Intel Cloud Computing Taxonomy and Ecosystem Analysis

- Single cloud taxonomy for use across Intel

- Helps understand the market and identify key suppliers

- Provides common terminology

An Intel cross-organizational group developed a common cloud computing taxonomy designed to meet Intel's comprehensive requirements by classifying the entire breadth of existing cloud technologies. Based on this classification, diagramed in Figure 1, we created an ecosystem analysis that helps identify suppliers that meet Intel's needs.

To develop a single taxonomy for use across Intel, we based our work on several externally developed taxonomies as well as Intel IT capability frameworks that describe our primary applications and infrastructure services.

The taxonomy provides a common terminology and baseline information that can be applied to help develop cloud strategies both for Intel's IT environment and for Intel's products and services.

Intel IT is using the taxonomy and analysis to facilitate internal discussions and identify innovative cloud computing solutions that deliver efficiencies.

Cloud Computing Taxonomy

Software as a Service
- Design Engineering
- Marketing
- Customer Relationship Management/ Partner Relationship Management
- Order Management/Procurement
- Supply Chain Management
- Workforce/Field Service Management
- Manufacturing
- Sourcing
- Finance
- Content Management
- Collaboration/Productivity
- Office Applications
- Business-to-Business/Business-to-Consumer
- Business Process Management/Enterprise Resource Planning
- Social Computing
- Portals/Search
- Digital Media
- Utilities/Management
- Context Awareness
- Home/Leisure

Infrastructure as a Service
- Computing as a Service
- Storage as a Service
- Communication as a Service
- Infrastructure Service Management

Platform as a Service
- Business Intelligence as a Service
- Application Development as a Service
- Web Hosting
- Business Analysis Process as a Service
- Open Cloud Platform
- Custom Cloud Platforms

Service as a Service
- Billing as a Service
- Security as a Service
- Metadata as a Service
- Service Bus as a Service

Client Software
- Data Software
- Computing Software
- Cloud Management Software
- File Storage Software
- Internal Cloud
- Rich Internet Application Platforms
- Cloud Platform Tools

Cloud Client
- Rich Internet Application Runtimes
- Browsers
- Client Application Services
- Context Awareness Services
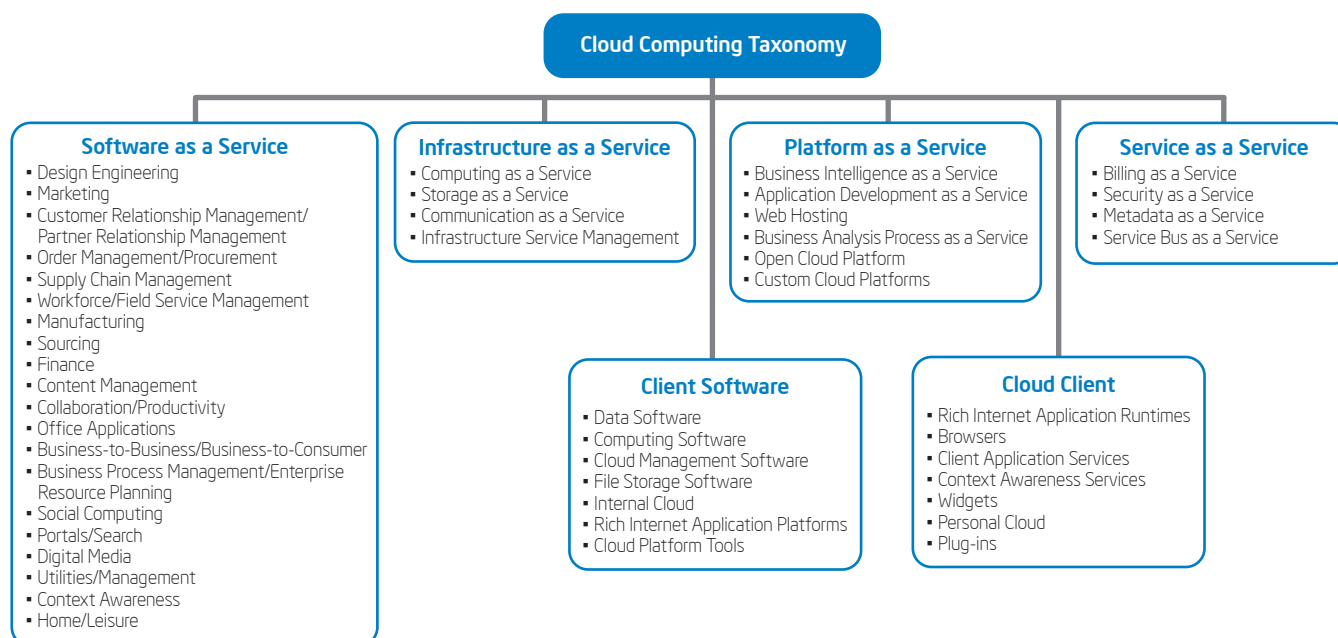- Widgets
- Personal Cloud
- Plug-ins

Figure 1. Intel's cloud computing taxonomy classifies the breadth of existing cloud technologies.

Intel IT Capability Frameworks

Intel IT has developed several capability frameworks that assist our planning and decision making. These frameworks provide important structure, which promotes understanding and alignment of top-level IT capabilities across the enterprise and the supporting ecosystem. We based our cloud computing taxonomy segmentation partly on these frameworks. Intel IT uses three frameworks, each representing a different area of focus:

Enterprise Capability Framework (ECF) holistically describes all of Intel's business capabilities along with corresponding IT capabilities, such as design, supply chain planning, and human resources.

Cross-Enterprise Capability Framework (xECF) describes the non-infrastructure technical capabilities used across many business functions, such as instant messaging or e-mail.

Infrastructure Services Framework (ISF) describes infrastructure capabilities, such as servers, data centers, and laptops.

Background

The cloud computing market is evolving rapidly, with a fast-growing number of external cloud services and enabling technologies. This creates a need for tools that Intel can use to better understand the market, define internal IT and external cloud computing strategy, and facilitate adoption of cloud computing services that meet our needs.

Taxonomies, which are classifications based on a hierarchical structure, have traditionally been used to understand technology market segmentation and geographic breakdown, evaluate suppliers, and map potential usage to the available technologies. Another important advantage of taxonomies is that they provide a common terminology to facilitate understanding and communication.

From the perspective of cloud adoption, the cloud ecosystem—including service providers, end users, developers, and administrators—has a natural evolving order that can be represented by taxonomy. However, though several cloud taxonomies already exist, none of them provides a comprehensive analysis of the entire market that can be used by groups across Intel, including Intel IT.

Intel therefore formed a cross-organizational team, including members from Intel IT, Intel Software and Services Group (SSG), and Intel Data Center Group (DCG), to develop a single cloud computing taxonomy for use across Intel.

Our goals were to provide common, standard terminology; help understand the rapidly evolving market; and identify key suppliers as well as products that meet our needs. Steps included defining the primary categories of cloud computing service, segmenting these into subcategories, and creating an ecosystem analysis of the suppliers within each category.

INTEL IT'S ROLE

Intel IT participated in this initiative, working with other Intel groups to help ensure that the taxonomy comprehended an enterprise IT perspective.

Intel IT has defined an overall cloud computing strategy based on growing the cloud from the inside out. We are developing an enterprise private cloud that will eventually extend to, and support interoperability with, the Internet or external cloud. Over time, this strategy will allow Intel to dynamically transfer workload in and out of the enterprise, taking into account considerations such as cost, security, and compliance.

At the same time, we are opportunistically taking advantage of external cloud offerings that deliver value such as increased agility and cost savings. An Intel cloud computing taxonomy can help identify offerings that meet our enterprise needs.

Cloud Computing Taxonomy

We began by reviewing several existing taxonomies. We used these as inputs to our own taxonomy. They included:

- An enterprise IT-centric cloud taxonomy developed by a cloud service provider
- A layered cloud stack developed by researchers; this included a representation of the inter-dependency between different cloud layers
- A supplier-focused cloud taxonomy developed by a cloud platform as a service (PaaS) provider

We also used existing Intel IT capability frameworks (see sidebar). These provide a simple picture of the enterprise, identifying primary IT applications and infrastructure services. Though not directly related to cloud computing, these frameworks provided a structure that we used when defining cloud computing service subcategories.

DEFINING CLOUD COMPUTING

We define cloud computing as a computing paradigm where services and data reside in shared resources in scalable data centers, and those services and data are accessible by any authenticated device over the Internet. Some key attributes that distinguish cloud computing from conventional computing are:

- Abstracted and offered as a service.
- Built on a massively scalable infrastructure.
- Easily purchased and billed by consumption.
- Shared and multi-tenant.
- Based on dynamic, elastic, flexibly configurable resources.
- Accessible over the Internet by any device.

PRIMARY CATEGORIES OF CLOUD SERVICE

We identified primary categories of cloud computing service. Figure 2 shows these categories arranged according to their value and visibility to enterprise end users. Though most of these category names were already in use within the industry, our taxonomy defined two new categories: cloud client and service as a service. These address the areas of user experience and interoperability, respectively.

Software as a service (SaaS) is a model of software deployment in which an end user or enterprise subscribes to software on demand. SaaS applications are built with shared back-end services that enable multiple customers or users to access a shared data model.

Platform as a service (PaaS) is the delivery of a cloud computing platform for developers. It facilitates development and deployment of applications without the cost and complexity of buying and managing the underlying hardware and software layers. PaaS provides all the facilities required to support the complete life cycle of building and delivering Web applications and cloud services over the Internet.

Infrastructure as a service (IaaS) is the delivery of technology infrastructure—such as network, storage, and compute—as a service, typically through virtualization. Users subscribe to this virtual infrastructure on demand as opposed to purchasing servers, software, data center space, or network equipment. Billing is typically based on the resources consumed.

Service as a service is the delivery of a horizontal service, such as billing, as a service. These services can be used, usually on a subscription basis, as a component within other cloud services such as SaaS, PaaS, or IaaS offerings.

Cloud software is purchased or packaged software that is uniquely used to build and run cloud services, for example cloud management software. Our goal was to include the market subsegments, ISVs, and products not typically found in a traditional enterprise or consumer ISV taxonomy.

Cloud client contains client-centric services, runtimes, and runtime optimizations that can impact the overall cloud computing user experience.

Cloud Ecosystem Segmentation

We expanded our cloud taxonomy by dividing the main categories into subcategories, as shown in Figure 1, based on the Intel IT capability frameworks and existing cloud taxonomies. This provided an additional layer of detail, which enabled us to cluster and compare ISVs with similar characteristics, delivered market insights, and helped to ensure that our taxonomy spanned the entire breadth of cloud computing offerings.

Cloud Ecosystem Analysis

We mapped key ISVs to each of the taxonomy subcategories, and then added analysis such as each ISV's strategy, market position, revenue, and ecosystem alliances. Our goal was to identify market leaders and fast-moving, potentially disruptive innovators.

Table 1 shows a generic extract from our detailed ecosystem analysis for several subcategories within the SaaS category.

Using the Cloud Taxonomy and Ecosystem Analysis

Intel teams are using the taxonomy and analysis in discussions that seek to identify available and emerging cloud computing solutions.

The high-level taxonomy forms the basis for these discussions, serving to introduce cloud computing concepts and categories, define common terminology, and position our inside-out strategy. The more detailed analysis is then used to focus on a cloud subcategory and identify top ISVs within the category. The resulting ISV list can be used in combination with industry analyst reports and other publicly available information to discover innovative solutions for further research and development projects, which in turn may influence Intel IT production roadmaps and Intel® platform technology enabling strategies.
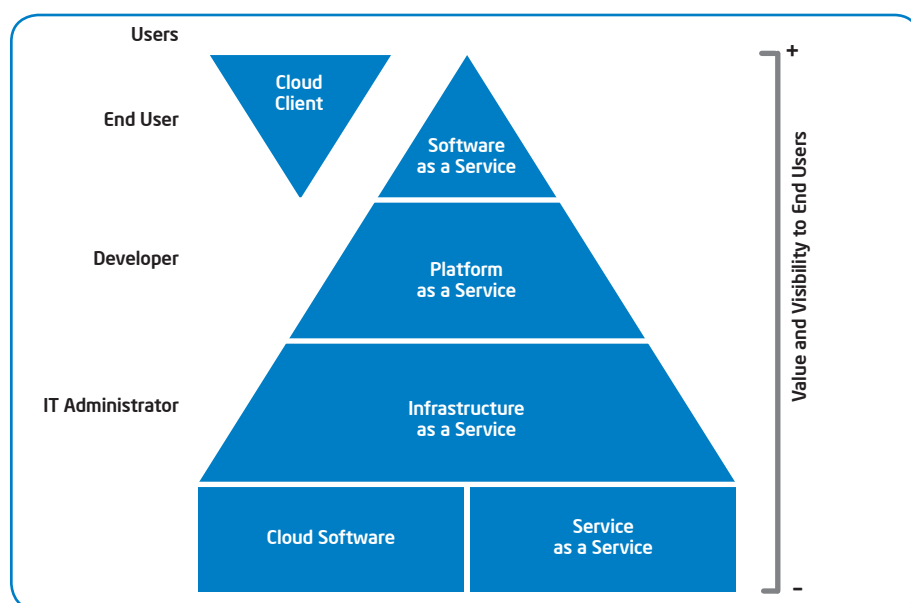

Figure 2. Primary categories of cloud computing service.

Table 1. Extract from Software as a Service (SaaS) Ecosystem Analysis

Enterprise Line of Business	Provider	Description
Marketing	ISV-1	Has a suite of products that provide core marketing capabilities for managing campaigns and complex marketing mixes.
	ISV-2	Provides focused software as a service (SaaS) marketing products. Venture capital-backed company with limited customer penetration.
	ISV-3	Strong customer portfolio including airlines, financial, telecom, software, and retail; revenue increased substantially last quarter.
	ISV-4	Targets the financial industry and retail/consumer packaged goods markets.
	ISV-5	Offers good breadth of functionality for basic and advanced campaign management, and for basic and advanced analytics. Has taken the lead on loyalty management, while many other vendors have still not disclosed firm plans.
	ISV-6	Strong hosted on-demand offering, which is attracting medium-sized businesses looking for cost effective solutions.
Customer Relationship Management	ISV-7	Full suite of customer relationship management (CRM) tools designed for any size customer, used by several large companies.
	ISV-8	Strong customer portfolio, significant increase in revenue for most recent quarter.
	ISV-9	Leading SaaS CRM vendor, leveraging their existing CRM suite for on-demand customer needs.
	ISV-10	Billed as the alternative to a full enterprise resource planning (ERP) suite but with solutions for small and medium businesses to larger companies. Strong customer base with a solid partner program supported around the world. Also contains a strong human resources software capability.
	ISV-11	Many new customers added, many of them larger than previously typical for this company. The company's strong ecosystem has assisted sales.
Partner Relationship Management	ISV-12	Revenue grew modestly in most recent quarter. Strong customer base. Sales slowly increasing; a company to watch.
	ISV-13	Strong channel supporting their core products. European company with strong ties to all key back-end products
	ISV-14	Provides hosted services model using Web services capabilities. Joint marketing effort has been very well received.

Note: For illustration purposes only. Information that is confidential or unique to specific suppliers has been removed or changed.

For example, Intel IT is already using a variety of SaaS offerings. As we think about the future of our application portfolio, we are considering which applications we should host internally and which make sense in the SaaS model. We have found that good candidates for SaaS are applications with industry-standard workflows and well structured data exchanges, which do not involve intellectual property or sensitive data. Our ecosystem analysis spreadsheet makes it easier to identify SaaS solutions with these characteristics; we can then compare these solutions with traditional packaged enterprise solutions to assess possible efficiencies and cost savings.

AUTHORS

Hong Li
Principal Engineer, Intel IT

Catherine Spence
Enterprise Architect, Intel IT

Robert Armstrong
Software Planner, Intel Software and Services Group

Ricki Godfrey
Business Development Manager, Intel Software and Services Group

Randy Schneider
Business Development Manager, Intel Software and Services Group

Jake Smith
Advanced Server Technologies Specialist, Intel Data Center Group

Rick White
Server Planner, Intel Data Center Group

CONTRIBUTORS

Khem Babbar, Sudip Chahal, Rekha Raghu, Brent Young

ACRONYMS

CRM	customer relationship management
DCG	Intel Data Center Group
ECF	Enterprise Capability Framework
ERP	enterprise resource planning
IaaS	infrastructure as a service
ISF	Infrastructure Services Framework
PaaS	platform as a service
SaaS	software as a service
SSG	Intel Software and Services Group
xECF	Cross-Enterprise Capability Framework