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In-Depth Revealing Grid Based Web Service Provision Model: Grid Service Provision (GSP)

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Abstract

Current development of network infrastructures is undergoing rapid transformation. With the emergence of the Open Grid Service Architecture and Globus Toolkit as incubators for evolving ASP business model to maintain profitability, this paper presents an in-depth analysis of the hypothetical Grid Service Provision (GSP) model by firstly giving an historical account of evolutionary factors in Internet architectures leading to Grid and P2P and secondly, investigating GSP model in the contexts of Service Level Agreements metrics and GSP implementation details. It is acknowledged by some experts that this hypothetical model is technologically feasible in reality.

1. Introduction

Application Service Provision (ASP) which is regarded as alternative and primary software application delivery model to Small or Medium Enterprises (SMEs) has been reaching maturity [1]. The ASP model, typically a 'one-to-many' model, often delivers web-enabled applications to SMEs using IP-based telecom infrastructure. Compared to the more numerous studies on the decision to outsource or not in the context of a client relationship [3] and ASPs marketing strategies, few studies have looked at the influence of new networking technology on the ASP

business model, and how this might optimize an ASP's Quality of Service (QoS). With the increasing migration towards the trend of interoperability and collaborative-work between individuals and corporations to conduct the electronic business (E-business) on Internet, a higher demand that shifting the internet service networks away from best-effort, vertical network architectures to a more intelligent and enhanced networking service to enable end-to-end service-aware network paradigm is claimed by both business practitioners and users [3]. With the emergence of Web Service [4] and WSDL[1] which have come to be known as an interface and description language in which software operations are network-accessible through standardized XML messaging, the attractive features of Web Service are showing potentials for xSPs to broaden the scope of QoS they deliver to end-users and also increase the skill to serve the business computing market. Today's business computing pattern features a collaborative ecosystem of corporations and individuals that can exist in a holistic computing process. Since Web Service makes it reality that the software applications can be platform-independent and also execution-independent of the programming language [4] in which it is written, Web Service technology offers the business computing users an alternative way to receive the software application service not only from xSPs' server farm, but also from the peer users' computers. This significant technical improvement progress provides users with chances to obtain the high QoS from a bigger and broader dimension of networking and computing environment, including Peer-to-Peer (P2P) computing. Consequently, one curiosity for requiring a feasible and ideal networking infrastructure underpinning and optimizing Web Service to function is arising to both academic researchers and service provision business practitioners. The emerging Grid Computing technologies with its unbeatable advantages are now expected to meet this requirement.

2. Related Work

Service providers of all types (xSPs), including ASPs, must deal with many issues if they hope to become long-term survivors in this fast-changing ecosystem. xSPs need compelling services to sell – and rock-solid infrastructure platforms on which to host those services [7]. xSPs need to monitor and measure service use and

[1] WSDL - Web Service Description Language.

the quality of the services (QoS) they deliver. Due to the fact that no single service provider can do all of this alone, xSPs need to form alliances, which usually include Independent Software Vendors (ISV), platform vendors, Internet Connection Vendors (ICV), and also infrastructure vendors. Each stakeholder plays a complementary role in delivering the service.

Focus of debates in prior research has been on the (re)allocation of the xSPs resources and also the alliance of the xSPs to offer the clients better QoS, as well as to enhance their competency to prevent the customers from turning to rival providers. Moreover, many academic researchers are now 'hyping' the development and deployment of the web service technology as the encouraging transition for ASPs; from web-accessible software-as-service to higher-level integrated collections of software operations that will finally operationalise successful ASP delivery for customers. Compared to pre-packaged applications, the unique aspects of web services can be summarized as:

- Web service-based applications are loosely coupled;
- Application component-oriented;
- Cross-technology implementations;
- Available to be used alone to carry out a complex aggregation or business transaction.

A leading IT consultancy, Ovum has released findings of its research on this latest development in computing and communications: [8,9]: "Within the next five years Web services will mean the death of the pre-packaged application, known to - and even occasionally loved by - users around the world today". However, all of these discussions are based on WWW protocols and IP-based telecom infrastructures. Hence, they miss the unprecedented advantages that Grid computing can bring to the IS world. In the Web Service era, old-fashioned ASP/xSPs software-as-service delivery pattern on the HTTP-IP based networking infrastructure is not likely to achieve interoperability due to the xSPs' intrinsic characteristic of "one-to-many" relationship between service providers and users.

2.1 JXTA vs. Microsoft.NET

To achieve the business process interoperability, P2P computing signifies a decentralized architecture [10]. The most mature application areas for P2P computing are file sharing and instant messaging in the users' space. P2P takes a class of advantage of resources available at the edges of the Internet including: Storage; Cycles; Content and Human presence. Web Services, on the other hand, is an attempt to take the Web model for publishing – loosely coupled components with a simple "request-and-response" model – and apply it to computing using XML messages instead of HTML documents [11]. Due to its insistence on well-defined standards such as XML-RPC, SOAP [2], WSDL and UDDI [3], Web service applications are able to communicate between client and server, and different Web Services are also designed to work together, in order to achieve the fundamental goal of interoperability.

The stumbling block for current P2P computing is that two P2P applications using HTTP transport mechanisms are not guaranteed to communicate due to the little progress that has been made so far in adopting general standards. For example, two Napster users must install the same application so that they can share MP3 songs. Likewise, another typical example of P2P collaborative work groupware [12] (requests all the users to install a class of software to organize their activity) is Groove [13], made by Groove Networks. Groove allows co-workers to expose data directly to other users while they are working at their computers, and when they are off-line, the other user can continue working on the file that has been saved on the shared "workspace". Users can get resynchronised once they reconnect to the shared "workspace" again. Although Groove equips users with an impressive array of tools for getting group work done over the Internet, users still need to install this software to form a virtual workspace to achieve interoperability.

2.1.1 Microsoft.NET

Two leading P2P practitioners in business computing like Microsoft and SUN Microsystems are pioneers in exploiting the great potential for combining Web Service with P2P computing.

Microsoft HailStorm (which is now called Microsoft .NET My Services) announcement brings a light to the dawn of increasing the two areas of overlap. Microsoft plans to bring new convenience and richness to the lives of consumers by increasing the utility and value of devices, applications, and the Internet. Building upon the proven capabilities of Microsoft .NET Alerts and Microsoft .NET Passport. .NET My Services will allow businesses to build stronger customer relationships by improving web sites and web services, offering operational efficiencies that can cut costs and increase profits, and provide new business opportunities for the industry [4]. From a customer's perspective, .NET My

[2] Simple Object Access Protocol – provides a means of messaging between a service provider and a service requestor.

[3] Universal Description, Discovery, and Integration.

[4] The .NET My Services platform is a collection of XML Web services that are invoked over the Internet by means of industry-standard protocols including SOAP, XML, and Universal Description, Discovery, and Integration (UDDI). The instant messaging system is undergoing changes so it can be used as a platform for Web services. The associated 'Passport' will provide identity services and Microsoft Messenger will offer presence management for networked applications, such as personal information storing, including contacts, e-mail,

Services ensures that the information is private, secure, and available. By default, personal information is only accessible to the user. Once information is placed in the .NET My Services "Digital Safe Deposit Box", a user can control it with fine granularity; choose to share that information with friends, family, groups with which they have an association, or with businesses. In addition, from the business perspective, Microsoft .NET My Services makes Mobile E-commerce a reality in which users can sign up to receive alerts on any of a number of desktop or mobile devices, enabled by XML cross-platform transaction functionality.

So far, the overlap area in which P2P and Web Services seem to be converging is XML messaging. P2P technology still needs to focus on general standards on which to build the conversation. Moreover, P2P is a narrow scope technique term referring to locating files in small-world networks. Locating files in an environment with potentially hundreds of thousands of geographically distributed nodes is challenging because of scale and dynamism. In such an environment, the system has multiple sources of variation over time:

- Files are created and removed frequently;
- Nodes join and leave the system without a predictable pattern,
- A large number of components may aggregate into frequent group level changes.

Notwithstanding this added opportunity, P2P is still under development; the benefits of decentralization have been recognized.

Decentralization was an architectural principle of the Internet itself, but over a period of 10 years, the Internet has changed significantly. The concept of the ASP model as major software application delivery pattern has been widely accepted and this has caused a shift in thinking of the Web/Internet as becoming increasingly centralized. Paradoxically, this is just what the internet and computing tenets often try to reverse.

2.1.2 SUN JXTA

With respect to progress has been made so far in infrastructure, Sun Microsystems developed a set of protocols in their Project JXTA for *ad hoc*, pervasive, peer-to-peer computing [15]. Project JXTA was designed to standardize a common set of protocol needed to build peer-to-peer applications that enable peers to discover each other, self-organize into peergroups, advertise and discover network resources, communicate, and monitor one another.

Project JXTA significantly differentiates itself with .NET by a set of creative features [15] that are appealing academics' interests:

- Achieved decentralization;
- Exploitation of increased bandwidth;
- Processing and storage available on devices connected at the edge of the Internet

Project JXTA presents a successful example of an optimization solution in the absence of general standards that early P2P computing might need to adopt. Decentralized computing systems constructed on JXTA architecture present the experience [15] of a community environment where members propagate and share information in a decentralized, self-organizing and open manner, as shown in **Figure 1**.

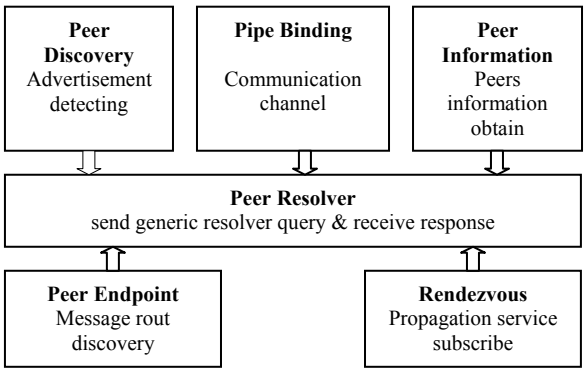

Figure 1. The Project JXTA Protocols

(Source: Project JXTA Virtual Network. Sun Microsystems. 2002)

JXTA protocols work together hierarchically by equipping Peer-to-Peer computing with generic infrastructure that is likely to be able to achieve the goal:

- Develop and deploy P2P services;
- Applications in a virtual self-adapting community;
- Enable a diversity of P2P application and services to be implemented.

2.2 Grid Computing and OGSA

Peer-to-Peer computing developments however try to build P2P applications and communications based on a standardized common set of protocols. The characteristic of P2P infrastructure (including all types of enablement) may intrinsically assign no dictating policies, nor dominant peers amongst the virtual community. P2P computing allows client computers to bypass traditional database stores and exchange data directly client-to-client, hence peer-to-peer. Nevertheless, P2P has a dark side [16]: P2P is considered by some to be a 'socialist computing platform' whose existence and survival relies largely on trust. The concerns that users can be *trusted* in P2P deployments and to securely transfer information are currently important questions asked by both academics and enterprises. Likewise, Peer-to-Peer virtual communities are based on decentralized organization

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calendar, profile, lists, electronic wallet, physical location, document stores, application settings, favourite Web sites, devices owned, and preferences for receiving alerts [14].

structures and without centralized monitoring could lead to networking-and-technology anarchism.

2.2.1 Grid Computing Origination

There is a bewildering debate concerning increasing and maximising computing efficiency by means of workflow decentralization, so that the computing pattern will comply with computing science principle: computing happens where the data is! But a certain degree of centralization is still inevitably necessary. However, this argument will fortunately not become a new fallacy at all. It depends on how we look at the definition of centralization. In today's e-business and e-science, we often need to integrate services across distributed, heterogeneous and dynamic communities formed from the disparate resources within a single enterprise and/or from external resource sharing and service provider relationships. This integration can be technically challenging because of the need to achieve various qualities of service (QoS) when running on top of different native platforms. Foster *et al* summarized that the ideal target environment for application developers should be:

- Homogeneous;
- Reliable;
- Secure;
- Centrally managed.

Business needs to deliver software applications and services to a vast customer base through distributed networks. There is also the requirement to integrate distributed resources to provide customers with higher Quality of Service. These requirements demand a large-scale, precise and advanced technical computing framework and this development now has led to the emergence of *Grid technologies* [17,18].

A Grid infrastructure is extremely intricate in terms of the scale and complexity of the services it must provide. The 'Grid Problem' or Grid challenge is defined as the flexible, secure, coordinated resource sharing among dynamic collections of individuals, institutions and resources. These collective organisations are referred to as 'Virtual Organisations (VOs) [19]. Despite their intricacy, Grids present many opportunities for applications in such areas as the World Wide Web, Enterprise Computing, Internet and Peer-to-Peer computing, Application Service Provision and other generic service provision schemas (xSP) [19]. Nevertheless, Grid computing is not simply a broader concept than that of Peer-to-Peer, there are fundamental differences in different contexts. **Table 1** shows the Grid and P2P computing comparison and their primary diversity.

2.2.2 OGSA Architecture

With the infrastructure of P2P computing for building a virtual community, similarly with Grids, there are a set of infrastructure elements, which now are known as Open Grid Service Architecture (OGSA) that is being used to construct virtual organizations.

OGSA as a holistic grid service architecture uses the Web Service Description Language (WSDL) to achieve self-describing, discoverable service and interoperable protocols, with extensions to support multiple coordinated interfaces and change management. In addition, OGSA uses the Globus Toolkit to define conventions and WSDL interfaces for a Grid service, which is a (potentially transient) service that can support reliable and secure invocation, lifetime management, notification, policy management, credential management, and virtualization [18]. As a result, OGSA provides a standards-based distributed service system that supports the creation of the sophisticated distributed services required in modern enterprises and inter-organizational computing environments.

Context	***Grids***	***Peer-to-Peer***
Enablement	• Enable Communities to share resources (computer power, data, storage) • Enable new Applications by the coordinated use of geographically distributed resources • Enable controlled and coordinated sharing of resources among "virtual organisations"	• Computers (PCs) in a P2P network share resources directly (bypassing a central server)
Infrastructure Type	• Persistent infrastructure for Computing • The Internet as a Computing Platform	• Distributed Computing File sharing, Instant messaging, Enterprise Collaboration, People-to-People
Original Motivation	• High-end science and engineering	• Distributed Computation, Sharing, Business

Table 1. Grids and Peer-to-Peer Comparison.

From the standardized common set of protocols prospective, the creation of large-scale infrastructure requires the definition and acceptance of standard protocols and services, just as the Internet Protocol (TCP-IP) which is at the heart of the Internet [20]. Thus far, no formal standards process has been developed for Grids, however, the Grid Forum [21] is working to create one. Nonetheless, currently there is a remarkable degree of consensus on core technologies. Essentially all major Grid projects are being built on protocols and services provided by the Globus Toolkit [22], which was developed by a group of scientists[5] in the United States and other institutions.

[5] Ian Foster's team at Argonne National Laboratory [29] (operated by the University of Chicago) in collaboration with Carl Kesselman's team at Information Sciences Institute, the University of Southern California.

3. New Generation Service Provision building on OGSA and Web Service

Taking advantages of both Grid and Web services technologies, the Open Grid Service Architecture (OGSA) defines mechanisms for creating, managing and exchanging information among entities which is emerging as new generation services delivery pattern – Grid Service. Briefly summarized, a Grid Service is a *Web service that conforms to a set of conventions (interfaces and behaviours) that define how a client interacts with a Grid service* [23]. The Web Service Definition Language (WSDL) has common application interfaces, and conventions (behaviours that include: dynamic service creation, interface address naming and discovery, controlled fault resilient, notification, manageability, and upgradeability of the distributed long-lived state). This and the OGSA infrastructure together define a Grid Service.

3.1 The Enabling Environment to Implement Grid Service within a VO

The collective organisations in a VO typically maintain not merely a static set of persistent services that handle complex activity requests from clients[6], they often need to instantiate new transient service instances dynamically, which then handle the management and interactions associated with the state of particular requested activities [18]. The OGSA conventions, protocols, and infrastructures underlie the Grid web service in service implementation. The WSDL application interfaces enable the specific execution in the hosting environments or with more sophistication the containers such as J2EE, IBM Websphere, Microsoft.NET and Sun One. The containers here refer to an implementation-programming model, programming language, development tools, and debugging tools.

3.2 Hypothetical GSP Model

Work [5] on the hypothetical Grid Service Provision (GSP) model so far that provides quality of service in Web Service Application delivery with Open Grid Service Architecture (OGSA) support is still in an embryonic phase. Current work on GSP can be divided into two stages: GSP definition and futuristic scenario simulating analysis in the context of Service Level Agreement (SLA) metrics.

The ASPs/xSPs applications and services provision model can embrace a new lifecycle. The key to reaching this new horizon is to move to a common program-to-program interaction model. New applications are being developed with programming models (such as the Enterprise Java Beans component model [24]) that insulate the application from the underlying computing platform and support portable deployment across multiple platforms. The Open Grid Service Architecture provides a broad set of protocols as low-level infrastructure to communicate and manage the pervasive computational edge resource of a VO. Meanwhile, the development of programming models which comply with Web Service Description Language (WSDL) and Extensible Markup Language (XML) specifications are building blocks to enable the ASP software application delivery model to evolve. As a result, unlike the scientific Grid service architecture such as SETI@home [26] or Grids in Aerospace industry [25], developing and deploying Grids in business computing are pledged to harness new opportunities and market niches in the Grid era. **Figure 2** is a hypothetical Grid Service Provision model and is shown at the end of this paper.

From the physical fabric point of view, OGSA is an extension of HTTP-IP based networking. After applying Grid computing to the current networking physical infrastructure using OGSA mechanisms to build a VO, the decentralization and distribution of software, hardware, and human resources would make it essential that the desired quality of service (QoS) are achieved. This type of ubiquity in computing and service patterns will largely change the traditional way that enterprises do business, especially e-Business. The impact of Grid computing, whether measured in terms of common security semantics, distributed workflow and resource management performance, coordinated fail-over, problem determination services, or other metrics – on resource assembled dynamically from enterprise systems, service provider systems, and customer systems [18] – will all alter our perception and understanding of computing.

4. Analysis and Implication

In old-fashioned ASP/xSP models, customers receive the software application through web, and host their business data on the xSP's server farm. Customers are confined to the relationship with the ASP/xSP on a long-term or short-term subscription basis and this depends on whether they decide to rent or lease the service [27]. Despite Service Level Agreements (SLAs), customers have to accept the "as is" quality of services provided by vendors with very little customizability. Furthermore, there are also several problems with the services: based around imperfect connectivity, ASPs' remote management and resource management.

Grid technologies support the sharing and coordinated use of diverse resources in dynamic VOs, from geographically and organizationally distributed components to highly integrated creations to achieve the desired QoS [19]. Enterprises are also now expanding the scope and scale of their enterprise resource planning (ERP) projects as they try to provide better integration with customer relationship management (CRM), integrated supply chain management and existing systems. Grid Service Provision may help to release this

[6] Clients here refer to service requestors, in the context of "resource-sharing relationship" in a VO.

significant pressure on the enterprise IT infrastructure as well as to achieve the following:

- Supports dynamic resources allocation in accordance with the service-level-agreement (SLA) policies, efficient sharing and reuse of IT infrastructure at high utilization levels, and distributed security from edge of network to application and data servers.
- Deliver consistent response times and high level of availability, which in turn drives a need for end-to-end performance monitoring and real-time reconfiguration.
- In addition, assure the security, auditability, SLA and complex transaction processing flows of multi-organizational supply chain management, B2B integration in cross-enterprise business-to-business collaboration.

4.1 Analysis of Grid Service Provision (GSP) model

Peer-to-Peer computing evangelises the current business computing pattern into interoperability paradigm, built on Grid computing and OGSA architecture. With the development of software engineering, the traditional software-as-service can be integrated with web pages and delivered via internet. .NET and J2EE as popular implementation-programming model, programming language, development and debugging tools that can help realize the Web Service which can be simply understood as "functioning-web-pages". With this functionality, web service can be simply and easily delivered by xSPs and received by users without pre-installed software-running supporting systems. From the users' prospective, Web Service largely reduces the cost of IT investment and the complexity of maintenance – the commonly and broadly used web browser can carry out this implementation of Web Service.

The functionality-encapsulated web service contributes feasibility to developing and deploying interactive and cooperative interoperability in today's collaborative electronic business ecosystems. Business and individual users can receive software applications (web service) from service providers, as well as from peer users alternatively. SMEs, as major marketing target for xSPs, are given flexibility to acquire web service from multi resources: xSPs' server farm and/or Peers users.

Due to the fact that web service can be hosted at various places, users do not need to shuffle raw data around a network to wait for processing by a centralised mainstream computer at an ASP's server farm, and furthermore, ASPs do not need to bear the overload work for user's computing requests - there is a large waste of resources, considering bandwidth, user idle time; data secure transferring issues, etc.

With the emergence of distributed computing, in which Grid computing has marked an important new phase; the ASP model can evolve by using the advanced networking architecture to deliver software applications. The convergence of web services and Grid computing technologies is expected as an approach to solving and resolving current ASP delivery problems. Moreover, such new technologies may bring a revolution to the current software application delivery pattern, and this could have a pervasive impact on the IS world, like IP based WWW (World Wide Web) did in the last two decades of the 20th century.

As a result, academic researchers [5] are attempting to evolve the old fashioned ASP business model into Grid Service Provision (GSP) model by combining and converging Web Service technology and OGSA architecture to achieve the fundamental goal of interoperability.

4.2 Inside GSP Model

GSP is not only an xSP technical framework, it is also likely going to be spoiled by business practitioners as a good business model that begins with an insight into human motivations and ends in a rich stream of profits [28].

When ASP evolves into GSP, users (SMEs) are regarded as VO members, who can inherit all VO's features: flexible, secure, coordinated resource sharing among dynamic collections of individuals, institutions and resources. Once users sign in VO to start each service session/transaction, at the same time, GSP begin to monitor and measure the quality of service using Java-based intelligent agents [29] to ensure end-to-end QoS specifications and service price negotiations in such an environment. Java-based SLA/Pricing Agents are used to process user's service request including identity verification, customised SLA specifications, and commit the service to be delivered to the requestor (user). Open Grid Service Architecture/Grid Engine/Container are used as application implementation platform and service interpreter/search/delivery engine to communicate both users and (Grid) Service Providers to ensure the service quality and SLA fulfilment.

(Grid) Service Providers are responsible for managing security issues, user information, resource discovery and advertising, data storage, etc. When a service request is accepted, GSP will search the resources throughout the whole VO and GSP itself in order to respond to this request. This responsive process is hidden and transparent from a user's point of view because the resources can be stored on GSP's server and also peer-users' computers. This responsiveness mechanism guarantees quick and efficient service response to the request. One of significant attributes of GSP model is the ability to create added-value that benefits peer users: members in a VO, who have spare resources such as storage space, can share the extra computational ability with GSP to help host web services and deliver to the other peer users. Both spare resource provider members and GSP benefit the profit from this sharing.

Compared to old fashioned ASP, GSP model presents many opportunities to improve the level of QoS and increase the profit margin, as shown in **Table 2**.

5. Conclusion and Discussion

Traditional ASPs have focused on economy-of-scale in the past a few years, and some successful players have achieved this goal. In today's Web service and Grid environments, vendors are being given the opportunity to embrace achievement of both economy-of-scale and skill. Current trend of Electronic Commerce (E-Commerce) is to accelerate the shift of power toward the consumer (Adrian J. Slywotzky). Some advantages of Grid-enabled P2P networking will allow SMEs to reduce fees, operational complexity, and increase interoperability. Grid computing and OGSA as originated for solving the scientific computing problems are now showing the potential to serve the business computing market. However, GSP is a hypothetical model which is lack of empirical evidence and study. It is consistent with technology development in reality. Hence, this model still needs to be tested and implemented by both academic researchers and business practitioners for further development.

Context	***GSP***	***ASP(old-fashioned)***
Service Delivery Pattern	Peer-to-Peer (Many-to-Many)	One-to-Many
Infrastructure Type	Extended HTTP-IP Networking	HTTP-IP, WWW Networking
Motivation	• Better QoS • Customised service for user	• 'as is' products • Pre-packaged service
Relationship with user	• Peer-to-Peer relationship • VO members	Server/Client
Interoperability	High	Low
Service Charge Method	per Session/Transaction	User's Subscription
User's accessibility	Easy access (Join the VO)	Need technical support
Networking Control/Monitoring	Difficult	Easy
User's Cost	Reduced(Low)	High
Providers' Investment	Reduced cost by resource sharing	Incremental investment
Organisation Architecture	Decentralised	Centralised

Table 2. GSP and old-fashioned ASP comparison.

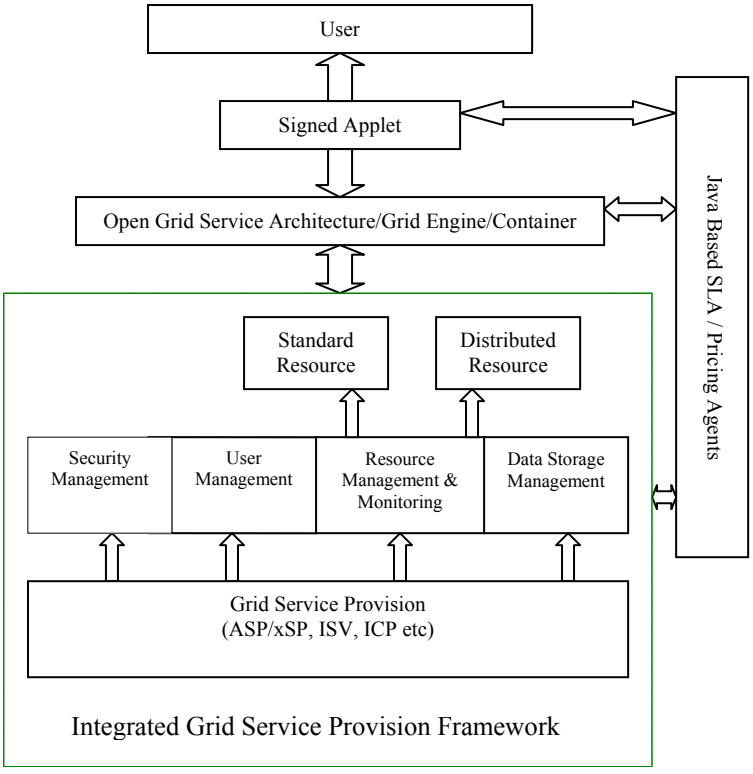

Figure 2. Hypothetical Grid Service Provision model

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