Service Delivery Platforms in Practice

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ABSTRACT

There is considerable work in defining an architectural framework that supports multimedia service delivery. The IP multimedia subsystem (IMS) is a recent standards initiative that outlines a service delivery platform (SDP) architecture. In practice, however, a number of service delivery platforms already were developed and commercially deployed. The existing implementations focus on the IT systems and domain for service design and delivery and accommodate the existing network implementations in their architectures. Such solutions may be viewed as IT-based designs whereas the newer emerging IMS standards provide greater detail on network element design. We have studied several IT-based service delivery platforms presenting longitudinal results from their deployment, including multimedia service usage, transaction demands, and external applications deployed. These characteristics may be used to further refine IMS based service delivery platforms by accommodating some of the functional characteristics supported in successful IT-based SDP systems. We present a consolidated set of SDP capabilities to meet this objective.

INTRODUCTION

There is considerable research and experimentation in the domain of multimedia, convergence, and next generation networks. The work is motivated largely by competitive forces that are driving commercial opportunities in enhanced multimedia service delivery for fixed and mobile networks. Salient examples include IPTV, gaming, video calls, and voice over IP. The IP multimedia subsystem (IMS) is a recent initiative that outlines a reference framework and architecture for building and deploying a platform that will enable a range of applications to deliver these enhanced multimedia services. Such platforms are often termed a service delivery platform (SDP).

Although the IMS architecture appears to be gaining wide acceptance as the emerging standard in service delivery, in practice a number of existing platforms were deployed by mobile and fixed line operators using existing and alternative architectures. Many of the existing implementations were developed by focusing on the IT systems integration requirements, rather than applying a consistent implementation approach to the network aspects for multimedia delivery. In spite of the approach taken, there is a desire to merge the existing architectures with current trends in IMS delivery to maximize the effectiveness of the SDP.

In this article we study a number of the existing SDP solutions, analyzing and presenting the results from their deployment. The analysis concentrates on supported multimedia services and the growth experienced. By observing the characteristics of these implementations we identify those components of existing IT based SDP designs, together with the IMS reference architecture, to propose a more complex architecture. These existing designs are required in addition to the IMS network oriented designs to assist in the definition of a more unified architecture.

RELATED WORK AND MOTIVATION

Although there is much work on standardization and reference frameworks, there appears to be little work on service delivery platforms and their deployment characteristics with respect to services and service growth.

A detailed analysis of the mobile Internet content provider model was studied with a focus on the Japanese market experience [1]. The findings highlight the importance of operator and external content service provider relationships, in terms of content provisioning and effective revenue sharing models. In [2], the author points out that partnership based upon standards is a key i-mode success factor, with particular support for IT systems such as billing and the presentation of content from external service providers. In [3] a platform is presented that outlines a service delivery environment to deliver multimedia content and services to mobile devices for alternative networks such as GSM. The capabilities to support both the fixed and mobile networks, peer-to-peer services, and other enhanced multimedia services also are addressed in [4]. Related work on delivery of services to the home using a delivery platform to enable third party services also is proposed [5]. A further study also observes the importance of IT system components such as Customer Rela-

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tionship Management (CRM), content management, and billing for content partner, service, and user growth [6].

IMS as a basis for the service delivery platform has been suggested [7]. In [8, 9] a service delivery platform that extends IP multimedia systems was developed. The authors outline a test bed architecture that integrates SIP and Parlay with the telecommunications network to deliver multimedia services. A further platform that delivers mobile games using IMS was also outlined [10]. More recently, there is broader interest in IMS and service delivery characteristics [11].

The key motivation for this work is to analyze the characteristics of successful IT based SDP deployments. Therefore, we identify those characteristics that require attention in emerging IMS based SDP implementations. The key contributions of this article are as follows.

- Report the results of multimedia service characteristics in successful SDP implementations.
- Conduct a longitudinal analysis of operational results in service growth, service type, and external service providers.
- Characterize deployments to identify those attributes that require consideration in IMS based deployments. Taken together, the board capabilities that combine aspects of the IMS and IT based delivery platforms are shown.

Service Delivery Archetypes

The Service Delivery Platform

Employing a consolidated platform for the large-scale delivery of content and services to mobile devices was first accomplished by the *i*-mode service in Japan [3]. The idea of building a platform to enable a diverse range of applications for service delivery has expanded over time to incorporate multimedia services for both fixed and mobile devices. While a service delivery platform is an enabling technology, there are several means to implement a solution capable of rendering (en-mass) value-added services to the broader community. The design philosophies that pervade include point based design, IT-based, and network centric based designs [12]. Before describing these approaches, we first provide a general definition of what constitutes a multimedia service.

What is an SDP Multimedia Service?

Multimedia is broadly understood as the use of several forms of media, typically text, audio, graphics, and video. In addition, a service is generally defined as the non-material equivalent of a good. In light of this, the term multimedia service, when used in the context of a service delivery platform, is used to denote multimedia content in the form of either content or service.

A further aberration of the multimedia service is in how this is manifested. In general, a Web enabled application is responsible for generating the output multimedia service. When an entity (i.e., a third party developer) creates such an application, it is the application entity that supplies the desired multimedia content or service. Hence, the term multimedia service also is used to denote the Web application deployed to the SDP that is responsible for generating the output content or service.

Point Design

Initial deployments of solutions capable of delivering content were based on point designs that catered to one or a related set of multimedia services. While these implementations were effective in delivering the discrete set of services the system had been designed to address, there was an inherent constraint on the ability to expand such designs to accommodate newer and alternative forms of multimedia content. This provided the motivations that led to the platform approach.

IT Based Design

An IT based SDP design may be characterized by system components that are largely associated with user registration, portal design, legacy systems integration, and provision of an expansive set of facilities to third party developers for multimedia service development. In a fundamental sense, the service delivery platform becomes a brokering agent for customer access to content and services from a variety of sources: simplifying access control, service navigation, and billing.

A key requirement that is central to this type of architecture is the integration with legacy IT systems (legacy interface; I/F) to support functions such as customer relationship management, billing for recurring and real-time customer charges, user identity management, service provisioning, and financial settlement for external third party service providers. The external third party applications provide the content, services, and products accessed by customers. These applications interact with the platform typically via an application interface implemented as Web services. Several portals are present, including a content portal for customer access to content and services, a service relationship portal for external service providers to manage registered services, and administrative portals for account maintenance. The network in these instances is viewed in an abstract manner, and integration via existing and heterogeneous systems is generally applied. Consequently, these systems are typically developed to support multiple mobile and fixed networks.

Network Based Design

The IP multimedia subsystem (IMS) was specified by the 3GPP consortium [13]. Originally developed for mobile networks, the specifications now describe a next generation networking architecture for the delivery of multimedia services over mobile and fixed IP networks. IMS is a standard that has more to do with network architecture, presenting an approach to abstracting the telecommunications environment in order to deliver multimedia services. The underlying protocol adopted by IMS in session management is SIP, which also serves to distinguish its focus on IP based services. The range of multimedia services includes peer-to-peer applications, video streaming, and other SIP related services.

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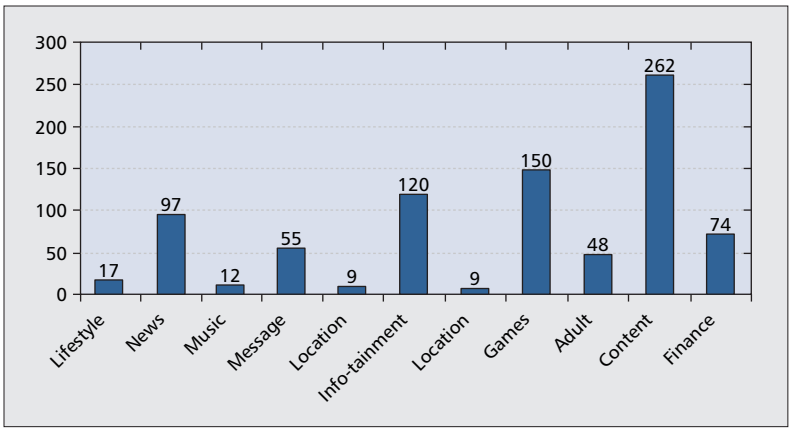

Figure 1. *Service distribution on typical IT-based SDP.*

The transport plane and control plane of the IMS architecture contain functions that relate directly to service delivery, such as quality of service, device authentication, and session management. The service plane provides the environment for executing various IP based services including presence, location, messaging, and video conferencing. This denotes a key difference to the IT based design. In IT based designs services such as shopping, advertising, and Internet applications are enabled through a service relationship management framework.

Real-time balance checking is vital to supporting many of the multimedia download functions. Additional support for external service providers is not explicit. The service plane supports IP based services using SIP as the primary mechanism to establish sessions between the user device and application. The IMS framework defines very clearly the method for integration with network elements and how to manage communication. This aspect is not well defined in IT based designs that focus more on the legacy IT integration.

A more detailed description of the IT based SDP and IMS components of these architectures are outlined next, where a combined architecture is presented.

Analysis of Service Deployment Characteristics

We studied several SDP deployments within Asia Pacific and Europe to understand the characteristics of commercial implementations from an IT based perspective. In the analysis that follows, the services and revenue growth of three key deployments are further analyzed and presented to give a basis of expected growth in services, users, and content providers. Although these solutions implement aspects of both a network based (such as IMS) and IT-based SDP, the governing paradigm was IT centric. Of the surveyed systems, we then examine in further detail the results of one of the more successful systems that experienced significant uptake, increasing 20 percent annually.

In each deployment scenario, a number of services were deployed, ranging from less than 100 to the more successful deployments of over 1,000 multimedia services. The content and service categories may be described as follows.

- **Lifestyle**: Health and lifestyle services such as dietary, beauty, and health and fitness clubs.
- **News**: News items including daily news, weather, and sports, as well as general information related content.
- **Music**: Music downloads, song charts, and music information.
- **Message**: Various messaging services that involve use of MMS, SMS, email, speech, and voicemail.
- **Location**: Location based application services. These typically provide a capability to the mobile user to identify the nearest subject of interest; often returned as a map with directions.
- **Infotainment**: Horoscope, fortune telling, diaries, relationship, and other comical services.
- **Games**: Either downloadable games or online gaming venues.
- **Adult**: Adult only content and services.
- **Content**: General downloadable content such as ring-tones, wallpaper, and images.
- **Finance**: Banking institutions and other financial services.
- **Self Care**: Subscriber related self-care activities such as payment top up, multimedia service registration, and profile (or personalization) maintenance functions.

Figure 1 shows the distribution of multimedia services among the service categories defined. This represents 902 chargeable multimedia services available from a catalogue of nearly 2,000 services at a typical successful site.

As can be seen in the diagram, the most widely deployed include general content, gaming, and infotainment related services. Although indicative of general appeal, a more important property of a successful system is the type of service that is most attractive for the service provider to deploy, which is based on revenue. Consequently, we examine the top 30 most popular services that contribute nearly 80 percent of all revenues. The following list summarizes how many of each type of service are within the top 30 ranked services.

- Games: nine services
- Content: six services
- Message: four services
- Music: four services
- Infotainment and Location: two services each
- Finance, news, and adult: one service each

Within this group we now examine the types of applications that contribute the most to revenue. This examination provides detail as to the complexity of the transaction that requires processing by the SDP. Moreover, non revenue generating transactions require fewer systems for processing a request, but financially related transactions dictate a greater dependence on billing systems and methods. The pie chart in Fig. 2 depicts this contribution.

Gaming is clearly the major category in revenue generating transaction activity, accounting for 41 percent of all activity. In addition,

music, general content, and infotainment also are key transaction contributors. Generally, the self-care activities are services that are not charged for their usage. Nevertheless, self care is an essential precursor to other revenue based services, permitting subscription to these services and the configuration of payment instrument to apply. The remaining services contribute to a lesser degree and do not appear to be linked to the number of respective services made available.

We further analyze the revenue capability versus the number of all services made available by service line. It is clear that music is the most desirable service, providing two percent (per music purchase) of all revenue per service. This is followed by location based services at 0.33 percent and games at 0.27 percent of revenues due per gaming service. The remaining multimedia services contribute to a lesser extent, (messaging, 0.09 percent; infotainment 0.07 percent; content 0.05 percent; and finance 0.05 percent). This is due to the dilution in number of services made available by the telecommunications operator or a generally reduced financial input. From this data it can be concluded that gaming, music, and location based services are potentially the most attractive and thus, essential for an initial IMS based SDP deployment.

There are generally two charging approaches implemented: transaction oriented and recurring charges. Transaction oriented charging is conducted as a pay per usage and generally involves a pre-paid billing arrangement. Recurring charges involve the traditional post paid billing scenario where the customer subscribes to the service for a regular service charge that is applied to their bill periodically. The recurring charges are the dominant form of revenue collection, comprising some 63 percent of billing. Given the high usage, the importance of integrating traditional IT billing systems is exemplified and is an important aspect of either an IMS or IT based SDP solution.

The transaction oriented approach to charging can be accomplished using payment cards or pre-payment systems that generally are available within the mobile phone market. In particular, a pre-payment system is viewed as an integral part of the network and would become an essential component of an IMS based service delivery platform. Although the results on charging mechanisms indicate a preference for the recurring charge approach, this is possibly due to the regional market disposition towards either a prepaid or a regular periodic billing plan. As such, this may vary considerably within each region, thus making both charging mechanisms essential in an SDP deployment.

Longitudinal Analysis of Growth

To understand the requirements for scalability, we conducted a longitudinal analysis of a successful deployment over a five year period. To extrapolate these figures, the results must be taken in the context of the geographic population. Hence, a straightforward linear extension of the results can be applied to make assessments for other geographic regions.

The diagram shown in Fig. 3 illustrates the subscriber growth rate over the five year period for a typical platform. This represents fee-paying users, where their activities result in some chargeable transaction. Although these results represent a very successful and sound rate of increase, they also must be viewed as conservative estimates for several reasons. Firstly, there are additional users who visit the service delivery portal and often access only the freely available content (without formally subscribing). This free (unregistered) usage may correlate to substantial activity and is dependent upon the extent of free to wire content that is made available. Furthermore, specific marketing campaigns or an extremely popular service augments subscription rates and thus the overall growth rate observed. The implication is that scalability requirements must cater for loads beyond the expected growth rate of financial transactions received.

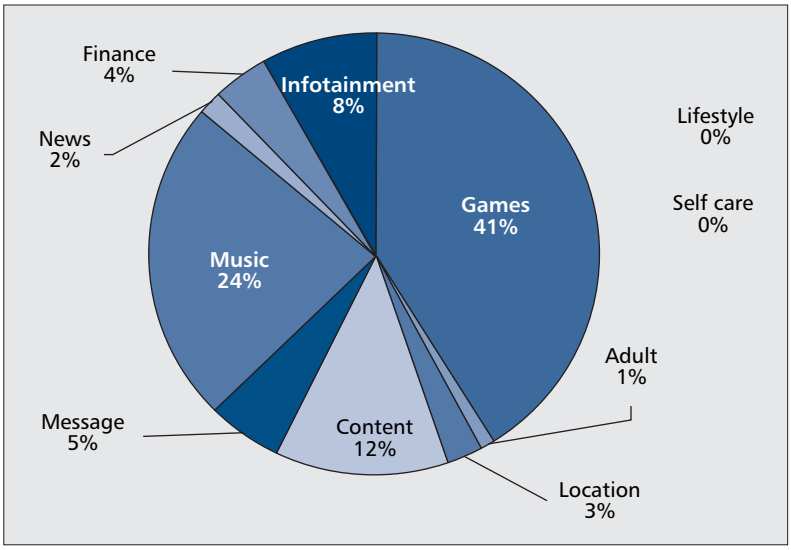

Figure 2. *Revenue contribution by multimedia service category.*

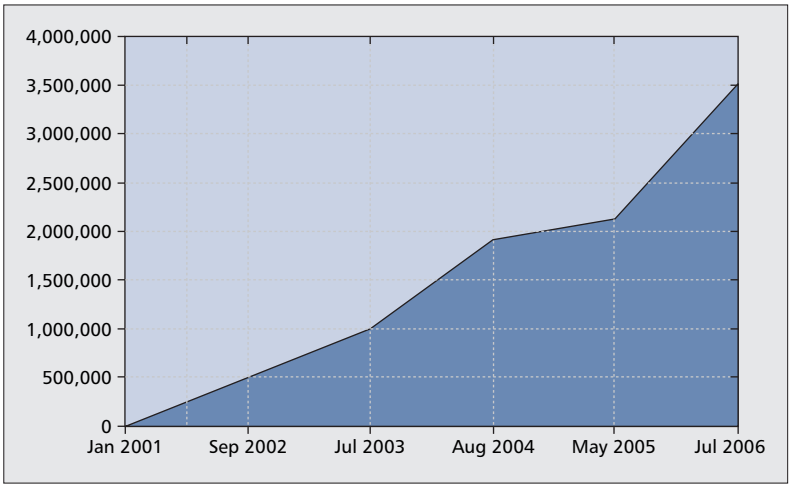

Figure 3. *Subscription rates to platform.*

A key protagonist of subscriber growth is the number and variety of multimedia services available. In the previous section, an in-depth analysis of services deployed was conducted. We extend that analysis to illustrate the rate of service (or application) growth during the five year period. The graph in Fig. 4 depicts this increase. In addition, the number of external third party developers is shown (third party developers are also referred to as service providers and may be an enterprise). In general, the number of applications appears to increase as a function of the increase in third party developers. However, from the data, it is clear that the number of developers does not necessarily translate in a linear manner to the number of services deployed; from around 40 developers initially to about 350 as the system evolved.

With a large number of external applications and third party developers to support, this data highlights the importance of integrating functions to support business processes required to register and deploy applications. These features would therefore be required in an IMS based SDP deployment.

Figure 5 provides an indicative perspective of the growth in financial transactions conducted against the platform (this is for pre-paid and post-paid transactions). This is a measurement of the increased activity of transactions that resulted in a financial commitment, either from a recurring agreement or pay per transaction usage basis. Conventional transactions against the platform result in activity on Web and application servers. A financial transaction is uniquely denoted by its increased load to the network, external third party applications, and legacy IT systems (such as billing) to fulfill the multimedia service request of the transaction. Figure 5 illustrates that these transactions experience an exponential growth in the first three years and then begin to taper. This has significant implications for existing legacy systems that are required to accommodate the increased loads.

The longitudinal data provides some perspective about the demands made on an IT based SDP deployment. Obviously results vary considerably, however, a clear relationship between the number and variety of services available to subscriber usage and growth is evident.

Taken together, this data is useful in predicating longer term non-functional requirements such as scalability, and in determining the type and range of network and IT systems integration that is required. This last point is of particular interest in this article, as we now elaborate on a set of capabilities that supports the IMS framework and the requirements of an IT based SDP.

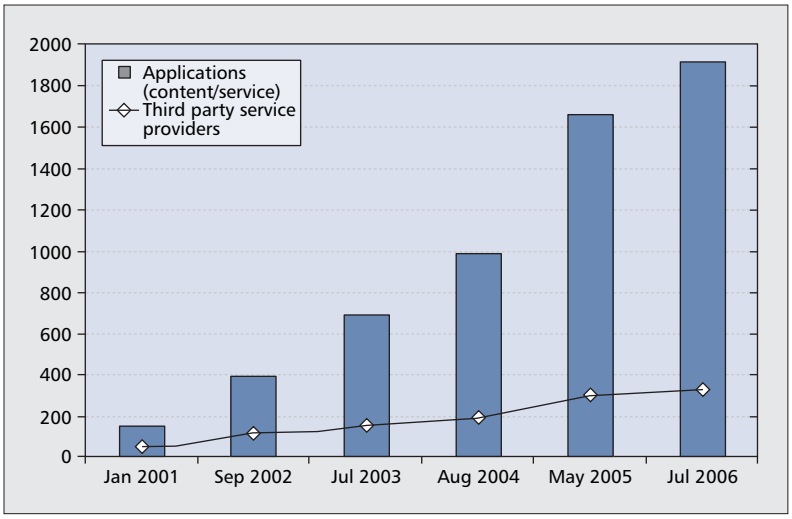

Figure 4. *Applications that provide multimedia services.*

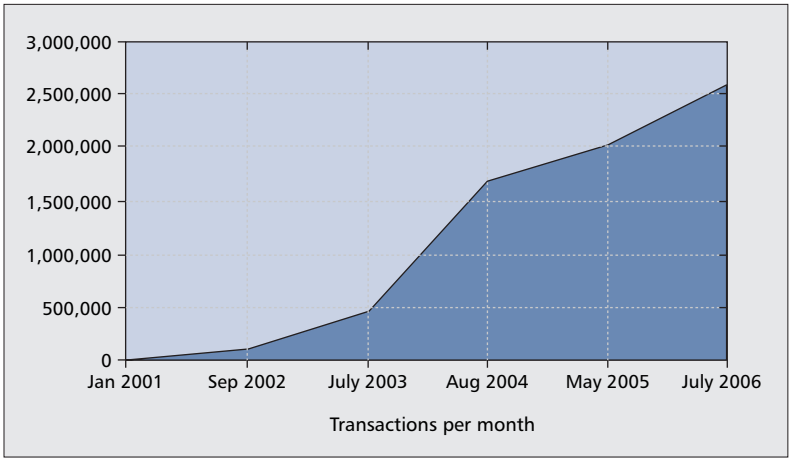

Figure 5. *Exponential growth: number of financial transactions per month.*

Service Delivery Platform Capabilities

By observing the characteristics in service usage and growth for IT Based SDP implementations, it is possible to outline the set of capabilities required for a unified SDP. Together with IMS as the basis, the set of capabilities is applied to address both network and IT related requirements for multimedia service delivery.

Figure 6 illustrates the overall functional architecture, depicting the key components essential in an SDP from both an IMS and IT-based perspective. This is separated into several layers, having a general relationship to the planes of the IMS framework (Table 1).

In the context of an IMS framework, the visible difference is the addition of core delivery function and foundation service layers between the control and service planes. The core function and integration layers encapsulate the capabilities of an IT framework for service design. The access network plane is not shown and is implicit; logically residing between the user device and transport function layers.

Referring to Fig. 6, the layers and broad capabilities are described with the intention of separating implementation detail. A description of the layer is provided, and the components are intended to indicate a list of the discrete functions that are generally supported in the systems analyzed. The key elements of the IMS architecture are also depicted within this framework. Hence, the capability framework is based upon the functions offered from both the IMS (net-

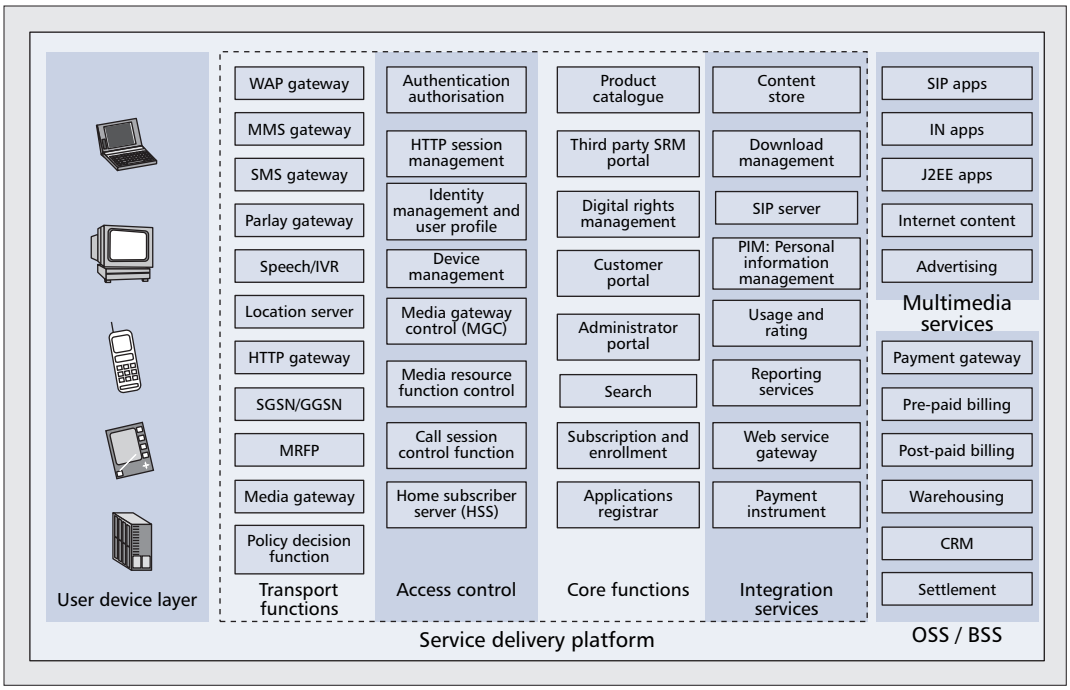

Figure 6. *Service delivery capabilities in a full service design.*

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work based) and IT Based SDP systems. This also can be viewed as the set of requirements to be addressed.

The device layer comprises the mobile and fixed devices or user equipment. This layer corresponds to the IMS user plane; however, at a functional level there is no strict requirement to support a particular software client. This appears to be a consistent feature of all IT based systems. Emerging or traditional client devices may be used, meaning that there is no restriction on the type of device that is employed. The results from the previous section highlight that a large number of supported devices are desirable. This means that devices with or without a specific application client, as well as IP and non-IP based protocols are supported.

The transport function layer consists of components that integrate directly with the mobile or fixed network. These include protocol gateways (IVR, WAP), messaging gateways (SMS, MMS, and EMS), and network element nodes (GGSN, SGSN). The ability to integrate and interoperate with various networks, including IP and non-IP networks, is an essential feature that provides the greatest flexibility in offering multimedia services over a variety of channels. IMS transport plane components such as the media gateways, media resource function processor (MRFP) for playing announcements, network elements, and policy decision function (PDF) reside within this layer. The PDF assigns resources to manage quality of service to ensure that there is sufficient bandwidth available to deliver the service requested by the user. Although depicted within this layer, the PDF also logically may sit within the access control layer. In general, the transport layer is the point of connection between a range of network interfaces and protocols. Connectivity between the transport layer and the access control layer is intended to be a homogenous IP based connection.

Capability layer	IMS plane
User device layer	User plane
Transport function layer	Transport plane
Access control layer	Control plane
Core delivery functions	—
Integrations service layer	—
Service layer	Service plane

Table 1. *Relationship between layer and IMS plane.*

The access control layer corresponds to the IMS control plane. Quality of service, user identity repositories, authentication and authorization policies, and session management are within this layer. In addition, support for SIP based functions (CSCF, MRFC, and MGC), as well as components for other non-SIP based protocols (e.g., HTTP) are resident. The call session control function (CSCF) manages session establishment by connecting the user to the correct application server in the service layer. The media resource function controller (MRFC) provides conference, roaming, and media control services; however, these capabilities often are available from within the applications of the service layer. The media gateway (MGW) enables internetworking between IP and SS7 and consists of two sub-components: the media

Taken together these results provide some insight as to how IMS based SDP solutions can be designed to accommodate several parameters, including multimedia services that are in high demand, the scalability and integration requirements, patterns for transaction growth, and integrating IT capability.

gateway control function (MGCF) and the breakout gateway control function (BGCF). The latter identifies the required local or foreign network. The home subscriber server (HSS) is the alternative to the home location register (HLR) of the GSM mobile network and is the master repository for user credentials. The HSS also is accessed at run time to determine subscription status to services that are accessed by users. In a similar way that the connection between the transport and access layer is an abstraction for multiple protocols to an IP based platform, the access control layer further abstracts the protocols to an HTTP or SIP based protocol. The SIP protocol caters for session oriented connections, and HTTP accommodates for other services that do not require a dedicated session in place. In this way, by progressing through the layers, further abstraction and independence is bestowed to the components deployed. This eases implementation and the ability to upgrade or interchange components within each layer.

Although it does not relate to a specific IMS plane, the core function layer contains those capabilities that relate to the portal and presentation services directly visible to the users of the system. This includes customers, administrators, and third party developers. As such, facilities for browsing the catalog of multimedia services (i.e., service menu), registering for services, selecting desired charging mechanism to be used, and maintaining personal profiles are provided. In addition to support for customers, portals for third party developers that enable them to register their multimedia applications are essential. In a sense this forms a service creation environment by providing tools and facilities to test, register, and deploy third party applications. This portal and development environment for third parties is also referred to as service relationship management (SRM). By providing a platform for external parties, the service delivery platform is also a merchant platform for selling content and services. As such the third party also requires facilities to review revenues due from transactions conducted, lodgment of claims and managing financial disputes, and processing commission payments.

The integration layer contains the set of foundation services that supports the distribution of multimedia content and services to customers. Capabilities for integrating with the various multimedia applications and existing IT systems of the organization are found in this layer. These include a Web service gateway used by third party applications, billing interfaces and rating engines, SIP application interfaces, download managers, and content repositories. In particular, the Web service gateway is used as an open standards integration layer between the platform and the third party applications. Customers that request services provided by a third party application may be redirected to the third party application site. When the application verifies the user, a Web service is invoked against the service delivery platform, which in turn interrogates the HSS. In this way, the third party application can be implemented by leveraging the capabilities of the service delivery platform, made available as a set of Web services.

Applications are shown as capabilities within the multimedia services layer, correlating to the service plane within IMS. In addition to applications types, basic content and advertising is a source for multimedia. Both internally hosted applications and external third party applications, via the Web service gateway, are supported. The operational support and business support systems (OSS/BSS) consist of traditional IT systems such as billing, CRM, and settlement. Integration with other systems is intended to be transparent, and the legacy services are made readily available to third party applications via the Web service interface.

In summary, the proposed architecture would augment an IMS based SDP in several ways. The Web service gateway and SRM portal provide greater support for third party external applications to construct, test, and deploy new applications. Support for managing their applications and revenue due is also a necessary contribution of these components for external parties. The additional layers introduced enable component interchange and protocol abstraction and permit elasticity in systems integration with existing legacy systems. In particular, flexible access to existing legacy systems enables the SDP to manage customer relations with existing CRM packages, exercise a wider range of billing options with pre-paid and post-paid charging, and provide financial network support for payment card transactions. Flexible access also enables front of house call center management of customer and third party disputes. Combined together, the architecture provides a capability to accommodate a wider range of applications including multimedia, shopping, advertising, and peer-to-peer services and furnishes a number of additional capabilities to support application deployment and run time access from a wider device base.

Conclusions

For IMS deployment to be successful, it must emulate the success that current IT-based solutions have experienced. We have analyzed and presented the results of these deployments, noting the multimedia services that are among the top 30 applications, with gaming, music, and location based services the most effective for deployment. In terms of an initial deployment, generally fewer services will be available, suggesting that these types of services are highly desirable during the commercial launch of an IMS platform.

Additionally, the longitudinal results demonstrate that to facilitate sustained growth, expansion of the number of multimedia services that include a comprehensive variety of services is required. The pattern of expansion tends to taper after the initial three years of deployment when approximately 30 percent of the existing subscriber base is registered with the platform.

Finally, we have outlined the broad set of capabilities that accommodates the IMS based aspects, as well as the current IT based SDP deployments.

Taken together these results provide some insight as to how IMS based SDP solutions can be designed to accommodate several parameters, including multimedia services that are in high demand, the scalability and integration requirements, patterns for transaction growth, and integrating IT capability.

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