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(72) HOLCOMB, GRANT K., US
(71) TERAGLOBAL COMMUNICATIONS CORP., US

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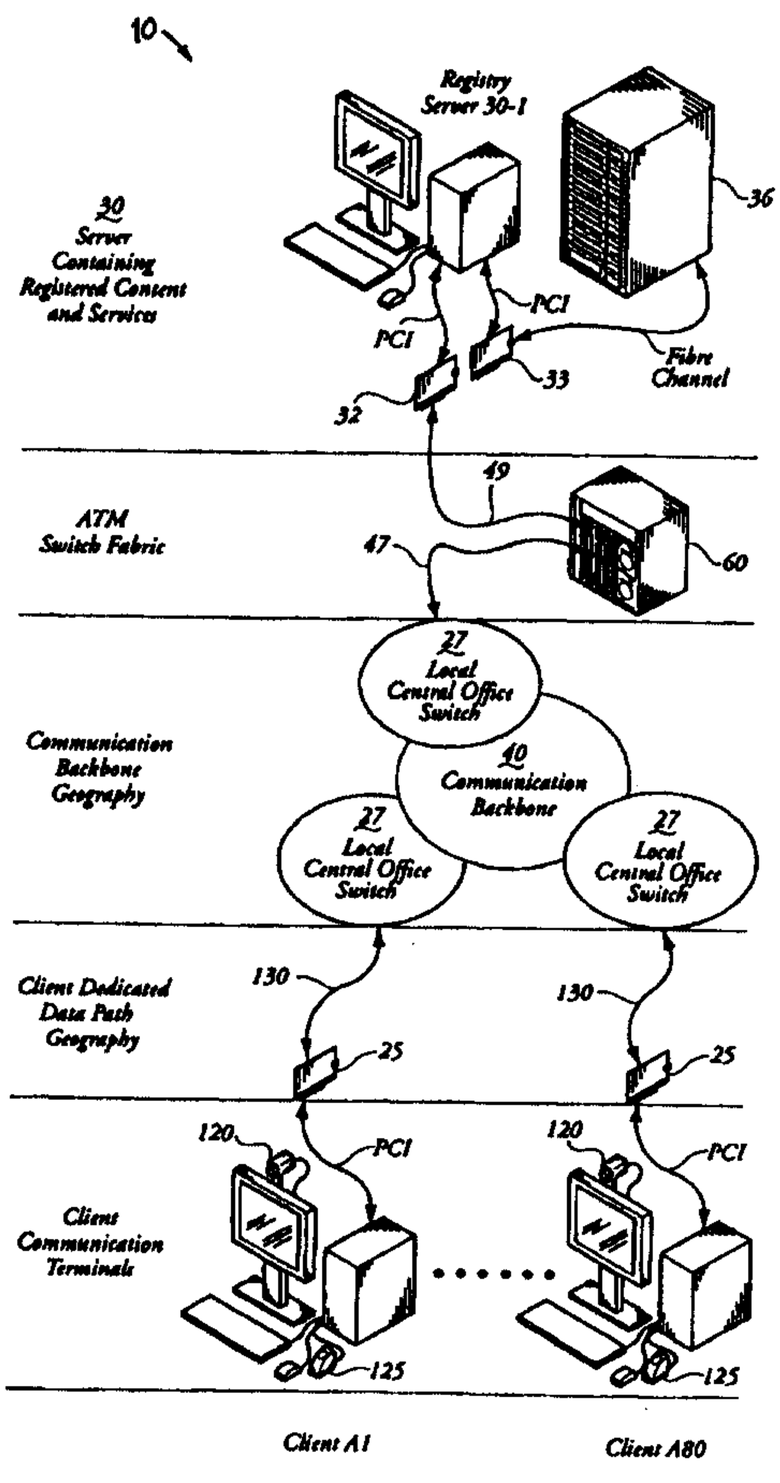
(54) **ARCHITECTURE DE CALCUL ET DE COMMUNICATION UNIFIEE**

(54) **UNIFIED COMPUTING AND COMMUNICATION ARCHITECTURE (UCCA)**



(57) L'invention concerne une architecture de calcul et de communication unifiée (UCCA), offrant une solution de communication multiplateforme, bon marché, sûre, en temps réel, bidirectionnelle, robuste, fiable, à compatibilité amont, continuellement évolutive. Cette architecture comprend une ou plusieurs cellules de

(57) A Unified Computing and Communication Architecture (UCCA), which offers a cost effective, secure, real-time, full-duplex, robust, reliable, backward compatible, continuously upgradable, cross-platform communication solution. The architecture includes one or more Service cells (10), and each Service Cell (10)

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service (10), chaque cellule de service (10) comprenant un ou plusieurs serveurs de registre (30-1), reliés à une pluralité de terminaux de communication (A1, A80) de clients par l'intermédiaire d'un commutateur ATM (60) central sans blocage. Chaque terminal de communication (A1, A80) de client comprend, en outre, une plateforme informatique dotée d'un ou plusieurs processeurs hôte de type processeurs arithmétiques avec une caméra numérique (120), des haut-parleurs, un microphone, un ou plusieurs dispositifs d'affichage, un dispositif de biométrie (125), et une interface de communication (25) ATM, afin d'établir une connexion spécialisée avec un commutateur ATM (60). Chaque serveur de registre (30-1) comprend également une interface de communication (25) ATM, afin d'établir une connexion spécialisée avec le commutateur ATM (60) et un réseau de disques durs à vitesse très élevée.

includes one or more Registry Servers (30-1) connected to a plurality of Client communications terminals (A1, A80) through a central non-blocking ATM switch (60). Each Client communication terminal (A1, A80) further comprises a computer platform with one or more supercomputer class host processors with Digital Camera (120), speakers, microphone, one or more displays, a biometrics device (125), and an ATM Communication Interface (25) for dedicated connection with said ATM switch (60). Each Registry Server (30-1) further comprises an ATM Communication Interface (25) for dedicated connection with the ATM switch (60) and an ultra-high speed hard disk array.

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(71) Applicant *(for all designated States except US)*: TERA-GLOBAL COMMUNICATIONS CORP. [US/US]; 6th floor, 9171 Towne Center Drive, San Diego, CA 92122 (US).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: HOLCOMB, Grant, K. [–/–]; 4560 Conrad Drive, La Mesa, CA 91941 (US).

(74) Agents: CRAIG, Royal, W. et al.; Law Offices of Royal W. Craig, P.C., Suite 1319, 210 North Charles Street, Baltimore, MD 21201 (US).

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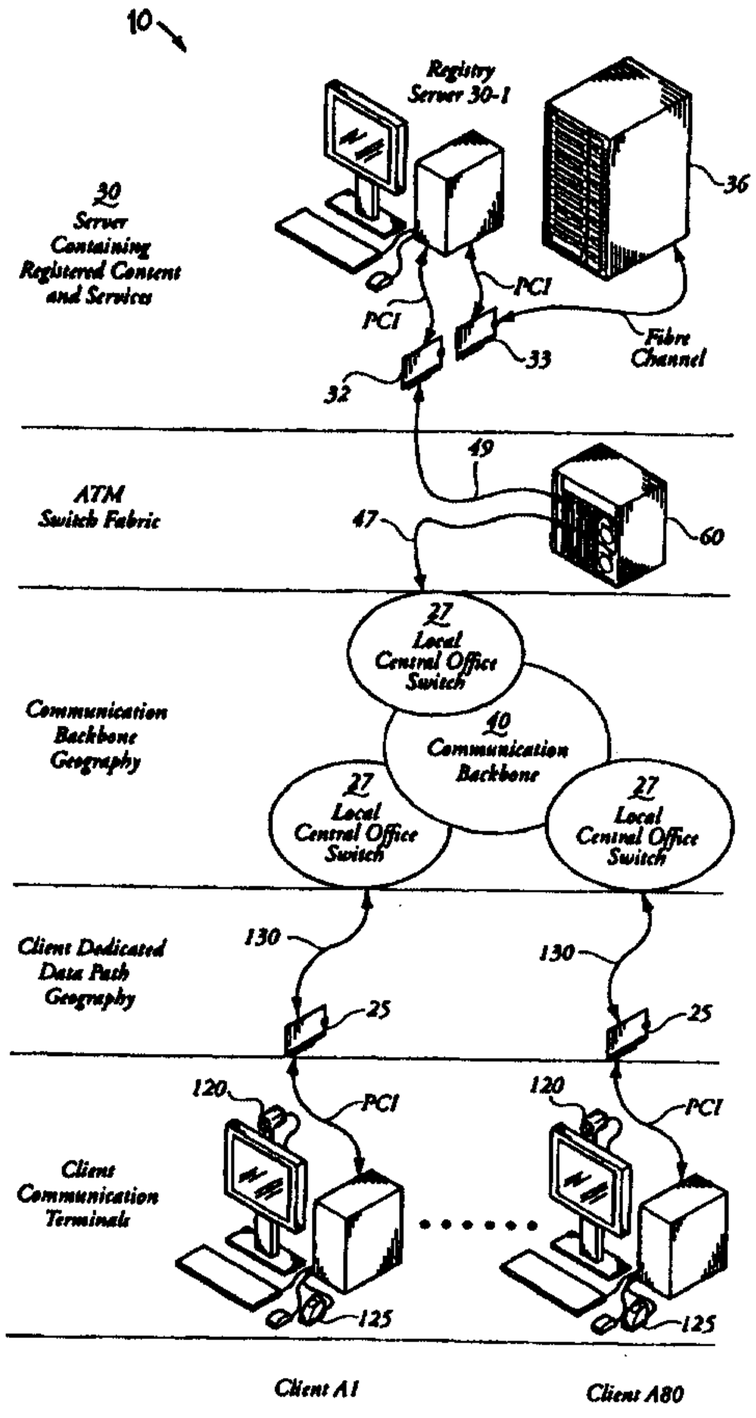
(54) Title: UNIFIED COMPUTING AND COMMUNICATION ARCHITECTURE (UCCA)

(57) Abstract

A Unified Computing and Communication Architecture (UCCA), which offers a cost effective, secure, real–time, full–duplex, robust, reliable, backward compatible, continuously upgradable, cross–platform communication solution. The architecture includes one or more Service cells (10), and each Service Cell (10) includes one or more Registry Servers (30–1) connected to a plurality of Client communications terminals (A1, A80) through a central non–blocking ATM switch (60). Each Client communication terminal (A1, A80) further comprises a computer platform with one or more supercomputer class host processors with Digital Camera (120), speakers, microphone, one or more displays, a biometrics device (125), and an ATM Communication Interface (25) for dedicated connection with said ATM switch (60). Each Registry Server (30–1) further comprises an ATM Communication Interface (25) for dedicated connection with the ATM switch (60) and an ultra–high speed hard disk array.



UNIFIED COMPUTING AND COMMUNICATION ARCHITECTURE (UCCA)

Cross-reference to Related Inventions

The present application derives priority from U.S. provisional patent application Serial No. 60/109,420, entitled "INTERACTIVE COMMUNICATION NETWORK"; filed: 19 Nov. 1998.

Technical Field

The present invention relates to computer based communication architectures and, more particularly, to a full-duplex real-time multiple point-to-point and multiple point-to-multi-point communication network topology that facilitates the seamless integration of audio, video, imagery, data, and user interaction into the computer based communication process through controlled Quality of Service (QoS) packet-based data transfers.

Background Art

Every organization regardless of size or market has the identical information flow problem, namely, getting the right information to the right people at the right time. Audio, video, images, forms, spreadsheets, records, applications, books, reports, designs, plans, courses, training materials, briefs, etc., all comprise the diverse array of content organizations need to operate. The goal of the Unified Computing and Communication Architecture (UCCA) is to deliver a computer based communication solution that supports the required information flow and allows the creation of content, management of content, distribution of content, security of content, and the assessment of the use of content.

A heightened level of communication is essential in the context of group collaboration and training. For these efforts to be successful, a subject matter expert must communicate content in a dynamic manner and manage and encourage the interaction of multiple participants. The subject matter expert must facilitate the interaction, preferably approximating face to face collaboration or "hands-on" learning. Finally, the subject matter expert must have the capability to monitor the

level of participation or success of individual participants and the group as a whole. Thus, the assessment capability becomes crucial.

The perfect network would simultaneously facilitate the creation, management, distribution, security, and assessment of use of a diverse array of content. When participating in a communication session using this network, the experience would be as dynamic and effective as two or more people conducting direct personal communication. Two or more individuals communicating in real time and fully collaborating in a "hands-on" situation represents the highest possible communication bandwidth. It occurs in real time, is fully two-way interactive, and generates the required stimulation that all humans need to effectively retain information.

It is also important to note that assessment is the most critical aspect of this information flow process. Of all of these capabilities, assessment has the most direct impact on measuring success and increasing both the productivity and efficiency of any process. For example, a medical treatment plan, a course series, a production line, a distribution channel, a combat mission, and a consumer marketing campaign all have a common need for assessment to determine if they were successful. There can be no continuous improvement of productivity and efficiency of any process without assessment.

All this implies that effective computer based communication should also be done in real time. It also implies that the participants must be stimulated visually, audibly, and emotionally as well as allowing the participants to interact with the information during the process. Any solution to the information flow problem must begin with a viable communication infrastructure. Unfortunately existing telephony, Local Area Network (LAN), Wide Area Network (WAN), Internet, satellite, wireless, and Cable TV technologies are barriers to information flow. All have inherent limitations that prevent real-time, two-way, guaranteed, global, equal access, reliable, continuously upgradeable, high quality service. The telephony infrastructure is

real-time two-way in nature, but it is statistically based and can only handle audio not the diverse array of content required of real information flow. Satellites are too complex and expensive when deployed in a real-time two-way fashion. Cable TV plants are one-way. LAN, WAN, and Internet technologies are statistically based and cannot deliver any of the guarantees of Quality of Service (QoS), performance, security, and reliability that are required to solve the information flow problem.

FIG. 1 is a conceptual model of a managed information flow solution ideally suited for collaboration and training over a distributed computer based communication network. Generally, the participation of six different denominations is required.

(1) A Manager (Moderator or Teacher) initiates sessions, performs session management, delivers content to one or more Participants (Users or Students) in the form of real-time audio, video, graphics, text, etc., and manages assessment and feedback from the Participants (Users or Students) of a session.

(2) The Participants (Users or Students) first authenticate themselves in a network centric fashion. The Participants (Users or Students) can communicate directly with a Manager (Moderator or Teacher) or any number of other Participants (Users or Students) in real-time in a variety of ways during an active session. The Participants (Users or Students) receive, add, edit, and interact with content and provide feedback in real-time to allow individual and group assessment of progress by the respective Manager (Moderator or Teacher).

(3) A Help Desk is available to all participants for any problems that might arise.

(4) The Network Administrator creates new network accounts and maintains

the network's accounts, security and billing through analysis of an audit trail of all network access.

(5) Auxiliary Communications are available to provide legacy and alternative communication capabilities. This includes Internet, telephone, facsimile, television, Cable TV, radio, etc.

(6) Content Developer is responsible for producing the diverse array of content for use and delivery by any number of Managers (Moderators or Teachers) and Participants (Users or Students).

All of the above-described kinds of participants must have seamless point-to-point and point-to-multi-point communication capabilities within the network, all communication formats (audio, video, imagery, data, etc.) must be seamlessly integrated into the network, and communication of all formats must be substantially real-time.

Unfortunately, the above-described information flow model cannot be implemented in a computer based communication solution without each participant's computer simultaneously having the right balance of extremely high computational power in the host processor and high-speed two-way data throughput capacity. These characteristics are essential to meet the demands of convergence, which represents the simultaneous support for all media formats (audio, video, imagery, data, etc.). Also, the information flow model requires real-time performance, the need for total and unconditional interactivity, and an extensive tracking requirement. Conventional technologies and processing power have made the foregoing prohibitive.

Nevertheless, there have been prior efforts. For instance US. Patent No. 5,790,553 to Deaton, Jr. et al. shows a layered communication architecture based on the Open Systems Interconnection Model ("OSI") wherein communications amongst stations in

any given layer can take place with no need for routing through or any other interaction with any higher layer stations. Of course, this significantly reduces overhead and greatly speeds the interactive communication process. The above-described '553 patent only provides a partial software solution in the form of a communication protocol. The '553 patent does not teach or suggest how to implement the software on a network architecture for dynamic real time multi-user communication. A true point-to-multi-point communication network must seamlessly integrate the following capabilities into the computer communication process by packet-based communication: advanced video conferencing; distributed 2D and 3D image manipulation; distributed virtual reality; advanced data manipulation; and a streamlined content development process that also facilitiates efficient content distribution.

The above is only a partial list of the array of audio, video, imagery, data, and user interaction capabilities that a robust architecture must support. More recent hardware advances have led to faster processing using less power in a smaller physical space. Moreover, parallel processing allows the linking of computers to accomplish tasks in parallel. Memory has increased in density and reduced in size. Also, as the hardware evolves, software development tools follow that take advantage of the above advances. On top of it all, market demand for the above has brought prices down. It is now commercially and technologically feasible, and would be greatly desirable to provide a high performance, low cost, easy to use, secure, and reliable communication infrastructure to implement the model of FIG. 1. Such an architecture would allow simultaneously the full participation of a session Manager (Moderator or Teacher), authenticated Participants (Users or Students), a Network Administrator, a Help Desk, any necessary Auxiliary Communication Services, and Content Developers. All of these denominations would have simultaneous and seamless point-to-point and point-to-multi-point communication capabilities within the network, inclusive of all communication formats (audio, video, imagery, data,

etc.), and substantially in real-time.

Disclosure of Invention

It is an object of the present invention to provide a cost effective, robust, reliable Unified Computing and Communication Architecture (UCCA).

It is another object to provide a managed information flow solution in which a Manager (Moderator or Teacher), Participants (Users or Students), Network Administrator, a Help Desk, and Content Developers share seamless point-to-multi-point communication capabilities for collaboration and training through the UCCA, inclusive of all communication formats (audio, video, imagery, data, etc.), and substantially in real-time.

It is still another object to provide a UCCA as described above which simultaneously supports standard Internet services, standard telephony services, advanced video conferencing, video on demand services, distributed 2D and 3D imagery, distributed virtual reality, asset management, data warehousing, content distribution, and a wide variety of other advanced capabilities that require guaranteed access, high performance, security, and control of Quality of Service (QoS) over a highly distributed network infrastructure.

In accordance with the above-described objects a UCCA is herein disclosed which is comprised of one or more interconnected Service Cells. A Service Cell is comprised of one or more Registry Servers, optionally one or more Special Purpose Servers, a plurality of Clients (communication terminals) all connected to one central Asynchronous Transfer Mode (ATM) non-blocking switch array. Each Client is comprised of one or more supercomputer class host processors, a digital camera, speakers, a microphone, one or more displays, high speed data storage, a biometrics verification device, and an advanced ATM based communication interface for dedicated connection to the respective Service Cell's central ATM switch. A Client can be in multiple forms like a desktop computer, a wireless handheld device, or an

interface device to a peripheral like a High Definition Television (HDTV) monitor. Each Registry Server is comprised of a computer connected to a scalable ultra-high speed data storage array with an advanced ATM based communication card for dedicated connection to the respective Service Cell's central ATM switch. In a single Service Cell the data controlled by the Registry Servers is mirrored across their respective data storage arrays and each Registry Server controls a predetermined maximum number of simultaneous Client connections. Each Client is served directly in a two-way point-to-point fashion by a permanently assigned Registry Server through the ATM switch using a full-duplex Switched Virtual Circuit (SVC) or Permanent Virtual Circuit (PVC) between the Client and its assigned Registry Server. Network and stored data access by a Client with its respective Registry Server is guaranteed. A Special Purpose Server is comprised of the same elements as a Registry Server, but both network and stored data access is statistically based from any Client's perspective within the respective Service Cell. A plurality of network and client services are maintained by each Service Cell to ensure the proper information management flow. The network services include availability, quality, reliability, serviceability, maintainability, extensibility, authentication services, security services, registry services, high availability services, fault tolerance services, resource management services, bandwidth management services, data storage services, communication services, Internet services, telephony services, and supercomputing services. The client services include contact services, session management services, session status services, scheduling services, audio services, video services, message services, chat services, assessment services, projection services, collaboration services, presentation services, authoring services, asset management services, Internet services, media services, help services, network management services, service administration services, security services, telephony services, simulation and gaming services, and supercomputing services.

The UCCA of the present invention has the processing power to more closely

approximate reality. Moreover, the present communication architecture lends itself to cross-platform operation with numerous different computer operating systems, computer architectures, communication protocols, and ways to physically network computers. The communication infrastructure is backward compatible and upgradeable without changing how a user interacts with the solution. In addition the UCCA can be continuously upgraded via software eliminating the need for frequent hardware upgrades necessary to periodically add new services and functionality.

Brief Description of the Drawings

Other objects, features, and advantages of the present invention will become more apparent from the following detailed description of the preferred embodiment and certain modifications thereof when taken together with the accompanying drawings in which:

FIG. 1 is a conceptual model of an effective managed information flow solution.

FIG. 2 is a communication flow diagram of the UCCA according to the present invention.

FIG. 3 is a block diagram of a minimally configured Service Cell 10 inclusive of a single Registry Server 30-1.

FIG. 4 illustrates the various dedicated communication data paths that are capable of connecting the Clients A1-An to their respective Service Cell.

FIG. 5 illustrates a single Service Cell with a plurality of Registry Servers 30-1...3 and one Special Purpose Server 30-4.

FIG. 6 illustrates the communication protocol layers employed by the advanced ATM based communication interface used in the Registry Servers, Special Purpose Servers, and Clients.

FIG. 7 is a block diagram showing the array of interrelated Network and Client services employed in the architecture of Figs. 3-5.

Best Mode(s) for Carrying Out the Invention

The Universal Computing and Communication Architecture ("UCCA") to be described herein includes the foundational network infrastructure plus the network and client services services that "converge" traditional voice, email, video conferencing, facsimile, and data networks. The resulting UCCA allows a diverse array of content to be created, distributed, managed, secured, and its use assessed through a true two-way real-time guaranteed access multiple point-to-point and multiple point-to-multi-point communication network.

The UCCA of the present invention is described herein in the particular context of a managed information flow solution ideal for collaboration and training, although it should be understood that the system is not so limited in scope. In the collaboration and training context, the system implements the communication flow diagram of FIG. 2. The system facilitates the participation of six active denominations of Registered Users 1-6.

The Manager (Moderator or Teacher) 1 initiates sessions, performs session management and control, delivers course content to multiple users in the form of real-time audio, video, imagery, text, etc., conducts assessment, and monitors the assessment results and session feedback from the Participants (Users or Students) 3.

The Network Administrator 4 maintains the accounts and privileges of all Registered Users 1-6. The Network Administrator 4 conducts the initial registration of all Registered Users 1-6 employing the use of a biometrics device like a fingerprint scanner. The Network Administrator 4 also maintains the audit trail of all usage by Registered Users 1-6.

The Participants (Users or Students) 3 authenticate themselves to the network through a combination of biometrics device and password authentication, after which all authorized communication services are published for their immediate access.

A Collaboration Moderator 2 moderates an active collaborative session that involves multiple participants working together on common information using the

system described herein. Any Registered User 1-6 can at some point be tasked by a Manager (Moderator or Teacher) 1 or an active Collaboration Moderator 2 to moderate an active communication session which gives them the privilege to manage, control, and terminate a session.

A Help Desk 5 is available to all Registered Users 1-6 for any problems that might arise.

One or more Content Developers 6 are responsible for producing course content and media for delivery by the Manager (Moderator or Teacher) 1, and in some cases a single Registered User may fill the roles of both Content Developer 6 and Manager (Moderator or Teacher) 1.

In addition, an Applicant (New User or Student) 7 may seek an account on a UCCA and if approved they become a Registered User.

Finally, an array of Auxiliary Communication Services 8 are available to provide direct access to legacy technologies like Internet services and telephony services during any active UCCA hosted communication session. In addition a Registered User on a Client, if granted the privilege, has on demand access to any or all published Auxiliary Communication Services 8.

Any Media 9 destined for use as a component of registered and published content is stored on Registry Servers that comprise each Service Cell 10-1...n (to be described). This facilitates usage assessment (also quizzes and exams) and the tracking of copyright protected media in the managed information flow process.

All of the above-described Registered Users are given simultaneous and seamless point-to-point and point-to-multi-point communication capabilities within the network. The network integrates the following media capabilities into the computer based communication process through controlled Quality of Service (QoS) packet-based data transfers:

- Advanced Video Conferencing - the UCCA supports the distribution of high resolution full motion video using less bandwidth. The higher computational and data

throughput power of each Client supports higher compression ratios and lower latency. This also facilitates real-time manipulation of any video stream. The ability to draw over, zoom, record, or even conduct image recognition is possible. The UCCA can employ two-way real-time video in any size point-to-multi- point communication session and does not have any of the disadvantages or limitations of existing video bridging or one-way video broadcast solutions.

- Distributed 2D and 3D Image Manipulation - Instead of waiting for a high quality 3D image to draw and move slowly on the screen, the image can be drawn and manipulated in real-time. During a point-to-multi-point collaboration session any size group can interact with the same 2D and 3D images simultaneously in real-time. This ability supports advanced simulations and "what if" scenarios that are not currently possible. Elements of information that more closely approximate reality can be created to enhance an individual or group communication session.

- Distributed Virtual Reality (VR) - Conventional VR solutions render low quality 3D graphic elements that give the perspective of being physically with the objects. To immerse and stimulate a user during a communication session, the UCCA can support true photo realistic VR in real-time. During a point-to-multi-point collaboration session any size group can interact with the same VR scene simultaneously in real-time. The present architecture provides the feedback and visualization of an experience that can more accurately reflect reality.

- Advanced Data Manipulation - The present architecture supports the ability to index, search, and analyze large volumes of data at ultra-high speeds. For example, during a communication session, data supporting 3D charts can be multicast to the appropriate Clients in real-time allowing critical data to be easily visualized by a group.

- Content Development - The present architecture facilitates the streamlined creation and efficient distribution of a diverse array of content, including the ability to edit video clips, create 3D simulations, or create VR scenes. The above is only a

partial list of the seamless integration of audio, video, imagery, data, and user interaction the present invention supports.

The following describes the network architecture of the invention.

1. Network Architecture

The communication and information flow diagram of FIG. 2 is implemented by a unique distributed network architecture that simultaneously supports multiple point-to-point and multiple point-to-multi-point real-time full-duplex connections without any network performance degradation. This network architecture according to the present invention will now be described with reference to Figs. 3-7.

The basic building block of the UCCA is called a Service Cell. FIG. 3 is a block diagram of a minimally configured Service Cell 10 inclusive of a single Registry Server 30-1, one central non-blocking ATM switch 60 and a plurality of Client Communication Terminals (e.g., "Clients") A1, A2...A80.

Within a Service Cell 10, the Registry Server 30-1 is assigned the responsibility of delivering guaranteed network and data access to a defined maximum number of Clients A1, A2...An. In FIG. 3 the maximum number of Clients is presented as 80, e.g., A1, A2...A80. Each Client A1, A2...A80 has a Switch Virtual Circuit (SVC) or Permanent Virtual Circuit (PVC) with Quality of Service (QoS) features that allow real-time communication through the ATM Switch 60 with its respective Registry Server 30-1. The total full-duplex data rates of all Clients A1, A2...A80 cannot exceed the Registry Server's ability to deliver content and services at 100% bandwidth utilization. Therefore, the maximum number of Clients A1, A2...An per Registry Server 30-1 is restricted by the Registry Server's ability to guarantee data delivery for an established suite of communication services. Due to the ability to maintain a large number of Virtual Paths (VPs) or Virtual Circuits (VCs) the requirement for guaranteed access and performance can be applied on a service by service basis, not just total bandwidth utilization. This allows a lower

cost UCCA implementation to be supported for non-mission critical applications. In other words, more Clients A1, A2...An can be connected to a single Registry Server 30-1 subsequently introducing statistical behavior at the cost of lower overall network performance.

Clients A1, A2...A80 are connected to their assigned Registry Server 30-1 through a respective Dedicated Data Path 130, a Communication Backbone 40, and an ATM Switch 60. Various types of Dedicated Data Paths 130 are possible as will be described. In existing highly distributed environments, particularly in the continental United States, small ATM switches are typically employed in Local Central Offices. Dedicated Data Path 130 relies on a local central office ATM switch 27 to concentrate the ATM traffic from Clients A1, A2...A80 through an existing Communication Backbone 40 for direct connectivity to ATM Switch 60. The ATM Switch 60 is "non-blocking" in that any simultaneous point-to-point and point-to-multi-point SVC combination is supported. In this fashion any Client A1, A2...An can establish a full-duplex point-to-point communication session with any other Client in a Service Cell 10 in a non-blocking (guaranteed access) fashion. One Client A1, A2...A80 can establish a communication session simultaneously with every other Client in a Service Cell 10. Multiple point-to-multi-point communication sessions between Clients A1, A2...A80 can be conducted simultaneously without performance degradation being experienced by any session participants. Finally, every Client A1, A2...A80 has non-blocked (guaranteed) access to content and services delivered by their respective Registry Server. Through these relationships FIG. 3 reflects the UCCA's ability to support multiple dimensions of connectivity not possible using a statistically based oversubscribed approach to connectivity employed by the existing Internet and telephony infrastructures.

A. Transport Protocol.

ATM is a transport protocol, e.g., a way of transmitting data, voice,

and video from one place to another. ATM is the international standard for cell relay, a fast-packet switching technology. It has inherent advantages in that it transports voice, video, and data traffic on a common circuit, and it delivers bandwidth on demand. Other types of networks are circuit-oriented, for delivering isochronous information like video or voice, or packet-oriented, for high-speed data transmission. These circuit switched networks guarantee end-to-end delivery and response times, but they waste expensive bandwidth. Isochronous packet switching optimizes the use of bandwidth, but has variable packet delivery times. Thus, packet switching can be unsuitable for isochronous traffic because of the amount of delay between packets, resulting in jittery transmissions. ATM combines the reliability of circuit switching with the efficiency of packet switching. ATM segments packets into 53-byte cells. The packets are switched onto paths operating at up to multiple gigabits-per-second. The ATM technology is well suited for both local campus LANs and Wide Area Networks (WANs) as set forth herein.

B. ATM Switch 60.

ATM Switch 60 is preferably a non-blocking Enterprise ATM switch. This is a known device that is designed to form the backbones of large wide-area enterprise networks. ATM Switch 60 should comply with the current ATM Forum, ATM User-Network Interface Specification, International 20 Telecommunication Union Telecommunication Standardization Sector (ITU-T), and European Telecommunications Standards Institute (ETSI) specifications and recommendations. The Fore System's ASX-4000 40 GBytes per second non-blocking ATM Switch is well suited and supports up to 15,000 Clients each with a 1.28 Mbps full-duplex connection.

C. Communication Backbone 40.

The use of the ATM based Communication Backbone 40 with defined

Client/Registry Server ratios eliminates the need for hubs, routers, bridges, inverse multiplexers, and ensures that the present system can guarantee Quality of Service (QoS) between any two Clients within a single Service Cell 10. This is essential for networked multimedia applications, which require strict control over network latency and jitter. The QoS guarantee of ATM, together with its cell based operation, enable the deployment of a single, multi-service network on which all traffic types ---voice, video and data--- can be transported in real time, hence reducing the cost, complexity and geographical constraints associated with conventional networks. In current networks the physical infrastructure of the network (e.g., the hubs and routers) typically dictates the physical LAN segment to which a terminal can be connected. Thus, proximate users must be placed on the same LAN. In contrast, the physical and logical topologies of an ATM network are not interdependent, and this creates a more flexible training environment and facilitates network administration. The UCCA sees no distinction between LAN and WAN. A user on a Client A1 cannot discern the difference between communicating with another user on a Client A2 in the next room or a user on a Client A3 that is 4,000 miles away.

D. Clients A1-A80.

The Clients A1-A80 are the communication terminals for the Managers (Moderators or Teachers), Participants (Users or Students), Network Administrators, Help Desk, and Content Developers. Each of Clients A1-A80 is a specialized computer that employs a Digital Camera 120, speakers, microphone, one or more displays, a Biometrics Device 125 (fingerprint scanner, retina scanner, etc.), and sufficient host processing power and data throughput capacity to simultaneously deliver a rich mix of audio, video, graphics, virtual reality, documents, and data.

The Digital Camera 120 is preferably a high-resolution FireWire video camera available from several vendors. FireWire is one of the fastest peripheral standards ever developed, which makes it well suited for use with multimedia

peripherals such as video camcorders and other high-speed devices. FireWire supports a low latency way to introduce video into a network, critical for the UCCA requirements, and includes integrated Quality of Service (QoS) control. This requires each Client to have one or more IEEE-1394 compliant FireWire ports.

The Biometrics Device 125 is preferably a Universal Serial Bus (USB) fingerprint scanner currently available from several vendors. A USB based biometrics device supports a lower cost, ease of integration, and due to the single event interrupt nature of the authentication process represents an appropriate use of the USB technology and its bandwidth limitations. This requires each Client to have one or more USB ports.

The preferred desktop computer variant of the Client A1-A80 is a computer platform that supports one or more of the Motorola MPC-7400 PowerPC™ processors as the host processor array. The MPC-7400 includes the 128 bit AltiVec™ execution unit and the processor is classified as a supercomputer. IBM is a second source for the PowerPC™ with AltiVec™ processor. The overall PowerPC™ based computer architecture with Accelerated Graphics Port (AGP), Peripheral Component Interface (PCI) bus, USB, and FireWire is an industry standard and is available from multiple vendors. The PowerPC platform runs all major operating systems in use today allowing all Macintosh, Unix, and Windows applications to be used in the UCCA environment. This provides greater support for legacy applications for organizations making the transition to the next generation capabilities of the UCCA.

Motorola's AltiVec™ technology expands the capabilities of the PowerPC platform by providing leading edge, general-purpose processing performance while concurrently addressing high-bandwidth data processing and algorithmic-intensive computations in a single-chip solution. Specifically, the MPC-7400 processor can process 128-bit data, instead of the smaller 32-bit or 64-bit data as used in previous processors. In addition, a single 450 MHz MPC-7400 processor can perform floating-point calculations at a rate as high as 4.5 billion operations per second and

integer calculations as high as 21 billion operations per second. The MPC-7400 works in concert with the PowerPC platform to accelerate data-intensive processing required to simultaneously deliver voice, video, and data.

The present architecture employs "QoS-to-the-Client" due to ATM's Quality of Service (QoS) capabilities and ability to converge voice, video, and data over a single direct physical or wireless connection.

The Client A1-A80 connections are accomplished with a PCI bus based ATM Communications Interface 25 installed in each Client A1-A80.

FIG. 4 illustrates the various types of Dedicated Data Paths 130 that are suited for use in connecting Clients A1-AN to a Service Cell 10. Given this variability, the Client ATM Communications Interface 25 (see Fig. 3) should support all of these inclusive of T1, E1, DS-3, OC-3, OC-12, SDSL, MMDS wireless, LMDS wireless, satellite. Further connectivity standards are being developed now. By implementing a single ATM Communications Interface 25 with this wide range of Dedicated Data Path 130 capabilities provides the following advantages:

i. Abstracts the communication layer and supports low cost upgrades to faster bandwidth technologies in the future.

ii. Allows a Client A1-A80 to take advantage of a lower cost regionally delivered Dedicated Data Paths 130 while still supporting a controlled Quality of Service (QoS) for an entire Service Cell 10.

iii. Allows a Client A1-A80 to reside in virtually any location worldwide.

iv. ATM over T1, E1, DS-3, etc. is low cost, fast, reliable, and has become standard internationally.

v. Allows all applications to be written without concern for the complexity of the UCCA infrastructure allowing greater functionality to be added to each Client A1-An economically in the future. This is part of the UCCA design to become the first continuously upgradeable communication technology.

For present purposes, there are preferably a number of hardware variants of the Clients A1- A80 to fulfill the various needs of the six different denominations 1-6 of FIG. 2. The standard configuration is designed for high volume applications where cost is an issue. The variants include different peripherals, more memory, larger hard disk drives, more displays, and other additional components as required. For example, a Content Development Client configuration can include conventional multimedia peripherals like a flatbed scanner and a document camera. This configuration allows the Content Developer 6 to create content and services for a Service Cell using a wider source of media.

The preferred desktop computer variant of the Client A1-A80 has two displays. The additional display real estate eliminates "mode" switching allowing full motion video to coexist with other media and interactive controls simultaneously. The current desktop computer Client embodiment can deliver in a real-time two-way fashion 320 by 240 pixel (4:2:2 YUV per pixel) Digital Camera 120 source video at 30 frames per second in two 1,024 by 768 pixel (32 bit per pixel) video windows (one video window in each display). A Client using a single MPC-7400 processor can do this consuming less than 512 Kbps of bandwidth for both the video and audio. This is done with the help of a symmetrical software-only Wavelet video compression/decompression program ("CODEC"). It has been found that a symmetrical Wavelet CODEC algorithm only consumes 40% of a single 450 MHz MPC-7400 host processor's computational power. Moreover, this type of CODEC can achieve compression ratios of greater than 60:1, and at least this level is essential within the present UCCA to preserve Service Cell bandwidth for convergence considering that video most coexist simultaneously with all other information services. This compression requirement exceeds the computational and data throughput power of any other affordable 32 or 64 bit processor currently available. In a multiple host processor environment higher resolution source video (640x480, 1280x720, and 4096x4096) at higher bit depths per pixel can be supported. Also, all

standard video and audio CODECs can be supported like MPEG-2 and the CODEC standards employed in H.323.

Additional variants of the Clients A1-80 can include a portable Client, a handheld wireless Client, and a Client designed as a HDTV interface using one or more MPC-7400 processors. Extending the physical configuration of the Client for use in any possible operating environment is essential to meet the desired level of flexibility and applicability.

E. Registry Server 30.

The Registry Server 30-1 is a computing platform identical in most respects to the Clients A1-80, and likewise inclusive of one or more processors with peripheral chipset and motherboard. However, the Registry Server 30-1 is uniquely configured with a PCI bus based Advanced ATM Communication Interface 32 connected to the motherboard for dedicated connection to the ATM Switch 60. In addition, Registry Server 30-1 are uniquely configured with an ultra-high speed data storage array 36. More than one Registry Server 30-1..n may be used to support each Service Cell 10. The Registry Servers 30-1..n represent the repository for course content, services, and accumulated usage data (audit trails). Each of Registry Servers 30-1..n is intentionally designed to control a maximum number of Clients with the current embodiment employing 80 Client A1-A80 connections. This approach facilitates a balanced redundant architecture. The preferred ATM Communication Interface 32 for the Registry Server 30-1 should be capable of delivering OC-12 (622 Mbps) full-duplex ATM capacity through a direct fiber optic connection to the ATM Switch 60. Alternate embodiments may include OC-48 and OC-192 fiber optic connectivity. All Registry Server content is stored on conventional RAID 5 arrays such as a hard disk drive array 36, which is connected by an ANSI standard Fibre Channel to a fibre controller card 33 resident in the Registry Server 30. Suitable fibre controller cards 33 need to deliver greater than 100 MBytes per second sustained

capacity.

F. Service Cell 10.

To fully implement the managed information flow solution of FIG. 2, each Service Cell 10 must be to able to scale to any desired number of simultaneous users. This entails connecting multiple Registry Servers 30 and their respective plurality of Clients A1-A80 in a building block fashion.

FIG. 5 illustrates a plurality of Registry Servers 30-1...3 as necessary to manage the desired number of Clients A1-A80, B1-80....N1-80. With regard to Fig. 3, e.g., each Client A1- A80 has an ATM Communication Interface 25, and it is in turn connected through the Communication Backbone 40 to ATM Switch 60.

In the context of the Service Cell of FIG. 5, the purpose of the ATM Communication Interface 25 is to "Abstract" the communication layer so the Clients A1-N80 are not aware of the type of Dedicated Data Path 130 being used to connect to their respective Registry Server 30- 1..n. This provides the flexibility to use the most cost-effective connectivity service that is available or desired in any given area. In the case where a large number of Clients are within what is currently described as a LAN environment, a Campus ATM Switch 55 may be used to "concentrate" the respective Client's full-duplex ATM streams into a single data stream. In this case, either a direct connection to the ATM Switch 60 is possible or a higher bandwidth ATM connection 47 is established through the Communication Backbone 40 to the ATM Switch 60. At the top layer of each Service Cell 10, the single ATM Switch 60 provides the necessary non-blocking connectivity to make a plurality of Registry Servers 30-1...3 look like a single "Virtual Server" to the Service Cell's entire base of Client stations A1...N80. Using the above-described Virtual Server configuration provides the following advantages:

i. Provides greater reliability through hardware and data redundancy.

ii. Limiting the number of Clients simultaneously connected to a

Registry Server and dedicates greater processing power and subsequently greater performance to each Client A1...N80.

iii. Clients A1...N80 are guaranteed access to their Registry Server 30-1...N at full communication bandwidth (not a statistically based solution).

iv. The incremental capital cost to support additional Clients in a Service Cell is very low.

v. The Registry Server 30 software (due to network topology advantages) is dramatically smaller and subsequently more robust.

vi. Data packet latency is finite and controllable due to the symmetry of the Service Cell topology.

vii. Supports dynamic and unlimited scalability of the Service Cell.

viii. The architecture provides the necessary Quality of Service (QoS) and reliability required of mission critical real-time communications.

As seen in FIG. 5, the optional use of Special Purpose Servers 30-4 facilitates statistically based access to services as is currently used by the Internet. A Special Purpose Server 30-4 is identical in every respect to a Registry Server 30-1 with the exception that the content and services it manages are not mirrored and that any Client may access its content and services in a first come first served fashion. As too many Clients N1-N80 access the Special Purpose Server 30-4, its performance will begin to degrade. For content and services that only a small number of Clients will require or where access is restricted to the appropriately small percentage of Clients, the Special Purpose Server approach can be employed within a Service Cell. The approach also presents an ideal way to integrate low performance and unreliable legacy technologies like Microsoft Windows NT™ based services during a transition to a complete UCCA implementation.

G. Communication Protocols.

FIG. 6 illustrates the communication protocol approach employed by the ATM Communication Interface 25 used in each Client and the ATM Communication Interface 32 used in both the Registry Servers 30-1...3 and the Special Purpose Server 30-4. The ATM Communication Interface 25 and 32 uses one or more embedded versions of the MPC-7400 or other embedded processor that provides the necessary computational power. The communication protocol used in the UCCA according to the present invention strives to make more efficient use of less bandwidth by employing a multi-layered approach. Currently, a typical Windows NT™ server can only utilize 3% of a Gigabit Ethernet data path. The Pentium™ processor's computational limitations combined with the inefficient implementation of the communication protocol stack in software by the Window's operating system represents a barrier to the delivery of real-time full-duplex converged communication as accomplished by the present invention. Adding additional bandwidth to a Windows NT™ network will not increase performance or productivity. What is needed is more efficient utilization of bandwidth necessary to take advantage of the current global investment in copper, fiber, and wireless spectrum.

More specifically, and with reference to FIG. 6, the top layer, called the Application Layer, abstracts the complexity of the ATM Communication Interface 25 and 32 from the developers of Registry Server 30 software and by developers of Client A1...N80 software. Instead of a developer having to understand how to establish rate control, flow control, multipoint session addressing, and precise control of Quality of Service (QoS) they focus on delivering a more powerful set of services to the end users of the UCCA.

The next layer is the industry standard X/Open Transport Interface (XTI) currently employed by several major server and server software vendors. This layer acts as a further abstraction layer to the underlying communication protocols. Blocks of data can be presented to and received from the Application Layer to be

subsequently processed appropriately by the XTI layer. The Transmission Control Protocol (TCP), User Datagram Protocol (UDP), and Internet Protocol (IP) are provided for legacy applications and for the ability to deliver traditional standards based Internet services through the UCCA. The eXpress Transport Protocol (XTP) version 4.0 is used to deliver rate control, superior flow control, and first class multipoint management services over ATM. Note that TCP, UDP, IP and XTP are layered over the ATM transport layer. XTP has been shown to deliver as much as 83% greater performance over the traditional Internet than the TCP/IP combination. Also note that XTP can reside over IP as well as directly over ATM. Finally, note in FIG.6 the "Future Protocol" block. There are communication and transport protocol combinations under research and development that present the promise of superior performance over the presently preferred use of XTP and ATM. By having sufficient processing power and programmability in the ATM Communication Interface 25 and 32, more powerful communication protocols can be dynamically implemented in the UCCA. A unique characteristic of the powerful ATM Communication Interface 25 and 32 in the context of the "ATM-to-the-Client" architecture of the UCCA is the ability to add secure data transmissions to the UCCA with absolutely no impact on performance. Currently the overhead of adding encryption to a data stream results in a unacceptable consumption of communication bandwidth. In essence, security through encryption currently represents a further reduction in bandwidth utilization in an environment that cannot currently deliver convergence. The ATM Communication Interfaces 25 and 32 preferably utilize a real-time ATM cell encryption process. A number of industry standard encryption algorithms can be employed. Alternatively, the Federal Government of the United States may specify and employ their own algorithms in a controlled fashion. Providing a dynamic multiple layered-protocol approach in the ATM Communication Interface 25 and 32 provides the following advantages:

i. Frees the host processor(s) of the Client to deliver real-time multimedia

services and in general deliver greater performance to simultaneous user actions.

ii. Provides the ability to effectively deliver greater than 100% bandwidth utilization of any given data path. Through sufficient computational power in the ATM Communication Interface the Peak Cell Rate (PCR) can be continuously sustained. Through the use of real-time compression and decompression by the Client's host processor any given data path can effectively send and receive data at a rate greater than the PCR.

iii. By achieving more efficient use of existing bandwidth more full-duplex SVCs can be supported simultaneously over a given data path subsequently lowering the operating cost of the UCCA. For example, if an OC-12 rate Communication Backbone 40 is leased for three years at a flat rate and more Clients can be supported over time, the cost per Client lowers.

iv. Lowers the capital cost per Client of building a UCCA by supporting more simultaneous full-duplex SVCs through the ATM Switch 60 of a Service Cell 10.

v. Provides the highest possible level of security without impacting the rich performance of the UCCA.

vi. Provides security on a communication session by communication session basis in a dynamic on demand fashion.

vii. Supports a multi-dimensional approach to delivering communication services by delivering rate control, flow control, and Quality of Service (QoS) control in a precise fashion in real-time on a communication service by communication service basis. This implies that while a given group of participants are collaborating simultaneously in real-time, each participant can be sending and receiving multiple other layers of information independently and simultaneously. By having sufficient processing power in the ATM Communication Interface 25 and 32, an extremely large number of ATM Virtual Paths (VPs) and Virtual Circuits (VCs) can be maintained.

2. Network and Client Services

In addition to the above-described network infrastructure of FIGs. 2-6, an array of interrelated software services are provided as shown in FIG. 7 to deliver managed information flow. Certain software services are resident on the Registry Server 30-1, and certain on the Clients A1-80 as shown. The particular software services provided (as will be described) and the allocation between Network resident and Client resident supports a higher level of information flow throughout the network and delivers distributed collaboration for any purpose, to facilitate effective education and training, and to provide a complete array of productivity multipliers that preserve resources, eliminate travel, etc. The types and residency of the Network and Client services also allows them to be continuously upgradeable entirely in software. The collective goal of these Network and Client Services is to deliver a solution so robust that each of the above-described Service Cells 10 and all accompanying complexities become completely transparent to its users. In solving an organization's information flow problem these Network and Client Services ensure that the information gets to the right people at the right time and that the assessment of that process also gets to the right people at the right time. The Services are organized into two major categories consisting of Network Services 200 and Client Services 400.

A. Network Services 200.

Network Services 200 represents the functionality derived from the implementation of the Service Cell 10 design or from written software running on the Registry Servers 30 and available to all users of a Service Cell 10 on demand. An array of Network Services 200 work together, and these may be classified according to the functions they accomplish as follows: (1) Availability 210; (2) Quality 220; (3) Reliability 230; (4) Serviceability 240; (5) Maintainability 250; (6) Extensibility 260; (7) Authentication Services 270; (8) Security Services 280; (9) Registry Services 290;

(10) High Availability Services 300; (11) Fault Tolerance Services 310; (12) Resource Management Services 320; (13) Bandwidth Management Services 330; (14) Data Storage Services 340; (15) Communication Services 350; (16) Internet Services 360; (17) Telephony Services 370; (18) Supercomputing Services 380.

(1) Availability 210.

As described above, a full-duplex CBR SVC data path is guaranteed between each Client A1...N80 and its assigned Registry Server 30-1...N. Moreover, the number of Clients connected to a single Registry Server 30 is limited to the point where there is no measurable degradation in access performance in a worst case usage scenario. This way, access to all users and content is on demand and access is not restricted by statistical availability, by the location in which service is provided, by the time zone in which the service is provided, or by the time of day. The speed of data delivery in each direction between a Client A1-A80 and its respective Registry Server 30 and between any Clients A1-A80 is maintained at an absolute minimum value that is constant within each Service Cell 10. The "Minimum Client Bandwidth" value is established for each Service Cell at a rate necessary to meet the information flow needs of its respective users. The speed of data delivery in each direction between the Registry Servers 30 within a Service Cell 10 is maintained at an absolute minimum value that is constant within each Service Cell 10. The "Minimum Server Bandwidth" value should be established for each Service Cell 10 at a rate necessary to meet the information flow needs of its respective users. Moreover, the actual speed of data delivery between the Client A1-A80 and its respective Registry Server 30, between Clients A1-A80, and between Registry Servers 30 within a Service Cell 10 is scalable to any value above the respective "Minimum Client Bandwidth" and "Minimum Server Bandwidth" values. Given these operating constraints, any Client A1-A80 can establish on demand a two-way data path with any other Client A1-A80 within a Service Cell 10. A Service Cell 10 can support the

simultaneous establishment of as many two-way data paths between any two Clients A1-A80 as there are total Clients divided by two (rounded down to an integer). Any Client A1-80 can send content one-way to any number of other Clients within a Service Cell 10. A Service Cell 10 is able to support the simultaneous establishment of multiple point-to-multi-point connections with the total number of connections determined by taking 75% of the Service Cell's Minimum Server Bandwidth and dividing it by its Minimum Client Bandwidth (rounded down to an integer). Moreover, a Client A1-A80 may physically reside anywhere globally and operate without any perceptible difference in performance in comparison to any other Client A1-A80 within its Service Cell 10.

(2) Quality 220.

The UCCA has the ability to simultaneously transmit and receive 4:2:2 YUV formatted digital video at 30 frames per second between any two Clients A1-A80 within a Service Cell 10. The system also has the ability to simultaneously transmit and receive Compact Disc (CD) formatted audio between any two Clients A1-A80 within a Service Cell. Moreover, the system supports precise synchronization of audio and video for any transmission that requires it. The compression, decompression, and transmission of QoS sensitive data (audio and video) is implemented completely in software and shall undergo continuous quality improvement. The one way transit time for a single data packet between any two Clients A1-A80 within a Service Cell is below one tenth of a second (0.1 second). The time it takes for QoS sensitive data (audio and video) to be captured and encapsulated into a data packet ready for network transmission within a Client is below one tenth of a second (0.1 second). The time it takes for QoS sensitive data (audio and video) received by a Client's network interface to be presented to a user is below one tenth of a second (0.1 second). This way, a user shall never have to wait more than one second (1 second) to see a response or the status of an action or

request.

(3) Reliability 230.

The reliability of the present system is a function of the network infrastructure, data delivery, stored data, and the processes that are layered over the service to maintain its overall integrity. The following are reliability considerations that are taken into account. The Registry Servers 30 that comprise a Service Cell 10 preferably reside in climate controlled, secure facilities that possess redundant power supplies. The balance between the number of users, worst case usage scenarios, processing power per user, data throughput of all hardware, and network latency are maintained all of the time to guarantee that all users get 99.99% of data they request on demand. A backup copy of all of the data that resides on a Registry Server is to be maintained at all times. Remote control, diagnosis, and failure recovery for any Client or Registry Server is to be provided.

(4) Serviceability 240.

The software preferably employs the following measures to increase serviceability. All hardware employed within a Service Cell 10 possesses an integrated capability that facilitates remote monitoring of operational status. Every Registry Server 30-1..n and Client A1-N80 can report the catastrophic failure of a UCCA written software application. At the Client A1...N80 level, failures are tracked and maintained in the Service Cell 10 usage data maintained by the Registry Services (described below) and subsequently managed by the Network Management Services (also described below) to conduct the trouble ticket process and failure monitoring. There are two distinct elements to the failure monitoring process. The first is to monitor operating system and registered application failures. The second is to monitor all hardware in the system. The following summarizes the software failure monitoring process and mechanisms:

(a) Rapid Development Environment and Application Framework - The software applications written specifically to take advantage of the UCCA's unique capabilities all share a common application framework. This framework delivers a common "Event Architecture". Every action taken by a user on a Client A1...N80 when using this software generates an "Event". The framework designates if a specific "Event" is important enough to record and to send across the network for storage by the Registry Servers 30. Of course, the importance of every conceivable Event has not yet been determined. Nevertheless, a "software switch" is provided for every "Event" and, if designated important, the switch can be activated under the application framework. An "Event" that is designated as important for network usage uniquely identifies the user, the Client A1...N80, the time the Event occurred, and other critical items of information before it is recorded on the Client A1...N80 and/or sent to the Registry Servers 30 for storage by the Registry Services. Whenever a registered application crashes or when a Client A1...N80 operating system crashes a special "Failure Event" is generated, recorded on the Client A1-A80, and sent to the Registry Servers 30.

(b) Registry Services - The Registry Services has a "Usage" class that maintains the generated and transmitted events. The "Failure Events" are managed by the Registry Services.

(c) Network Management Services - The Network Management Services used by a UCCA's Network Operations Center staff monitors the "Failure Events".

(d) Rapid Response Team - It is presently preferred that a Rapid Response Team (a team of programmers) remain available to reproduce and solve the software failures. Using the stored copies of Events leading up to the failure

the Rapid Response Team can reproduce the failure. Once the Rapid Response Team solves a problem, the corrected code is to be validated and distributed to the appropriate Service Cells 10. The following summarizes the hardware failure monitoring process and mechanisms:

(a) Remote Diagnostics - Every hardware asset that comprises a Service Cell 10 has a remote diagnostics capability that provides warning or signals that a hardware failure has occurred.

(b) Registry Services - The Registry Services has an "Equipment" class that maintains the history of any piece of hardware that comprises a Service Cell 10.

(c) Network Management Services - The Network Management Services (to be described below) are used by the UCCA's Network Operations Center staff to monitor the history of hardware failures. The Network Management Services has the ability to periodically poll each piece of hardware that comprises a Service Cell 10.

(5) Maintainability 250.

The UCCA preferably employs the following measures to increase maintainability. Additional ATM Switches 60 and 55, Registry Servers 30, and Clients A1-A80 are preferably integrated, burned in, tested, and staged in strategic locations to facilitate rapid major component replacement in the least amount of time.

(6) Extensibility 260.

The system preferably employs the following measures to

increase extensibility (the ability to scale the capacity or add new functionality to the system). Each Client A1...N80 is capable of delivering a minimum of 15 billion operations per second to facilitate the widest possible addition of new real-time services through automated software upgrades. In addition, each Client A1...N80 delivers a minimum of 600 megabytes per second (600 MBytes/Sec) throughput between its processor(s) and main memory. Each Client A1...N80 provides a minimum of 256 megabytes (256 MBytes) of main memory, and a minimum of 18 gigabytes (18 GBytes) of hard disk drive capacity. The System Administrator should maintain a number of Registry Servers 30 equivalent to 20% of the total global installed base of Servers not assigned to a specific Service Cell 10 in a "Server Reserve Pool" to allow for the rapid growth of any Service Cell 10. This ensures that a Service Cell 10 can be rapidly scaled through the automated addition of one or more Registry Servers 30 available through the "Server Reserve Pool".

(7) Authentication Services 270. The Authentication Services 270 provide the ability to uniquely identify a Registered User of a Service Cell 10.

(8) Security Services 280. Security Services 280 are Registry Server resident services that access Registered User account information maintained by Registry Services 290 (defined below). They provide a Registered Security Agent with the ability to remotely authenticate the unique identity of any Registered User and grant any desired level of service access and privileges. This capability is critical for remote electronic proctoring of a certification or exam process.

(9) Registry Services 290.

Registry Services 290 facilitate the management of all assets that comprise information flow. An asset is herein defined as a managed and tracked resource essential to a customer in facilitating effective information flow within their

organization. Thus, the Registry Services that resides on the Registry Servers 30 stores the critical information on all Registered Users, network devices, programs, preferences, documents, media elements, usage audit trail, and other assets. This is distinct from the Asset Management Services (to be described) which are Client A1...N80 based and are delivered by an application that resides on each Client A1...N80. A central Registry Services record is comprised of fields with a single field being the smallest logical construct that is be managed and tracked by the system. A Registry Services record is comprised of at least 2 to the 32nd power fields, and each field in the Registry Services record can be up to 2 to the 48th power bytes in size. A field in a Registry Services record can contain any combination of audio, video, imagery, and text data. The Registry Services maintains like records in logical groupings called Record Classes, and Registry Services supports up to 2 to the 48th power records per Record Class. In addition, Registry Services has the ability to dynamically add on demand new fields to all of the records within a Record Class. Registry Services also provides the ability to layer a relational hierarchy over any and all Record Classes. Specifically, Registry Services maintains several base Record Classes. For example, authorized users are maintained in a People Base Record Class. Registry Services also maintains a record for each item of equipment, each software application, each item of media, each item of content within each Service Cell, all usage data for each Registered User, all communication sessions that occur within and between all Service Cells. Registry Services also maintains one or more template Base Record Classes per Service Cell that can be rapidly customized to meet any unique information flow needs.

(10) High Availability Services 300.

High Availability Services 300 provide Registry Server based mechanisms for server high availability that eliminate potential downtime and ensure continuous access to all Service Cell 10 based data and services.

(11) Fault Tolerance Services 310.

Optional Fault Tolerance Services 310 provide high performance Registry Server based mechanisms for delivering server fault tolerance that virtually eliminates server downtime and ensures continuous access to all Service Cell 10 based data and services. Fault tolerance is available for those mission critical applications where the several minutes of downtime presented by High Availability Services 300 is not acceptable.

(12) Resource Management Services 320.

Resource Management Services 320 provide Registry Server based mechanisms that manage the Registry Servers 30 processor utilization, disk array capacity 36, and ATM Switch 55 and 60 capacity of a Service Cell 10. This capability is essential to maintain the balance and symmetry of the UCCA to ensure the highest possible quality of service.

(13) Bandwidth Management Services 330.

Bandwidth Management Services 330 provide Registry Server based mechanisms that manage the available bandwidth consumed by every service provided by a Service Cell 10.

(14) Data Storage Services 340.

Data Storage Services 340 provides Registry Server based mechanisms that deliver data redundancy for all Service Cell 10 stored data.

(15) Communication Services 350.

Communication Services 350 are Registry Server resident and facilitate the ability for any user to access content or communicate with any size group of other users in a highly reliable fashion. Communication Services 350

include the ability to support any standards based communication protocol simultaneously within a Service Cell. Communication Services 350 provide precise control over the Quality of Service (QoS) of any data transmitted within a Service Cell. Communication Services 350 also provides precise control over the Reliability of Service (RoS) of any data transmitted within a Service Cell. Communication Services 350 also provides the ability for a Registered User from their authorized Client(s) to access and interact with content published as available for that specific Registered User by their respective Registry Server in their local Service Cell. Communication Services 350 also provide the ability for a Registered User from their authorized Client(s) to access and interact with Content published as available for that specific Registered User by a designated Registry Server in a remote Service Cell. Communication Services 350 also provide the ability for a Registered User from their authorized Client(s) to locate any other Registered User (or group of Registered Users), and to establish and maintain a real-time two-way communication session with any Registered User or group published as available by their respective Server in their local or any remote Service Cell. Communication Services 350 also provide the ability to schedule any process, publish that schedule to all affected Registered Users, and to resolve schedule conflicts when they arise.

(16) Internet Services 360.

Internet Services 360 are Registry Server 30-1...3 and/or Special Purpose Server 30-4 resident. They provide all of the services of the current Internet seamlessly integrated in the UCCA without degrading any other UCCA service capabilities. All Internet services are Internet Engineering Task Force (IETF) compliant. The Internet Services include Mail Server services, File Transfer Protocol (FTP) Server services, USENET News Server services, and Web Server services. All of the Internet Services remain under independent and continuous control from a

centrally established Quality of Service (QoS) mechanism that ensures that they do not degrade the performance of real-time services like video and audio. The Internet Services include security software that delivers intrusion detection, authentication, central auditing, and privacy control for all Internet traffic. They are administered from a unified system management console that enables secure, remote, and centralized control of all functionality.

(17) Telephony Services 370.

Telephony Services 370 provide the customer with access to the existing legacy telephony infrastructure. Telephony Services 370 provide the ability for a Registered User from their authorized Client(s) to make and receive a traditional phone call whereby all current telephony limitations and costs apply. In addition, Telephony Services 370 provides the ability for a Registered User from their authorized Client(s) to make and receive a phone call to any other Registered User logged onto the same Service Cell without experiencing statistical access limitations or incurring long distance charges. A user can also use a traditional telephone to dial a local phone number and make a phone call to a Registered User logged on to a Client without incurring long distance charges. Registered Users from their authorized Client(s) can also send and receive industry standard facsimile documents.

(18) Supercomputing Services 380.

Supercomputing Services 380offers the ability for the customer to employ the inactive processors of Clients A1...N80 on any Service Cell in a massively parallel fashion to solve problems like image rendering, predictive analysis, and numerous other tasks that fall within the classification of a supercomputing problem.

B. Client Services 400.

Client Services 400 represents the functionality derived from the implementation of written software running on the Clients A1...An and available on demand to authenticated and Registered Users. The Client Services 400 are classified and herein described under the following categories: (1) Contact Services 410; (2) Session Management Services 420; (3) Session Status Services 430; (4) Scheduling Services 440; (5) Audio Services 450; (6) Video Services 460; (7) Message Services 470; (8) Chat Services 480; (9) Assessment Services 490; (10) Projection Services 500; (11) Collaboration Services 510; (12) Presentation Services 520; (13) Authoring Services 530; (14) Asset Management Services 540; (15) Internet Services 550; (16) Media Services 560; (17) Help Services 570; (18) Network Management Services 580; (19) Service Administration Services 590; (20) Security Services 600; (21) Telephony Services 610; (22) Simulation and Gaming Services 620; (23) Supercomputing Services 630.

(1) Contact Services 410.

Contact Services 410 provide the ability to manage contacts and groups of contacts as well as establish a communication session with any other Registered User or group of other Registered Users. A Base Contact Record is created for any contact entered, and the Registered User is free to add as many fields as desired to the Base Contact Record to facilitate the desired level of personal information management. For instance, one field allows the designation of "Personal Contact" if the contact is not a Registered User. A Registered User can search for, edit, print a report, import, export, and/or delete Contact Records. In addition, the Registered User can organize Contact Records into logical groups by entering a Contact Group name. The Registered User can access the status of all Registered Contacts and Groups inclusive of basic availability information such as if a Registered Contact is logged on or logged off at the time of viewing.

(2) Session Management Services 420.

Session Management Services 420 provide the ability to manage any communication session. A Session is defined as either a Registered User accessing Content stored on a Registry Server 30 (Independent Session) or a Registered User communicating from their Client with one or more other Registered Users on their Clients (Individual and Group Sessions). The present system employs Session Management Services 420 that support Independent, Individual, and Group Sessions. Every Session initiated within a Service Cell is uniquely identified, and an exhaustive record is kept of its existence, duration, participants, and all participant actions through the Session. There are 6 basic types of Sessions that a user can initiate. The Independent Session (Local and Remote) provides a means by which a Registered User can select from a list of published Content in order to initiate an Independent Session. The Individual Session (Local and Remote) provides a means to allow a Registered User to initiate a person-to-person Session by simply choosing a contact from their private Contact Record list. The Group Session (Local and Remote) provides a means to allow a Registered User to initiate a Group Session by simply choosing a group from their private Group Contacts list. Session Management Services 420 also allows a Registered User to place any active Independent, Individual, or Group Session on hold and to access or initiate another Session. Each Session can be paused, recorded and/or resumed for later access, and Session Management Services 420 provide the ability for a Registered User to see a history of sessions in which they have participated. All Individual and Group Sessions are moderated, and the initiator or active Moderator of the session can control which Client Services 400 are active during the session and to varying degrees, the actions of the session's participants. Session Management Services 420 also maintain proper group protocol for the Moderator. For instance, only the initiator or active Moderator of a Group Session can end an active Group Session, although any participant of the Group Session can drop off the session at any time. The active Moderator of an

Individual or Group Session may assign any other session participant as the Moderator, may add or drop any other session participant from the session, and may select the Application Service or Services delivered during the session. The following represents an authorized list of Client Services 400 available to the Moderator of an Individual or Group Session: Audio Services 450; Video Services 460; Message Services 470; Chat Services 480; Assessment Services 490; Projection Services 500; Collaboration Services 510; and Presentation Services 520 (all defined below). In addition, the active Moderator of an Individual or Group Session may add, drop or block access to authorized Client Services 400 by the other participant(s) at any time during a session. Session Management Services 420 also provides a means of locating session participants that have logged on, and notifying them that a session is active such that they can join the session. Any type of session inclusive of the participants (if applicable) and the services (if applicable) can be scheduled, and Session Management Services 420 publishes scheduled sessions so that when any Registered User logs onto their authorized Client(s) the session is reflected in their personal schedule. Session Management Services 420 allows the automatic initiation of a scheduled session subject to a variable time out capability if no session participants are logged onto the network. The duration of any scheduled session can be limited if desired.

(3) Session Status Services 430.

Session Status Services 430 provide the Registered Users with the status information of any active sessions. This includes the ability for the Registered User to see a list of the active participants, whether it is being recorded, the local starting date, time and duration of the active session, and the time remaining for any active session with a scheduled time limit. Each Registered User also has the ability to see a list of all sessions that are currently on hold, or paused.

(4) Scheduling Services 440.

Scheduling Services 440 are delivered by a Client resident application that allows a Registered User to schedule any activity, session, or the use of any resource they desire.

(5) Audio Services 450.

Audio Services 450 are available at any time during an Independent, Individual, or Group Session, and appropriate controls are available at anytime to a Registered User from any authorized Client. Audio streaming is possible automatically when streaming video, or independently of video, and all of the following sampling rates are supported: 11 KHz 8 Bit Mono Sampling; 44.1 KHz 16 Bit Stereo Sampling; Variable sampling rates for audio streaming from 11 to 44.1 KHz, 8 or 16 bit, and mono or stereo. In addition, audio streaming may be half-duplex or full-duplex, and various quality controls are available to the Clients A1...N80 including de-reverberation, background noise reduction, and the ability to compress and decompress two-way audio simultaneously in real-time. The UCCA provides the ability to control various audio sources including Apple QuickTime movies, Compact Disc, laserdisc, Digital Versatile Disc, or video cassette to the degree that specific segments, clips, frames, blocks, songs, or tracks can be identified and played as part of selecting an Audio Channel. Audio Services 450 provides the ability for the Digital Camera 120 to be a pan and tilt camera that can follow the active speaker, and existing speech recognition software may be incorporated to provide the ability to recognize English speech and translate it into text in real-time, or text into English speech. This facilitates closed captioning.

(6) Video Services 460.

Video Services 460 facilitate the use of video during an Independent, Individual, or Group Session. Video can be streamed at any time during

an Independent, Individual, or Group Session, and video controls are available at any time to a Registered User from any authorized Client. Video Services include software for digitization, distribution and collaborative editing of video. Video Services 460 provide the ability to compress and decompress two-way video simultaneously in real-time. This is done through an existing Client based software-only symmetrical Wavelet CODEC. A variety of other commercially-available standards-based CODECs may also be used. Video Services 460 provide software to compress, decompress, store, and distribute a wide range of video formats. Default video streaming takes place at 320x240 (4:2:2 YUV) full-duplex video at 30 frames per second, and the two video streams can be selectively displayed independently in 160x120, 320x240, 640x480, or 1024x768 32 bits per pixel resolution windows on the two Client A1...N80 displays. Support is provided for D1 (SMPTE SDI standard) video and 1280x720 progressive HDTV video. Video Services also provides the ability to control various conventional video sources including Apple QuickTime movies, laserdisc, Digital Versatile Disc (DVD), and video cassette to the degree that specific segments, clips, frames, blocks, or tracks can be identified and played as part of selecting a Video Channel. Video Services provides the ability for real-time manipulation of the video stream, plus the ability to draw over, zoom, record, or even conduct image recognition. A registered user can also simultaneously view multiple video window thumbnails of Registered Users participating in a Group Session. Each video window thumbnail is 144 pixels wide, 192 pixels high, 32 bits per pixel, and displayed at 5 frames per second or higher. Thus, the active Video Channel is selectively displayed in any video window size simultaneously with the active video thumbnails and the near side Video Channel (far side thumbnail input). The active Moderator of the Group Session can select the active Audio and Video Channels used during the session. All of the participants of a Group Session are displayed both under each thumbnail and in a master list, and the active Moderator of the Group Session is provided with multiple levels of feedback on who is requesting to provide the active

Audio and Video Channel, how many times they have been active in a session, how long they have participated in the session, and other feedback to be determined as important in the future. Any Group Session participant can request control of the active Audio and Video Channel, and their 144 pixel wide by 192 pixel high portion of the near side video window is then highlighted so that each Group Session participant knows what portion of their video is being transmitted to all other Group Session participants.

(7) Message Services 470.

Message Services 470 facilitate the Registered User's ability to send and receive a class of Message characterized as media type independent, secure, and real-time, at anytime including during an Independent, Individual, or Group Session. Appropriate message controls are available at anytime to a Registered User from any authorized Client A1...N80. Each message includes the Registered User that created and sent it, all Registered Users that are to receive it with the appropriate distinction between primary, carbon copy, and blind recipients, a subject field, a text only body field, any supported media or content, and the attachment of any Client A1...N80 resident file. In addition, each message includes security precautions as established by the Message originator, the desired minimum time for a Message reply, the desired minimum time for a response to a request in the Message, the time remaining before expiration, and the time and date it was created and transmitted. If security options are chosen, Message Services 470 requires biometrics and/or password access by the respective recipient(s) in order to view the body and content.

(8) Chat Services 480.

Chat Services 480 are provided to facilitate the participants of an Individual or Group Session to maintain a continuous dialog using text entered in real-time and audio, video, and imagery based media presented on demand. Chat

Services 480 can initiate a continuous dialog at any time during an Individual or Group Session and present controls at anytime to a Registered User from any authorized Client A1...N80. Chat Services provide a participant of the active Individual or Group Session with the ability to enter a text statement called a Dialog Item. The participant may then send a completed Dialog Item, and the Item is to be appended immediately to a Dialog Item list displayed to all of the session participants. The Dialog Item list includes the name of the originator of each Dialog Item, and the date and time a Dialog Item was sent.

(9) Assessment Services 490.

Assessment Services 490 facilitate any participant of an Individual or Group Session to efficiently gather feedback from the other participants of the session in a wide variety of ways. Assessment controls are available at anytime to a Registered User from any authorized Client A1...N80 by which they can solicit participant feedback during an Individual or Group Session. Several forms of solicitation are possible, including a Query which is a single question or instruction statement combined with a single type of Assessment such as Yes or No, True or False, Multiple Choice, etc. The Registered User may also submit a Form, which is a logical grouping of any number and type of Queries into a single form. All Assessments are moderated in that the Assessment Moderator must determine which Query or Form to present, receive the Assessment responses, determine which participants receive the Assessment, and control the characteristics of the Assessment delivery. In moderating assessments, the initial or active Moderator of the Individual or Group Session is always the first Assessment Moderator. However, the active Assessment Moderator can assign a new Assessment Moderator from the current list of participants of the Group Session in which the Assessment exists. The active Assessment Moderator can also add and drop participants, and create or select from a list of existing Queries or Forms and broadcast it to the selected Assessment

participants simultaneously then monitor the assessed participant's responses in real-time. In addition to queries and forms, Assessment Services allow the organization of groups of Queries and Forms into Assessment Bins to facilitate rapid Assessment, and new Queries or Forms can be added or deleted to/from the Assessment Bin at will. If a response time is established for the Query or Form the Assessment shall provide a count down clock to the session participants so they know the time remaining before a response is required. The net result of the collective responses is stored as an Assessment Response, and Assessment Services 490 allows a user to analyze, create, display, and print reports of their Assessment Responses.

(10) Projection Services 500.

Projection Services 500 provide controls to any participant of an Individual or Group Session that allow the projection of an application operating on their Client in a window on the displays of the other session participants. This allows legacy applications and the content they support to be viewed as if a user connected a projector to their computer in a conference room filled with the other session participants. Projection Services supports a single application at a time and filters out of the Projection any non-application windows like those generated by other Client Services 400 like Audio, Video, Message, Chat, etc. Projection Services 500 shall redirect any audio or video that a projected application may support through the Audio Services 450 and Video Services 460. A Projection is moderated in that a Projection Moderator has control of which certified application is used, full control over the projected application's user interface, and has the ability to control who else has access to the projected application's user interface when and for how long. The initial or active Moderator of the Individual or Group Session shall always be the first Projection Moderator, but the task can be reassigned to any other session participant.

(11) Collaboration Services 510.

Collaboration Services 510 are provided to facilitate any participant of an Individual or Group Session to collaborate on any subject matter. Collaboration Services 510 provide file management controls to Registered Users by which they can access a Collaboration at any time during an Independent, Individual, or Group Session. Collaboration controls are available at anytime to a Registered User from any authorized Client. All Collaboration is moderated in that the Collaboration Moderator must determine which media elements or Content to present, determine which participants are part of the Collaboration process, determine which participants can control the Collaboration process, and determine which contributions remain as a permanent aspect of a finished Collaboration effort. The initial or active Moderator of the Individual or Group Session shall always be the first Collaboration Moderator, but this role can be reassigned. The active Collaboration Moderator is provided with a means of adding and dropping any other Collaboration participant, or enabling and disabling at anytime any Collaboration participant's ability to enter or modify media elements and Content during the Collaboration. Authorized Collaboration participant may enter or modify media elements and Content during the Collaboration, and may organize the same in Content Bins for their rapid introduction into the Collaboration process. Content Bins are susceptible to full file management. The collaboration contents are displayed at each participating Client A1...N80 in a Collaboration Workspace, and each Collaboration Workspace is fully customizable, and participants have the ability to change each media element or Content added to the workspace. In addition, the Collaboration Workspace provides the Collaboration participants with the ability to see a textual summary of the media elements and Content contributed to the workspace to include what time it was contributed, who contributed it, size, location, name, note, description, etc. A vast collection of editing tools and resources are available for using and editing collaboration content.

(12) Presentation Services 520.

Presentation Services 520 facilitate presentation of content during an Individual or Group Session and subjects the same to control by a Presentation Moderator. The Presentation Moderator has control of which Content is used and control of the navigation through the active Content. The initial or active Moderator of the Individual or Group Session shall always be the first Presentation Moderator, but this role can be reassigned. Presentation Services 520 shall provide a means for the Presentation Moderator to change Content at anytime, or to add or drop session participants from the Presentation. Presentation status information is displayed to all participants during the Presentation, including the date and time the Presentation was initiated, duration, the name and description of active Content, and the active Presentation Moderator.

(13) Authoring Services 530.

Authoring Services 530 facilitate any authorized Registered User to create Content by providing a workspace and the tools necessary to create Content independent of subject matter or media type and the ability to register completed Content. Upon completion, the content may be published to the designated Registered Users. Authoring Services 530 provides the Content creator with a Production Workspace and the tools that allow them to create Content through the addition, deletion, editing, and organization of reusable object oriented logical constructs. This facilitates the creation of a diverse array of content for any purpose.

(14) Asset Management Services 540.

Asset Management Services 540 facilitate any authorized Registered User to manage their personal and organization's assets. This is accomplished by maintaining a client registry of all user account information, protocol bindings, software program settings, user preferences, registered programs,

etc. The Asset Management Services 540 are delivered by an application that resides on each Client A1...N80. This is distinct from the previously described Registry Services, which are Registry Server 30 based. Thus, the Registry Services provide the back end while Asset Management Services 540 deliver the front end Registered Users functionality for conducting data analysis, data entry, and creating lists, reports, and forms. Asset Management Services 540 create a number of embedded logical constructs including Asset Type, Asset Record, Asset Field, and Asset Form. The Asset Record either contains the Asset or represents the Asset. The Asset Field contains any supported media type, with one or more Asset Fields defining an Asset Record. The Asset Form allows the media elements of one or more Asset Fields of a single Asset Record to be entered, modified, or viewed. The Asset Report allows any combination of Asset Fields of any number of Asset Records within an Asset Type to be viewed in a list. Given these constructs, the Asset Management Process provides an authorized Registered User with the ability to define Asset Types, create and edit Asset Records and its Asset Fields, create and view Asset Forms, and create and view Asset Reports as necessary to facilitate the management of any Asset. Asset Management Services 540 automatically define several Base Assets, inclusive of People (a Base Asset Type and Asset Record with appropriate Asset Fields that define the individuals an authorized Registered User has a requirement to maintain), equipment (a Base Asset Type and Asset Record with appropriate Asset Fields that defines the equipment, hardware, or inventory items an authorized Registered User has a requirement to maintain), applications (a Base Asset Type and Asset Record with appropriate Asset Fields that defines the software applications an authorized Registered User has a requirement to maintain), media (as above, but containing the media elements an authorized Registered User has a requirement to maintain), content (supra), etc. Asset Management Services 540 also provide an authorized Registered User with the ability to create new Asset Types, new Asset Records for an Asset Type, new Asset Fields for an Asset Record, and to modify or add new Asset Fields

to a Base Asset Type. These constructs support the ability to index, search, and analyze large volumes of data in real time.

(15) Internet Services 550.

Internet Services 550 are Client based applications that provide Registered Users with the ability to access all Service Cell 10 published Internet Services 360. This includes the Internet browser of choice, email application, or other off the shelf Internet application.

(16) Media Services 560.

Media Services 560 are Client based applications that provide Registered Users with a rich array of media editing tools from video to high resolution imagery.

(17) Help Services 570.

Comprehensive Help Desk Services are available at all times through any Client regardless of any other process a user may have initiated at the same time. The Help Desk Services include online help via direct access to Client(s) A1...N80 designated as Help Desk support for the respective Service Cell 10 and subsequently access to an on duty Help Desk staff member. Each Help Desk Client A1...N80 is equipped with content designed to help a user trouble shoot a full range of identifiable problems. When a user selects the Help Desk access functionality provided by the Help Services 570 the user is required to select a keyword categorizing their problem subsequently invoking local electronic support as a prerequisite to establishing a connection to a Help Desk staff member.

(18) Network Management Services 580.

A variety of Network Management Services 580 are available

to assist an Administrator in coordinating usage. These services include usage monitoring to measure the network usage load, failure monitoring to monitor network failures, Client monitoring to monitor Client failures, Registry Server monitoring to monitor Registry Server failures, software monitoring to monitor catastrophic software failures, network failure resolution to track network failure resolution, software failure resolution to track software failure resolution, Client configuration to maintain the data on client configurations, Registry Server configuration to maintain the data on server configurations, software management to manage all software version control and distribution, and preventative maintenance to maintain a hardware preventative maintenance program.

(19) Service Administration Services 590.

Service Administration Services 590 are delivered by a Client resident application that allows an administrator to establish user accounts, set user privileges, establish security measures, and register content onto the Registry Servers 30-1...N.

(20) Security Services 600.

Security Services 600 are delivered by a Client based application that provides a Registered Security Agent with the ability to control network access, assign priveledges, and the ability to conduct electronic proctoring for skill certification and exams. Security Services 600 uses Registry Server 30 resident Security Services 280.

(21) Telephony Services 610.

Telephony Services 610 are delivered by a Client resident application that allows a Registered User to make and accept standard telephone calls and send and receive standard facsimiles.

(22) Simulation and Gaming Services 620.

Simulation and Gaming Services 620 are delivered by a Client resident application that allows a Registered User to participate in advanced simulations and gaming through a Service Cell 10.

(23) Supercomputing Services 630.

Supercomputing Services 630 are delivered by a Client resident application that allows a Registered User to initiate and control the Service Cell 10 based Supercomputing Services 380 capabilities. The above is only a partial list of the capabilities that the UCCA supports.

While the invention has been described in conjunction with various preferred embodiments thereof, it will be understood that it is capable of further modifications. The claims are intended to cover any variation, use or adaptations of the invention which are generally consistent with the principles of the invention, and including such departures from the invention as come within known and customary practice within the art to which the invention pertains.

Industrial Applicability

Effective computer based communication should be done in real time to ensure that the participants are stimulated visually, audibly, and emotionally, as well as allowing the participants to interact with the information during the process. Any solution to this information flow problem must begin with a viable communication infrastructure.

Unfortunately existing telephony, Local Area Network (LAN), Wide Area Network (WAN), Internet, satellite, wireless, and Cable TV technologies are barriers to information flow. All have inherent limitations that prevent real-time, two-way, guaranteed, global, equal access, reliable, continuously upgradeable, high quality service. The telephony infrastructure is real-time two-way in nature, but it is

statistically based and can only handle audio not the diverse array of content required of real information flow. Satellites are too complex and expensive when deployed in a real-time two-way fashion. Cable TV plants are one-way. LAN, WAN, and Internet technologies are statistically based and cannot deliver any of the guarantees of Quality of Service (QoS), performance, security, and reliability that are required to solve the information flow problem. Consequently, a truly effective information flow model cannot be implemented in a conventional computer based communication solution due to the shortage in computational power in the host processor, the limitations on two-way data throughput capacity, lack of support for all media formats, non-real-time performance, and less than full interactivity.

There remains a significant commercial demand for a unified Computing and Communication architecture that allows simultaneous participation of a session Manager (Moderator or Teacher), authenticated Participants (Users or Students), a Network Administrator, a Help Desk, any necessary Auxiliary Communication Services, and Content Developers. The goal of the Unified Computing and Communication Architecture (UCCA) set forth herein is to give all the foregoing denominations simultaneous and seamless point-to-point and point-to-multi-point communication capabilities and to allow the creation of content, management of content, distribution of content, security of content, and the assessment of the use of content within the network, inclusive of all communication formats (audio, video, imagery, data, etc.), and substantially in real-time.

PCT/US 99/27587
IPEA/US 19 JUN 2000

What is claimed is:

1. A computing and communication architecture comprising:

at least one service cell formed of a network of interconnected computers to facilitate managed, multi-media, point-to-multi-point information flow therebetween, each service cell further including,

an asynchronous communication backbone,

a central non-blocking switch connected to said asynchronous communication backbone,

a plurality of clients each connectable to said switch, each of said clients further comprising a computing platform having,

at least one supercomputer class processor, and

an asynchronous communication interface coupled to said processor to provide a communication link to said switch, and

at least one server coupled to said switch, the at least one server having,

at least one processor,

an asynchronous communication interface to provide a communication link to said switch, and

a data storage;

whereby a number of client connections to said switch is maintained at or below a predetermined maximum number to maintain a balanced symmetrical asynchronous network topology within each service cell, the topology supporting non-statistical, full-duplex communication between said clients, and between any group of said clients and said server.

2. The computing and communication architecture according to claim 1, wherein each of said clients and said at least one server are connected via their respective asynchronous communication interfaces to a dedicated connection at said switch, the number of clients being limited to said predetermined maximum to ensure that a two-way data path exists between each client and server within each service cell.

AMENDED SHEET

PCT/US 99/27587
IPEA/US 19 JUN 2000

3. The computing and communication architecture according to claim 1, further comprising at least one special purpose server, each special purpose server having,

at least one processor,

an asynchronous communication interface coupled to said processor to provide a dedicated connection to said switch, and

a high speed data storage,

whereby access to said at least one special purpose server is statistically based from the perspective of the clients within the respective service cell.

4. A computing and communication architecture comprising:

at least one service cell formed of a network of interconnected computers to facilitate managed, multi-media, point-to-multi-point information flow therebetween, each service cell including,

an asynchronous communication backbone,

a central non-blocking asynchronous switch connected to said asynchronous communication backbone,

a plurality of clients each connectable to said switch, each of said clients having an an asynchronous communication interface to provide a connection to said switch, and

at least one registry server connectable to said switch, each registry server having an asynchronous communication switch coupled to said switch, and

a data storage device,

said registry server being configured to control a predetermined maximum number of simultaneous connections such that a permanent two-way data path exists between each client and registry server within each service cell.

5. The computing and communication architecture according to claim 4, further comprising a plurality of network services maintained in each service cell to ensure proper information management flow.

AMENDED SHEET

PCT/US 99/27587
IPEA/US 19 JUN 2000

6. The computing and communication architecture according to claim 5, further comprising a plurality of client services maintained in each service cell to ensure proper information management flow.

7. The computing and communication architecture according to claim 5, wherein said network services comprise any one or more from among the group of availability services, quality services, reliability services, serviceability services, maintainability services, extensibility services, authentication services, security services, registry services, high availability services, fault tolerance services, resource management services, bandwidth management services, data storage services, communication services, Internet services, telephony services, and supercomputing services.

8. The computing and communication architecture according to claim 6, wherein said client services comprise any one or more from among the group of contact services, session management services, session status services, scheduling services, audio services, video services, message services, chat services, assessment services, projection services, collaboration services, presentation services, authoring services, asset management services, Internet services, media services, help services, network management services, service administration services, security services, telephony services, simulation and gaming services, and supercomputing services.

9. The computing and communication architecture according to claim 4, further comprising at least one special purpose server, each special purpose server having an asynchronous communication interface to provide a connection to said switch, and an ultra-high speed data storage array,

wherby access to said at least one special purpose server is statistically based from the perspective of the clients within the respective service cell.

10. The computing and communication architecture according to claim 4, wherein the asynchronous communication interfaces of said clients and registry servers provide connections to said switch.

AMENDED SHEET

PCT/US 99/27587
IPEA/US 19 JUN 2000

11. The computing and communication architecture according to claim 10, wherein said asynchronous communication interfaces support a plurality of communication protocols simultaneously and allow new communication protocols to be added dynamically.

12. The computing and communication architecture according to claim 11, wherein said asynchronous communication interfaces support a plurality of industry standard physical layer interfaces including any one from the group comprising T1, E1, DS-3, OC-3, OC-12, OC-48, MMDS wireless, LMDS wireless, and XDSL.

13. The computing and communication architecture according to claim 12, wherein said asynchronous communication interfaces support real-time encryption of asynchronous transfer mode cells delivering secure data transmissions without adding latency or consuming bandwidth.

14. A computing and communication architecture comprising:

a plurality of service cells each formed of a network of interconnected computers to facilitate managed, multi-media, point-to-multi-point information flow therebetween, each service cell further including,

an ATM communication backbone,

a central non-blocking ATM switch connected to said ATM communication backbone,

a plurality of terminals each connectable to said ATM switch, each of said terminals further comprising a computing platform having an ATM communication interface for dedicated connection to said ATM switch, and

at least one registry server connectable to said ATM switch, each registry server further comprising a computing platform having an ATM communication interface to provide a connection to said ATM switch, and

a high speed data storage array,

said registry server being configured for controlling a predetermined maximum number of simultaneous connections such that a permanent two-way data path exists between each terminal and registry server within each service cell; and

AMENDED SHEET

PCT/US 99/27587
IPEA/US 19 JUN 2000

a plurality of network services maintained in each service cell to ensure proper information management flow; and

a plurality of client services maintained in each service cell to ensure proper information management flow;

whereby said switches of said plurality of cells are connectable to a common ATM switch to create a two-way inter-service cell data path between at least one terminal and at least one registry server.

15. The computing and communication architecture according to claim 14, wherein said network services and said client services are continuously upgradeable entirely in software.

16. A computing and communication architecture comprising:

at least one service cell formed of a network of interconnected computers to facilitate managed, multi-media, point-to-multi-point information flow therebetween, each service cell further including,

an asynchronous communication backbone,

a switch connected to said asynchronous communication backbone,

a plurality of clients, each connectable to said switch, each of said clients having,

a processor, and

an asynchronous communication interface coupled to said processor to provide a communication link to said switch, and

at plurality of servers coupled to said switch, each server having,

at least one processor, and an asynchronous communication interface to provide a communication link to said switch, and

a data storage device;

whereby a number of connections to said switch is maintained at or below a predetermined maximum number to maintain an asynchronous network topology within each service cell, the topology supporting non-statistical, full-duplex communication between said clients, and between any group of said clients and said servers, and between servers.

AMENDED SHEET

PCT/US 99/27587
IPEA/US 19 JUN 2000

17. An architecture as claimed in claim 16, wherein each client includes a camera.

18. An architecture as claimed in claim 16, wherein each client includes an audio speaker.

19. An architecture as claimed in claim 18, wherein each client includes a microphone.

20. An architecture as claimed in claim 19, wherein each client includes a visual display.

21. An architecture as claimed in claim 16, wherein each client includes a biometric device.

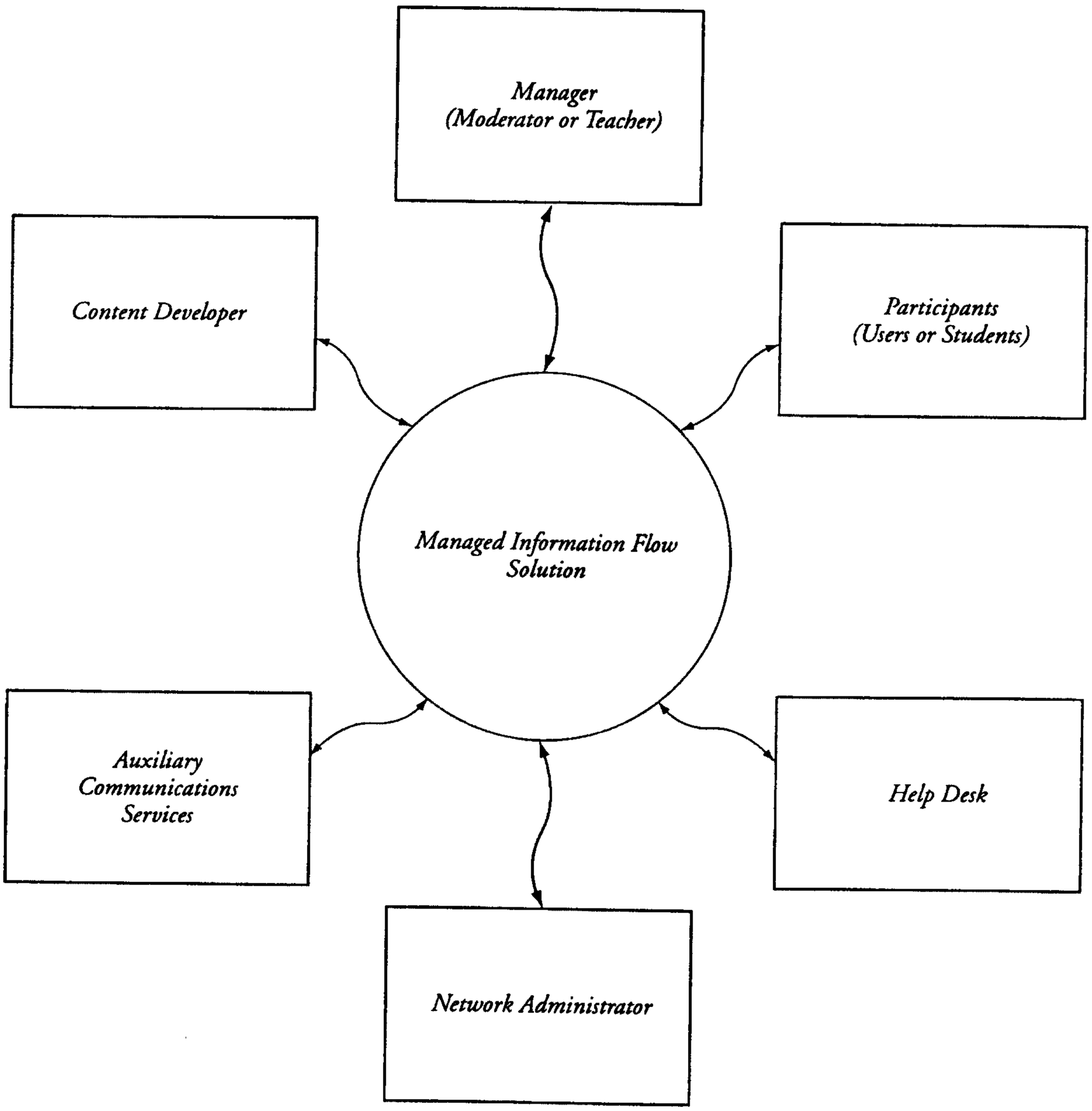

Manager
(Moderator or Teacher)
Content Developer
Participants
(Users or Students)
Managed Information Flow
Solution
Auxiliary
Communications
Services
Help Desk
Network Administrator

Fig. 1

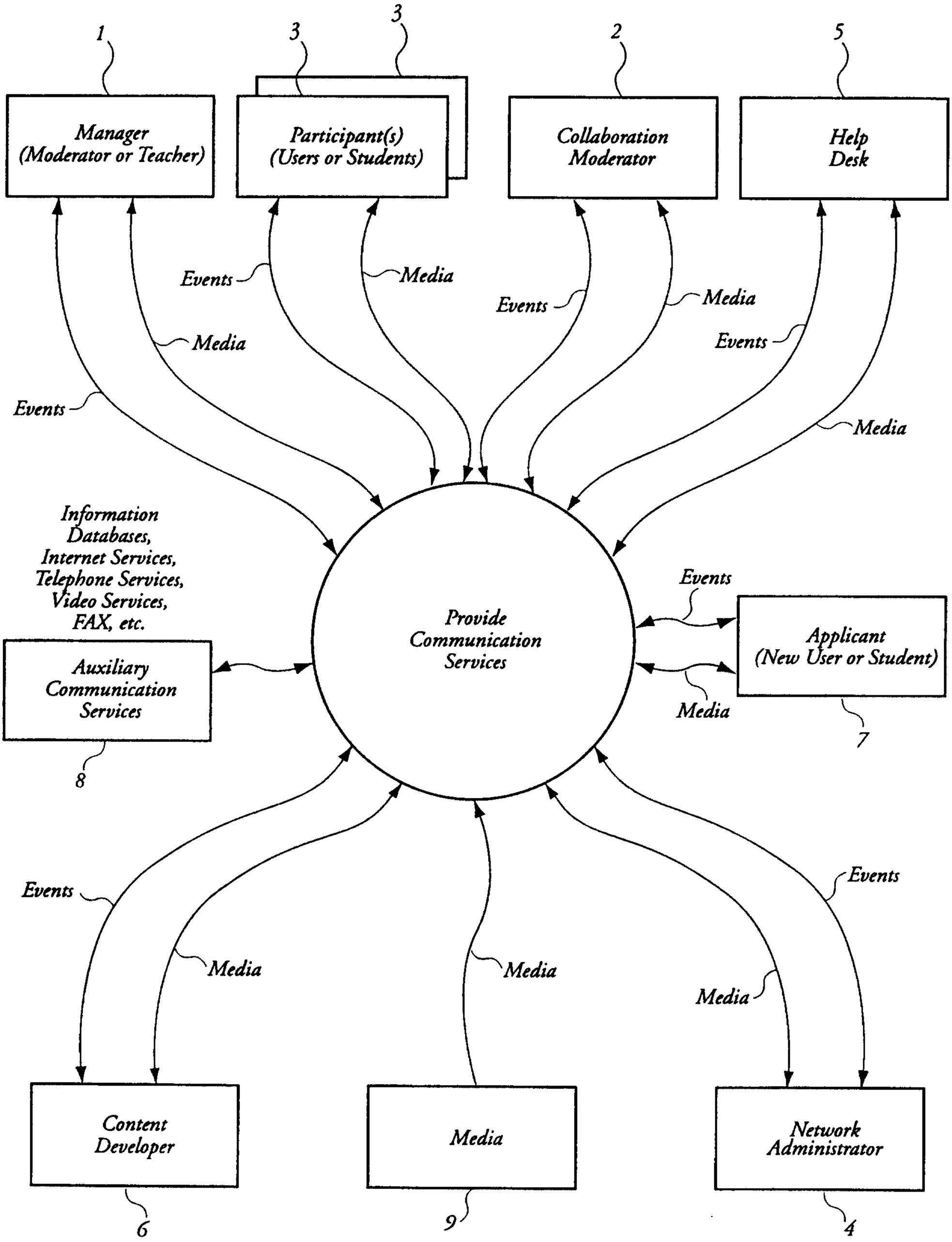
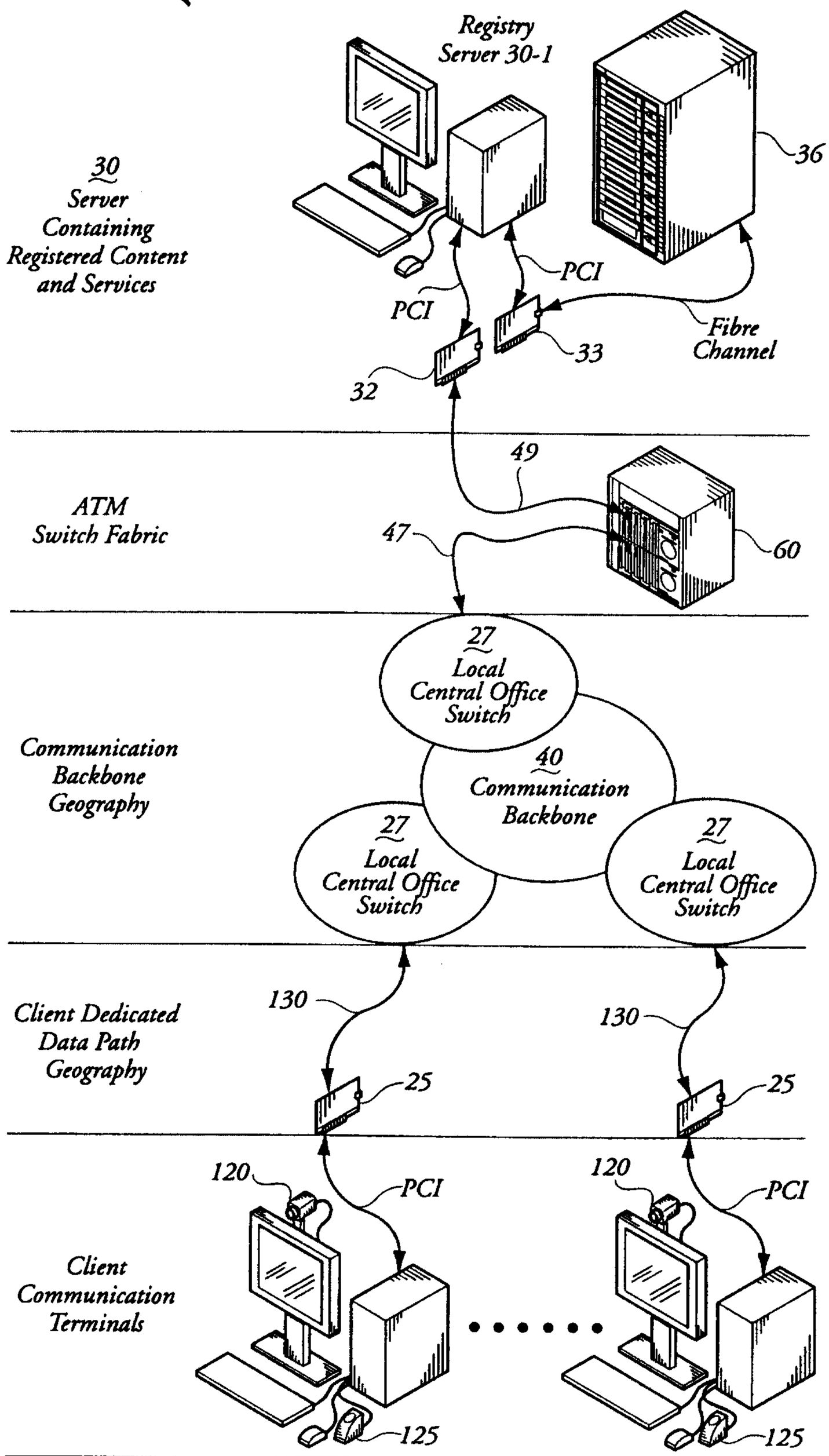

1
Manager
(Moderator or Teacher)
3
3
Participant(s)
(Users or Students)
2
Collaboration
Moderator
5
Help
Desk
Events
Media
Events
Media
Events
Media
Events
Media
Events
Media
Information
Databases,
Internet Services,
Telephone Services,
Video Services,
FAX, etc.
Auxiliary
Communication
Services
8
Provide
Communication
Services
Events
Media
Applicant
(New User or Student)
7
Events
Media
Events
Media
Media
Events
Content
Developer
6
Media
9
Network
Administrator
4

Fig. 2


10
30
Server
Containing
Registered Content
and Services
Registry
Server 30-1
36
PCI
PCI
Fibre
Channel
33
32
49
ATM
Switch Fabric
47
60
27
Local
Central Office
Switch
40
Communication
Backbone
27
Local
Central Office
Switch
27
Local
Central Office
Switch
Communication
Backbone
Geography
130
130
Client Dedicated
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PCI
PCI
Client
Communication
Terminals
125
125
Client A1
Client A80

Fig. 3

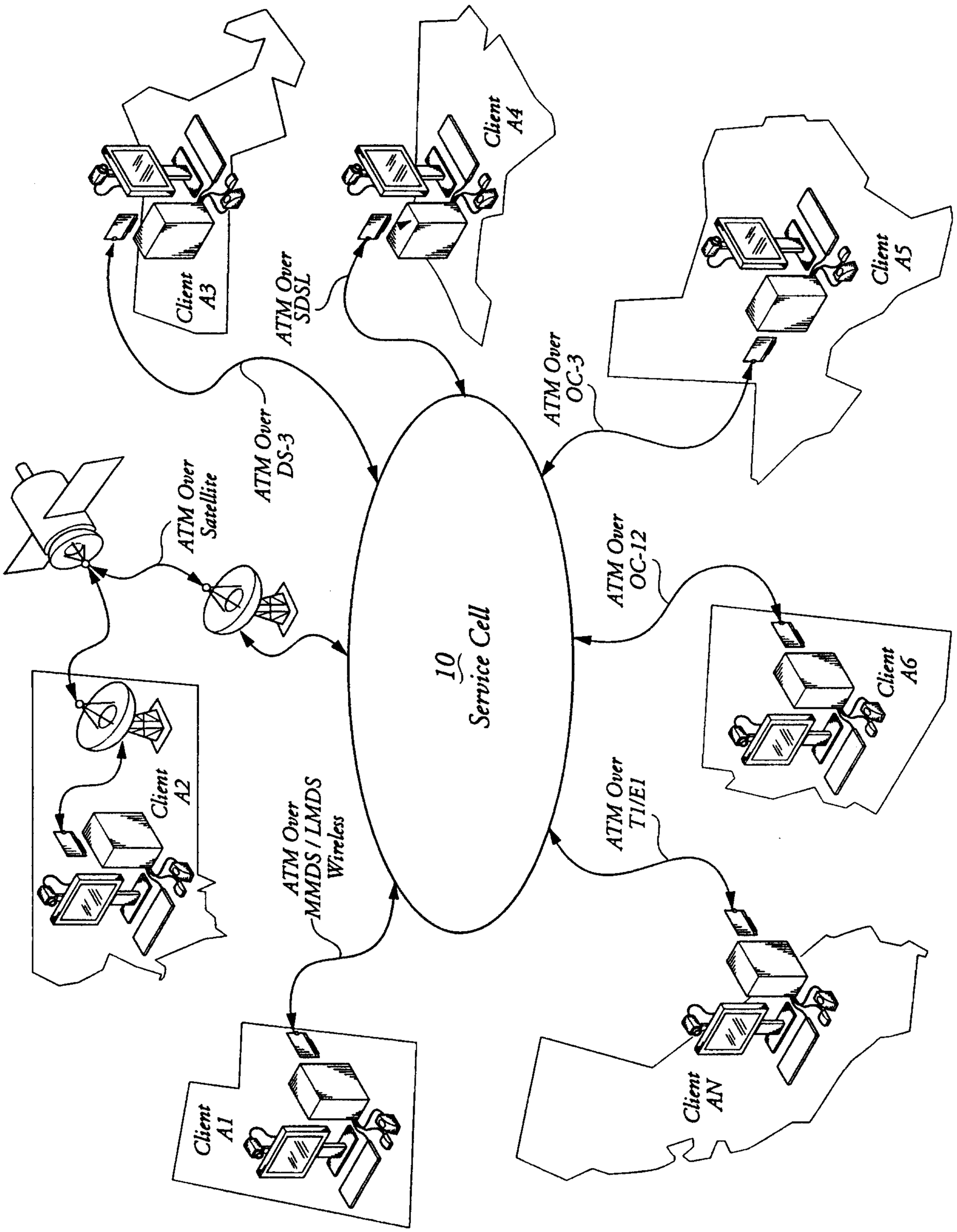

Client A1
Client A2
Client A3
Client A4
Client A5
Client A6
Client AN
ATM Over Satellite
ATM Over DS-3
ATM Over SDSL
ATM Over OC-3
ATM Over OC-12
ATM Over T1/E1
ATM Over MMDS / LMDS Wireless
10 Service Cell

Fig. 4

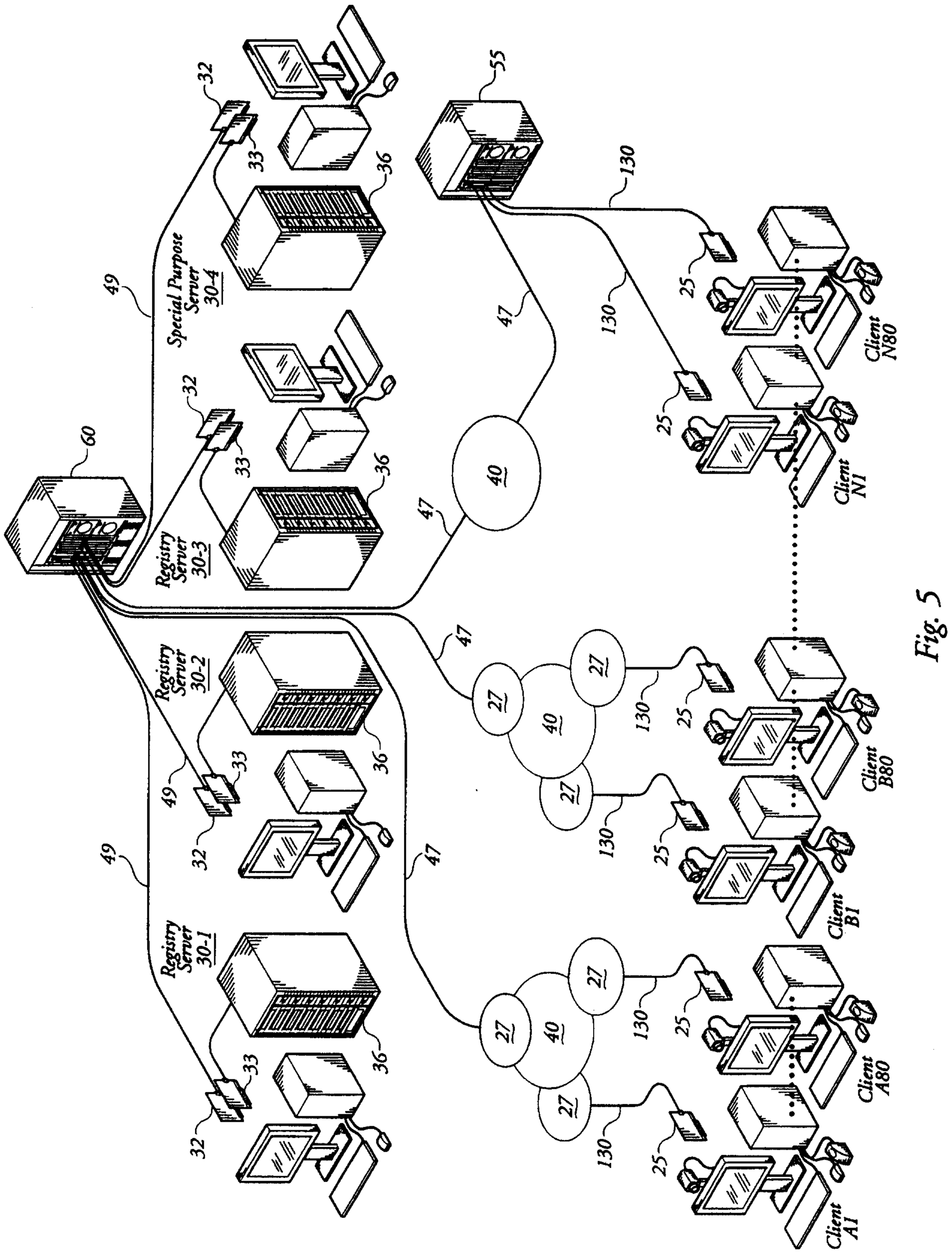

Registry Server 30-1
Registry Server 30-2
Registry Server 30-3
Special Purpose Server 30-4
Client A1
Client A80
Client B1
Client B80
Client N1
Client N80
40
47
49
55
60
130
25
27
32
33
36

Fig. 5

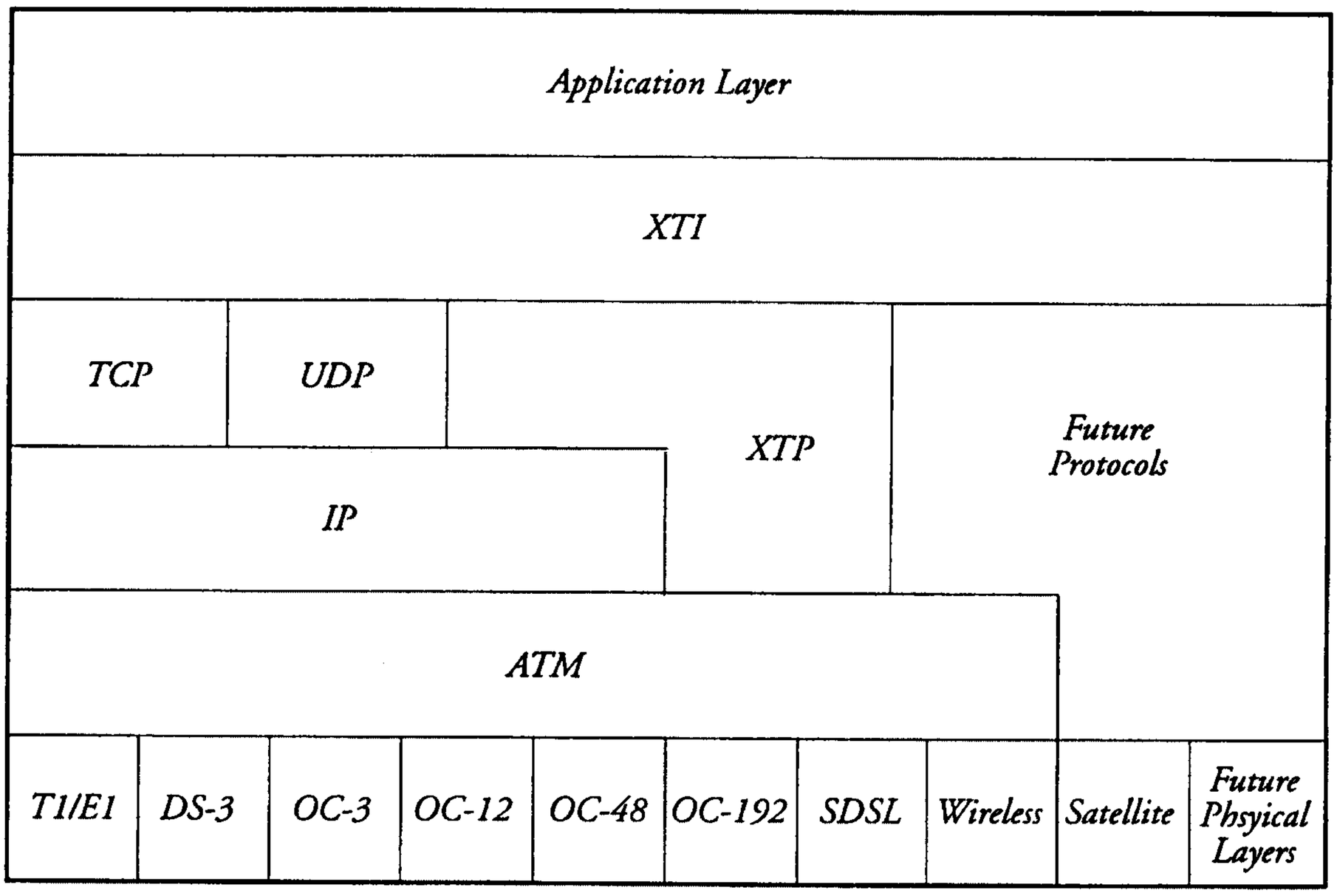

Advanced ATM Communications Interface
Application Layer
XTI
TCP
UDP
XTP
Future Protocols
IP
ATM
T1/E1
DS-3
OC-3
OC-12
OC-48
OC-192
SDSL
Wireless
Satellite
Future Phsyical Layers

Fig. 6

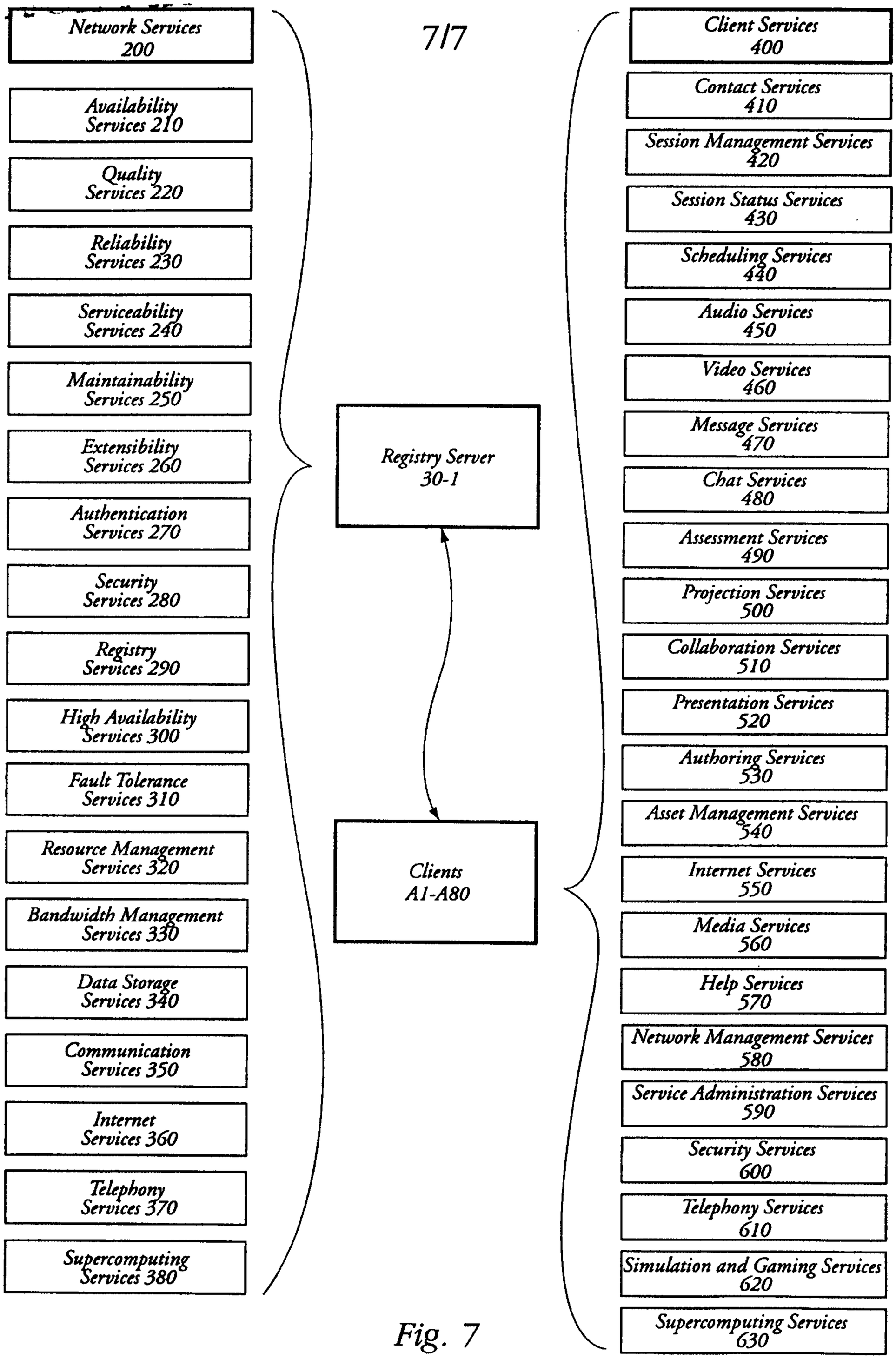
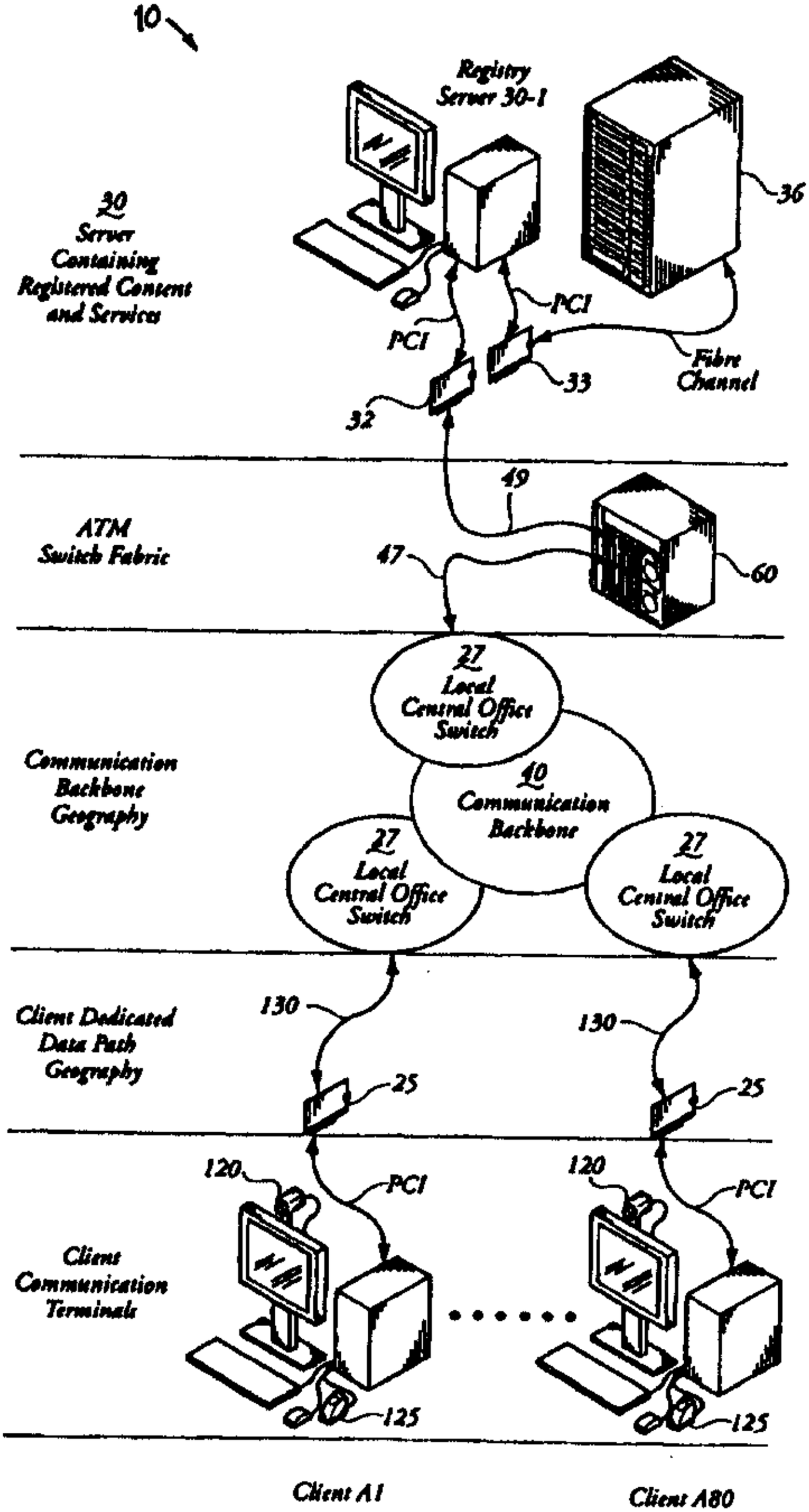

Network Services 200
Availability Services 210
Quality Services 220
Reliability Services 230
Serviceability Services 240
Maintainability Services 250
Extensibility Services 260
Authentication Services 270
Security Services 280
Registry Services 290
High Availability Services 300
Fault Tolerance Services 310
Resource Management Services 320
Bandwidth Management Services 330
Data Storage Services 340
Communication Services 350
Internet Services 360
Telephony Services 370
Supercomputing Services 380
Registry Server 30-1
Clients A1-A80
Client Services 400
Contact Services 410
Session Management Services 420
Session Status Services 430
Scheduling Services 440
Audio Services 450
Video Services 460
Message Services 470
Chat Services 480
Assessment Services 490
Projection Services 500
Collaboration Services 510
Presentation Services 520
Authoring Services 530
Asset Management Services 540
Internet Services 550
Media Services 560
Help Services 570
Network Management Services 580
Service Administration Services 590
Security Services 600
Telephony Services 610
Simulation and Gaming Services 620
Supercomputing Services 630

Fig. 7


10
Registry Server 30-1
36
20 Server Containing Registered Content and Services
PCI
PCI
Fibre Channel
33
32
49
ATM Switch Fabric
47
60
27 Local Central Office Switch
40 Communication Backbone
27 Local Central Office Switch
27 Local Central Office Switch
Communication Backbone Geography
130
130
Client Dedicated Data Path Geography
25
25
120
PCI
120
PCI
Client Communication Terminals
125
125
Client A1
Client A80