

## The role of standards in driving cloud computing adoption

### The emerging era of cloud computing

The world of computing is undergoing a radical shift, from a product focus to a service orientation, as companies increasingly access services through the cloud. There is no single definition of cloud computing. Intel defines it as a model of computing that is characterized by services delivered and consumed over the Internet. It is an end-to-end model that encompasses everything from the data center to devices that access the cloud.

Two attributes differentiate cloud computing from other implementations of computing services: scalability and elasticity. Scalability is the ability of service performance to improve as the amount of physical resources allocated (CPU, memory, disk space, network bandwidth) is increased. Elasticity is the ability to shrink or expand the resources consumed easily, even automatically, so that users pay only for the level of computing resources needed at a given time. Cloud computing is an efficient model that supports sustainability by improving the efficiency of the data center through workload consolidation (i.e., better utilization) and power management techniques.

While today many cloud providers are located in North America, this emerging model of computing is gaining visibility throughout the world. For instance, as part of its Digital Agenda to improve European access to fast Internet services and interoperable applications, the European Commission has launched a €170 million public-private partnership to help build the Internet of the future, with cloud computing as a key component. China is also focusing on the cloud; its 12<sup>th</sup> Five-Year Plan, issued in 2010, addresses cloud computing as part of an initiative to develop strategic new industries.

Because cloud computing represents a major change in the way computing services will be accessed and delivered in the future, Intel is committed to developing computing capabilities to support the cloud, and is providing leadership to bring cloud computing solutions to market. A key part of that effort is Intel's work in driving standards.

### The importance of standards

Standards are essential to the advancement of cloud computing. While there is a place for proprietary cloud solutions—an option that Intel expects to remain viable—many businesses are eager to see offerings based on open standards as well, as standards will add to the value of cloud services and encourage adoption. Customers have made it clear that interoperability is a critical aspect of cloud computing.

Today only a small percentage of the value of the cloud has been tapped, due to significant obstacles such as a lack of interoperability and the fear of vendor lock-in. Cloud customers are limited to the static use of services residing on a set of physical and virtual components provided by one vendor. The real value of the cloud will be unlocked when users can mix and match service offerings from different vendors to create customized solutions. Standards are needed to enable interoperability and to address other issues that are inhibiting adoption, such as concerns over data security.

### Key areas for standards development

While there are many areas in which standards are needed to advance the state of the art of cloud computing, Intel believes that standards around interoperability, cloud service and service level descriptions, automation, and common management and policy are critical elements, essential to the future of the cloud.

#### ***Interoperability: eliminating walled gardens***

Interoperability may be the single biggest barrier to the widespread adoption of cloud computing. Without standards-based interoperability, each vendor is a “walled garden” that is unable to share data or collaborate with other clouds.

Without interoperability standards, users must rely on a single cloud provider to meet their needs, which poses business risks, no matter how reliable the vendor. If the cloud fails, the customer cannot

immediately transfer business to another cloud until service is restored. In addition, lack of interoperability limits price competition.

Making cloud components standardized and thus interoperable would spur innovation and lower prices by enabling vendors to compete for business. And it would enable users to create customized solutions from a wide range of interoperable components, eliminating vendor lock-in.

***Standardized service descriptions: enabling valuation and negotiation***

When acquiring a server, a buyer knows the size, speed and other dimensions of the equipment being purchased. When it comes to cloud computing, the resources being acquired often are not as clearly defined, due to the typically virtualized nature of cloud computing offerings.

Without standardized descriptions of cloud computing services, buyers find it difficult to understand precisely what computing resources they are buying and cannot easily compare one service to another to determine the relative value of offerings from different providers.

Standards can provide a consistent way to describe and negotiate cloud services, enabling the creation of a marketplace of services that users can value accurately and bid on correctly. Standardized descriptions would allow buyers to make “apples to apples” comparisons of services across multiple providers and determine which provider offers the best value—a key to developing a competitive marketplace for cloud computing. These standardized descriptions must be able to accommodate all of the possible functional and non-functional aspects that customers of the cloud might require. This includes the ability to differentiate cloud services that run on hardware with certain security features built in, for example, and the ability to differentiate between a service that includes 24-hour technical support and one with support provided only during office hours.

The Open Data Center Alliance has created a usage model for “Standard Units of Measurement for IaaS” as a description of the challenge and the required solution.

***Security: ensuring data protection and transparency***

Enterprises are legally responsible for the security of their own data and that of their customers, so they must be assured of security when outsourcing services to a cloud provider. Standards are needed to ensure the security of cloud services and to assure customers that their data and information will be protected in the cloud.

Security is needed at every level of the stack. It must be comprehended in the entire architecture, from the infrastructure level to the application level and including operations; it cannot be added as an afterthought.

Security includes transparency. Among other things, transparency means that customers know where their data resides at any point in time and have a means of verifying security through a monitoring process. A lack of transparency from a security perspective has been a significant obstacle to widespread adoption of cloud computing, and is a critical issue that standards can address.

***Automation: making dynamic cloud services possible***

To outsource services dynamically—to access additional resources immediately when needed without the need for manual intervention—requires automation. At the infrastructure level, virtual machines must be initiated without human involvement. Service Level Agreements (SLAs) must be standardized so that automated tools can be used to effectively manage adherence to the SLAs. Many virtual machines may reside on a single physical machine, to achieve scale and cost benefits, so there need to be standards for managing how VMs utilize I/O in such a way that there is no contention among the VMs.

***Common management and policy: achieving regulatory compliance***

Standards also can help to ensure regulatory compliance. There is a need for a common management mechanism and policy that can be recognized and which presents itself in different clouds, in order to ensure that providers and customers comply with regulatory guidelines surrounding cloud computing—and to avoid significant penalties for non-compliance.

## **Developing standards for cloud computing**

Many existing standards can be repurposed for cloud computing—especially standards around grid computing and data centers—but only a few standards exist today that are specifically targeted to the cloud. Several industry groups are working to fill the gap. The following is an overview of key organizations that are informing or developing standards for cloud computing.

### ***Open Data Center Alliance (ODCA): Creating standards requirements***

The Open Data Center Alliance (ODCA) is an independent consortium of leading global IT companies that have joined forces to promote cloud computing technology. The ODCA is not a standards body; rather, it creates requirements, then collaborates with leading standards development organizations (SDOs) to translate the requirements into cloud computing standards. The goal is to create standards that any vendor can choose to meet, fostering the development of open, compliant solutions and the creation of a competitive marketplace for cloud computing.

Unlike most SDOs, whose members are vendors, the ODCA is driven by users. Intel supported the formation of the organization as a technical advisor, and supported the recruitment of more than 100 members initially. Bringing together users to define their requirements and drive suppliers to support the requirements is a growing trend. The model emerged from Intel's success in applying this approach in the pharmaceutical and financial sectors.

Today the ODCA has more than 300 member companies that collectively spend over \$100 billion annually on IT. While most members are IT buyers, the organization has opened up its membership to solution providers who want to gain a better understanding of buyer needs.

Intel is not a member of the ODCA but was invited to serve as technical advisor to the organization, ensuring that the appropriate topics are considered and that topics are actionable (i.e., that vendors can translate ODCA requirements into cloud computing solutions). While Intel advises the ODCA, it does not contribute content; requirements are developed solely by end users.

To support the creation of multi-vendor, standardized solutions, the ODCA defines standards requirements through usage models that are published to the cloud computing ecosystem, which provides feedback and suggestions for refining the requirements. The ODCA has published eight initial usage models that address key challenges related to cloud adoption (see sidebar on page 4).

### ***Distributed Management Task Force (DMTF): Driving interoperability***

The Distributed Management Task Force (DMTF) is the global industry organization that is driving standards for interoperable systems management. DMTF standards enable interoperability across multi-vendor IT systems and solutions, including cloud solutions.

The DMTF has 160 member organizations in 43 countries. Intel is a member and serves on the board of directors of the organization.

The DMTF created one of the few cloud computing standards in existence today: the open virtualization format (OVF), which enables secure packaging and portability of virtual machines between clouds—essential to interoperability. OVF was adopted in 2011 as an international standard by the Joint Technical Committee 1 (JTC 1) of the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC)

In 2009, Intel formed the Open Cloud Standards Incubator through DMTF to develop informational specifications for cloud resource management. In July 2010, the incubator work was completed, and DMTF established the Cloud Management Working Group to develop the API that cloud service subscribers see and define attributes a cloud provider must expose to that interface—another step toward making cloud adoption easier for users. In addition, the DMTF has formed the Cloud Auditing Data Federation Working Group to support the submission and retrieval of audit event data from cloud providers.

In November 2011, the DMTF formed an alliance with the ODCA to speed the development of industry standards for managing cloud computing environments. The alliance is focusing initially on interoperable management of VMs, to create an easier way to migrate workloads across clouds. It is also addressing

how to enhance OVF and exploring standardized approaches to licensing software in cloud environments.

<b>ODCA Initial Usage Models</b>	
	<b>Usage Model Summary</b>
<b><i>Provider Assurance</i></b>	<ul style="list-style-type: none"> <li>• Provides standard definitions of security levels for cloud services, enabling users to:                             <ul style="list-style-type: none"> <li>○ ensure that providers meet certain security standards</li> <li>○ compare security between providers</li> <li>○ make more informed choices</li> </ul> </li> <li>• Defines four levels of security: bronze, silver, gold, and platinum</li> </ul>
<b><i>Compliance Monitoring</i></b>	<ul style="list-style-type: none"> <li>• Provides cloud users with a standard monitoring framework, format, and syntax that will allow them to query the status of security and compliance on a continuous basis.</li> </ul>
<b><i>Virtual Machine Interoperability</i></b>	<ul style="list-style-type: none"> <li>• Specifies actions and process to spur development of interoperable VM management solutions aimed at lowering management complexity and costs, especially in heterogeneous, multi-vendor environments.</li> </ul>
<b><i>I/O Control</i></b>	<ul style="list-style-type: none"> <li>• Aimed at ensuring organizations can create and launch VMs with workloads that meet their storage and network I/O performance requirements and effectively manage I/O performance and inter-VM contention.</li> </ul>
<b><i>Regulatory Framework</i></b>	<ul style="list-style-type: none"> <li>• Designed to help organizations assess and monitor their regulatory obligations when engaging and acquiring cloud services.</li> </ul>
<b><i>Service Catalog</i></b>	<ul style="list-style-type: none"> <li>• Describes a standard programmatic interface to securely interrogate service catalogs, a data model for representing service characteristics and requirements and mechanisms to negotiate, reserve and provision services.</li> </ul>
<b><i>Standard Unit of Measure</i></b>	<ul style="list-style-type: none"> <li>• Defines requirements for quantitative macro measures for compute, network and storage along linear, throughput, consumption-based, time and block scale dimensions. Also defines requirements for qualitative measures.</li> <li>• Identifies four standard levels—bronze, silver, gold and platinum—and requirements for each level.</li> </ul>
<b><i>Carbon Footprint</i></b>	<ul style="list-style-type: none"> <li>• Designed to ensure organizations can predict CO2 emissions and track actual emissions through technical capabilities instituted by providers of cloud services. Discusses requirements and use of metrics such as Carbon Usage Effectively (CUE) and power usage effectiveness (PUE).</li> </ul>
<p><i>Source: "The Open Data Center Alliance and Developing a Usage Model Roadmap for Cloud Computing," Anna Claiborne, WG Chair, ODCA &amp; Product Manager Security Services, Terremark, and Ravi Subramaniam, Lead Technical Facilitator, ODCA &amp; Principal Engineer, Intel. Presented at Intel Developer Forum 2011.</i></p>	

**Cloud Security Alliance (CSA): Influencing security standards**

The Cloud Security Alliance (CSA) is the most active organization in security standards. Similar to the ODCA, the CSA doesn't operate like a traditional standards body. Rather, it is creating a list of best practices which SDOs can integrate into their standards. The CSA is led by a wide range of corporations (including Intel), associations and others with a stake in cloud computing.

Intel is one of a handful of major technology companies that recently joined a voluntary program of the CSA, committing to reporting to the CSA Security, Trust and Assurance Registry (STAR) on their level of compliance with CSA's best practices. These reports will be made publicly available to cloud service consumers, to help them determine the security of products and services they're considering buying.

**ISO/IEC JTC 1 subcommittee 38 (SC38): Formalizing cloud standards**

Intel is also engaged with a technical subcommittee of the ISO and IEC that is responsible for cloud computing standards. Intel participates in SC 38 deliberations and contributes to the working documents of the group, including the subcommittee's Study Group on Cloud Computing.

## **Implementing cloud solutions**

It remains to be seen how cloud computing standards will evolve over the next few years. Cloud software and hardware are evolving rapidly in response to customer demand. Many companies are experimenting with the open source model as a way of implementing clouds. These open source implementations could inform the development and refinement of formal standards.

Intel is helping companies to meet the challenges of implementation through the Intel Cloud Builders program. This cross- industry initiative aims to make it easier to build, enhance, and operate cloud infrastructure. The focus is on building or simplifying clouds, enhancing security, and improving efficiency within cloud environments.

Intel is collaborating with more than 40 partners in the Cloud Builder program, conducting hands on experiments in developing cloud reference architectures that meet standards requirements but involve products from multiple vendors. These evaluations are then documented in whitepapers as use cases; almost 60 such use cases can be found on the Cloud Builders site, and the volume continues to grow.

## **Standards work remaining**

In the standards arena, there are two key challenges identified by the DMTF incubator program that must be addressed and overcome before we are likely to see widespread adoption of cloud computing. One challenge is defining and automating SLAs. Without clearly defined SLAs, there is no recourse for cloud computing users in the event of an outage, breach, malware intrusion, or other problem. Standardized, machine readable SLAs are needed to ensure dependability and interoperability, and to enable a freely scaling automated system for cloud computing.

For the past few years Intel has been addressing the challenge of developing machine readable SLAs. In the European Commission supported SLA@SOI research project,<sup>1</sup> Intel researchers have helped develop a technique for expressing SLAs in machine readable form. In the coming year they will explore how to standardize these expressions of SLAs. The longer-term goal is to develop standardized interface specifications and some level of standardization support for SLAs interacting, to enable full dependability in the cloud.

Another issue the DMTF incubator program identified as key to the future of the cloud is the need to create standards for security across APIs. If a customer has its own IT security infrastructure and outsources work to a cloud service provider, how can the security infrastructure be extended to the provider's environment?

A related issue has to do with audit and compliance. Companies must ensure that they have complete auditability of the services they outsource, so the security aspects of a cloud service must be properly exposed. How can a customer conduct an audit of a service provider that the customer accesses through an API? The ODCA is advocating transparent compliance—the ability for customers to access audit data directly, without the need to send employees to the provider's site to conduct the audit. In June 2011 the ODCA formed a workgroup to address the challenges of auditing in the cloud.

## **Advancing the future of cloud computing**

We have discussed some of the standards work underway to accelerate the adoption of cloud computing. There are other challenges that must be overcome before the promise of this emerging model can be fully realized. For instance, there are implications for the many client devices that will access the cloud, from PCs and notebooks to smart phones, tablets and other mobile devices. The cloud must be aware of the client and its capabilities and tailor services to the devices on which they will be consumed.

There are non-technical challenges as well, including regulations that make cloud adoption difficult. For instance, in terms of data privacy, the lack of harmonization among EU member states and lack of compatibility at a global level lead to different interpretations and enforcement of legal concepts. There is a need for industry to work with governments to find ways to promote cloud computing while maintaining data privacy. Intel is working with government and policy organizations to address such issues—

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<sup>1</sup> <http://www.sla-at-soi.eu>

including, among other efforts, contributing to the cloud computing work of the Digital Agenda in Europe.

While government regulations can pose a challenge, commercial rules and practices can also inhibit cloud adoption. For example, some companies have licensing models that fail to recognize that the software may be running in a virtualized environment or that the application may only be running occasionally, thus not requiring a full-time license.

Intel is actively engaged in addressing these and other issues that are crucial to the future of cloud computing. Through the ODCA, initiatives such as the Intel Cloud Builders program, and collaborations with organizations such as the DMTF and CSA, Intel is helping to drive the open standards and build the ecosystem needed to realize the full potential of the cloud. That commitment will remain steadfast as ecosystem members work together to overcome the remaining hurdles to widespread cloud adoption.