen-2 VMs, which impose constraints on the movement of workloads between Azure Stack and Azure. Cisco does not offer automated workload migration today, but its CloudCenter application profiles and policy framework give it an opportunity to develop such a capability in the future. The smaller vendors in this category tend to be one step removed from the platforms and workloads they support, and so are less able to deliver or ensure portability.

One caveat is worth noting: if you adopt public cloud-native services, it might become more difficult to migrate your workloads back out of the cloud, should you choose to do so in the future. So it is worth giving some thought upfront about how you will use each public cloud and the specific workloads you will deploy there.

Evaluation of Intelligent Workload Placement

Vendor capabilities in this category will allow you to get the most of out of your hybrid cloud investment, by helping to ensure that each workload is placed in the cloud, region, cluster and/or host that best meets cost, compliance or service-level requirements.

In this category we assessed the degree to which each vendor offers recommendations for placing workloads to optimize such factors as IT governance, cost, and the ability to meet service-level objectives, based on policy and operational intelligence. Three vendors stood out: RightScale, Turbonomic, and VMware. RightScale provides workload assessments, cost insights and application-specific policies to help govern where a workload can best be placed to meet business objectives. Turbonomic modeling of cloud economics allows it to make placement decisions in a given cloud or across regions or clouds to help optimize workload cost and/or performance. VMware vRealize Suite provides policy-based placement to meet governance and service-level objectives, as well as cost visibility and insights through vRealize Business for Cloud to help optimize placement based on cost and other business considerations.

Microsoft Azure Stack services facilitate VM placement decisions to meet capacity and configuration needs, but do not help customers to optimize placement based on cost today. Embotics vCommander offers policy-based intelligence to allow workloads to be placed where they can best meet cost and compliance objectives. Cisco CloudCenter can help place workloads to meet governance rules. Most of the remaining vendors provide some level of operational visibility to enable admins to make better informed placement decisions, but do not directly address this need through policy-based automation.

Evaluation of Elastic Resource Control

This capability is critical to the success of a hybrid cloud deployment. The ability to elastically manage and control cloud resources enhances infrastructure efficiency and agility, while helping to ensure that workloads achieve required service levels without exceeding the budget.

Here we examined whether each vendor's software architecture enables distributed resource management across on premises and the cloud, and the degree to which the solution supports policy-

based administration of resources in support of IT governance. We looked also at the ability to spin up or spin down instances on demand, in response to policy-driven triggers, along with the ability to reclaim and re-use inactive resources, to avoid waste and inefficiency. Microsoft scored well due to its Azure Resource Manager, which provides distributed resource management and a policy-driven framework. The Autoscale function in Azure enables instances to be spun up or down based on demand, and also helps to reclaim inactive resources, but the use of Autoscale is currently inhibited in Azure Stack, since it cannot operate on VM scale sets (groups of identically configured VMs that can be deployed without pre-provisioning).

Red Hat also scores well based on its CloudForms distributed cross-cloud architecture, policy engine, and resource reclamation capabilities, along with the auto-scaling of compute instances in RHEL OpenStack. RightScale Cloud Management Platform (CMP) provides distributed, policy-based resource management, and provides auto-scaling, but it takes a bit of work to set up. ServiceNow partners with RightScale to deliver elastic resource control, and Cisco CloudCenter provides the distributed management architecture and delivers auto-scaling for agent-enabled VM workloads. CloudBolt and Turbonomic, two of the smaller vendors in our study, also do well in this category, based on their distributed management platform architectures, auto-scaling, and partial resource reclamation capabilities.

VMware has a well-rounded solution for elastic resource control, powered by Elastic DRS, which performs most of the functions we were looking for in this category.

Evaluation of Unified Management/Monitoring

In this category, we evaluated some key operations management features and capabilities in the context of a hybrid cloud. Specifically, we looked for the presence of a distributed control plane, independent of data flows, that extends between on-premises and an external cloud. We considered the ability to remotely monitor the health, capacity and performance of workloads, and the ability to obtain a single consistent view of operations and workloads across multiple management instances. Finally, we assessed each offering's lifecycle management capabilities, applying both to hybrid cloud apps and services and the management solution itself (e.g. does it enable regular non-disruptive upgrades, etc.).

Microsoft, ServiceNow and VMware earned strong scores in this category, primarily on the basis of their distributed control plane architectures, workload monitoring and lifecycle management capabilities. In addition, each vendor supports consistent views through multiple distributed management instances—Microsoft through Azure Resource Manager service endpoints; ServiceNow via ServiceWatch on its Cloud Management Portal; and VMware through Hybrid Linked Mode, which links multiple vCenter instances together and presents a common view as a single control plane.

Cisco CloudCenter offers a distributed control plane, agent-based workload monitoring, and strong application lifecycle management features. Red Hat CloudForms and Red Hat Insights together provide a similar set of functionality, as does the RightScale Cloud Management Platform. The four smaller cloud automation and orchestration vendors in our survey—CloudBolt, Embotics, Morpheus and Turbonomic—are a little more challenged here: they are all based on hybrid cloud-capable management architectures, and deliver solid lifecycle management, but must link to third party tools to deliver workload monitoring.

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Evaluation of Security, Compliance and Governance

The final hybrid cloud management evaluation category is focused on vital security, compliance and governance features, most of which should be regarded as must-have, checkbox items in your evaluation of alternative solutions. Based on our regular surveys of IT professionals, security is still viewed as the #1 concern for organizations that are considering moving to a public/hybrid cloud.

In our assessment we prioritized features such as fine-grained role-based access controls, firewall services, data encryption, and policy-based compliance and governance capabilities that span on-premises and public cloud environments. We also looked for network-based security features such as micro-segmentation to isolate and protect particular workloads.

Cisco, Microsoft and VMware achieved the highest scores, based on the strength of their native platform security features and policy-based compliance and governance frameworks. VMware stood out among these vendors, with its comprehensive NSX security features—including micro-segmentation; vRealize Automation governance; and robust third party support.

Red Hat, RightScale and ServiceNow also scored well, with their focus on providing end-to-end security and policy-driven compliance capabilities. The smaller cloud automation-oriented vendors in our study come out a bit weaker here. All four offer policy-based compliance and governance at some level, but as a consequence of their abstraction-layered architectures, they are one step removed from underlying cloud infrastructure and workloads, preventing them from offering the level of end-to-end security enabled by the cloud platform vendors.

CLOUD NATIVE APPLICATIONS LANDSCAPE

In this section we present the category-level scores for Cloud Native Applications, along with our rationale, based on our assessment of the vendors' offerings against each of the evaluation factors. To arrive at overall marks, we computed an average of the 4 category scores, and then adjusted the scores based on our own judgment of each vendor's market position, installed base, product strategy, and focus and expertise.

The vendors included in this section are VMware (VMW), Microsoft (MSFT), ServiceNow (SVN), Cisco (CSCO) and Red Hat (RHT).

The categories covered in this section include Container Management and PaaS (management), along with the more DevOps focused Agile Application/Performance Management and the offering of Remote Management-as-a-Service.

For each category we have provided a summary that discusses the key factors we used to evaluate vendor offerings, the importance of the factors and significant observations.

CLOUD NATIVE APPLICATIONS COMPETITIVE LANDSCAPE *(4= HIGH)*

Cloud Native Apps Competitive Factors	VMW	MSFT	SVN	CSCO	RHT
Agile Application and Performance Mgmt	◑	◑	○	◔	◔
Container Management	◑	◕	○	◕	◕
Remote Management-as-a-Service	◕	●	●	◔	◔
Platform-as-a-Service Support	○	●	○	○	◕
OVERALL SCORES:	◔ 1.8	◕ 3.3	◔ 1.0	◔ 1.3	◑ 2.0

Evaluation of Agile Application and Performance Management

One of the first challenges of supporting and managing cloud native applications – those applications built, packaged and deployed by DevOps if not by developers themselves – is how to provide any management insight or control over what is truly a highly agile, incredibly flexible, scalable and scale-out, distributed hybrid "cloud" of inter-related services. Traditional tools that embed presumptions about one app per server or even per VM quickly lose their footing and relevancy when applications are containerized and flung across elastic cloud infrastructure. Containerized applications, as a core value, are incredibly portable for one, highly scalable (if built according to micro-service principles), and are expected to be managed more as "cattle instead of pets".

We look here for capabilities that support an agile DevOps approach to application and application performance management (expandable to other metric and event "informed" management activities like security) rather than simply wrap containerized applications within a static infrastructure management solution. These capabilities can include interactive, online, metric exploration, developer/personal dashboarding, quick compilation/creation of triggers defining new events, and an effectively wide open capacity to fold-in and integrate any kind of data stream for immediate analysis.

To be sure, this is a new category this year in our report because it really addresses a whole new type of management user with new ideas about best practice management in this rapidly evolving space. It will be some time before there is agreement about best approaches in this space. However, VMware's Wavefront acquisition is a prime example of how to bring cloud-native applications into a larger management scheme in order to cover the whole portfolio of applications (into new architectures) that companies might now deploy. Notably, Red Hat with a rapidly expanding CloudForms aperture covering their solid cloud-native application portfolio of solutions (from RHEL to OpenShift) is in a prime position to quickly capitalize on open source advances (which may not be at first enterprise rock-solid, but are a big driver behind most things cloud-native).

Evaluation of Container Management

Container management is also an area under fast evolution, and also includes a large swath of open source projects and initiatives. Recently there has been some convergence and settling, with Docker and Kubernetes getting cozier, and together becoming a more stable, "standard" platform. In this category, we are considering the inclusion and integration of something like Kubernetes (or better) into the broader set of cloud management activities, with perhaps again Red Hat setting the bar.

VMware in the past has rolled some interesting container deployment options, including vSphere Integrated Containers and Project Photon in order to leverage the benefits of the hypervisor (and some of its existing management) and established virtualization staff/skillsets. Recently they brought out Pivotal Container Service, a Kubernetes platform quickly deployable in turn inside the virtually hosted environment. Microsoft Azure Stack is also recently notable as bringing an Azure appliance option (with Azure Container services) immediately on-premise.

Evaluation of Remote Management-as-a-Service

One facet of supporting cloud-native applications that we expect to become increasingly important is the ability to subscribe to management services instead of having to acquire software and then implement and maintain management servers and applications over time. In the past, security and risk were often cited as obstacles, but today those are no longer roadblocks. Instead we see cloud-hosted management as possibly the best if not only way to adequately manage hybrid and multi-cloud scenarios.

ServiceNow, of course, is a completely cloud hosted, SaaS-style management service provider, which has given it a head start in this area. Microsoft has offered OMS for a couple of years, which has added things like logfile analysis, often better had as a cloud-hosted service than as an on-premise burden, to an on-premise SCOM. Now in 2017 VMware has weighed in with multiple remote Cloud Managed Services like Network Insight that offer the same functionality as their on-premise counterparts, and can be readily applied across hybrid clouds.

Cisco has announced Intersight as a subscription-style management offering intended to replace on-premise UCS Director (et.al.), but they admit this may take years to reach a critical mass of functionality. Microsoft is moving towards positioning Azure (and Azure Stack) as their main solution platform, with Azure (i.e. cloud) hosted management services becoming their default offering (while on-premise SCOM fades away).

Evaluation of Platform-as-a-Service Support

Platforms like Cloud Foundry are a key element in many enterprise cloud-native application deployments. With PaaS, developers can skip out of dealing even with DevOps level containerization,

and just deploy application code directly, letting the platform handle all the dirty work of packaging, deploying, managing and securing applications under the hood. There could be some argument as to whether a PaaS is necessarily considered cloud management, but we have no doubt that there is a lot of cloud management that goes into an environment automating PaaS solution. We expect increasing differentiation in cloud management solutions extending through containerization and into the application layer, taking strong advantage of PaaS capabilities and automation and likely applying new Machine Learning intelligence to handle the large scope and scales involved.

Red Hat's Openshift (and hosted offering Openshift.ai) is their highly integrated Containerized Application Solution with many PaaS features built-in like JBOSS middleware, database services and one-click deployment style support for developers. VMware vSphere readily hosts Cloud Foundry, and Microsoft Azure Stack delivers Cloud Foundry (and other Azure cloud services).

CLOUD COSTING AND BUSINESS MANAGEMENT LANDSCAPE

In this section we present the category-level scores for Cloud Costing and Business Management solutions, along with our rationale, based on our assessment of the vendors' offerings against each of the evaluation factors. To arrive at overall marks, we computed an average of the 4 category scores, and then adjusted the scores based on our own judgment of each vendor's market position, installed base, product strategy, and focus and expertise.

The vendors included in this section are VMware (VMW), Microsoft (MSFT), ServiceNow (SVN), Cisco (CSCO), RightScale (RSC), Embotics (EMB), CloudBolt Software (CB) and Turbonomic (TUR).

The categories covered in this section are Cost and Consumption Transparency, Business Management, Data Center Planning and Cloud Cost Optimization.

For each category we have provided a summary that discusses the key factors we used to evaluate vendor offerings, the importance of the factors and significant observations.

CLOUD COSTING & BUSINESS MANAGEMENT COMPETITIVE LANDSCAPE *(4= HIGH)*

Cloud Costing Competitive Factors	VMW	MSFT	SVN	CSCO	RSC	EMB	CB	TUR
Cost and Consumption Transparency	●	●	●	◑	●	◕	◑	◕
Business Management	●	●	◕	◑	◕	◑	◑	◑
Data Center Planning	◕	◔	◵	◵	◕	◕	◵	◕
Cloud Cost Optimization	●	●	◑	◕	●	◕	◑	◕
OVERALL SCORES:	◕ 3.8	◕ 3.5	◑ 2.5	◑ 2.0	◕ 3.5	◑ 2.8	◔ 1.8	◑ 2.8

Evaluation of Cost and Consumption Transparency

A comprehensive cost model is at the heart of business management and cost transparency. It shows the distribution and interdependencies of costs across the entire IT landscape including infrastructure, cloud environments, technical services, applications, and consumers (business lines). That said, the cost model is only as good as the data, and therefore a steady stream of cost and usage data, enabled in part by programmatic access to cost and capacity information, is required to ensure rapid and efficient data collection. The final aspect of cost transparency is analytics, which allows users to explore cost drivers, trends and KPIs from different viewpoints using customized reports and role-based dashboards.

Four vendors—Microsoft, RightScale, ServiceNow and VMware—rise to the top in this category. They all provide programmatic access to cost data from multiple sources, including financial systems, cloud environments, service desk software, and/or asset databases (e.g. CMDBs). The common clouds supported are VMware, AWS, Azure and OpenStack.

These same four vendors receive top marks for comprehensive cost models since they all perform data normalization, model interdependencies, and automate cost allocation. Analytics is another strength of these vendors, with their flexible, role-based dashboards and custom reporting.

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Two of the smaller vendors, Embotics and Turbonomic, also scored well in this category. Both offer dynamic and visual cost models, some level of programmatic access to cost data, and analytics to help optimize cost-performance for a tenant's workloads.

Evaluation of Business Management

Many companies would like to see more responsible IT consumption, but they don't know how to change organizational behavior. We believe a great place to start is better communication and better alignment, more specifically with IT communicating costs and value and business units having a better understanding of how their spend/consumption stands up against their budget.

Towards these goals, showback/chargeback is IT's most powerful weapon, facilitating cost recovery and providing an understanding of what IT services actually cost. The beauty of showback/chargeback tools is that business unit reporting can be automated with business rules and allocation templates, so IT administrators can throw out their spreadsheets and focus on more strategic activities. The leaders in this category—Microsoft, RightScale, ServiceNow and VMware—all have strong showback/chargeback functionality.

Automated budget tracking (planned vs. actual) and knowing when you are under- or over- spending is a very important component of Business Management. Nearly all the vendors we evaluated have built-in budgeting, and those that don't generate data and insights that can be used to inform and improve externally administered budgets. VMware, for its part, assists managers with budget forecasting and provides flexibility to adjust planned usage.

Another important dimension to running IT more like a business is service quality management functionality that enables a better understanding of the trade-offs between cost and quality. This is an area where VMware really shines by providing alerts when SLAs and other commitments are in danger of being missed and publishing monthly service reports covering performance, along with root cause and business impact reports to identify remedial action. ServiceNow can also measure performance against SLAs, while Microsoft System Center 2016 strives to help IT deliver predictable performance for business-critical applications by offering application health metrics that help trigger remediation actions.

Evaluation of Data Center Planning

Decision support is a key aspect of data center planning and business management overall. In order to improve data center operations, companies need tools to assist them in resource planning and modeling the impact of new workloads, and to enable them to run multiple what-if scenarios before committing to changes in their data center or cloud environments.

At the top of the list of valuable decision support tools is resource cost and capacity planning. The companies that scored highest in this category—Embotics, RightScale, Turbonomic and VMware—offer strong functionality in this area, as do Microsoft and ServiceNow. Resource planning solutions help companies plan for future resource requirements based on historical usage and help teams understand who is using what resources and for what purpose. These solutions also help groups estimate the impact and cost of adding new workloads to remaining capacity.

The use of what-if scenarios can be one of the most effective ways to determine how changes in consumption can affect charges for application licenses and infrastructure resources. What-if modeling can also help companies forecast and optimize service costs, for example by comparing cloud services for best-cost workload placements. Embotics, RightScale, Turbonomic and VMware offer strong what-if planning capabilities as part of their data center planning products.

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Evaluation of Cloud Cost Optimization

Cloud cost optimization is all about minimizing cloud service costs by helping enterprises select the most cost-effective cloud/region for each workload, as well as reducing the waste and inefficiency resulting from over-provisioning. Three vendors—Microsoft, RightScale and VMware—really shine in this category by doing both of these particularly well, while Cisco, Embotics and Turbonomic deserve honorable mention.

When it comes to comparing cloud services, all three of the leading vendors in this category provide full visibility, tracking and comparisons of costs across all major public clouds, including Microsoft Azure, Amazon Web Services and Google Cloud, as well as selective private/hybrid clouds (e.g. Microsoft includes OpenStack and will likely be adding Azure Stack, while VMware will likely include VMware Cloud on AWS). In addition to comparing the cost of current cloud alternatives, RightScale goes one step further with Optima Scenario Builder, enabling you to directly compare potential future costs across different clouds, based on assumptions about future spend for new or existing workloads, as well as different instance sizes, regions, and purchase options (e.g. spot vs. reserved instances).

The top 6 vendors in this category also provide customers with opportunities for workload rightsizing and resource reclamation/re-use to increase efficiency, such as automatically shutting down idle workloads; leveraging storage volumes not in use; or rightsizing VM instances.

Overall, VMware offers the strongest cloud costing and business management solutions, giving it the top roll-up score, with Microsoft and RightScale coming in a close second.

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CLOUD MANAGEMENT MARKET SUMMARY EVALUATION

In this final rollup, we've brought together the scores for each of the five functional areas. While there are numerous options to weight these scores, here we've simply averaged the five scores to arrive at a final, top-level cloud management landscape score reflecting our original choice of criteria across the evaluation as the set of important and necessary items for complete cloud management (each IT organization may want to individually consider the importance of each area/category according to their own needs and requirements).

Evaluation Scores	VMW	MSFT	SVN	CSCO	RHT
Cloud Orchestration	3.6	3.0	3.0	3.1	2.9
Operations Management	3.8	2.5	1.5	1.4	1.9
Hybrid Cloud Management	3.0	2.8	2.0	2.0	2.0
Cloud Native Apps	1.8	3.3	1.0	1.3	2.0
Cloud Costing & Business Management	3.8	3.5	2.5	2.0	Not Evaluated
Summary Score	**3.2**	**3.0**	**2.0**	**1.9**	***2.2***

Legend: VMW=VMware, MSFT=Microsoft, SVN=ServiceNow, CSCO=Cisco, RHT=Red Hat

VMware and Microsoft post leading scores, likely because they are both inherently also hypervisor/cloud platform vendors and therefore intimately familiar with and focused on the practices and capabilities that IT organizations need in their respective cloud transition efforts. ServiceNow does very well in areas that it focuses on, but is a layered "add-on" solution (which can be an easy way to add business service management to an existing architecture). Cisco and Red Hat have improved in this year's evaluation; Red Hat demonstrating great viability when one starts with a more pure cloud concept (and Cisco when one starts with UCS infrastructure). But VMware vRealize Suite tops the chart in the IT enterprise evaluation, indicating that VMware should be an early consideration by any IT organization looking to grow and mature their cloud management capabilities.

ABOUT TANEJA GROUP

Taneja Group's mission is to deliver best-in-class technology analysis and consulting for the storage, server, virtualization, cloud and big data markets to enable our clients to convert technology into business. We are a boutique firm of operational experts with both broad and deep expertise in storage systems and technologies, server and desktop hardware and software, virtualization platforms and appliances, cloud software and services, big data technologies, and physical and virtual infrastructure management solutions. For more information, please visit www.tanejagroup.com*.*

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