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December 2002

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Abstract

The rapid evolution of the Telecommunications Industry (TI) has resulted in efficient convergence of voice and data transmission using a variety of technologies and mediums. This convergence has made the TI networks more cost effective and at the same time more complex to operate. To address the convergence complexity issues, the Systems Designers and Developers (SD&D) of this major Fortune 500 Telecommunications Company have developed the a Telecommunications Management Model (TMM) that is based on phased-domain technology and management solution. The TMM model converges voice and data over a myriad of heterogeneous environments, diverse architectures, multiple vendors and domains.

This paper discusses the TMM Internet-Domain Management System that is designed to effectively integrate users' multifaceted, interdependent and heterogeneous systems by employing multiple Data Management Systems (DMSs). The TMM reduces the existing complex systems into their most manageable, simple and integrated forms and provides flexibility, extendibility, inexpensive, and state-of-the-art services to its users. The TMM architecture is designed to provide flow-through provisioning of cross-domain end-to-end system design, full service hierarchy layered applications, inter-domain fault analysis and reduction, across the board standardized components and logical and physical access to converged voice and data transmission. The model has been effectively applied in two business units of this telecommunications company, it has accomplished its primary goal of reducing network complexity, and has successfully converged voice and data transmissions.

Keywords: Telecommunications systems, data communications, voice and data transmission

Introduction

The Telecommunications Management Model is a state-of-the-art model that very effectively improves the three major aspects of the network complexity issues: service introduction, equipment maintenance and upgrade, and system management and control. The model efficiently reduces network complexity by a set of principles such as simplification, separating, distributing, configurating, updating, interfacing, and integrating.

The model uses three case-by-case procedures to reduce network complexities: service procedure, portioning, and upgrading. In addition, the model employs nine inter-domain technologies to make a network more effective to its users: single point entry, end-to-end design, expeditious attention, service management, single access point, capacity threshold, demand tracking, root cause fault analysis, and standard and open interfaces [Grover and Vaswani, 2000]. Figure 1 is a presentation of model's architectural integration in a Ti environment. As Figure 1 indicates, the model is an internet-based model that interconnects service and control module with media and access requirement module.

The model's architecture provides its users a competitive edge through five inter domain management applications: Inter Domain Fault Manager (ID-FM), Inter Domain Capacity Manager (ID-CM), Inter Domain Tree Manager (ID-TM), Inter Domain

Provisioning Manager (ID-PM), and Inter Domain Presentation Manager (ID-PM). In conclusion, the TMM model not only effectively converges voice and data transport over myriad of diverse architectures and technologies, it also provides its users with a competitive edge during the three life-cycle phases of a network: design and development, testing, and maintenance [Chatzipapadopoulos and Peterdikeas, 2000]. Figure 2 shows the model's packet switching solution architecture and its components. The model's packet switching module employs the ATM and IP control and bearer switches and technologies to integrate voice and data (Figure 2).

Background

The Telecommunications Industry (TI) is challenged by a significant increase in the complexity of information transfer due to a recent proliferation of data mining technologies, techniques and applications. As the result, the TI is facing a fundamental paradigm shift, with the convergence of voice and data services as well as ever expanding technologies to its users. These technological movements towards a convergence of telephony and computer technologies, web-based networks, wired and wireless services are creating areas of tremendous opportunities. These areas of opportunity are for continuous quality improvements and applications of the voice and data convergence mining techniques and their implementations. The TI's implementation of the data mining algorithms reduces information overloads, increases data integrity and accuracy, and effectively manages its global networks.

The proposed TMM is packet-based; integrating voice, data, and video and other high-technology services. This model is capable of managing networks data mining and providing third-party programmability to a variety of system users connected by different mediums [Van Vliet, 2000].

Paradigm Shift

The SD&D are now facing a paradigm shift as how to integrate more modern packet-based systems with other outdated networks in existence. Modern TI service providers are demanding consolidation of their capabilities under one global network or as part of a packet-based system. This integration improves users' product and service applications and their programmability across the networks. The TMM has improved network service integration by implementing modern data mining technologies, information filtering, and deploying packet-based voice and data systems independent of more outdated circuit-based voice telephony [Comer, 2000]. Figure 3 is a presentation of the TMM's service architecture. The model's service architecture has four interactive and interdependent server modules that manipulate the integrated voice and data and prepare them for transmissions; two application servers, directories, and programmable feature server (Figure 3).

One of the primary methods of network integration is convergence of voice and data. The reason for network convergence is to increase services, profits and user satisfaction. Advanced TMM technology is capable of converging voice and data as well as improving the systems' efficiency, simplification, productivity, data management and mining. The model is also flexible enough to permit additions of new tools and adaptation of other technologies such as information filtering, economic aspects and dimensionality reduction, optimization and sensitivity analysis [Eldring and Sylla, 1999]

The TMM is especially suitable to major global telecommunication networks that consist of complex systems and components. It is designed to improve productivity of interrelated, dynamic, and rapidly evolving global systems. The "dichotomy" of the model is that as it converges voice and data, while it simultaneously makes them more complex through adaptation of new advanced technologies. Therefore, the primary objective of the model is to simplify a network by continuously updating, upgrading and modernizing it. This pursuit of continuous system convergence and modernization is the rationale behind the need for the model [Morrison, 2000].

Rationale

Traditionally, the major telecommunication companies have provided two independent services to their network users: packet-based data, and circuit-based voice telephony. Interdependency of these services has caused bottlenecks, redundancies, and chaos in the networks. The TMM eliminates these network problems by converging the two services together as a unified entity of the packet networks. To reduce problems, TMM helps the network providers with third-party programmability and support. Service convergence also includes the transmitting of voice and data through the network's systems. In addition, the model standardizes the network's applications which eliminates dependency and reliance on one vendor. However, integration of the network services decreases its complexity and operability costs, and increases service consolidation and functionality [Guston, 1999].

Originally, packet switching was developed for computer telecommunications networks. The model employs switching technologies to converge other network systems such as transmitting, transporting and accessing along with their products and services. It employs object oriented programming, distributes client and server simulation modeling, middleware processing, and open application programming interfaces to standardize the model's application and usage [Solomon, 1998]. The TMM architecture has made it feasible for complex networks to provide data communications through various media transports; wired and wireless access; narrow and broadband; and Internet-based technologies. These new technologies are the foundations of the TMM voice and data communication convergence that can be used in modern Internet-based networks [Hollifield and Donnermeyer, 2000].

Modern mechanized TI networks are urgently in need of convergence of voice and data, as well as computer and Internet communications. The TMM packet switching technologies are able to converge broadband voice, data, and video access. The TMM technologies are also capable of supporting wireless technologies such as Asymmetric Digital Subscriber Line (ADSL), Wideband Code Division Multiple Access (W-CDMA), and Wideband Time Division Multiple Access (W-TDMA). Without any complications, these different technologies are bridged into the TMM providing a common packet node with a core set of services across all the access types [Jerome and DeLeon, 2000]. The TMM technology is able to efficiently service between the end points of different types without interference from each type. The TMM packet switch technology provides TI users with real time Web-based customized service interfaces such as Application Programming Interface (API). Using object-oriented-based and Programmable Feature Services (PFS) technologies in a Distributed Processing Environment (DPE), TMM standardizes the Web-based user platform services [Kibirige, 2000].

Modern Technologies Used

Most TI networks consist of a variety of systems with differing operating environments. They include a host of heterogeneous technologies and management methods that are mostly inconsistent, not standardized, lack resources, need upgrading and very costly. The SD&D of these networks experience difficulties bridging TI networks with user systems, and are not able to properly converge their voice and data telephony. Vertical management tools are becoming predominant in these environments. While adding their abilities to interface with new technologies, they also add their own complexities. As the result, TI has attempted to standardize its networks by adapting similar technologies across the board, and unifying a multiple vendor policy [Guston, 1999].

Network users and providers are encouraged to become more proactive in cooperating with the SD&D as a new system is being developed. The users and service providers are asked to work with SD&D to more efficiently manage and integrate their existing diverse and complex legacy systems. Also, to implement modern technologies such as Time Division Multiplexing (TDM), Asynchronous Transfer Mode (ATM), Synchronous Optical Network (SONET), Synchronous Digital Hierarchy (SDH), Frame Relay (FR), Dense Wavelength Division Multiplexer (DWDM), Internet Protocol (IP), and others to their advantage [Van Vliet, 2000].

TMM uses inter-domain management system to integrate physical and logical applications of a network with its processes. The inter-domain management system bridges network applications using the following nine technologies:

1. *Single point entry*; ensures that data is properly entered from one point of entry and properly processed, tracked, and monitored.

2. *End to end design*; ensures synchronization and coordination of the logical and physical data for systems that traverse the service providers hybrid network.

3. *Expeditious attention*; ensures immediate process of voice and data that contain system compositions.

4. *Service management*; ensures that user services are effectively provided, monitored, upgraded, and managed.

5. *Single access point*; ensures that users are able to access converged voice and data, control their logical and physical systems on a real-time basis, and enhance their information flow.

6. *Capacity thresholds*; ensures that voice and data convergence capacity limitations are developed, triggering mechanisms are activated, and backups are accessible when thresholds are reached.

7. *Demand tracking*; ensures tracking of pending equipments, parts, tools, facilities, and technologies such as TDM, ATM, SONET, SDH, FR, DWDM, IP, etc.

8. *Root cause fault analysis*; ensures identification and isolation of problem areas, analysis of each situation, and their eliminations using the inter-domain fault correlation.

9. *Standard and open interfaces*; ensures fault, performance, and physical inventory management of the existing and legacy domain configuration systems using standard and open interfaces such as Common Object Request Broker Architecture (CORBA*).

Capabilities

The model uses the following seven capabilities to access the highest quality Internet-based data and voice information throughout the telecommunication company's global network:

1. *Simplifying*; decomposing network components into their basic forms enables the TMM to breakdown a network's complex functions into their basic forms. This capability results in a common signaling and interconnecting core that is able to open interfaces between its new basic functional components. The capability also results in a more flexible architecture by supporting mix and match interworking that can effectively interface and configure with differing applications. The TMM implements the Intelligent Network (IN) technology to simplify a network's service complexities and related problems [Comer, 2000]. The IN technology is based on upgrading outdated services, deploying new ones, testing their consistencies, programmability, and interoperability with other systems and components. The IN also evaluates and compares network services, and determines whether a service needs an upgrade or not [Hollifield, 2000].

2. *Separating*; ensures separation of network services from its components through application of Layered technology. It improves the network's ability to continuously monitor its services and components independently, by creating separate paths for each one. Makes it possible to identify common services and employ them throughout the network's transport and access types [Kibirige and DeLeon, 2000]

3. *Distributing*; ensures creation of a fully distributed architecture and processing environment to the network users that is capable of component location transparency. The client server technology transforms flexible packaging of logical functional components into their basic physical elements for further analysis and use [Lee, 2000].

4. *Configurating*; using the mix-and-match capability, the model provides flexible configuration, upgrades its various components and enables them to work together in a synergistic manner. Using the mix-and-match methodology a functional subset component is identified and configured for a unique application. This identification technology evaluates and identifies targeted components, and recommends either upgrade or replacement without any adverse impact to the other components [Eldering and Sylla, 1999].

5. *Updating*; using advanced service programmability technology, the model updates network software and hardware services, provides fast network service creation and network usage, and improves third part programmability.

6. *Interfacing*; identifies a new network's functions that require integration with the existing legacy system components, and systematically bridges them together.

8. *Integrating*; decomposes a network's components into their basic forms, and integrates them efficiently. It also flattens a network by integrating its component operations; controlling its unified processes; and controlling its various functions. This integration capability is possible by dividing the components into unique and identifiable nodes and controlling them in sequence [Solomon, 1998].

Conclusions

This paper describes the TMM, its architectural approach and technology, and the challenges the System Designer and Developers (SD&D) had to overcome to develop the model. The TMM is based on a set of sound scientific principles and algorithms that help converge network's system with their service architectures. The TMM is providing SD&D a methodology and framework for knowledge discovery, information filtering, and portioning service functions into manageable categories [Parker, 2000].

The model improves the three major aspects of the network complexity issues: service introduction, equipment maintenance and upgrade, and system management and control. The model effectively reduces network complexity by a set of principles such as simplification, separating, distributing, configurating, updating, interfacing, and integrating. The model also uses three case-by-case procedures to reduce network complexities: service procedure, portioning, and upgrading. In addition, the model employs nine inter-domain technologies to make a network more effective to its users: single point entry, end-to-end design, expeditious attention, service management, single access point, capacity threshold, demand tracking, root cause fault analysis, and standard and open interfaces. Figure 3 is a presentation of model's service architecture and its technologies.

Acknowledgements

The authors greatly appreciate support from NJK Holding Corporation grant and its subsidiaries. In addition, we are thankful to our colleagues at the University of Nebraska at Omaha, and our graduate students. Especially, we are truly grateful to two University of Nebraska at Omaha individuals: Dr. Mark Pauley for his editing and his suggestions; and Lin Cao for preparing the figures. Finally, we are also grateful to our System Engineering colleagues at the AT&T-Labs, Lucent Technology Bell-Laboratories, and IBM Watson Research Center for their valuable inputs, directions and suggestions.

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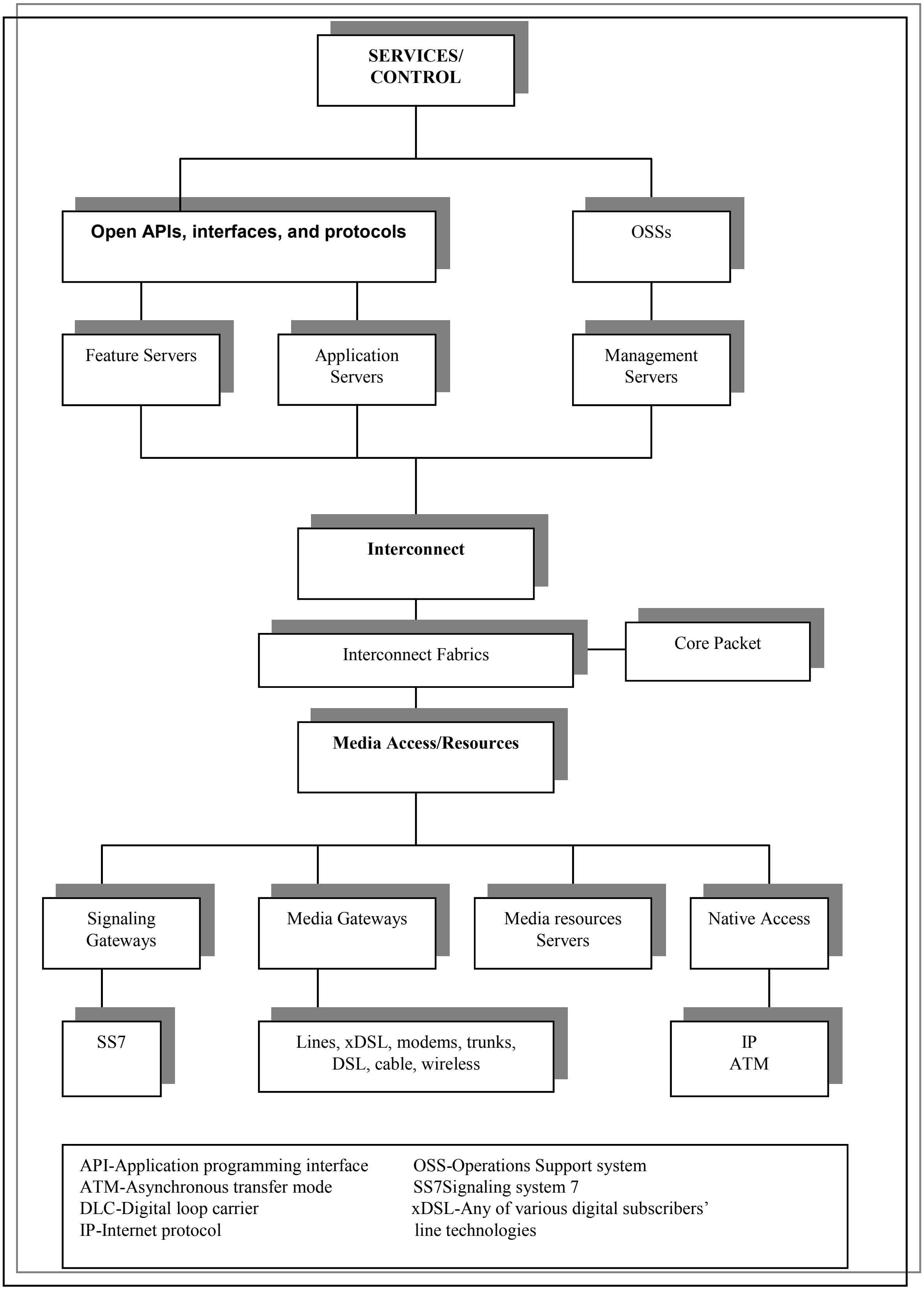

Figure 1. Model's Architecture Integration in a TI Environment

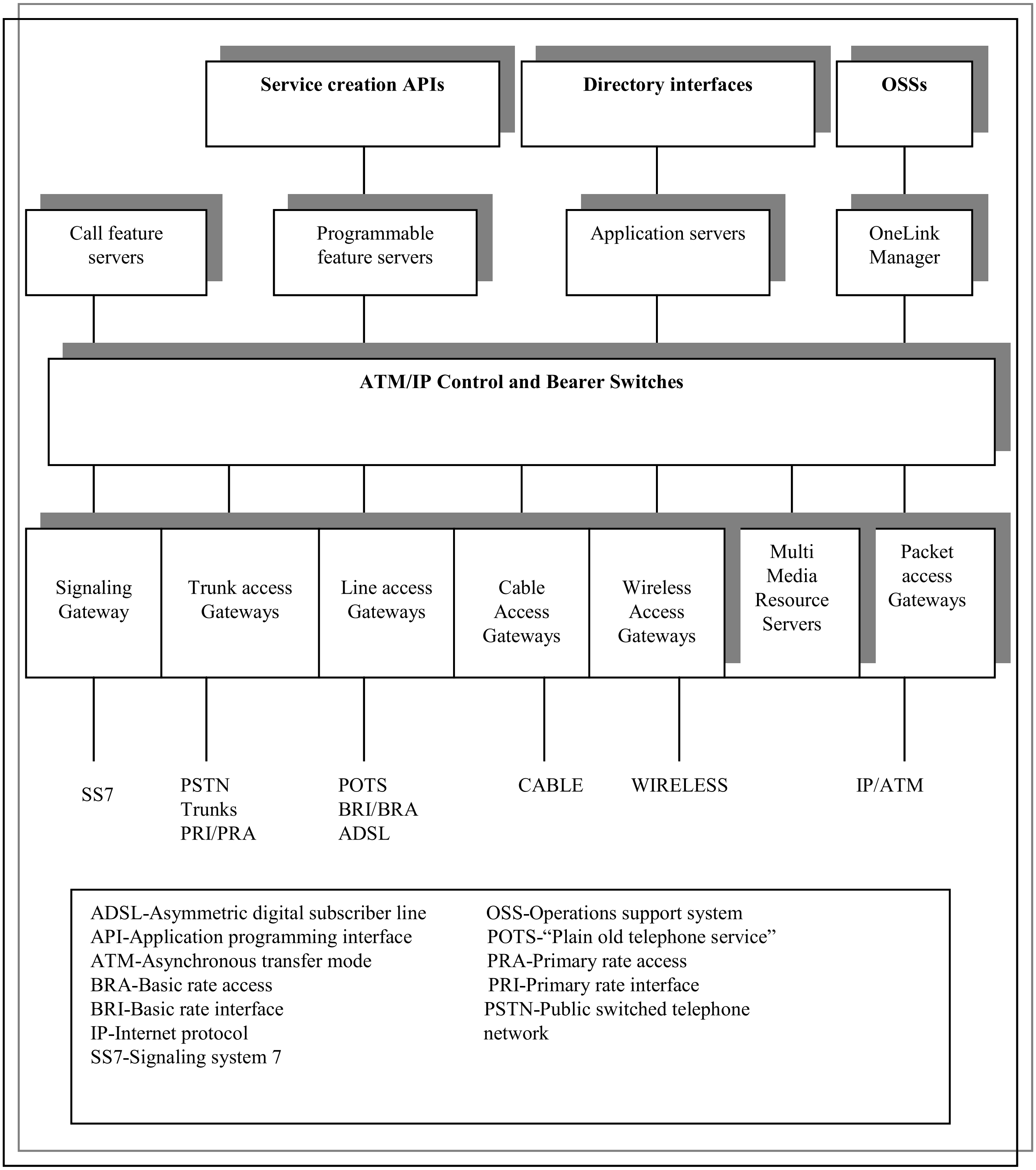

Figure 2. Model's Packet Switching Solution Architecture and Its Components

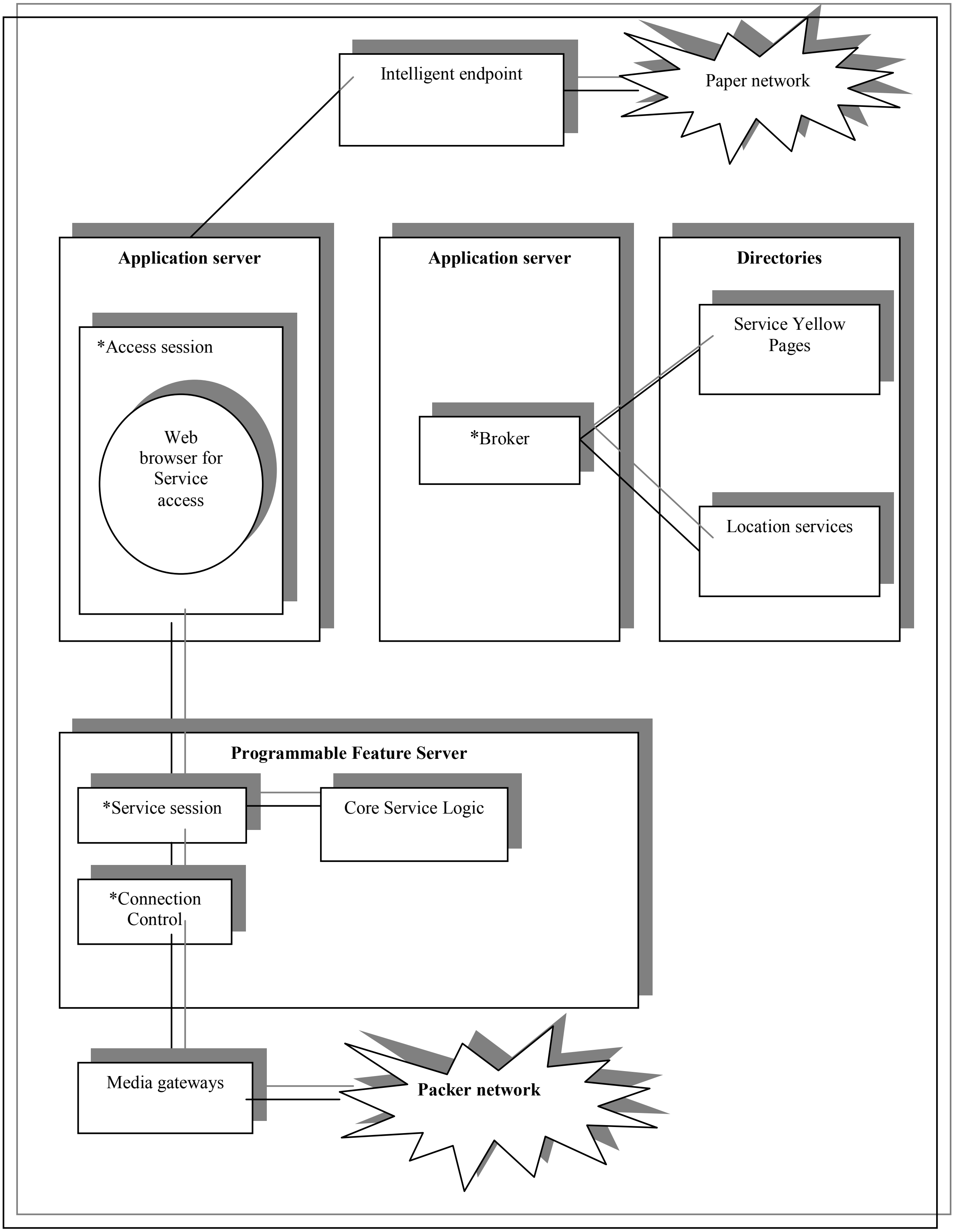

Figure 3. Model's Service Architecture