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white paper

Cloud orchestration a real business need

Atos

Cloud Computing does not scale well. Such a bold statement may seem incorrect given that according to accepted wisdom, scalability is one of the essential properties that make Cloud Computing so attractive to businesses. Scalability as used here is less about the addition of servers and resources, and more about what is being done today with Cloud Computing and what 'more' can be done tomorrow from a true business perspective.

Also, with the rise of smartphones, tablets and other intelligent devices that are now participating in the complete enterprise ecosystem, interaction patterns between cloud components and consumers become even more complex. Cloud Orchestration and Messaging will help enterprises to achieve seamless integration of business processes spanning multiple applications, clouds and smart devices. Such integrated messaging will not be a "nice to have" requirement, but a "must have" necessity for effective and efficient future business process management, not limited to an Enterprise Service Bus but also addressing Extended Enterprises issues.

This White Paper explores this apparent contradiction and proposes potential solutions based on research conducted by the Atos Scientific Community.

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Cloud orchestration A real business need

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About the Atos Scientific Community

The Atos Scientific Community is a network of some 100 top scientists, representing a mix of all skills and backgrounds, and coming from all geographies where Atos operates. Publicly launched by Thierry Breton, Chairman and CEO of Atos, the establishment of this community highlights the importance of innovation in the dynamic IT services market and the need for a proactive approach to identify and anticipate game changing technologies.

Hypothesis

Cloud advocates a promise that Cloud Computing is the technology that will allow organizations to access software from anywhere at any time 'as a Service'.

In accepting this premise, one also needs to recognize that, in the future, Cloud Computing will be a significant, if not dominant, model for organizations to acquire IT capacity. With smartphones and devices being part of the business ecosystem; Cloud Computing now demands parts of the enterprise's business processes to run across different clouds or devices, making the business scenarios even more complex.

Some, and especially homogenous cloud vendors, might advocate that a complete end to-end business process could be processed within a single cloud infrastructure. However, Atos' view is that the corporate IT infrastructure will inevitably fragment into different layers of dedicated on-premise and/or outsourced computing and private and/or public cloud environments. This will be driven by what is most fit for purpose for any given application (or part of it), based on an SLA trade-off between cost and business criticality. The corporate application landscape will therefore also fragment into those layers and into many business processes, requiring access to multiple applications and data connections that will need to span those layers.

Unless enterprises consider these implications in advance, they risk building a heterogeneous IT infrastructure, only to discover that their key business processes can no longer be plugged together or supported.

In this White Paper, the concept of connecting crosscloud applications, machine to machine communications, social media and smartphones (or transactions living inside applications) to other applications or transactions is called Cloud Orchestration and messaging.

Introducing Cloud Computing and 'as-a-Service' Models

Cloud Computing is the answer provided by vendors to leverage the benefits of three major trends: service orientation, virtualization and standardization of computing. It is defined by Gartner as, "a style of computing where massively scalable IT-enabled capabilities are delivered as a service to external customers using Internet technologies."

Explaining Cloud Models

The name 'cloud' refers to the utility-like fuzzy nature that computing resources and infrastructure would present to a user, once these resources had been virtualized and standardized; just as the public water system is quite fuzzy to the average consumer who just wants running water when they turn on the tap, and are happy to let others worry about the standardization of the pipes, valves, etc. that make it all just work[1].

NIST, the US National Institute of Standards and Technology, provides the first three definitions of 'IT-enabled cloud models'[2] that will be used throughout this White Paper:

- **Cloud Infrastructure as a Service (IaaS)**. A user of IaaS can provision processing, storage, networks and other fundamental computing resources, and can deploy and run softwarelike operating systems and applications. The user does not manage or control the underlying cloud infrastructure, but does have control over the operating system, storage and deployed applications. Additionally, there may be limited control of a select set of networking components (e.g. host firewalls).
- **Cloud Software as a Service (SaaS)**. A user of SaaS can access the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through a thin client interface, such as a web browser (e.g. web-based email) or by other applications via SOA calls using web services. The user does not manage or control the underlying cloud infrastructure, including network, servers, operating systems, storage or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.
- **Cloud Platform as a Service (PaaS)**. A user of PaaS can deploy self-created or acquired applications, created using programming languages and tools supported by the PaaS provider, onto a cloud infrastructure. The user does not manage or control the underlying cloud infrastructure including network, ervers, operating systems or storage, but has control over the deployed applications and possibly application hosting environment configurations.

In addition to the models provided by NIST, Atos introduces:

Business Process as a Service (BPaaS). BPaaS is different from SaaS and Atos believes it to be an important element of the as-a-service stack. Instead of buying a packaged software product, such as a SaaS 'solution', BPaaS adds in the ability to deliver end-to-end business processes and create a unique and tailored functional environment that is:

- designed from the outset to run on top of a cloud infrastructure,
- geared towards openness and collaboration between different delivery components and (legacy) processing systems, and
- is all about the orchestration and management of business processes.

BPaaS places business process activities at the core or the center of the functionality, while still delivering the benefits of the cloud-computing model.

In addition, BPaaS also adds Complex Event Processing and Enterprise Integration Pattern features in order to process efficiently service requests, status update and other messages.

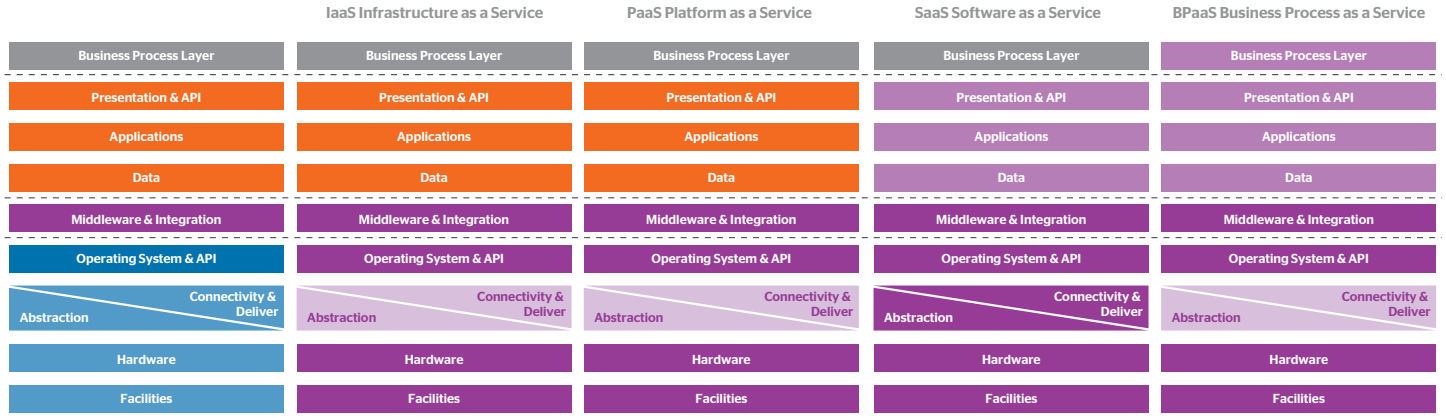


Figure 1: IT-Enabled Cloud Models

[1] A more popular explanation of the origin of the term 'cloud' is that it is a metaphor for the Internet, based on the cloud drawing used in the past to represent the telephone network, and later to depict the Internet in computer network diagrams, as an abstraction of the underlying infrastructure it represents.

[2] http://csrc.nist.gov/groups/SNS/cloud-computing/cloud-def-v15.doc

Business Context

In the past, economies of scale have always been successful. The payment, stock exchange and airline reservation sectors have all been completely shaken up by major players that have established benchmark prices, introduced commoditization and standardization to massively lower the entry price, thereby eliminating competitors that have not adapted to these changes.

Today, personal productivity tools (email, instant messaging, social networking and information sharing) are also being commoditized. And in the near future, similar benefits from standardization and economies of scale can be expected within support functions (Finance, HR, and CRM).

Nevertheless, for the providers and developers of applications that execute core business processes, the challenge will be to offer business process differentiation, while at the same time benefiting from the advantages of Cloud Computing.

In this commoditization process, the changes in the business applications will most likely start with the separation of core processes that don't change very often from the extensions that are tightly integrated within the core to allow a more rapid innovation cycle. These tightly integrated extensions within the core processes prevent the application from expansion and 'scale' in a true business sense.

When the changes in the business applications have been effected, the applications themselves will be able to scale because the, now more loosely coupled, integration between the core and the extensions will make this possible.

Understanding how to integrate business applications that run on different standardized cloud services will be the key differentiating factor for IT service companies and service providers.

Present changes

At the IaaS level, Cloud Computing based upon virtualization technologies is rapidly adopted by traditional IT vendors and service providers, in order to enable multi-tenancy and hitherto unheard of levels of utilization of the infrastructure.

Whilst this introduces a scalability of hardware and computing power, it does not necessarily allow for the scalability of applications. For upper layers of the cloud stack (PaaS, SaaS and BPaaS), new services (applications) need to emerge that have adopted a multi-tenant architecture using a new generation of delivery and platform technologies that are currently being developed by middleware vendors such as Oracle/ BEA, Microsoft, IBM and Cordys among others.

Initial Cloud developments were shaken by aggressive offerings, including:

- Virtualization technologies by VMware and upcoming technologies in open and closed source.
- Google SaaS and PaaS solutions for personal productivity.
- Amazon Web Services, cloud storage solutions and computing on demand.
- CRM solutions and an application foundation layer from vendors like Salesforce.com. HRM and Finance SaaS applications from new vendors.

This has resulted in 'The Cloud' being composed of a variety of disparate clouds from different providers and in different formats, which do not necessarily work together as beautifully as the 'The Cloud' paradigm suggests. In fact, these different cloud platforms are typically closed and proprietary by design, and therefore are not easily extensible for integration/interoperability with services outside their boundaries – "you can have any cloud as long as it is ours". Interoperability, security and data management across new cloud-based services present significant challenges and there are real reasons to worry whether the average consumer will indeed get their running water next time they turn on the tap!

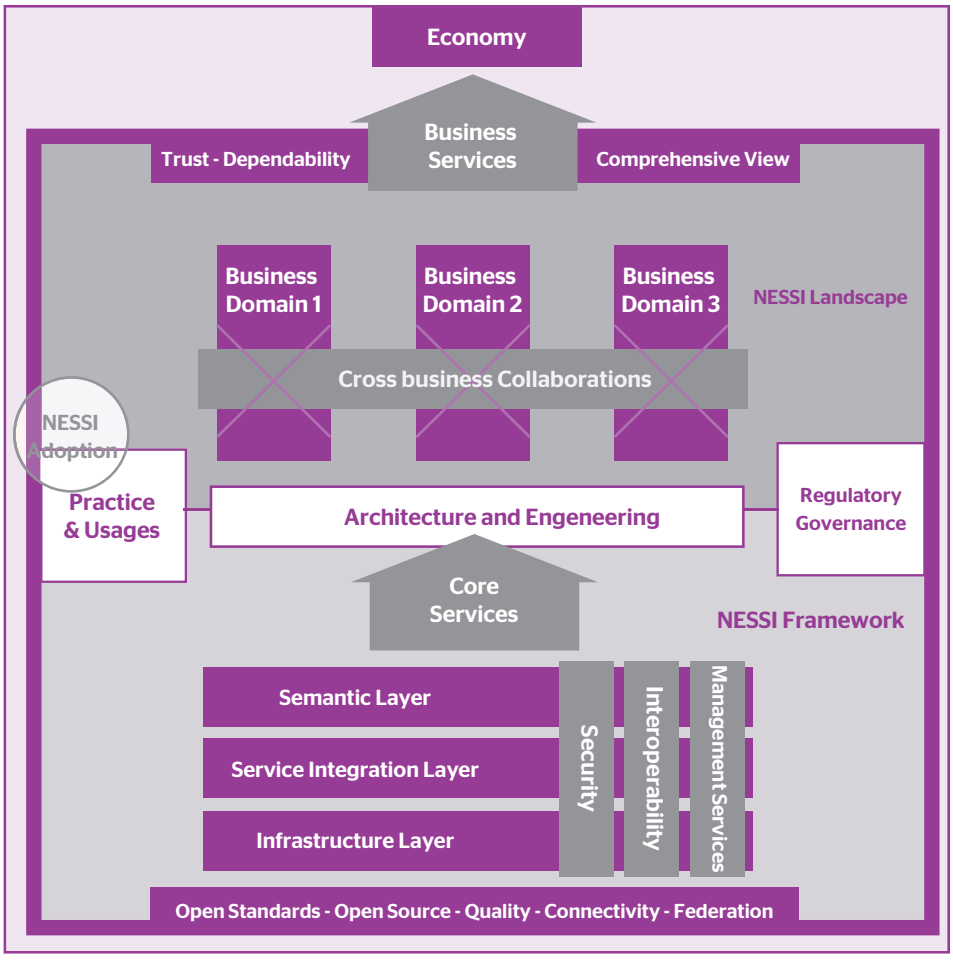


Figure 2: Business Landscape Model based on NESSI's model

Future changes

NESSI, the European Technology Platform for Software and Services (http://www.nessi-europe.com), has created an illustration (See Figure 2, previous page) of the business landscape in the European economy in relation to the evolution of new service offerings (based on cloud-computing models and duly reinforced by appropriate layers, such as security, semantics, interoperability and management).

The NESSI model reinforces the idea that all business domains will be fields of growth for the cloud-computing offer (public sector, telecom, healthcare, etc.). A growing part of the market is for cross-business collaboration, again with the need for strong integration of services and interconnectivity between new cloud-computing offerings.

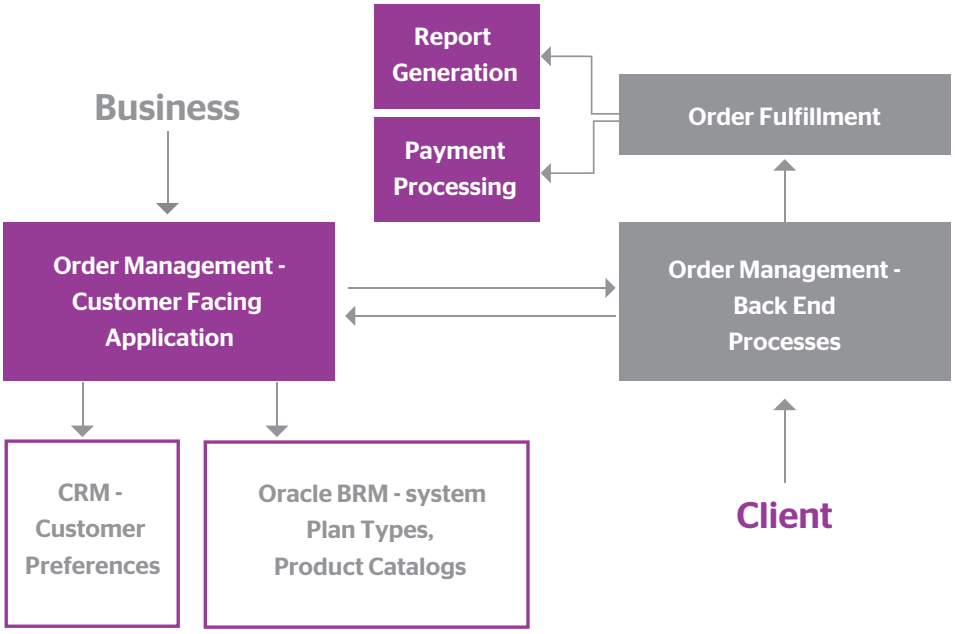
Cloud services today focus on providing specific horizontal capabilities; from computing resources (in the IaaS model) to application offerings, such as desktop virtualization, CRM or payment application services (in a SaaS model). In order to make the above-mentioned scenario real in 'The Cloud', it is necessary that Cloud Computing go beyond current offerings to become an ecosystem of commodity and business services that users can compose, aggregate and broker to realize end-to-end business processes across heterogeneous added-value services.

Based on this, Atos identified a need for Cloud Orchestration and messaging.

At the moment, each of the three Cloud Computing models (IaaS, PaaS and SaaS) still focuses on singularities in their provisioning model; they provide only computing, run-time or an application platform. This may scale very well from a quantitative point of view (for example, talking about thousands of users accessing applications, the number of terabytes of data, etc), but does not scale well when looking at it from qualitative point of view (for example, business processes spanning across multiple clouds or transactions that deal with multiple platforms and applications, etc).

This is due to the way as-a-Service models are delivered. They are a product of one provider and the singular context is protected by that provider in order to keep the customer inside that one delivery model, inevitably leading to vendor lock-in.

Figure 3: Order Management & Fullfillment Process



Such a lock-in model is well illustrated by Amazon that only provides support for specific operating systems; Microsoft Azure that only supports a limited set of run-times for application development and execution; and Salesforce.com that only provides a CRM application[3] (with a very proprietary API). None of these offerings provide tools that enable interoperability between their respective services.

Looking at the wider landscape of an enterprise's business processes, it is clear from a holistic view that business processes will not be confined to residing in a single cloud, but will need to reach across clouds. As the needs of the business grow, the underlying business processes will become more complex and a conventional single-cloud environment will no longer be able to support end-to-end processes as data and processing from other sources becomes necessary. It therefore inevitably evolves into a heterogeneous environment of services across multiple clouds and on-premise systems.

Despite the growing understanding of the need for interconnectivity between these models by exposing proprietary APIs or adopting 'open' standards, it becomes apparent that no real integration is really emerging from providers.

Standards are basically formal specifications and norms that providers follow. Open standards can be accessed and implemented free of charge and usually enable feedback mechanisms (so that contributions to the standard can be made by third parties). The power of open standards resides in the absence of barriers to access and the implementation of the standard. Also, since standards enable an underlying framework that makes different products, services or systems compatible, they allow providers to concentrate efforts and compete on value-added parts of the system, product or service. Standards stimulate competition and innovation and the customer benefits from provider focus on valueadded services and enhanced competition to drive true differentiation. In addition, open standards:

- Generally favor interoperability (thus reducing integration costs).
- Diminish vendor lock-in (unlike non-standard, proprietary developments, where customers may find themselves in a 'shotgun wedding' kind of relationship with a provider).

[3] All providers of commoditized cloud-computing models are in the process of publishing more and more methods (APIs) to connect into their respective clouds. Some standards are also emerging. Real integration is not yet being driven by cloudcomputing providers; it is expected from the user and restricted by the richness (or lack thereof) of the provided API.

As a result, it is of prime importance that in multicloud environments, interoperability is greatly underpinned by adherence to open standards defined by organisations like (W3C, OSGi, IETF, ISO etc.) and standard protocols supported in internet world (eg. HTTP(s), REST, SMTP etc)[4].

List of Possible Use Cases

To make this clear from a business perspective, a number of use cases are given:

- **Use Case 1: Order Management Process** An order management process (See Figure 3) starts with a customer placing an order through a customer-facing application sitting on a cloud (which may be just one of the applications supporting the overall process). When the order is being placed, the product or product catalog (for example, information on various plan types when ordering a mobile phone) may come from an Oracle BRM system or a central system sitting on a different cloud which stores all product catalog information. This in turn is a separate system managed by different departments within the organization. Customer preferences may also need to be provided by a CRM system which is on an entirely different cloud. In addition, order processing and approval happen through different departments within the organization and via approval processes sitting on different data clouds. Finally, payments are processed and reports generated in an environment which happens to be outsourced.

From a complete system and end-user view, it is all just one process spanning multiple clouds and datacenters. Connecting and managing transactions seamlessly across these business process components is what Atos defines as Cloud Orchestration.

- **Use Case 2: Disability Benefit Claim Process** In some countries, the government provides disability benefits to claimants (see figure 4). The underlying process requires that the claimant put in a disability benefit claim. Again in this case, disability benefit types may come from a different system which centrally manages various benefit types. The claim is pushed for initial review by a healthcare professional. During this process, the healthcare professional may need further medical evidence and may send the information to a diagnostic center where the claimant may need to go for diagnosis. In order to get to the nearest diagnostic center, the claimant may need to use a rail-road traffic communication site. The appointment for the claimant may be done by an independent appointment scheduling system, which may be sitting in a different datacenter. The practitioner performs the examination to confirm the disability claim; but may require the expertise of practitioners or doctors sitting somewhere in an altogether different part of world. The practitioner's report will be sent to an auditor or supervisory body to verify it. Finally, the case is sent to a governmental body for approval, which in turn may need to talk to a financial unit, and so on. This can be even more complex if the government disability department provides this service to a number of different organizations.

The common themes in the use cases are the management of business processes across various clouds, movement of transactional data to different clouds, and the need for each application (when isolated from the rest of the business process) to interact in order to achieve an overall objective - a classic case of orchestration!

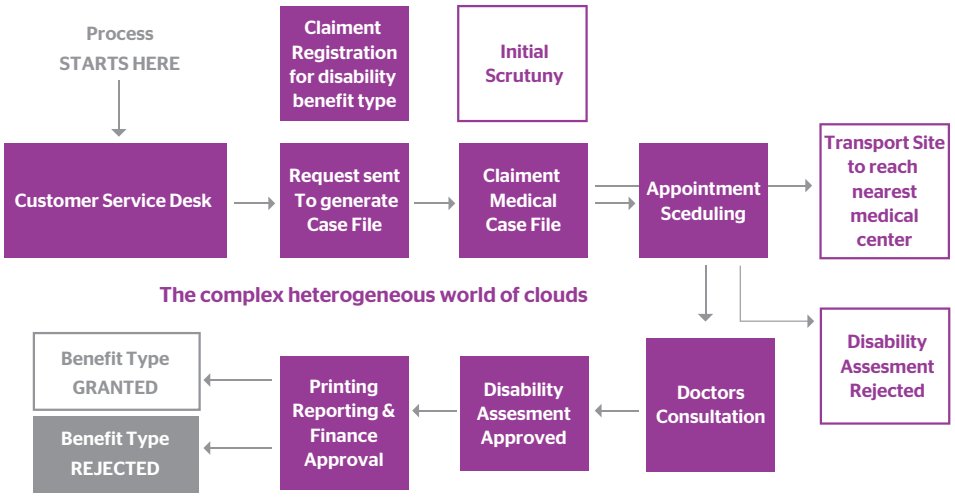


Figure 4: Disability Benefit Type Assessment Process

[4] Recently we see also new initiatives for standards focusing on IT operations, most noticeably an industry initiative called 'Open Datacenter Alliance: "The Open Data Center Alliance is an independent consortium comprised of leading global IT managers who have come together to resolve key IT challenges and fulfill cloud infrastructure needs into the future by creating an open, vendor-agnostic Usage Model Roadmap." Atos is a member. More info on http://www.opendatacenteralliance.org/

Cloud Orchestration research

There is a need for a cloud-integration and aggregation delivery model that takes into account this element of orchestration across clouds. This also suggests that there is a need for BPaaS, Business Process as a Service; a layer on top of the Software as a Service models that looks at making business process components available in a way that allows for orchestration.

To explore the possibilities of orchestration in multi-cloud environments, the Atos Scientific Community conducted research in the form of a proof of concept which looked at the various challenges and possible solutions to spread business processes across multiple clouds.

Scope

The scope of research primarily covered the following objectives:

- To connect different components of a transaction in a business process across different cloud environments.
- To move a component of a transaction in a business process step to a different cloud to meet business requirements (e.g. meeting an availability SLA during loss of connectivity, cost control through a lowest cost of processing approach or qualitative aspects, such as compliancy rules).
- To manage a transaction end to end, making sure that:
  - all components needed to execute the transaction are available,
  - the transaction data and state is held until the transaction ends, and
  - the associated reporting is generated to complete the business process.

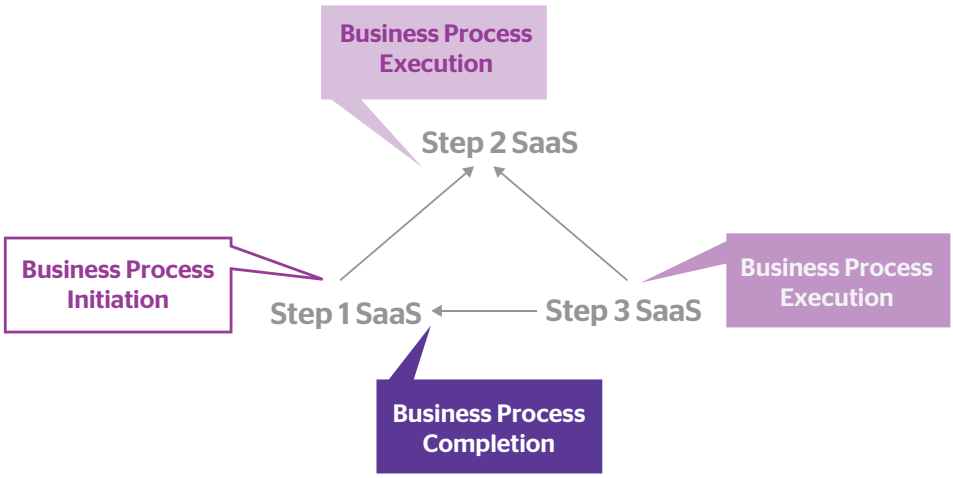
Execution

To explore the possibilities as defined in scope, a business process spanning across clouds was required (referred to in BPM terminology as choreography – see Figure 5).

To understand multiple cloud-based BPM, it was essential to split the business process that was spanning across clouds, into three pieces:

- Business process initiation.
- Business process execution.
- Business process completion.

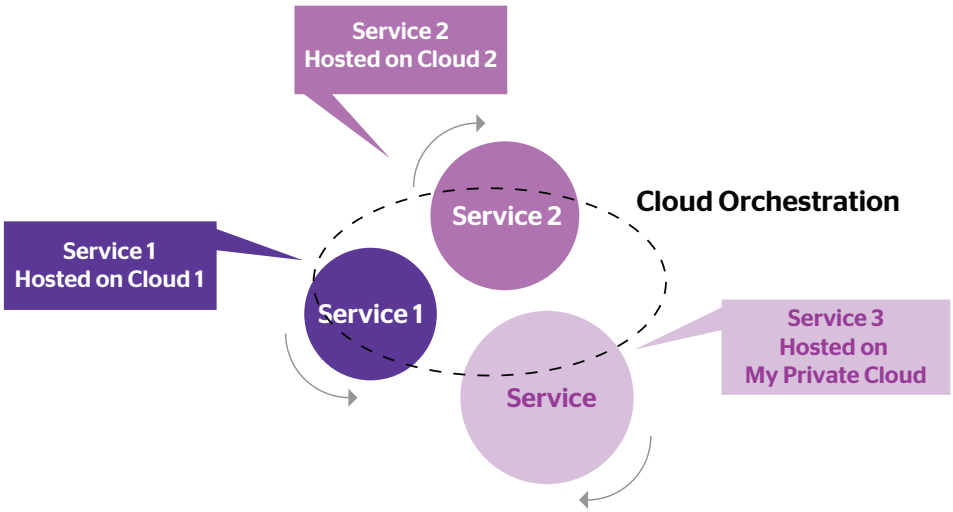
Figure 5: BPM Choreography



Business process initiation happens in one cloud, business process execution happens by communicating with different clouds (by consuming services hosted by other clouds, also referred to as Service Orchestration (see Figure 6) and business process completion happens in a different cloud, with the generation of a report for the end user.

For the proof of concept, an Atos Private Cloud was used to initiate the business process (See Figure 5), and business process execution and completion were executed through public clouds. To move one step in the business process transaction to a different cloud to meet objective 2 in the scope section on page 7, the Google App Engine (GAE), which is on a public cloud, was chosen to host a replica of the business process. Execution

Figure 6: Service Orchestration

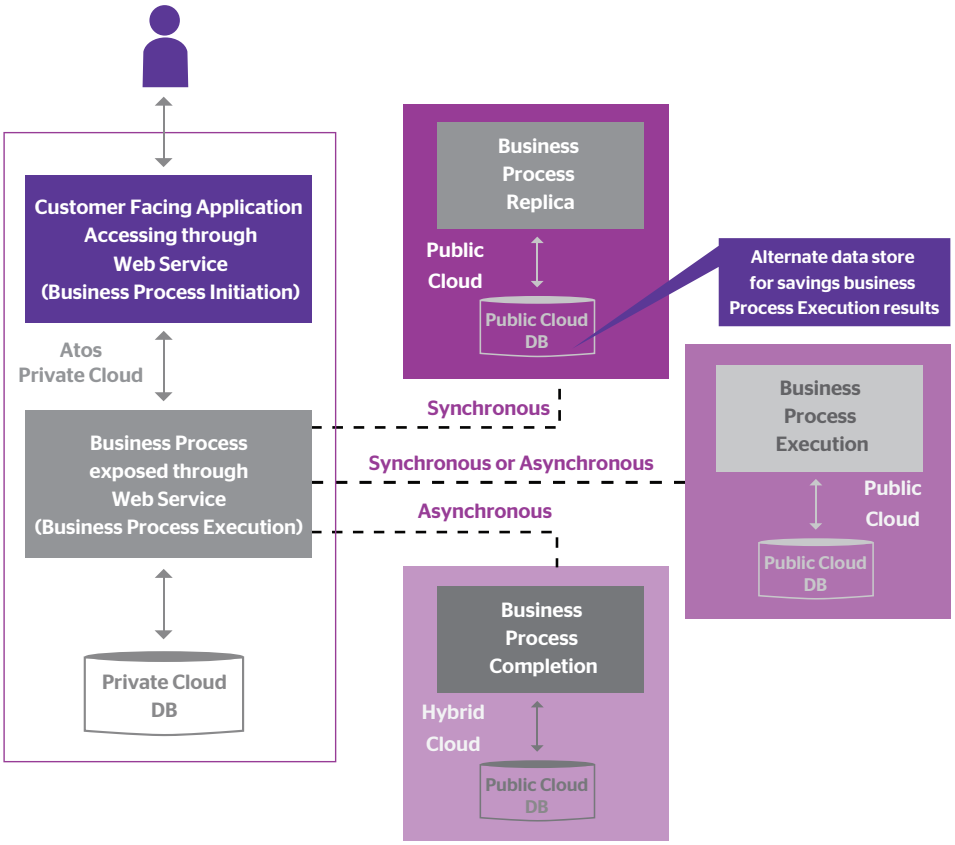


Results

The proof of concept was carried out successfully using both an open source and a closed source BPaaS offering[5]. For the open source, Atos' internal open source reference architecture framework built on Sun's Glassfish platform using RedHat's Jboss jBPM over ESB was used. For the closed source implementation, Cordys Business Operation Platform (BOP4) was used[6].

- **Cloud Communications.** During the proof of concept, the Atos Scientific Community also discovered that a business process which spans across clouds may need to communicate with the clouds using various modes of communication and support the underlying associated protocols. For example, the business process may use synchronous communication (i.e. the business process waits for a response from the service it communicates with), asynchronous communication (i.e. the business process may proceed with subsequent steps whilst waiting for a service response) or both means of communication when invoking or consuming services in the cloud world. Both modes of communication were validated in the proof of concept. From a protocol perspective, the proof of concept tested various standard protocols, like HTTP(S) and SOAP, and also upcoming standards, like REST[7]. The sending of binary information (e.g. files) was also tested by putting commands and content in the queues for generating report files (PDFs) as part of business process completion.
- **Fail-over between Clouds.** The proof of concept looked at another interesting idea; in an event of a cloud failure, can transactional business process data still be made available in an external cloud? This would mean that a user needs not to worry about what would happen to the business process if a cloud goes down. The business process would still continue to function, operating from an external cloud thanks to the availability of the underlying business process transactional data. This was demonstrated and confirmed by replicating the business process transaction steps from the private cloud to the public cloud (see the movement of business process transactional steps from red cloud to green cloud in Figure 7 (below) by connecting the BPaaS layers across clouds using the Atos' 'Cloud Orchestration Bus'.

Figure 7: Proof of Concept



[5] For more details on technical aspects, a 'Technical White Paper - Cloud Orchestration' which includes all observations and results is available on request from Atos.
[6] Similar technologies are now being researched in the SOA4All project (www.soa4all.eu).
[7] REST (representational state transfer) is an approach for acquiring information content from a website by reading a designated webpage that contains an XML (Extensible Markup Language) file that describes and includes the desired content (source: searchsoa.com).

The Cloud Orchestration bus

Why a Cloud Orchestration Bus?

A cloud solution today, which calls on two external cloud services, may seem quite simple to orchestrate and manage. But the same solution tomorrow may need to call on four or even more services depending on (changing) business needs. If the connection of the two clouds was hard coded, the scalability required to benefit from the future plethora of Cloud Computing possibilities cannot be achieved. This is where the complexity of orchestration and management becomes clear. An organization wants to grow and its underlying business processes need to intelligently interact with different ser vices in different contexts to accommodate that growth. Orchestration points cannot be limited to just one or two. The ability to manage the process would be severely impaired if the end-to-end solution is not well designed and properly managed.

Implementing Cloud Orchestration as a point-topoint solution is not viable in a growth scenario. Managing, auditing and monitoring the network of innumerable point-to-point web-service invocation paths in a customer's business is an impossible task. A 'medium' would need to act as a scalable connector. Atos calls this medium 'The Cloud Orchestration Bus' as it connects the heterogeneous or multi-cloud space.

Principal Architecture of the Cloud Orchestration Bus

The Cloud Orchestration Bus (COB) is a solution for establishing a guaranteed and reliable data exchange methodology when one cloud needs to invoke a service outside its own technology environment. The proof of concept COB was constructed by building on a SOA-based architecture with an Enterprise Service Bus (ESB) as an underlying platform. The ESB supports different message formats (XML-based, text-based, object-based, file-based, etc.). It also supports redundancy and scales by design (using the SOA principles). The ESB connectivity model (using adapters) allows the COB to transform the message into the required destination format.

Figure 8: Complex Interconnectivities in Business Processes

Conclusions

Atos has in-depth experience and competency in the areas of both Business Process Management (BPM) and Cloud Computing. Atos also understands the complexity of customer business processes and that managing these business processes and their underlying transactions across clouds is not trivial. It anticipates that this will become a real business need within a short timeframe. Business processes or services spread across different clouds need to be connected seamlessly in order to make the business process scalable.

As the number of services in the cloud grows and the services increase in logical complexity, from the horizontal services found today (CPU, Network, email, CRM, etc.) to full vertical offers that cover a business process either completely or partially, the need for mechanisms that govern the inter-cloud execution of processes will become a clear necessity.

It is not so far off the day when users, in order to execute a business process, will be able to state their requirements in a user-friendly way and transparently and automatically select from a full range of services available both on public and private clouds. These services will be composed smoothly and in a SLA-driven way in a business process that is executed across clouds. Usage of these services will be billed in a pay-per-use model. This seemingly simply model can change the way business and, in general enterprises, operate. It will allow enterprises to focus on their core capabilities and rely on third parties for elements that do not constitute a competitive advantage. In this way, companies will become more specialized and focused on their core businesses, externalizing non-core functions to a wide network of trustworthy providers. This scenario cannot yet be realized due to the need for the standardization of service descriptions, security mechanisms in data movement across clouds, and because of legal issues, amongst others. Nevertheless we can see a trend emerging; to create simplicity with control.

Atos is in a prime position to address this trend, given its existing knowledge and experience in supporting customers in the definition of their business processes, and its Atos Sphere offerings.

Atos anticipates that it will enable these capabilities in two directions:

- By providing tools, knowledge and mechanisms to customers to internally deploy the necessary technical mechanisms to make this scenario a reality.
- By becoming a broker, aggregator or orchestrator of services delivered internally and by third parties, which it packaging and offers to customers in the form of a Virtual Vertical Application Stack (see also the Atos Scientific Community White Papers 'Top-to-Bottom Technology Provisioning' and 'Transformational IT Outsourcing').

Atos' Cloud Orchestration and messaging research has been a successful first step that confirms a basis for the further evolution of this concept. Cloud Orchestration, however fanciful or complex as it may look today, will soon turn into reality and become a necessity for connecting businesses tomorrow. Atos truly believes that Cloud Orchestration is the seamless and secure intersection of business, technology and integration in the heterogeneous cloud world in a real business sense. Cloud Orchestration and messaging will be a key enabler to help enterprises to achieve seamless integration of business processes spanning multiple applications, clouds and smart devices.

About Atos

Atos is an international information technology services company with annual 2011 pro forma revenue of EUR 8.5 billion and 74,000 employees in 48 countries. Serving a global client base, it delivers hi-tech transactional services, consulting and technology services, systems integration and managed services. With its deep technology expertise and industry knowledge, it works with clients across the following market sectors: Manufacturing, Retail, Services; Public, Health & Transports; Financial Services; Telecoms, Media & Technology; Energy & Utilities.

Atos is focused on business technology that powers progress and helps organizations to create their firm of the future. It is the Worldwide Information Technology Partner for the Olympic and Paralympic Games and is quoted on the Paris Eurolist Market. Atos operates under the brands Atos, Atos Consulting & Technology Services, Atos Worldline and Atos Worldgrid. For more information, visit: www.atos.net.