Multimedia Communications[1]

Philosophical and Technological Interactions

Terrence P. McGarty[2]

The Telmarc Group. Inc

[1]This paper was presented at the MIT Course on Multimedia Communications taught by the author in the Fall of 1989, as Course 6.992, in the Department of Electrical Engineering and Computer Science at MIT.

[2]Telmarc Group, Inc., Florham Park, New Jersey.

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1. THE CONCEPT

From time to time, a change occurs in the way people communicate, to cause a shift in thought, perception, awareness, and in a sense of what is truth and knowledge. It has been argued that multimedia and multimedia communications is such a shift. This paper addresses that perception from a perspective that is dramatically different than any other taken. The perspective developed in this paper is one that is philosophical. It does not talk to technology or business. It does not refer to companies and equations. The approach is that taken by an engineer who was first trained as a philosopher. An approach that tries to address first principles from the context of the perceptions and understandings of the many other thinkers who have addressed the issues of human knowledge and communications before. We consider the process by starting with Plato and end with the most current thinking in the areas of epistemology and human understanding. This is an evolving approach. The schema presented and developed herein are still formative. They do, however, set a direction and a discipline.

1.1 Current Definitions of Multimedia

Multimedia concepts encompass a wide variety of interpretations. To some, the multimedia environment consists of one that has many elements of storage, to others the environment entails the interfacing of various storage devices. In another extreme there is the concept of a multimedia environment being nothing more than that of a windowed display environment that uses some limited form of hyper media, that is windows in depth besides just length and width.

In this paper we attempt to develop a theory of multimedia communications, that encompasses the elements of both the multimedia environment as well as the effective utilization of the rich nature of that environment. Let us begin by understanding the nature first of the human using information in the context of their own limited environment and then expand it to the case where the human can share the information with others.

There have been a significant number of definitions of multimedia. Comparing some of these definitions will be a quick way to determine what multimedia is not. All too often the authors are reporters who have not struggled with the issues of multimedia or at the other extreme they are vendors who define multimedia to be what is in their current product line. The first definition is due to Wright, who describes multimedia in the context of the Global Village. To her, multimedia is;

> *" Computer based presentations combining two or more media, such as text, graphics, writing, and video and audio signals."*

If we look at her definition we note that she defines media in the context of the type of message (text, graphics, video, audio) as well as the way it may be stored (video and audio signals). She does not take into account the complexity of storage, the sophistication of interfaces, the interaction of the senses, nor the intelligence of the human processor. The mere fact that multimedia is "Human" directed as compared to "Computer" directed is not an element in her definition. As a point of fact, Wright goes as far as to define the Human Being as:

> *"An analog processing and storage device with the bandwidth of 50 bits per second. Human beings excel at pattern recognition but are notoriously slow at sequential calculations."*

One is amazed that the author fails to recognize that the essence of multimedia is to more effectively match the input/output capability of the human as a species. We humans are amazingly fast at processing visual information, less fast at aural information and slower at the use of our other senses. Ms. Wright in her Scientific American presentation totally misses the essence of this new paradigm.

Probably one of the more insightful presentations of the Human as processor is the book by Max Delbruck. Delbruck, the Nobel prize winner in Biology, presents the argument that the evolution of primates, and

humans especially is epitomized in the evolution of vision as the primary sense. Three specific developments allowed for this speciation to created the mind of the human. The events are;

1. A transition from an olfactory and tactile creature to a visual creature.

2. The displacement of the eyes from lateral to frontal allowing for the perception of three dimensions.

3. The differentiation of the cone receptors in the retina allowing for color perception.

Starting with these three events, Delbruck demonstrates that the human mind is intimately connected to these events, and as such is a complex image processor. This is the basis of the multimedia paradigm. This is what Wright has totally missed in her exposition.

A second presentation of multimedia is done by Jane Morrill. Morrill defines multimedia in the following even more interesting form.

> *"Flip charts? Overheads? Isn't this the computer era? Surely, with all the high-speed machines, CD-ROMs, synthesizers, and image processing capabilities available, there must be something that will convey your message better than flip charts and overheads. Well, there it is. It's called multimedia, and it marries the best of image, voice, text, and video processing."*

Her attempt at a definition is a tautology, in that you know what it is when you see it. Her article then proceeds to develop multimedia in the context of what vendors of workstations have in terms of different storage devices. She again does not even acknowledge the issue that the human is a factor and that multimedia is a blending of the human in the stream of the information flow.

A third paper by Shandle defines multimedia in altogether different terms. Specifically he calls it:

> *"...the delivery of video, audio and other heretofore exotic data types to the desk top...."*

Again there is no mention of the human, why the data is to be transported or even what it is to be used for.

1.2 Philosophical Pillars

To fully understand multimedia it is necessary to explore the work of two sets of major thinkers. The first is Marshall McLuhan and the second is Winograd and Flores. McLuhan, in Understanding Media, and Winograd and Flores in Understanding Computers and Cognition have complemented each other in a way in which their convergence of ideas lays the ground work for "Understanding Multimedia Communications". We shall be relying on these two sets of authors for a guide through the development of the meaning of multimedia. McLuhan has been discredited of late because of his simplistic views. We shall argue and shall attempt to show, that this may be a direct result of the critics, frequently the Pop Press, not understanding how perceptive McLuhan was in his more academic treatises. McLuhan will be the definer the "bright line" that results when a paradigm shift occurs in a new medium.

Winograd and Flores are the other set of lights that the author shall rely heavily upon. Unlike the Pop writers of the above definitions, Winograd and Flores have developed one of the most seminal works in the areas of computers and computation that have ever been done. These authors have used access to the most recent philosophical understandings of knowledge and knowledge processing from a philosophical perspective to develop a philosophy for computing, especially software development. We shall, in this paper, develop and extend these concepts for the multimedia area.

Drucker, in his biographical sketches of his contemporaries, remarks on his first encounter with McLuhan. It was during a presentation that McLuhan was making on the results of his do doctoral studies. His presentation reflected upon the impact that the printing press has had upon the university system in the late

Middle Ages. He contended that the modern university came into being in the sixteenth century because of printing, which changed not only the method of instruction but, more importantly, what the university intended to teach. He further contended that the cultural results of this period had little to do with the Renaissance and was all a direct result of the printing press.

To quote Drucker, who paraphrased McLuhan;

> *"Did I hear you right," asked one of the professors in the audience, "that you think that printing influenced the courses that the university taught and the role of university all together." "No sir," said McLuhan, "it did not influence; printing determined both, indeed printing determined what henceforth was going to be considered knowledge."*

Thus this led to McLuhan's famous phrase that the medium is the message. Specifically, as we developed a new medium for human communications, we dramatically altered the nature of the information that was transferred and the way in which the human perceived what was "truth" and what was not. The television generation of the 1960's was an clear example of the impact of television versus film in portraying the war in Vietnam as compared to the Second World War. The perception of these two events was determined by the difference of the two media that displayed them to the pubic masses. Television allowed for a portrayal that molded more closely to the individual humans impact of the events as compared to films overview of the groups involvement's. Both media deal with the same senses but they are different enough to have determined two different outcomes of the wars. This conclusion is a McLuhanesque conclusion but is consistent with the changes that McLuhan was recounting in the 1960's in his publications.[3]

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[3]The concept of information in the context of the human has all to often been viewed as text or numeric data that has been reduced to the form of a digital map of the data. The Shannon concept of information was an extension of the nineteenth century concept of entropy and the essential uncertainty of a measurement. Inherent in this paradigm was the assumption that there was a definable truth. To better view this concept, one can view the approach taken by Wiener in the estimation of trajectories of aircraft in the early days of Cybernetics. In this context, Wiener assumed that there was truth in the form of a real trajectory, and that by using data corrupted by noise that this truth could be estimated with a definable measure of accuracy. In fact, Wiener still further stated that there was an optimum processor that got a close to truth as one could.

In the Shannon context, Shannon being a student of Wiener, there was a basic message, that was itself uncertain. The message was however composed of truth elements, that is bits of values zero and one. The probability that any one bit was a zero or one led to the data uncertainty. The data was then transmitted across a noisy channel that further increased the uncertainty. Shannon then developed the channel and source coding theorems that stated how low the error rates could be and how few bits were needed.

In a multimedia environment, however, there are other dimensions that make the problem more complex. Let us firs consider the case of a data base inquiry that can be performed today. In a database inquiry we may ask the question, "How many patients greater than fifty have thrombophlebitis?" . If the database is composed of text entries that are machine readable then we can match all elements in the database and actually count the number of patients that have the indicated disorder. The reason for this is that we have mapped the term "thrombophlebitis" into a "truth" bit pattern of zeros and ones and that we can now achieve the match with no error.

In contrast, if we are dealing with multiple sources of information that is not inherently unambiguous, such as x-ray film, blood flow tests, and palpation of the patient, we can still ask the question but now there is no longer the unambiguous matching of the word "thrombophlebitis" and the information contained in the series of tests. This is the typical problem of dealing with multimedia. Specifically it has not been predigested by a processor to eliminate ambiguity to questioning.

Whereas Shannon dealt with the question of taking data and being able to reproduce it as it was before transmission, the multimedia problem frequently is that of syntax and semantics. The syntactical question is one of how do I pose questions in the forms of English on information that is more complex and robust,

The important observation that McLuhan makes is not often understood. He really means that the medium defines what is knowledge. A new medium, as a general construct, will define a new knowledge base. We all too often define knowledge so obtained with truth. In fact, truth is that relative reality that we find comfortable to our understanding, and all to often ascribe an absolute character to it. The essence of this paper will deal with these two issues; knowledge as defined in the McLuhanesque sense, and truth as a phenomenological expression of that knowledge. Multimedia communications will alter those definitions and will dramatically change the way we see, think, and ultimately act. We argue, for example, as with McLuhan, that television violence, for example, changes what is knowledge, the acceptance of moral norms, and this change in moral knowledge is reflected in the truths of everyday existence. The expansion of multimedia communications will take this minor concern many levels higher. Thus multimedia communications is a technological issue, a philosophical consideration, and ultimately a moral imperative.

1.3 Multimedia Structures

Multimedia consists of three major dimensions; the storage media, the interface media and the senses. A true multimedia environment provides a full mix of all of these. Let us begin by first considering the senses. The five senses are; sight, sound, touch, taste, and smell. As humans, we specialize in the first three senses, and only secondarily allow for use of the last two. Max Delbruck, the noted biologist and Nobel prize winner has discussed the uniqueness of the human as one whose dealings with his environment is more visual than olfactory than any other species.

Most animals have highly developed senses of smell and frequently their total social patterns revolve around them. We as humans revolve around sight first and sound second. Point of fact, as cultures evolve, we find that the use of the other senses are less and less socially acceptable. We no longer sniff at each other, nor do we employ the other two senses as other parts of Animalia do.

The senses element of multimedia provides a basis for the understanding of the limitations and emphasis of the human as a processor of information. The information is contained in a combination of sensory inputs. These inputs are all parts of the communications environment. A discussion of an ad layout for a print publication involves the image, the voice interaction as well as the human interaction of peripheral nature that ensues during the presentation of the ad copy. To develop multimedia effectively, it is necessary to evoke all elements of the human response.

The interface element of multimedia communications describes how the human interfaces with the electronic interlocutor, the electronic medium. Again we all too frequently view the interface in simple terms as a computer display and nothing else. The current view of multimedia communications is that of a display terminal that allows for both a windowing environment and a hyper media environment. It may also extend to including video. As we have just described, the essence of multimedia is to maximize the input from the senses, and also balance the communication of all sensory data on the topic to be discussed.

Thus the interfaces must communicate all five senses both from the electronic medium and to the medium. Visual displays are but a part of that communications. Effective multimedia today must also integrate voice and sound with some form of tactile interface. A now primitive example of this is the first set of electronic games wherein the human had visual, aural and tactile interfaces with the electronic medium.

The final element of a multimedia environment is the storage media. The storage media in some sense dictates what is effectively communicated and the ability of the human to retrieve and process the information. The media today has allowed for the storage and retrieval of information in short times for large amounts.

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such as images and speech. The semantic question is the one of having posed the question, assuming that one can do it, how do I interpret the answer.

Here the author defines Multimedia Communications in a broad context.[4] "The term multimedia is used in many different contexts and is greatly misunderstood. In the current popular press it is viewed as merely a set of mechanisms for the storage of different data types on a local basis and their display to a single user. In the extended view of multimedia communications it is understood as an environment for the sharing of information in various forms, video, image, voice, text, records, etc., that are stored in different locations. Diagnostic imaging places significant challenges upon the diagnostician as well as the attending physician and multimedia communications can assist in meeting this challenge. There is an increasing need for the set of physicians to act in concert in combining their talents for the best delivery of service to the patient.

Multimedia communications is characterized by the following factors:

o **Multi Sensory**: It uses several of the human senses in transferring, processing, and creating information.

o **Multi-User:** It interconnects several users of the information into a conversational mode and allows a dialog based on a fully interconnected set of media.

o **Displaceable:** It allows for the establishment of communications and information transfer that is displaced in both space and time from the source.

o **Interactive**: It permits a real time interaction between any of the users of the medium, whether the users be human or databases or applications software.

The multimedia environment is one that is user centered and is designed to meet the users needs in interfacing with complex images and in conveying information from one location to another. Multimedia is not just a description of how the data is stored, it is, more importantly, the description of a philosophy of human interaction with complex data elements in a multi sensory fashion."

We must ask the question of what does the human want to do with multimedia that the human does not either want of is able to do with the classic single media information sources. There are several processes that are necessary;

o **Define:** The user desires first to define a multimedia object. This object is in sharp contrast to a normal data object that is typically a structured and bounded alphanumeric data element, convertible into a digital representation. A multimedia object is the concatenation of video, voice, text, and other sensory representations of the event at hand. A multimedia event is the analog of a data object. The data object is the representation of a definable and measurable term used in common communication, such as the word, NAME. In contrast the multimedia event is a collection of multimedia presentations that have a temporal and spatial extent to them. That is a multimedia even is a set of voice segments, a set of video elements, and a set of text frames.

To define a multimedia event means to concatenate in a rational form the set of disparate multimedia elements into a connected event. The process of connection is complex but it goes to the heart of human communications and understanding.

o **Query:** The query in a data object case is a way to do one of two simple tasks. A data object may be either selected or enumerated. The selection process is based upon the ability to take a data object and recognize that it has a unique representation in some stable denumerable set. For example we can use the alphabet or a binary representation for any data element. Once we select a data object we can then enumerate all of the objects that meet a certain criteria, by again matching and now counting. Thus we can answer the question of how many patients over forty have high blood pressure. We first use the select process on high blood pressure and then the enumeration on patients. In a multimedia environment, we are now posing much more complex queries.

[4] See McGarty, Multimedia Communications in Diagnostic Imaging, Investigative Radiology, April, 1991;

o **Store**: This means that we must store complex multimedia objects, composed of video, voice, image, pointer movement, text etc. that may reside on different storage devices at different locations. We must be able to retrieve them in the same order and timing that they were stored and do so in a minimum time.

o **Process:** We must be able to process multimedia objects, to alter, enhance, combine them. We must perform the processing in a fully distributed fashion, using the resources from multiple processors.

o **Display:** The display of the multimedia objects includes not only the display of the image or video but the "display" of the voice and other sensory elements of the multimedia object.

o **Communicate:** Communications means the development of a conversational mode. Conversation is key to communicating in a multimedia environment. Thus, we must not reproduce a communications environment that is attuned for the computer but one that is matched to the human user. The essence is the ability to effectively share the multimedia objects in a dialog fashion, interactive and interpretive.

These multimedia processes are to be done in a fashion that is transparent to the user. They must also be done in a fashion that is resonant with the way the users currently performs the tasks.

There are several dimensions that can be used to characterize the extent of the multimedia environment. These dimensions are;

o **Time and Duration:** This dimension shows the amount of simultaneity that the medium allows both for a single user as well as for a collection of users. Further a dimension of durability to the environment is essential as the complexity of a multimedia object requires that time pass until it has its full representation. Thus unlike a mono-media object that can be represented to a single user in a fixed period, the interlining of media and users requires a sustainability of the environment.

o **Communication and Conversationality:** This characteristic is one of allowing for a multimedia multi-user environment that permits a full sharing of the environment a an equal basis amongst all of the users. It further allows the users to interact with any other user while at the same time allowing this interaction along any one of the multimedia dimensions.

o **Interactivity and Responsiveness:** This dimension relates to the ability of the environment to allow one or several users to utilize all elements of the medium and at the same time to pose questions that are robust in a multimedia sense and to obtain adequate answers.

o **Presentation and Interaction:** The interactiveness of the environment is a key element of understanding the

o **Non-Linearity and Hyper-Dimensionality:** This dimension of characterization allows for the movement amongst the object in an unbounded fashion. It allows for movement in space, all dimensions, and time, as well as in point of reference. The spatial movement entails the ability to view at different magnifications that is common amongst hypermedia environments. The ability to view at different points of reference allows one users to accept the reference frame of another to view the object.

o **Sense-Complexity and Representation:** This dimension allows for the combining of multiple sensory elements into the multimedia objects as well as the presentation of those elements either as direct manifestations or as appropriate analogs.

In the context of this paper there will be three elements that define multimedia and multimedia communications; the message, the medium and the messenger. The ultimate result is the impact of the

information created on the environment. Without the result, there has been no transfer of information. The objective of this paper is to show the relationships between all three of these elements and the blend with them a set of philosophical underpinnings that will allow them to be used in analyzing the development of multimedia communications.

We first define the three elements of message, messenger and medium.

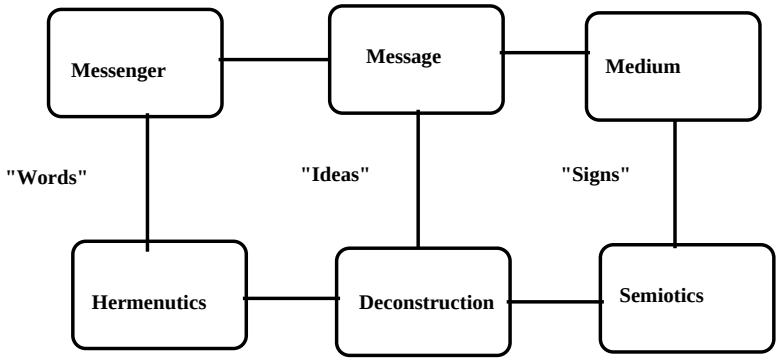
> **Medium:** The medium is the collections of all physical elements outside of the mind of the creator of the message that facilitates the externalization of the message. Paper, a video screen, a hypermedia environment, a set of signaling flags, a stone tablet are all the elements of the medium.
>
> **Message:** The message is the "idea" to be transferred from one individual to another. It is the information content to be transferred and thus to acted upon. It is an actionable element of internalized conceptualization.
>
> **Messenger:** The messenger generally is thought of as an individual. In our context, the messenger is the collection of any and all entities that move the message from one point to another. Recall that the movement may be i space and time. Recall also that the channel used in the movement may be a "noisy" channel that can introduce errors

There are three schools of philosophical thought that will be used to assist in developing and overall theory of multimedia communications and these schools, complementary in many ways, assist in each of these three elements. They are;

> **Semiotics:** This is the study of "signs". In the current context, semiotics helps us with the study of the medium elements of multimedia communications. For indeed, the medium consists of the signs that are used in the conveyance of the idea. To the semiotician, the world is viewed in the sense of a pure sign, an outward display that can be interpreted to mean what the displayer intends. The semiotician reflects on the issues of identifying the sign and then identifying the meaning.
>
> **Deconstructionism:** This is the school of thought that tries to understand the idea or the essential information from the message. What was really meant by the message sent. It takes the combination of the message, the medium and the messenger, in context, and tries to determine the essential message or information content. It does this through the inherent assumption that messages are actionable and it is through the direct of implied actions that the information may be revealed. The deconstructionist relies upon the deeper philosophical underpinnings of the conveyer of the sign. To properly deconstruct a sign, the deconstructionist must understand what world view or philosophical sets of precepts the holder of the sign has. Deconstruction begs the question of a real philosophical ethos, expressed or not expressed.
>
> **Hermeneutics:** This is the study of what the messenger really meant by the words uttered. Hermeneutics focuses on the message via the messenger. It is an extension of biblical study of trying to reinterpret the message of the gospels and old testament writers from the human perspective of the writer, in our case the messenger.

We depict the interplay of these nine elements in the following figure.

Figure: Interplay of Multimedia Elements and Philosophical Underpinnings



This figure depicts the overall flow of this paper. Our approach is to define and the describe each of the elements in the above and then to apply them to multimedia communications. The application will focus on two issues. First we will develop a set of analytical tools that will allow the user to understand an existing multimedia environment. Second, we will develop a methodology to synthesize the multimedia environment that meets the objectives of the designer. The reader must note that it is the joining of the words, the ideas and the signs that leads to the actionable event.

This paper is structured to address each of these above issues. It first focuses on the message, the medium and the messenger. It then shows how the three philosophical schools ca converge to better understand the issues of multimedia communications.

2. MULTIMEDIA; ELEMENTS AND STRUCTURE

Multimedia technology or systems have been viewed as multisensory end user focused technological add-ons to existing or new computer processing environments. Multimedia is a catch phrase for new technology that displays, either orally or visually, information that may be stored in an dense and complex form at the end users site. It has been viewed in many ways as a means to an end, yet viewed as an end in itself. To date, there has been no "philosophy" of multimedia, no Marshall McLuhan of the multimedia world to articulate who wants to use it and for what purpose. The key questions from a business perspective is how does the set of multimedia technologies provide increased value to business customers, and how does the consumer value the multimedia technology in their daily lives. The use of multimedia technology and its acceptance is an economical factor, based on value creation and perception on the part of the user. It is not, as has all too often been suggested, a technologically driven market.

2.1 Elements of Multimedia

To begin, the elements of multimedia as currently understood by the hardware and software providers can be presented. There are six major categories of multimedia technology and elements. These are;

o Displays: The MM display areas focuses on enhancement of images, improved resolution, and display presentation processor enhancement. The display may be generically for any one of the senses; sight, sound, touch, or others that may be appropriate. HDTV is an example of one area of progress. Especially digital TV.

o Processors: The processors and processes are the special software or hardware elements that locally enhance, manipulate, display, or interpret multimedia elements.

o Content: This is the more general software that is created and used on a multimedia system. It is the result of authors works in creating information and interactive systems for multimedia.

o Storage: This is the composite of elements that are used for a multimedia database, storage and retrieval system.

o Enhancement: These are special purpose non-co-located processors and processes that are used for special purpose enhancements.

o Communications: This is the ultimate heart of a multimedia system, namely the ability to communicate in a full and complete multimedia fashion. This is a complex amalgam of protocols, transport infrastructures, servers, and interfaces that allows and support multimedia communications amongst a group of users. All other elements are at best users to interface or utility, and not user to user. Multimedia communications systems support sessioning; namely synchronization and orchestration of multi-media/multi-user conversationality.

These elements must be combined in a fully integrated and networked fashion to deliver a transparent system or service to as wide a variety of end users as is possible.

2.2 Value Creation in Multimedia

The use of any new technology must fit within the overall context of value creation to the user. Value, as a concept, may be related to the microeconomic concept of the utility function of demand but it more closely is related to the ability to market the new product or service directly to the customer. Namely, value in the context of multimedia communications is best defined in being able to quantify for the user what savings in expenses or capital shall accrue from the use of the new product or what new revenue stream will result. Ultimately, value in an commercial context is nothing more than the increase in the net present value of the business entity. In the consumer market value is measured by means of its ability to displace other expenditures that the consumer already has made for a perceived greater value from the product offered.

In either case, value creation is essential when determining what multimedia has to offer. The focus in this White Paper is primarily commercial and not consumer. The latter has a greater risk threshold in uncertainty and will be dealt with latter. In the commercial context, therefore, value creation is a definable and measurable result of using the new technology in an existing business context. The business imperative, therefore, is that multimedia services must create value for the firm.

2.3 The Multimedia Food Chain and Its Missing Links

The lack of understanding of what multimedia is, combined with the need to meet the measures of the customers value chain, dictate that all elements of the customer's operational environment must be understood and considered to effectively establish and operate an effective multimedia service business. This is called the "food chain" concept. Having even a single element missing will result in starvation no matter how robust the other elements in the chain are. Thus, it is essential to determine if, in the development of a service business, any one company, supplier, customer, or other such entity, has been left from the flow of the service and thus will cause it to fail.

For example, in the healthcare market, imaging and multimedia applications have been developed in significant numbers. However, several key elements have been missing. Specifically; bill transaction processing and record management and keeping. The current approaches to the delivery of medical imaging systems attempt to support applications in radiology by merely replacing the viewing screen. However, this is but one step in the process. AT&T and Philips have learned the hard way that such a point replacement is unacceptable. The system that they have developed, COMVIEW, has had limited acceptance. The system is a typical high end multimedia system. It handles complex images and text, allows for the integration of voice into the overall system, and provides a limited amount of record management. However, it does not readily fit the pattern of the radiological suite in most hospitals. It does not solve the integration of record management and does not solve the issue of patient record keeping and billing.

In the Hospital environment, the use of multimedia will be driven by the need to treat each medical Department as a profit and loss center. Revenue must be ascribed to each procedure and each patient and expense tracked. Quality care will be an equal imperative. Thus a multimedia system must be one that starts with that premise, allows for graceful and incremental migration and addresses the needs of the physician, the technician, the nurse, the administrator and the support staff. The same can be said about all other market applications. Moreover, multimedia systems and services in healthcare and other similar markets, will have a significant impact because these markets are very information rich, and require communications of this information to may people. It is this nature of information richness, in both type and form, combined with the need to transact along with the sharing of the information that establishes a need for multimedia services.

2.4 Elements and Structures

The end user interface in a multimedia environment is dramatically different than that in a traditional data processing environment. Specifically, in a multimedia environment, we have more intimately involved the human as a processor and evaluator of the information flow and we furthermore have complex information sets flowing from one point to another as well as in a conversational fashion. We will develop the end user concept in terms of the paradigm developed by Winograd and Flores.

In the development of a theory for design of computer systems involving the human user, Winograd and Flores invoke the theories of the German Philosopher, Heidegger. Specifically they refer to four key propositions of the philosopher that impact the overall end user interface issue in the multimedia environment. These are:

- *Our implicit beliefs and Assumptions cannot be made explicit.*

We all too often may make the statement, "You know what I mean." In so doing we are creating to mistakes. First, the other may never know what we mean just by the nature in which we individually perceive experiences and objects. Second, we may, ourselves, not have the insight to our own true beliefs, because we all too often find ourselves questioning them. Hermeneutics, the study of meaning in documents, has been expanded by Gadamer to investigate human reasoning. Thus, indicates Gadamer, our understandings can change with the time and place. This changing makes the explicit articulation specious at best.

- *Practical understanding is more fundamental than detached theoretical understanding.*

Heidegger has a concept called "thrownness", part of being-in-itself. We know something only by being thrown or involved in it. We know what a radiologist does with an image and how he manipulates it for understanding by doing the process ourselves. We cannot expect the user to detail their beliefs and in fact those understandings are time varying.

- *We do not relate to things primarily through having representations of them.*

We relate to things themselves. We do not relate to a representation. The representation to the "thing itself" is done in the context of the task to be accomplished. For example, teleconferencing is useful is we are not to relate to the person but to a subject whose essences can be presented directly through the medium, rather than just a representation. We find that teleconferencing is inadequate for personal contact since the contact is through a representation.

- *Meaning is fundamentally social and cannot be reduced to the meaning giving activities of individual subjects.*

Meaning is obtained in dialog, in a conversational fashion, with the ability to meet consensus. Gadamer and Heidegger both relate meaning to the social process of communicating. Both also relate the evolution of meaning to the ongoing set of discourses.

Specifically, social or conversational activity is the ultimate foundation of intelligibility. This means that both in the design process as well as in the operations process, the need is critical to have the communications channel be conversational if the intent is to convey intelligibility. If the intent is only to transfer predefined package from one point to the other them the conversationality is not essential. In a multimedia environment, intelligibility in the context of the various media and thus intelligibility demands conversationality.

We can also try to better understand the interface by recognizing that the challenge is matching man to the machine. To do this we are frequently pressed into a metaphorical set of analogies. Typical is that of "man as the human computer". Metaphors of this type are both powerful explanations of new concepts and clear statements of our total lack of understanding of the issue. To quote from Mac Cormac:

> *"Explanations without metaphor would be difficult if not impossible, for in order to describe the unknown, we must resort to concepts that we know and understand, and that is the essence of the metaphor, a juxtaposition of the familiar and the unfamiliar."*

MacCormac further quotes from Arbib, Man a Machine, The Metaphorical Brain;

> *"We wan to understand how people think and behave....In some ways the brain of a man is like the computer of a robot, in others it is akin to the brain of a frog. Our aim here is to convey an understanding of the brain in terms of two main metaphors: The cybernetic metaphor, "Humans are machines," and the evolutionary metaphor, "Humans are animals." We shall downgrade the differences, but we hope to learn much from the similarities."*

The harshness of Arbib pronouncements are striking. For indeed he represents the voice of many computer designers who view the human at best as a fellow computer and at worst a level above slime mold. Metaphor is powerful for it is in essence our most gracious way as humans to express our total ignorance of the true essence of the problem at hand. To use the Heidegger view, the use of metaphor is essential if we have not experienced the throwness of the problem, that we have not immersed our total being in the basic uncertainty at hand. We use metaphors as a way of re-expressing what we already know rather than understanding the unknown.

The danger in the use of such metaphors is clearly that we fail to come to deal with the needs of the end user in interfacing with the multimedia world. We view the end user as another peripheral computer system and not as an entity that must be thrown within the environment to best profit from its performance. Thus, as we saw in the last section, current authors view multimedia as nothing more than another display or another storage device. Their world view, as so aptly developed in Kuhn's thesis, is limited to the existing paradigms. They talk metaphorically as man as computer, or worse as man as frog.

This world view is dramatically different from that of the rational school of thought that focuses on the idea that there exists a perfect truth independent of the individual and that through proper perception as a single individual this truth can be made clear. Heidegger's approach is that we must combine the rational objective world with the totally subjective individualistic world into an environment where the human users becomes part of the environment of the media.

As Gadamer has stated (see Warnke), we understand in a dialog manner. Specifically:

> *"If one examines Gadamer's analysis ...all knowledge of the natural and social world...is grounded in traditional orientations. We never come upon situations, issues or facts without already placing them within some context...and interpreting them in some fashion."*
>
> *"In equating the logic of understanding with the structure of dialogue, Gadamer suggests that the proper answer is that..in genuine conversations ...all participants are led beyond their initial positions towards a consensus.."*

Thus the process of consensus in a conversational mode is what leads to new understanding. All initial constructs are based upon prior prejudices that can best be formed in the context of metaphors. If our goal in developing new user interfaces is the ability to allow the users to understand, as viewed by Gadamer, then we must do so as to support the conversational modality and to allow the reaching of consensus.

Winograd and Flores have noted six effects of accepting the Heidegger world view. These are;

o You cannot avoid actions.

Even inaction is a form of action. Managers, as developed by Simon, interact with their day to day industrial environment, and managers who act by inaction have the corresponding results.

o You cannot step back and reflect.

Events exogenous to us are continually occurring and any attempt to stop time to best understand the situation is at best specious. At worst, it becomes inaction. The concept of hermeneutics is one that extended to the environment of the end user say that we make interpretation with what is at hand and what is part of our tradition.

o Effects of actions cannot be predicted.

We can anticipate, we can plan and we can strategize, but the world is filled with uncertainty. As such, we act in an environment where the exact outcome is uncertain. The user must anticipate that but not be fearful of it.

o You do not have a stable representation of the situation.

Every situation is a representation in flux. When a user accesses a system, there are many factors that impinge on the interaction of the user, their needs and responses. No system interface to a user should assume a stable representation of facts. Designs should be such as to prepare for ambiguity.

o Every representation is an interpretation.

X rays are inherently representations of physiological factors. In looking at an x ray a physician is looking at a representation and performing an interpretation. When we design a user interface, we are representing a set of facts to the users. The act of the designer in representing the facts is an act of the designer in interpreting for the user the facts. Thus in designing the interface, the designer must be aware of the fact that they are entering into the interpretation process. Not only is the user interpreting but so too is the designer for the user.

o Language is action.

Speech through our language is a spontaneous reaction to a set of situations. In the design of computer interfaces we spend many hours on structuring the presentation of the visual material. Images are carefully scrutinized. Speech, in a multimedia context is fluid and open to instant interpretation that may not be consistent with the other participants in the multimedia session. For example, our tone of voice may make us appear arrogant, our questioning may make us appear petulant and our suggestions may make us appear pedantic. Despite all our structured work on the interface, the instantaneous impacts of the language may override the setting. Thus a multimedia environment must have the flexibility to self correct.

There are eleven design guidelines that Winograd and Flores have articulated and these play well into the end user interface effort associated with multimedia system. These guidelines are as follows;

1. There are no clear problems to be solved. Action needs to be taken in a situation of irresolution.

2. A business is constituted as a network of recurrent conversations.

3. Conversations are linked in a regular pattern of triggering and breakdown

4. On creating tools were designing new conversations and connections.

5. Design includes the generation of new possibilities.

6. Domains are generated by the space of potential breakdown of action.

7. Breakdown is an interpretation - everything exists as interpretation within a background.

8. Domains of anticipation are incomplete.

9. Computers are tools for conducting the network of conversation.

10. Innovations have their own domains of breakdown.

11. Design is always already happening.

If we follow these design rules in developing the human interface and if we understand the underlying theories of human understanding and intercommunication, this will assist the designer in being flexible to converge to a more stabler interface.

Language is a means to expresses knowledge. Language is also a means to gain and crate knowledge. We can now expand the concept of a language from what we see as words and what we hear as speech to what we see as actions and what we create as situations. The ability to provide for more breath of language as intercourse and interaction, and the ability to extend that intercourse to all of the senses, no just sight and sound, allows for the attainment of the fulfillment of a multimedia communications environment.

The concept of the end user interface that we developed in the last section centered around the need for conversationality. Conversationality is embodied in the concept of a session which is the electronic implementation of communications in a multimedia environment. We shall discuss the concept of a session in more detail in Section 5 on communications. Simply put, however, the session is the underlying communications construct that ensures the binding of users together. Understanding the multi-user environment will provide the boundary conditions that envelop the communications environment.

The essence of multimedia communications in a multimedia environment is the embodiment and completion of transactions. Transactions are an ordered set of actions taken by the set of participants in the session, whose completion leads to the successful

The users in a multimedia world are categorized into several classes. We can consider three levels for discussion purposes and we may possibly expand these as we proceed. The three are the end user, the physical and the virtual user. The end user is a definable entity that has action responsibility for effecting the transactions that occur in the system.

Data elements in a commonly accepted database are collected according to some schema and labeled accordingly. For example, we may consider a typical database containing the elements of name, address

and phone number. In a computer database these elements are then encoded into a digital format and the name, address and phone are stored in some binary form for latter retrieval. The retrieval process can be performed by asking a simple question of the database, specifically, "List all of the name for the case where the zip code is 05XXX." Here we have asked the database to perform certain acts. First to go through all of its records and perform a match on the basis of zip codes. This is a redials performed task since all it entails is matching a bit pattern for the desired code with the bit pattern for each data entry along the zip code field. We know how to do this. The we accumulate all the names and finally print them out.

There are certain inherent structural assumptions that we make in this type of database. First we assume that each data element of a data object has a defined structures. Second we assume that each data element is decomposable in a finite sequence with uniquely defined data objects. For example, we know that address is composed of the objects of street number, street name, city, state, and zip code. We further know that zip code is composed of five digits, not characters. We also know that there is no other representation for address and that further the object address contains no other information. Address, for example, cannot tell me about the type of house, its color or the number of windows. The questions that I ca ask are a priori stated and implicit in the structure of the data object.

Now consider a multimedia data object. The object is an image, specifically an x-ray. Now we can create a patient record which contains the information of the type, name, address, date of admission, attending physician, blood tests, and x-ray. The objects, with exception of the last in this record, are of the type that we discussed above. They are bounded, fixed, and definable. Specifically we can ask a specific question and obtain a quantitative answer. In contrast we cannot ask questions of the x-ray on a specific basis and hope to get an unambiguous answer. We may ask for the last name and get the answer "Jones". We can ask about the x-ray the question of the disease and get a totally ambiguous answer.

A more common data object may be considered to be a a hyper object if we allow for the depth that may be part of the decomposition of the object. For example, we have the record for "Student" which is composed of name, address, and grades. Name is further decomposed into last, firs, middle, and even parents. Parents is decomposed into mother and father.; And they in turn into last, middle, and first. The common data object is in itself a hyper object having depth and extent. However, the depth and extent has been defined a priori and is part of its very creation. The database designer had defined fields for allow of the elements and for the relationships between the hyper objects depth and co-relations.

If we extend the hyper object case to the multimedia object, we fond dramatic differences. Consider again the case of the x-ray. At best the database designer assigns 100 million bits of space for the data object. There is no structure. For example, the image may be that of a chest x ray and we may be interested in the lungs, the heart, the stomach, or any one of several organs. In the context of that interest, we are further interested in asking a set of important questions as to the nature of the lung's clearness, and if not clear, what is the nature of the perceived shadowing. All of theses are useful for a careful diagnosis. Thus with a multimedia object, the object contains information in a complex form, a form that is processed by the cerebral cortex only a posteriori, and not a priori. Further, the information has dimensions that are not fully known before the interaction with the end user. This is the essence of the concept of Heidegger that we had discussed as an integral part of the Winograd and Flores theory of computation. A multimedia object is truly a new paradigm for the representation of data.

The record in a standard database is quasi static in nature and can be changed in a typical transaction processing system only upon the commands of the central data base administrator or upon the allocation of commands in a distributed database environment. Thus, for example, we can envision a database that has the record for the number of seats available on a typical airline flight. The seats available may be changing with time but the change is controllable and is synchronized by some overall database mechanism.

In a multimedia object, there is change in the object that is a natural progression of the object in time. For example, if the multimedia object is a speech signal, we know that if the signal was sampled at 64 Kbps then we must play the record back at the same speed. If we create a compound multimedia record of voice and video, we must now synchronize not only within the objects but also between the objects. Time now plays an integral role in even static records. If we now extend this to the case of a dynamic transaction like

multimedia record, we find that the maintenance of the synchronization within and between objects is as critical an element as is all others.

Thus multimedia objects have a complexity and richness of structure and dynamism and interrelationship of form that separates them dramatically from the typical data records that we use as part of the typical data environment.

Multimedia objects have three major dimensions of complexity. They have a temporal, spatial and logical structure. The temporal structure there is tempo to the object as there may be in a speech segment or a video segment. The tempo may also relate to the movement of a cursor and its relationship to other objects. In addition, the temporal object structure may be a segment (namely bounded a priori such as an image) or a stream (uncertain terminus such as a speech or video segment). The temporal structure of a multimedia objects reflects the timing, sampling rate, type of object, appropriate delivery time and the boundedness of the object.

The spatial characteristic reflects the ability to decompose the multimedia object into spatial parts. This is particularly true of images that have some spatial dimension in two or three dimensions. The basic need her is to have a decomposition structure that can be discussed about the object in an in band or out of band fashion. The metaphor of boundedness is a concept that reflects the location of the information on the spatial decomposition of an object. If the object has its rules for decomposition imbedded in the data stream itself, we call it in band. If the decomposition information is located as a separate descriptor, namely a data header, we call it out of band. We must deal with this fact. In images, we restrict the boundedness to a finite set of display elements. Thus we know a priori that an image is 2,000 by 2,000 pixels of 24 bits per pixel, rather than an unknown length voice segment.

In the logical domain, we also are concerned about decomposing images. Logical decomposition may be simple to state but very difficult to implement. For example we may want to decompose objects in the form of type of bones in x-rays or by excited speakers in a voice segment. There is currently limited analytical processing power to extract this type of decomposability.

We can then further combine these simple multimedia objects together into a compound multimedia object. The compound object now has needs for orchestration, that is timing all of the timings of the simple objects. The concept of orchestration is simply just that, being the conductor to assure that all of the instruments in the symphony are not only properly tuned by timed with regard to each other. We also worry about the issue of concatenation, the opposite of decomposition. Concatenation states how we handle the spatial and logical combing of the simple objects.

Communications in a multimedia environment is a process of allowing agents of the communications process at various levels to interexchange information in support of the complete end to end flow of multimedia elements. This definition allows for the existence of agents which are definable and locatable entities that have specific responsibility for communications flow and management. In the world of multimedia communications, these agents must be empowered with significantly more responsibility than is typically the case in a data communications world.

We will develop the concepts of the communications environment in the multimedia world by first developing the concept of a session. A session is a shared multimedia conversational mode of communications allowing multiple users and devices to share a common working space in such a way as to make the communications interfaces and transport not only transparent but acting as a facilitator of the communications process.

A session provides for several key layers of functionality. These are:

- Event Management: Any multimedia activity leads to a transaction. The event manager is the transaction manager. Multimedia events are complex and thus the manager must deal with these distributed complexities.

o Dialogue Management: The multimedia conversation must allow sharing of resources and must encourage and facilitate conversationality. Dialogue management is that function.

o Activity management: Activities are extended events, they are displaced conversational elements that must be remembered and connected.

o Synchronization: The orchestration of the many elements in a multimedia conversation is the role of the synchronization function.

We must define entities that connect together and further define the entities that ensure that this session level connectivity is supported.

2.5 Definition of Multimedia Services

Multimedia Services requires a working definition. This section attempts to provide such a definition. It differs dramatically from many of the definitions offered for multimedia in may of the current trades or even in the business and strategic plans for companies purportedly in this business. The following is the definition:

> *Multimedia Services is a set of services offered to a community of users that enables and empowers them to perform tasks in a collective fashion that can be accomplished in a significantly more productive fashion by including multisensory information and interexchange in a fully conversational mode, transparent to any and all users, and allowing all of the processes performed to be monitored, recorded, retrieved, and transacted in a fully electronic fashion. Multimedia Services responds to the needs of the users and can be measured in the context of increasing value to the user base and can be provided in such a fashion that it does not neglect any element of the organizational food chain.*

Multimedia Services has certain characteristics that empower it to enable the user to achieve the value that has been determined. Multimedia Services must account for the elements of the human and organizational environment. From the human perspective, several of the common features are as follows:

o Human Factors

o Conversationality: A system, as service, must allow, and more importantly encourage and support, a conversationality amongst users that enables all of the multimedia senses. Understanding and meaning are essential a social act that requires the full sensory interaction amongst individuals and permits them to act together. Multimedia services must not only enable this type of activity but must do so in a fashion that is consistent with existing social paradigms. The essence of multimedia conversationality is its ability to empower the user to be "present-at-a-distance".

o Throwness: The ability of the user's actions to have some immediate or consequential effect on their environment has been called being thrown into the environment and the term throwness has been used. This capability implies that the user of the service is able to manipulate the object or objects at hand in all of their sensory dimensions. The use of a multimedia service in the design process must be such as to allow the designer to see the impact of the design in terms of its tactile and visual elements, and also the aural elements that may be part of the design. The designer must also have the ability to "use" the designed object in the context of its use to better understand it functionality and acceptability.

o Breaking Down: The individual does not understand something of an object, especially a multimedia object, unless they have the ability to break it down, namely do something with it to make it function as we know it. Take for example the use of multimedia in healthcare pathology. When a physician views a slide of a tissue sample, they are viewing it after having done so many prior times and having related certain cell boundaries and shapes, blurs to the uninitiated, yet critical to diagnosis of certain conditions of the body organs.

o Transparency: A multimedia service qua service must be transparent to the users. For example, setting up a simple conference call on a telephone is made so by calling an operator who then calls all of the participants and adds them to the conference. Cumbersome as this may be it creates a sense of transparency, namely, no one user must know how the call is to be set up. Multimedia services must be operator independent and yet have transparency to operations. This will be one of the major challenges of the service. It will also be a barrier to exit in a competitive market.

o Action: The service must allow and enable action. This may mean that in a multimedia session, control of the conversation can be taken around the session, allowing any single individual to explain a point through demonstration. It may mean the obtaining of an object or element on demand, and then having the ability to manipulate it at will. It is the ability to demonstrate, contradict, confer, and compromise by example.

The second set of factors to be part of a multimedia service relate to the organizational structure that the service fits into. Specifically:

o Organizational Factors

o Transaction: The service must support the total set of transactions that will occur through its use. At the simplest end, it must create and process bills for services rendered as part of the service. It also must track each interaction of a user with the system in order to support customer service and assist customers in the event of problems.

o Productivity: The service must address the needs of the customer for productivity improvements. This means that the service must immediately reduce costs through more effective use of existing manpower. For example, in the advertising application, the service must reduce the cost and time associated with the development and production of ad copy. In short, it must be cheaper and faster.

o Infrastructure: The service must become transparent to the user. It must exhibit all of the qualities of an infrastructure.

o Value: The service must have a calculable value to the user. The service must address specific processes or operations, with known cost structures, and must definitively show how the costs are reduced and the value of the business unit increased.

o Holistic: This implies that the service must integrate into the overall way in which the business operates. It should not optimize one part and fail to address inefficiencies in others. It must address the entity as a whole.

3. THE MESSENGER; COMMUNICATIONS AND INFRASTRUCTURE

The messenger is the process and processes that link with the medium to effect the transaction of the message. It is of interest to see that the old AT&T used Mercury as the messenger. Hermes, also a messenger, although a mischievous one, is a better choice. Mercury delivered the messages correctly. Hermes would always put a little twist on them. We shall in this section develop the concept of a

communications system and then move forward on how that system may be viewed as an infrastructure. A great deal of talk about infrastructure has occurred as of late with little definition. We try herein to define out terms. This will be critical as we apply philosophical principles to the issue of messages, messengers and media.

3.1 Communications Systems

There are four architectural elements in the telecommunications network. These elements are the control functions, the transport function, the interconnect function, and the interface function (See Figure 5 where these are generically depicted). We now provide further detail on these functions. It should be noted that these functions have evolved over the years in content and complexity. We view these elements in the context of a communications network that must support the most advanced current concepts in communications. Specifically, the world view adopted in this paper that lead to an interpretation of this architecture are:

> *(i) End users desire to have interactions in a real time fashion with images and other high resolution information that must be provided in a fashion that meet both time and resolution requirements (See Barlow).*
>
> *(ii) The end user devices are extremely intelligent and complex and can operate in a stand alone environment.*
>
> *(iii) The users desire to operate in a totally distributed fashion. Data bases will be a different locations, users are at different locations and input output devices are also at different locations (See Dertouzos and Moses, and de Sola Pool pp. 57-59 for details on these directions).*
>
> *(iv) The network may provide different levels of service to different users. There is no need to provide universal service of full capability to all end users.*

This view of the network will significantly influence how extensively we defined the elements and in turn will impact the combination of those elements in an overall architecture. All of these assumptions on the world view are different then before, in an all voice world. In this paper, we define a network as an embodiment of an architecture, in all of its elements.

The architectural elements are control, transport, interconnect and interface.

> o **Control**: Control elements in an architecture provide for such functions as management, error detection, restoral, billing, inventory management, and diagnostics. Currently, the voice network provides these functions on a centralized basis, although in the last five years there have evolved network management and control schemas and products that allow for the custom control and management of their own network. Companies such as IBM, AT&T and NYNEX have developed network management systems that move the control from the network to the customer (See McGarty and Ball, 87, for a detailed discussion of the different types of control and network management strategies). On the sub-network side, companies such as NET, Timeplex, Novell, 3-COM and others have done similar implementations for local area networks, data multiplexers and other elements. Centralized network control is now longer necessary and in fact it may not be the most efficient way to control the network.
>
> What is important, however, is that network control providing the above functions is an essential element for either a public or private network. Thus as we consider network evolution, this element or set of function must be included.
>
> Control has now been made to be flexible and movable. The control function is probably the most critical in the changes that have been viewed in the context of an architecture.

All buildings need windows, for example, but where one places the windows and what one makes them of can yield a mud adobe or the cathedral at Chartres. The same is true of the control element. In existing networks, the control is centralized, but in newer networks, the control is distributed and empowered to the end users. The users can now reconfigure, add, move, and change their network configuration and capacity

o **Transport:** The transport element is provided by the underling transport fabric, whether that be twisted pair of copper, fiber optic cable, radio or other means. Transport should not be mixed or confused with other elements of the network. Transport is merely the provision of physical means to move information, in some form such as digital, from one point to another. At most it is expressed in bits per second and at best it is expressed in bandwidth only. Bandwidth as a transport construct is the most enabling. Transport does not encompass the need to change the information or to do any other enhancement to the information.

o **Interconnect**: The interconnect element of the architecture describes how the different users are connected to one another or to any of the resources connected to the network and is synonymous with switching. Interconnection assumes that there is an addressing scheme, a management scheme for the addresses, and a scheme to allow one user to address, locate and connect to any other user.

Interconnection has in the past been provided by the Central Office switches. As we shall discuss latter, this implementation of an architectural element was based on certain limitations of the transport element. With the change in the transport element of structures allowing greater bandwidth, the switching needs have changed. Specifically, distributed systems and scale economies of the distributed Architectures allow for interconnectivity controlled by the CPE and not the Central Office. As we shall show later, the advent of Local Area Networks and CATV voice communications are ones using distributed interconnectivity elements.

There are three general views of interconnection that are valid today; the Telcom, the Computer Scientist, and the User. The Telcom view is based on the assumption of voice based transport with universal service and the assumption of the inseparability of interconnect and control. The Computer Scientist view is based upon the assumption that the network, as transport, is totally unreliable, and that computer hardware and software must be used in extremis to handle each data packet. Furthermore the Computer Scientist's view of the network is one where timeliness is secondary to control. The Computer Scientists view has been epitomized in the quote, "Every Packet is an Adventure". This is said with glee, in that each data packet is set out across the network and it is through the best of hacking that the Computer Scientist saves the packet from the perils of Scylla and Charybdis. The third view is that of the user, who is interested in developing an interconnect capability that meets the needs and minimizes cost. This is minimization of both obsolescence and cost strategy. Figure 8 depicts the challenge to the User view of interconnect. Processing cost or capacity is declining every year. Thus an investment must try to follow the curve. In a hierarchical view of interconnect, such as a large centrally switched network, the changes occur once every few years. Thus the lost cost or performance efficiency can become significant. In contrast, in an end user controlled environment, with a fully distributed architecture, the lost efficiency is minimized as technology advances.

o **Interface**: The interfaces are the end users connection to the transport element. The interface element provides for the conversion from the end user information stream and the information streams that are used in the transport form of the network. For example, the telephone interface for voice is the analog conversion device.

Moreover, we must also view interfaces as being composed of not only the hardware that provides for the physical interconnection with the end user but the software that assists in the logical interconnection. The telephone hand set is merely the first physical step in interconnection. A second step included the PBX which included software that allowed for additional features. However, these features are frequently not used because of the user lack of acceptance.

We have divided the network elements into these four categories to demonstrate that there are clearly four distinct and separable areas for growth and policy formation. Issues of regulation, due to potential monopolist control are always a concern, but it will be demonstrated that in all four there are economies in market disaggregation.

Is there a natural taxonomy for the set of network architecture alternatives? Do these present limitations on what can be done or are they extensive? Is there a natural limitation in the existing architectures that prevent the new technologies from introducing the new paradigms to the communications world? We address these issues in the context of several existing network hierarchies.

o **Hierarchical**: The current network architectures are structured in a hierarchical fashion. As we have already indicated, there are historical and technical reason for this architecture. Specifically, we see the set of transmission schemes connecting from a lower level to higher ones. A path may or may not go horizontally. It may go vertically, all controlled by a single control at the highest level.

o **Centralized:** A centralized architecture is similar to a hierarchical system in that the control function is centralized. However, the transport elements are not in a hierarchical format. The hierarchical structure is no longer present, but there is a single point of control. The control element covers all other elements in the system. A typical example of this type of network is that of a large bank in a metropolitan area. Part of the network is the local ATM (Automated Teller Machine) network and the voice network for the bank. Each are separate but the bank controls both from a single point of control.

o **Distributed:** The distributed system has distributed control, distributed interconnection and flat transport alternatives. Here we first note the reduction in concatenated switch and transmission elements. The network is much less dense and the switch is actually co-located with the interface. The LAN networks are typical example of distributed designs.

o **Segmented**: A segmented network is really a hybrid. Each segment uses a sub architectures that meets the requirements of the existing system but the networks are interconnected through standard interfaces. In this case we show that this network architecture is an amalgam of the first three. What is still common, however, is the partitioning into local and long distance nets. A typical example of this network is that of a large corporate network. Part of the network can be for the voice circuits, controlled at a single point and based upon use of both local and inter-exchange carrier circuits. The second part of the network is the data network, again using both local and long distance carriers, and control from a separate location.

o **Partitioned** (Local and Long Distance combined in a community of interest): In all of the above, we have assumed that local and long distance transport are separate. This is a world view dominated by the regulatory environment. We can see the segmentation along community of interest lines rather than along these more traditional lines. Thus one community of interest is a network for financial service companies and a second for a network providing service to the residential user. These each have all of the local and long distance services, but are now segmented by the user market or the community of interest. The sub architecture may be any of the above. The major difference in this system is that we have segmented several overlay networks, each containing elements of the above four. This architecture allows for local and long distance in separate partitions.

It says that you can segment the network by users not just by function. Had the MFJ understood users rather than functions, the results could have been dramatically different. An example of a Partitioned network would be that for American Express or Sears. It contains the set of local and long distance networks as well as subnets for specific distributed applications. However, each of these companies may have access to a separate public switched environment.

Understanding that there are several varying architectural designs allows one to better understand that each reflects not only connectivity but also the world view.

3.2 Infrastructures

Let us extend the concept of infrastructure. We find that there is a great deal of discussion about infrastructures, in both academic and governmental circles. Unfortunately, none of the participants deem it appropriate to define what they are talking about, namely what do they mean by infrastructure. We feel that such a definition is critical to developing multimedia communications concepts, since the concept of an infrastructure will be at the heart of the change process. In our context, ***an infrastructure is a shareable, common, enabling, enduring, resource, that has scale in its design, and is sustainable by an existing market, and is the physical embodiment of and underlying architecture.*** Specifically;

o **Shareable**: The resource must be able to be used by any set of users in any context consistent with its overall goals.

o Common: The resource must present a common and consistent interface to all users, accessible by a standard set of means. Thus common may be synonymous with the term standard.

o Enabling: The resource must provide the basis for any user or sets of users to create, develop and implement any and all applications, utilities or services consistent with the underlying set of goals.

o Enduring: This factor means that for an infrastructure to be such, it must have the capabilities of lasting for an extensive period of time. It must have the capability of changing incrementally and in an economically feasible fashion to meet the slight changes in the environment, but must meet the consistency of the world view. In addition is must change in a fashion that is transparent to the users.

o Scale: The resource can add any number of users or uses and can by its very nature expand in a structured form to ensures consistent levels of service.

o Economically Sustainable: The resource must have economic viability. It must meet the needs of the customers and the providers of the information product. It must provide for all of the elements of a distribution channel, bringing the product from the point of creation to the point of consumption. It must have all of the economic elements of a food chain.

o Physical Embodiment of an Architecture: The infrastructure is the physical expression of an underlying architecture. It expresses a world view. This world view must be balanced with all of the other elements of the infrastructure.

An infrastructure is built around the underlying architecture. An infrastructure is in essence the statement of the architecture which in turn is the conceptual embodiment of the world view.

Infrastructures as physical embodiments of architectures must, to have economic lives that are meaningful, be developed when the world view, technology and user needs are stable. If any of these three are in states

of significant flux, the infrastructure may soon not meet the change in the world view and then become obsolete.

It is important to distinguish between architecture and infrastructure. We have extensively defined architecture in terms of its three parts: elements, world view and technology. Infrastructure unfortunately has been reified in terms of some physical embodiment. The discussion of NREN being an infrastructure is viewed by many as being a determinate thing. Kahin has, however, de-reified the concept in terms of its being an embodiment of a concept or set of common goals. We expand that and state that an infrastructure is an enabling capability built around a common construct.

There are four types of infrastructure views that are pertinent to the current discussions of networks. These are of particular import to such networks as NREN since they will lead to the policy directions that it will take. These four infrastructure types are as follows:

o Physical: This is the most simplistic view of an infrastructure. It requires a single investment in a single physical embodiment. The old Bell System was such an infrastructure. The National Highway system is such an infrastructure.

o Logical: This network may have separate physical embodiments, but all users share a common set of standards, protocols and other shared commonalties. All users have access through an accepted standard interface and common higher level transport facility. IBM had attempted in their development of SNA in the mid 1970's to develop a logical infrastructure in data communications. This was expanded upon by the ISO OSI seven layer architecture, selecting a specific set of protocols in each layer.

o Virtual: This type of infrastructure is built on intermediaries and agreements. It provides shared common access and support interfaces that allow underlying physical networks to interconnect to one another. Separately, the individual networks may use differing protocols and there are no common standards. The standards are at best reflected in the gateways to the interconnection of the network. Thus this infrastructure is a loose binding through gateways. It is in many ways what is the INTERNET today, if we include all of the subnets.

o Relational: This type is built on relationships between the network parties and the establishment on higher level accessing and admission. Specifically, a relation infrastructure is based on agreements on sharing addresses, not necessarily common addressing, and on the willingness to share data formats and types. It is an infrastructure based on shared common interests but not shared common access. This type of infrastructure is what in essence exists in most cases today. Users can move from network to network through various gateways. The difficulty is the fact that the interfaces are cumbersome and may require sophistication on the part of the users. However, more intelligent end user terminals and interfaces will reduce this cumbersome interface problem.

We show the relationship of these four infrastructures in a diagrammatic fashion in Figures 13 through 16. Our conclusion is that understanding the type of infrastructure that the coalition of users want, will also impact the architecture, based upon an imputed world view. Arguably, a physical infrastructure leads to maximum hierarchical control and the resulting impacts that such control leads to. This is a critical issue for networks such as NREN, since by choosing infrastructure and architecture may not be as uncoupled as desired. In particular, the selection of Gbps capability may really be GHz capability and is best suited to a Virtual or Relational infrastructure.

3.3 Current Infrastructure Options

There is a considerable amount of effort to define and implement an information infrastructure. In this section we describe some of these current proposals, many of which are still quite formative and lack

substance. In some case we shall try to place them in the context of the constructs that we have developed in the preceding sections. In order to fully describe these infrastructures, it is also necessary to deconstruct the work of the authors, understanding their meanings in the contexts of what they are saying and taking an approach that blends the hermeneutics of Gadamer with the semiotics of Levi-Strauss. We now address several of the more current views of infrastructures. In each case, we describe as best can be done the concepts of each of the individuals, and then attempt a deconstruction in terms of their underlying architectural assumptions, their view of infrastructure and more importantly their world view of information and information networks.

(i) Dertouzos Infrastructure

This is the most widely discussed of the information infrastructures having been proposed by Professor Dertouzos who is a Computer Scientist and the Head of the Laboratory for Computer Science at MIT. Simply put, he defines the information infrastructure as:

> *" Common resource of computer-communications services, as easy to use and as important as the telephone.."*

Dertouzos states that there are three elements to his vision of an information infrastructure. These are:

> *o Flexible Transport: This includes bandwidth on demand, flexible pricing and security and reliability.*
>
> *o Common Conventions: This includes his concepts of E Forms and Knowbots. The former is a set of standard for formats and the latter are intelligent agents for the movement and processing of data.*
>
> *o Common Servers: This is a set of common file servers or generalized servers to provide directories, text/image translation, data base access and active knowledge.*

In Figure 17 we depict all of these elements.

In the paper, Dertouzos discusses this architecture and he uses as an example a system conceived of and designed by the senior author (McGarty 1990 [1],[2], 1991 [1],[3]). In the author's system, the assumption was to both empower the end user and to do so in an incrementalist fashion. The architecture shown in this second system was based upon:

> o Available Transport: Take what is present and build in an economically viable fashion. Build communications on an incremental and economically effective basis.
>
> o Open Interfaces: Use standards as appropriate, and allow the users the freedom to meet their economic needs. Recognize the changing needs of the user and buyer and incrementally change to meet the evolving needs.
>
> o Client Server Architecture: Maximize use of end user terminals and empower end user applications development. Provide tools and not strictures.

The system designed and operated by the author actually connects the MIT campus with hospitals, publishers, and other economic entities in a build-a-little, test-a-little, use-a-little approach that allows for use acceptance and economic justification. The Dertouzos Infrastructure assumes directions that are significantly different and diverge from the end user driven approach of the author but take a more centralist approach. This latter approach has been advocated by Moses in his discussions on the subject, yet are somewhat counter to Moses' layered organizations that maximize flexibility and minimize complexity.

(ii) Kahn Infrastructure:

The vision of Bob Kahn, of CNRI is one of a broad band research backbone, loosely coupled, with dark fiber and as high a bandwidth as possible, read data rate. This proposal, frequently confused with the Gore infrastructure, is generally more open and flexible. However, it too lacks any economic underpinnings.

(iii) Gore Infrastructure:

Gore, the Vice President of the United States in the Clinton Administration, son of the initiator of the Federal Highway system, has argued for a single network, government directed and funded, hierarchical in fashion, that allows everyone to have access to every bit. Consider his comparison of data bits to corn kernels;

> *" Our current national information policy resembles the worst aspects of our old agricultural policy, which left grain rotting in storage silos while people were starving. We have warehouses of unused information "rotting" while critical questions are left unanswered and critical problems are left unresolved."*

He believes that every bit is a good bit. He further has no value concept of information. His definition is clearly the one of quantity and not value. Researchers are not necessarily starving for lack of bits. Quite the contrary, there is a need for coherent data reduction. He further states;

> *"Without further funding for this national network, we would end up with a Balkanized system, consisting of dozens of incompatible parts. The strength of the national network is that it will not be controlled or run by a single entity. Hundreds of different players will be able to connect their networks to this one"*

He is somewhat contradictory. On one hand he states that there should be one network and not many, on the other hand he has all the separate networks connecting to this one. In this case, his world view comes through clearly. He wants a hierarchical or at most centralized architecture as well as a physical architecture. The proposal lacks the flexibility of a economic entity.

(iv) Heilmeier Infrastructure:

Heilmeier, the new President of Bellcore, the R&D arm for the Bell Operating companies on the regulated side, advocated a hierarchical, BOC controlled, network intensive, monolithic network. This is not surprising considering his extensive stay in Washington as a government bureaucrat. He further argues for control of both wire based and wireless networks. He is quoted as saying;

> *"I'd like to see a bona fide information infrastructure rather than a fragmented world of different systems for everything."*

Networks are currently fragmented and as a result of this fragmentation local economic optimization has occurred. In contrast to the hierarchical, centrally controlled view of Heilmeier, also formerly head of DARPA, wherein he views the need for a single point of control and direction, the world of communications networks and information networks have grown through the increased power of the end user interfaces and interconnected distributed throughout the network. In addition growth has resulted from less control in the network and less centralization. The work of the author (McGarty 1990 [1], [2], 1991 [1],[3]) has shown an architecture for a distributed multimedia environment that has been built and is still in operation that uses a mix of communications channels and thrives on those channels that have the least functionality. Specifically, dark fiber transport is the most enabling and empowering of any communications channel.

(v) Proposed Infrastructure

Infrastructures are enabling entities. As we have discussed, an infrastructure does not have to be a single centrally controlled, managed, and funded entity to be effective. In fact an infrastructure on the loosely constructed basis of a relational infrastructure is just as effective as the extreme of a physical infrastructure. We make the following observations, and based on the prior developments in the paper propose an alternative direction for infrastructure development.

> (i) Technology is rapidly changing and will continue to do so. The directions in technology are towards increased processing capability per unit workstation and increased capacity in performing both complex processing tasks while at the same time handling sophisticated protocol procedures. We depict this change in Figure 18.
>
> (ii) User terminals are expanding in a network multimedia environment that is empowering the end users to both use many new media types as well as dialog in a conversational basis with other users in the same network. The extremes in this environment are depicted in Figure 19
>
> (iii) End users are becoming more pervasive and training of users based upon strict confines of computer languages are disappearing. The end user is empowered to act and to use information system with no training or education. Citibank, in its development of the ATM network has ensured that the systems have minimal need for human intervention or training. In addition, the Citibank home banking product, the most widely used of any home banking products on PCs, is almost instruction free. The Apple MAC computer is also another example of enduser empowerment through intimidation free end user interfaces. The relationships between these are depicted in Figure 20.
>
> (iv) Successful technology development in a productive fashion has best been effected within the constructs of entrepreneurial small companies that allow for the creation of new ideas judged by the dynamics of a free market. Large centralized technology development organizations have time scales that are much longer than the time scales of the underlying technologies. The developments in the computer industry of today are prime examples.
>
> (v) Users are not only empowered to use systems in a variety of ways but they are also able to select from a wide variety of systems, interfaces and data sources. To quote A.G. Fraser of Bell Laboratories:
>
> "Every standards body seems to be churning out protocols left, right and center. We may already have passed the point where we can all come together." (Coy, 1991)
>
> Thus, distributed networks, interfacing with disparate other networks, through gateways is already a reality.

These observations then indicate that with a changing base of customers, a changing set of needs and an already progressing infrastructure that is relational at best, that to continue to maximize our technical creativity it is best to match the information infrastructure to our cultural paradigms. Thus it is argued that the proper evolution of an information infrastructure should be along the relational model. That, in fact, the physical extreme is counter to the trends of user empowerment and economic efficiency. It further could provide a roadblock to technical creativity.

4. DECONSTRUCTION

Deconstruction consists of the unraveling of actions and physical realities to determine the underlying sets of truth, such being definable and determinable. In its simplest state, the unraveling is the determining of intentions within the context of how the intended views the world at the time of the intent. Deconstruction from the perspective of multimedia communications is a toll that helps the designer understand the biases, prejudices and limitations of the designer. Deconstruction allows for the ultimate use of the technology in

the context of the user. We start the development of the deconstructionist approach with the development of the concepts of paradigms and world views. We have already discussed them in some details but it will be critical to the deconstructionistic approach to have them developed in full detail. Then we shall move to the analysis of a set of key questions that appear when we begin the development of a multimedia communications theory.

4.1 Paradigms and World Views

The concept of a information system or communications architecture has been a cornerstone in the development of new information and communications systems. However, the structural elements of these architectures have not played a role in the development of policies. In this section we will develop the concept of an architecture as a means to understand the network as both a market and regulatory entity, and will provide a new set of perspectives for viewing the network in terms of a new paradigms and world views.

The concept of a telecommunications architecture has been a cornerstone in the development of new telecommunications systems. However, the structural elements of these architectures have not played a role in the development of policies. In this section we will develop the concept of an architecture as a means to understand the network as both a market and regulatory entity, and will provide a new set of perspectives for viewing the network in terms of new paradigms and world views.

An ***architecture***, first, requires that the underlying system be treated in terms of a set of commonly understood elements and that these elements have a clearly demarcated set of functions and interfaces that allow for the combining of the basic set of elements. The way the elements then can be combined, reflected against the ultimate types of services provided, determine the architecture.

An ***architecture***, secondly, is driven by two factors; technology and world view. Technology places bounds on what is achievable, however those bounds are typically well beyond the limits that are self-imposed by the designer or architect in their view of the user in their world. This concept of architecture and the use of design elements is critical in understanding the paradigms used in the structure of information systems (SeeWinograd and Flores, pp. 34-50, especially their discussion of Heidegger and Throwness in terms of design). World view is the more powerful driver in architecture (See Kuhn, pp. 72-85). We argue in this paper that it is essential to develop a philosophical perspective and understanding of how to view networks. We argue with Winograd and Flores, and in turn with Heidegger, that we must be thrown into the network, to understand the needs of the users, and to understand the structure of the paradigms that are used to construct the world view.

The concept of a ***paradigm*** is in essence the collection of current technologies that we have at hand for the network and the ways we put these elements together. However, the true meaning of a paradigm is in the context of the examples or experiments that we all relate to with that technology. Paradigms are not technology in and of itself, but technology as example. New paradigms result from new technologies. New technologies allow for the placing of the elements together in new ways. Kuhn, then goes on to demonstrate that the world view, that is how we view ourselves and our environment is based upon the our acceptance of these paradigms, as either collections of techniques and technologies or as collections of embodiments of these techniques and technologies in "examples". We then tend to accept this as the way things are and should be. Then Kuhn argues, as the technologies change, changes in the paradigms do not occur in a continuous fashion but almost in quantum leaps. The new paradigms build and congeal until they burst forth with new world views. It is this model that we ague applies to the evolution of broadband.

Thus, ***architecture is the combination of three parts: the common elements, the underlying technology and the world view.*** We depict the conceptualization of architecture as the amalgam of these three elements. We shall develop this construct more fully as we proceed.

The concept of a ***world view*** is an overlying concept that goes to the heart of the arguments made in this paper. To better understand what it implies, we further examine several common views and analyze the implications of each. If we view our world as hierarchical, then the network may very well reflect that

view. If we further add to that view a bias towards voice communications, these two elements will be reflected in all that we do. The very observations that we make about our environment and the needs of the users will be reflected against that view. As an external observer, we at best can deconstruct the view and using the abilities of the hermeneutic observer, determine the intent of the builder of the networks.

To better understand the importance of an architecture we develop the concept of the historicity of architectures based upon the work of Kuhn and ten that of McLuhan. Kuhn begins his thesis of how scientific revolutions occur by the introduction of the concept of paradigms. He defines these as (see Kuhn p. 175);

> *"...the term paradigm is used in two different senses. On the one hand, it stands for the entire constellation of beliefs, values, techniques, and so on shared by the members of a given community. On the other, it denotes one sort of element in that constellation, the concrete puzzle-solutions which, employed as models or examples, can replace explicit rules as a basis for the remaining puzzles of normal science, The first sense of the term, call it sociological, ..., "*

The concept of a paradigm is in essence the collection of current technologies that we have at hand for the network and the ways we put these elements together. New paradigms result from new technologies. New technologies allow for the placing of the elements together in new ways. Kuhn, then goes on to demonstrate that the world view, that is how we view ourselves and our environment is based upon the our acceptance of these paradigms, as either collections of techniques and technologies or as collections of embodiments of these techniques and technologies in "examples". We then end to accept this as the way things are and should be. Then Kuhn argues, as the technologies change, changes in the paradigms do not occur in a continuous fashion but almost in quantum leaps. The new paradigms build and congeal until they burst forth with new world views. It is this model that we ague applies to the evolution of broadband. It is this philosophical view, almost Hegelian in form, that is essential in understanding the underlying and formative changes in paradigms that will change our world view.

As a second perspective of the impact of technology as a dominant driver, we can refer to McLuhan and his development of the concept of media. Drucker has referred to the presentation of McLuhan's doctoral thesis and McLuhan is quoted as follows (See Drucker, p. 250):

> *"Movable type, rather then Petrarch, Copernicus, or Columbus was the creator of the modern world view.. "Did I hear you right," asked one of the professors as McLuhan had finished reading, "that you think printing influenced the courses the universities taught and the role of the university, altogether?" "No, sir, " said McLuhan, "it did not influence; printing determined both, indeed, printing determined henceforth what was going to be considered knowledge."*

This concept later evolved into the medium being the message. In our context it is the fact that both Kuhn and McLuhan recognized, albeit in differing fields and in differing ways, that fundamental changes in technology and technique, call it paradigm or the medium, will change the world view, also the message. It is the importance of understanding the change in the technology, its function and evaluate the possible change that this will have in the world view. It will be argued, that much of the thinking in the current broadband areas, NREN in particular, is based upon outmoded techniques and structures, and that a differing world view will evolve.

Take, for example, the use of twisted pair, pairs of copper wire, to transport telephone traffic. For years it was implicitly assumed that this transport medium was limited to 4,000 Hz of bandwidth, that necessary for an adequate quality voice signal. Specifically the world view was that of a voice network that was to be used for voice traffic only. Ten years ago, this was a true limitation, since the transmission was forcefully limited to 4,000 Hz by inductive loads or coils on the telephone lines, assuring that you could do no more than the 4,000 Hz of bandwidth. Then, there was a short period in the mid 1980s, when Local Area network manufacturers found that you could transmit 1.544 Mbps over the common twisted pair, and that data was viable in what was assumed to be a voice only medium. What had been almost religiously believed to be a

limit was found to be untrue. Then with the introduction of digital switches, the old "inductive loads" were returned with the switch now limiting the data to 4 KHz or 64 K samples per second. The world view of a voice only network took hold again, but this time in the context of a data rate limitation, rather than a bandwidth limitation. In the early 90's there is another attempted break out of the world view and to put 100 Mbps on twisted pair, so called FDDI circuits. Again, due to the limitations on the part of the network as a voice dominated system, the world view keeps this high data rate capability on the customer's premise only, and not the network.

We describe this transport world view evolution. Here we indicate the two dimensions of information transport, bandwidth and data rate. The designer of the transport facility may limit the data rate by selection of signaling format or delimit bandwidth by filtering. Twisted pair actually has a bandwidth-data rate profile. It encompasses a large capability of either providing bandwidth or data rates to the user. The two limiting world views are indicated as two solid lines, one at 4,000 Hz and one at 64 Kbps. Both are voice only world views. We can readily see, that with optical fiber superimposed the same issue of architecture dominated by world view may result. In the fiber case, the result may be a segmenting of the architecture along selected data rate lines, again formed by the voice world view.

Thus, architecture can be defined as the conceptual embodiment of a world view, using the commonly understood set of constructural elements, based upon the available set of technologies.

For example, Gothic architecture was a reflection of the ultimate salvation in God in the afterlife, in a building having a roof, walls, floors, and windows, and made of stone and glass. Romantic architecture was, in contrast, a celebration of man, using the same elements, but some employing a few more building materials. The impact of the differences in world view are self evident in the embodiments of the architecture. (See the discussions on the impact of world view on architecture in Wolfe. In addition see the cultural or world view impact on the Gothic architectures in Jantzen and in Toy.)

Let us consider a second example of the impact of world view on architecture, specifically the difference between the ISDN architecture and the architecture embodied in Local Area Networks, LANs. ISDN is an architecture consistent with a voice dominated, hierarchical world view of single points of control. LANs are architectures of world views that reflect both end user self empowerment and the environment of a data driven utility. Figure 4 depicts the LAN embodiment as well as its extension in the CATV architecture of voice communications using a LAN world view. This evolution in thought is critical to understand the impact of world view. The LAN is an embodiment of empowerment of the individual view, developed in the context of the 1960's and 1970's. The LAN concept, originating at such locations as XEROX PARC, was driven by the developers needs to enable and empower the end user with computing capabilities heretofore unavailable.

Out of this view came the LAN architecture of a fully distributed system, using a coaxial transport mechanism to do nothing more than provide bandwidth. The transport mechanism is a broad enabler. The actual implementation of the details is done at the users terminal in hardware and software. This is in sharp contrast to ISDN, where the ISDN central switch does the enabling. In ISDN, bandwidth is not provided, rather it is a voice based data rate, 64 Kbps or multiple thereof. Consider this contrast in terms of how cable TV companies provided voice communications in the early 1980's. Both Cox and Warner, using variations on LAN technology, delivered a voice, video, and data service over the coaxial transport medium, by empowering the end users terminal, not by regimenting the transport network.

Technology also plays a very pivotal role in telecommunications. Alfred Kahn (1971, p 300), indicates that in the pre-divestiture period of the Bell System, the arguments for the needs of both vertical integration and need for monopoly control were based on technology. Specifically, there was a contention made by the Bell System that a single point of control to the network was essential. Also, it was argued that an adequate scale economy was attained only through a single monopoly. Indeed, given the state of technology of that time, the argument may have held. For in point, the loaded copper transmission capabilities allowed only limited transport, namely one voice channel per twisted pair. However, as we shall demonstrate, the underlying technology has provided a dramatic change in the underlying system. Functions now provided by the network, may be more efficiently provided by intelligent Customer Premise Equipment (CPE). The

question to be posed is; what is the role of the network, and how do we provide the dimensions of creative freedom to allow these new roles to evolve? To effectively approach this problem, we must first develop a canonical structure of a network.

Before continuing, we will define in a more structure fashion the paradigm, the world view, the architecture and the technology base. First, Kuhn defines world view as:[5]

> *" An entire constellation of beliefs, techniques, and so shared by the members of the community."*

And he further defines the paradigm as, first:[6]

> *"One sort of element in that constellation, the concrete puzzle-solutions which employed as models or examples can replace explicit rules as a basis for the solution of the remaining puzzles of normal science."*

and then second as:[7]

> *" Paradigms are what the members of the scientific community share and conversely a scientific community consists of men who share a paradigm."*

We however, take from these definitions and place them into the context that we have developed in this section.

Definition: A ***paradigm*** is a unique and defining experiment or demonstration that in and of itself crystallizes a concept as representative and descriptive of a broader class of similar ideas.

The classic paradigm was that of Watson and Crick in developing the structure of the DNA molecule. The defining moment was best described in their paper in Nature that off-handedly alludes to the DNA molecule having the properties of self replication and thus containing the genetic information for all life. This defining experiment then led to the massive changes in Botany, Biology, Medicine and even computer science. The paradigm is the rite of initiation for any believer in the new religion. The paradigm for Christianity was the resurrection of Jesus, and that of Judaism was the pact of Abraham with the Lord.

To understand all other elements of deconstructionist thought, it is first necessary to find and identify the defining moment, or the paradigm.

Definition: The ***world view*** is the collection of all beliefs that follow from a consistent application of the paradigm in reflecting life and its existence.

The world view of the DNA paradigm is genetic engineering, of the Univac paradigm, is the central processor, of the Church in the Middle Ages is salvation after death. The world view is more than a single statement, it is a collection of beliefs. All the beliefs are predicated on the unique and singular interpretation of the paradigm. Until Martin Luther, the Church in Rome was in control. Luther, through the printing press and the availability of the bible to all challenged and changed this. The new paradigm in this case was the printed bible in vernacular. The world view was hat of Protestantism.

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[5]Kuhn (TFTTM, p132)

[6]Kuhn (TFTTM, p175)

[7]Kuhn (TFTTM, p176)

All too often we see the world view in parts. Even if we see the world view in total we may fail to see the paradigm. The religious organizations typically define and deify their paradigms. Jesus at the mount, Mohammed and the angel, Joe Smith and the angel, May Baker Eddy and divine revelation, and even the Buddha and his revelations. They are the paradigms. In religion it is critical to have the paradigms unchallenged. They are thus constructed.

Definition: The ***technology base*** is defined as the set of all technologies available to demonstrate the paradigm and to implement the representation of the world view.

We define technology in its broadest sense. We may have a paradigm of a god who has shown themselves through the visions of a mushroom. The world view is that we must perform all of our important acts under this influence. The technology allows us to analyze the mushroom and determine based on our neuroscience knowledge that the effects are those of psilicybin, not of our god. That will challenge the paradigm. Another is the ability to measure the age of the earth and to carefully, through genetic analysis, determine the evolutionary pathways of all creatures. This may challenge the paradigm of the creationists. A third, and current one is the technology to determine that homosexuality is genetically based. This challenges the paradigm of choice in the homosexual community and thus attacks a power base. Technology can thus either empower the world view and express it or it can challenge and destroy the paradigm.

Definition: ***Architecture*** is defined as the conceptual embodiment of a world view, using the commonly understood set of constructural elements, based upon the available set of technologies.

Definition: The ***design*** is the current implementation of an architecture using the current technology base.

Definition: The process of ***deconstruction*** is the process whereby the current observer, by using the understanding of the technology base evolution, and by understanding and structuring the current and prior architectures, can determine the base paradigm and thus infer all elements of the world view of the implementor of the architecture.

We shall use this process in the development of many multimedia systems. The design of a multimedia system must understand the paradigms of the users. This is inclusive of all of the user sets, namely the food chain elements that we discussed before. To deconstruct, we must understand and identify the paradigm. Without that we cannot hope to achieve the converasationality that we seek.

Finally, we add the definition of an infrastructure, recapturing what we developed in the last section.

Definition: An ***infrastructure*** is a shareable, common, enabling, enduring, resource, that has scale in its design, and is sustainable by an existing market, and is the physical embodiment of and underlying architecture.

4.2 Questions

We proceed with the effort of developing a deconstruction theory by developing a set of key questions that ultimately relate to our understanding of object or entities. It will be through this understanding that we come to grasp the underlying structures of multimedia.

1. What is an object?

An object is and entity in a multimedia environment that is actionable. It is a single or compound collection of multimedia elements, combined from one or several users, that creates a transaction. Actionable implies that the objects can be used by others or shared amongst others and the sharing or use results in human actions or responses. The concept of actionable objects is at the heart of multimedia communications.

2. Do Objects exits?

Objects exists through the transactions that they create. Does a conversation exist? Words are created, sounds are made, and a consensus is achieved. Possibly the objects used in the conversations are perceived differently by each of the participants, and possible the consensus is perceived differently, even if it is placed in writing and agreed to by all. The true sign of the objects existing is their ability to create a transaction at some point, namely a change element.

3. What role does the human play in the expression of the characteristics of an object?

Does a tumor such as a lymphoma exist? The patient presents with a symptom of a swelling in the neck. The physician palpates and remembers the past 99% of the cases were lymphomas, by definition, the pathologist reads the slide and sees the telltale cell pathologies. The object of the lymphoma exists. The existence is in the consensus of the individuals. The ultimate existence is in the life or death of the patient

4. How does a human deal with objects?

The human deals with the set of objects through their totality of senses. The object may be visual, all too frequently what we are trained to respond to in today's culture, it may be a sound, a touch, a smell, or any of the other sensual combinations. The human rationalizes the sense objects and creates a communal sense of agreement with others with regard to a collection of such objects. The human deals with multimedia communications objects in a conversational and communal fashion. Unlike a book, or a video game, which is an internalized experience, a multimedia communications based object is externalizable, and allows for the displaced conversationality described earlier.

5. Why does a human deal with an object?

The human deals with the objects through their senses and with the interaction of other humans. It is a consensus-conflict resolution process.

6. Why does a human react to the presence of an object?

The human reacts to the object by transacting an event. The multimedia objects are essentially demands on the individuals senses that will not go unanswered. It is an active medium that demands a reaction and response. Unlike television which may be internalized and has responses that are displaced in their cultural context, multimedia communications is in the context of a real time communal dialog.

7. "What is communications?"

Communications in the context of multimedia is a conversational transaction. It allows multiple individuals, humans or otherwise to interact, converse, and through that conversation to transact. Communications is the movement of information between individuals, movement that entails the interaction of as many of the sense as is possible.

8. "What is conversation?"

Conversation is the sharing of senses, the establishment of consensus or the resolution of conflict, with the end result be the transaction. A conversation requires two or more humans, a common shared medium, co-temporaneous or otherwise, and a shared set of beliefs, that allow for a common understanding of the signs used on the conversation. The semiotician would look at the conversation in terms of the external signs. The deconstructionist would look at the underlying pre-beliefs of the communications. The hermeneuticist would try to understand the motives of the messengers in the conversation. In the case of multimedia communications we are using signs that are externalities of ideas that we wish to transmit from one individual to another. The end result of this transmission of ideas is a transaction, a change in the state of the receiver or even the sender of the ideas.

Multimedia communications is about conversations. It is about using all of the constructs available to communicate information that results in that desired or otherwise transaction. The challenge is to determine what elements are necessary for the state change. The further challenge is to determine if that change really occurred.

9. "How do humans interact with information?"

Humans interact with information by responding and creating a transaction. Information allows the change of knowledge state in the individual. If I am provided with a new piece of information, I change my understanding of something that I had not fully understood before. It may clarify it or it may dramatically alter it. If there is no change, then we argue that there was no information.

10. "What is a representation?"

A representation is an embodiment of a collection of information elements. In a multimedia communications environment we are almost always dealing with representations and never the actual entity. For example, in a radiological environment, we look at the MRI of the brain of a patient with multiple sclerosis. We see in the brain the white spots that represent the demyelenation of the brain cells, the evidence that there is a sclerotic event. If we were the surgeon, we would most likely see nothing, if the pathologist, we would see the demyelenation on a different scale by staining the cells and see the loss of myelin. All are representations of the underlying disease process. The reality os as best defined a genetic and viral induced process that is the humans immune system rejecting the self. This is the long winded way of defining the entity via the process as compared to defining the entity via the representation. The representation defines an entity that may be defined in no other way.

11. "Does there exist an abstraction that can be shared by two people that allows common understanding?"

The essence of multimedia communications is the delivery of abstractions. An abstraction is a representation of an entity delimited by the technological resources available in the multimedia communications environment. A full representation may require all the senses, or a breath of the senses that exceeds what is generally available to the current technology. The abstraction is the mapping of the representation onto the technology base. Sharing abstractions may allow two or more people to attain a common understanding if there is adequate information conveyed in the abstraction. For example, two physicians may see a chest x ray and determine that the patient has a carcinoma of the left lung. The spot is clear and non-disseminated, and based upon mutual shared prior experience it is clear what the abstraction is saying. If one of the viewers is the patient who is not medically trained, the abstraction would not convey such information. Thus information exchange requires a shared abstraction as well as a shared experience base with that set of abstractions. Expecting that abstractions per se convey information is not viable.

12. "Does a representation exist independent of the observer."

This is the dualism between forma and substance, between essence and existence. Is there such a thing as a rose, or is there a set of observable that when clustered together reach the consensus in most people that

this is a rose. The body of plant Systematics faces this problem at all times. The answer is that there is no such thing as an abstract representation. Information and determination, the transaction, take place with a set of noisy observations that have been characterized and categorized.

13. "Does a representation change in its meaning when observed by more than one observer."

This is the same as asking if consensus changes if there are more or less participants in the process. Will a jury meet a different decision if there are different jurors. The answer is possibly. Consensus is convergent but there is no abstract convergent point.

Why are these questions important and how do they relate to multimedia communications. Multimedia communications consists of communicating objects that relate to the human in only one fashion; through a transaction or through the empowerement to act. When designing a system, we empower the users to act. They must do so through the use of objects, the manipulation of the objects and the gaining of a consensus.

4.3 Answers?

The questions posed in the last section and the discussion concerning them clearly indicate that a certain set of long standing issues are still at the heart at how we view ourselves as creatures. The main driving issue has been the mid and body dualism. As we creatures that think with and act with our minds, or are our bodies the totality of ourselves. To quote from Winograd and Flores:[8]

> *"...mind-body dualism...rests on several taken-for-granted assumptions:*
>
> *1. We are inhabitants of a real world made up of objects bearing properties. Our actions take place in that world.*
>
> *2. There are objective facts about the world that do not depend on the interpretation or even presence of any person.*
>
> *3. Perception is a process by which facts about the world are registered in our thoughts and feelings.*
>
> *4. Thoughts and intentions about action can somehow cause physical motion of our bodies."*

This concept of the ideal form and the ideal an achievable entity is as old as Plato and Aristotle. The concept of the ideal form, as a Platonist would state, is that there is a true idea of a daylily. It is an abstraction that is the daylily, and what we see as humans is a mere shadow of its true form. To the multimedia communications, we then ask how does a Platonist communicate, namely, does he try to use the abstraction that closely matches the form? Copleston speaks on this with regard to Plato:[9]

> *" I would point out that the essence of Plato's doctrine of Forms and Ideas is simply this: that the universal concept is not an abstract form devoid of objective content or references, but that to each true universal concept there corresponds an objective reality."*

Continuing he states further:[10]

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[8]Winograd & Flores (UCC p 30-31)

[9]Copleston (Vol I, Part I, p. 175):

[10]Copleston (Vol I, Part I, p. 175):

> *"In the Republic it is assumed that whatever a plurality of individuals have a common name, they have also a corresponding idea of form. This is the universal, the common nature or quality which is grasped in the concept."*

It is the attempt to describe the "nature" or essence of things and to use this as a means to communicate that is the basis of many of our problems in design. An example is the compression of speech or video. We compress to avid the need for more bandwidth. We compress also because we believe that by doing so we get to the essence of it. We do so in a Shannoesque fashion, assuming that there is an essence of bits, minimal as they may be. This extension is best described by Popper:[11]

> *" I use the name methodological essentialism to characterize the view, held by Plato and many of his followers, that the task of pure knowledge or "science" to discover and to describe the true nature of things; their hidden reality or essence. ...All these methodological essentialists also agreed with Plato in holding that these essences may be discovered and discerned with the help of intellectual intuition. A description of the essence of the thing they called the "essence"."*

An extreme position to this essence approach is the positivist approach expressed by Ayer when describing the early work of Wittgenstein.[12]

> *"..the main theses of the Tractutus can be easily summarized. The world is said to be totally of facts which themselves consist in the existence of what are called.. atomic facts.. or states of affairs. The states of affairs consist of simple objects, each of which can be named. The names can be significantly combined in ways that express elementary propositions. Each proposition is logically independent of all its fellows. They are all positive and each of them depicts a possible state of affair which constitutes its sense....The fact that they are logically independent means that in order to give a complete account of reality one has to say which of them is true or false."*

The development of multimedia is the development of new metaphors. MacCormac best describes this change that metaphor can take:[13]

> *" Metaphor can be described as a process in two senses: (1) as a cognitive process by which new concepts are expressed and suggested, and (2) as a cultural process by which language itself changes...epiphors are metaphors that express more than they suggest..diaphors suggest more than they express."*

He goes on to state:[14]

> *"Generations of students who have passed through introductory philosophy courses in colleges an universities have come to believe in the division between the mind and nature. The rise of cognitive psychology in opposition to behaviorism, which denied the existence of the mind, fins comfort in the philosophical efforts to build a foundation for knowledge. The account that I have presented of metaphor as a cognitive process*

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[11]Karl Popper has stated (Hull, Ershefsky ED. p 201):

[12]Ayer(Witt, p 17)

[13]Mac Cormac (Met, p 5)

[14]Mac Cormac (Met, p 155)

presumes the existence of the mind existing as a deeper level of explanation that of semantics and surface language."

The essence of the Heidegger philosophy as relates to multimedia design has been best described by Winograd and Flores:[15]

"We...present...a...discussion of Heidegger's philosophy,...

(1) Our implicit beliefs and assumptions cannot be all made explicit.

(2) Practical understanding is more fundamental than detached theoretical understanding.

(3) We do not relate to things primarily through having representations of them.

(4) Meaning is fundamentally social and cannot be reduced to the meaning-giving activity of individual subjects."

The final element of Heidegger's approach is the breaking down effort of providing information in a way in which it is broken down or handled by the user.[16]

"... Heidegger's ...insistence that objects and properties are not inherent in the world, but arise only in an event of breaking-down in which they become present-at-hand...In sum, Heidegger insists that it is meaningless to talk about the existence of objects and their properties in the absence of concernful activity with its potential for breaking-down."

The latter comment on Heidegger is the essence of multimedia communications. The breaking down if the basis of a transaction, of a change in state of the human or humans in the conversation. We must then take into account the impact of this new medium. It is an impact with many dimensions of consequences. To quote McLuhan:[17]

"The personal and social consequences of any new medium result from the new scale that is introduced into our affairs by each extension of ourselves or by any new technology."

And to further the quote:[18]

"The message of any medium or technology is the change of scale or pace or pattern that it introduces with human affairs."

The multimedia revolution is on the scale of all other revolutions. It will be a revolution if and only if it does to the multimedia word what the printing press did to the written word. To quote McLuhan:[19]

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[15]Winograd & Flores (UCC p 30-31)

[16]Winograd & Flores (UCC p 36-37)

[17]McLuhan (MIM, p 23)

[18]McLuhan (MIM, p 24)

[19]McLuhan (MIM, p 29)

"The French Revolution, as per de Tocqueville, was a result of the homogenizing nature of the printed word."

Homogenizing means making it accessible to all. Making it accessible means making it actionable, and actionable at a distance. The actionable at a distance, and the ability to have the throwness in the medium and the integration with the message is what will make for the revolution.

5. HERMENEUTICS

Deconstruction is the process whereby the current reader attempts to place themselves in the context of the writer, both used in generic terms, and determine what the message was that was meant to be sent, relative to the context of it being sent. It in many ways is a Bayesian analysis of a human communications process. Hermeneutics is complementary to this effort. Hermeneutics, named after the god Hermes, is in essence the attempt to understand the environment of the singer and writer of the songs, but to sing them as clearly and faithfully as one can. [20]

5.1 Hermeneutic Principles

Hermeneutics is originally imbedded in the interpretation of texts. In our analysis the "text" is the broadened entity of the multimedia environment. The "text" must be expended into the context of the Messenger as carrier of the Message. Thus the need for a hermeneutic understanding is to focus on the messenger and what does the messenger bring to us about the message. In very practical terms, therefore, the same hermeneutic arguments that allowed us to address how to interpret the bible, are and will be at the heart of how do we interpret an x-ray and blood smear in a multimedia environment. The question posed is that does the multimedia environment land through the changed medium ad different message since it is communicated by a different messenger. Or, do we try to ensure that he messenger is kept in tact. Another analogy is does the bible change when one understands it from teleevangelists rather than reading it. Or historically, does the bible change when each person reads it as compared to having it preached from the pulpit. The latter change led to the reformation and the end of the hegemony of Catholicism in Europe.

The hermeneutical school is a contrast to the positivists who argue that one can obtain objective knowledge. To the hermeneutic student, all knowledge is "interpretation".[21] It is in this noisy channel that we try to obtain information. It is thus upon this noisy information that we ultimately act. The multimedia architect must take this into account in the designs of their systems. The channel is inaccurate and furthermore the messenger may actually be devious. The try of hermeneutics attempts to address the issue of devious messengers in the context of texts. We argue that the same questions and approaches are essential for the development of "multimedia text" messages.

The issue relating to texts is developed in Warnke. She states the problem in a historical context:[22]

"Questions of interpretation had been raised earlier, in particular in the Reformations Challenge to the catholic reign of the bible. Did an understanding of Scripture require a prior acceptance of the precepts of the Catholic faith or could it be understood on its

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[20]Illich & Sanders (ABC, p 85)

"The early Greeks had a sporting attitude towards duplicity.."untruth" is always the telling of things that are not, not of thoughts that are contradicted. The patron of this cunning craft was Hermes, the trickster, the thief and the inventor of the Lyre that urges the singer further into epos. "

[21]See Warnke, p. 1.

[22]Warnke, pp. 1-2.

own?...Schleiermacher significantly expanded the scope(asking) how many could be comprehended, what methods would permit an objective understandings of texts and utterances of any kind...Dilthey even asked broader questions: what were the methods that would permit an objective reading of any kind, including actions, social practices, norms and values? How could the understanding of meaning be raised to the same methodological clarity characterized in the natural sciences? How could it find as solid a basis for methodological progress?"

Gadamer is the most recent and articulate espouser of the hermeneutic school. He has evolved and matured the hermeneutic approach from one of literal translation to exposition. To quote Warnke describing the evolution in hermeneutics in Gadamer;

"The Bible is assumed to have a normative authority for everyone and the task of the hermeneutic understanding is therefore simply to help transmit the content of its normative claims." [23]

Simply put, Hermeneutic in this context states that the deconstuctionist approach may be use in a relative setting, but in the context of a normative setting such as the law of God, we us either hermeneutic approach to seek the "truth" or normative facts. The difference is best stated in terms of selecting a justice of the Supreme Court. Judge Bork is the classic hermeneutic seeking the letter of the constitution. Justice Douglas is the decosntructioninst trying to take Madison's words and placing them in a current time frame.

Gadamer takes the hermeneutic goal of positivism and objective answers and introduces the subjective. This is characterized again by Warnke:[24]

"Hermeneutics, as Gadamer conceives of it, then, is no longer to be seen as a discourse on methods of the "objective" understanding as it was for the hermeneutic tradition of Schleirmacher and Dilthey. It no longer seeks to formulate a set of interpretative rules; rather, in referring to his analysis as "philosophical hermeneutics", Gadamer turns to an account of the possibility of understanding in general, conditions that in his view undermine faith in the ideas of both method and objectivity. Understanding is therefore rooted in prejudice and the way in which we understand it is thoroughly conditioned by the past of by what Gadamer calls "effective history"."

From our perspective, as designers of multimedia systems, we have a cultural environment that we are working in. We have an environment with a history, a past, a culture, and a noisiness that makes event objective transmission of information a transformation of information. The hermeneutic channel challenge is to model the channel, to deconstruct its structure, to generate the optimal processing filters for the complex messages that are to be transmitted.

From a historical perspective, the hermeneutic problem for the multimedia designer is the same as the random noise problem was for the designer of signal detection systems of the 1940's and 1950's. As we had indicated before, it was the work of Shannon who determined that information was essential the elimination of uncertainty. Shannon's teacher, and in many ways mentor, was Norbert Wiener. It was to Wiener, who had both mathematical and philosophical raining, that the development of the concepts of the detection of signals in noise is credited. Wiener conceived of the use of the correlation and auto correlation functions. He introduced the history of an random process in a structured for that has led to information theory and the processing of signals in computers and communications. It is the same construct that we are trying to develop that is of utmost importance. The mathematical theory may not be in place, but the philosophical constructs to develop them must first be worked through.

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[23]Warnke, p. 9.

[24]Warnke, p. 3.

Warnke goes on in terms of hermeneutic development:[25]

> *"Hermeneutics thus has a largely pedagogical task: it is supposed to exhibit the truth that inheres in a given claim so that its audience can understand and learn from it. As hermeneutics develops, however, attention is redirected from the understanding of truth context of a text and towards the understanding of the intentions. The aim of understanding is no longer seen as knowledge of* die Sache- *a substantive knowledge of claims to truth or normative authority. It is seen rather as insight into the historical and biographical circumstances behind their expression. Understanding becomes genetic: what were the conditions under which the agents acted, spoke or wrote as they did?"*

This leads to a focus on the circumstances qua written word. Deconstruction focuses on the meaning qua circumstances. We must enter into the hermeneutic thought process from the perspective of multimedia communications because the displacements of Gadamer and Haberamus are physical and temporal, but the displacements of multimedia communications are electronic and cultural. The nature of displaced understanding is the same in both cases. The issues, we argue, are also isomorphic.

The complementarity of approaches can be related to the complementarity of ideas in cultural context. For example, Bloom recounts the issue in the context of the French;[26]

> *" Descartes and Pascal are national authors, and they tell the French people what their alternatives are, and afford a peculiar and powerful perspective on life's perennial problems...On my last trip to France I heard a waiter call one of his fellow waiters a "Cartesian"...Descartes and Pascal represent a choice between reason and revelation, science and piety."*

These two authors are also choices between two types of certainty; the divine and the mind. In reality, as we have seen with Gadamer, certainty of any kind has its limits. The positivist school still argues for the existence of absolute certainty. The hermeneutic school of Gadamer eschews such certainty. At best we can interpret. At worst, the interpretation is a reflection of our own past, history, biases and intents. Even in medicine, the process of diagnosis is one of noisy interpretation. Certainty may exist in a pathology slide that portrays without doubt a malignancy. The outcome of that diagnosis may still have some uncertainty.

Namely, there is a philosophical underpinning in our general line of communications. It is this basis that will lead to understanding or cacophony. Gadamer goes on to define his focus in hermeneutics as follows;[27]

> *" The task of philosophical hermeneutics, therefore, is ontological rather than methodological. It seeks to throw light on the fundamental conditions that underlie the phenomenon of understanding in all of its modes."*

Gadamer further stresses the importance of language in this process:[28]

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[25]Warnke, pp. 9-10.

[26]Bloom (CAM, pp 52-53).

[27]Gadamer (Phil Herm, p. ix)

[28]Gadamer (Phil Herm, p. 3)

" Language is the fundamental mode of operation of our being-in-the-world and the all embracing form of the constitution of the world."

The issue of language being the form of history, the carrier of the formation, and the medium of the message, and thus being the message itself, has implications to the hermenuticist. One of these is the change in the nature of the media for the transmission of the e message. Weizenbaum notes:[29]

" The computer has thus begun to be an instrument for the destruction of history. For when a society "legitimates" only those data that are "in the standard format" and "that can easily told to the machine" then history, memory itself, is annihilated. The New York Times has already begun to build a database of current events...from which historians will make inferences as to what really happened."

The conversion of words in the twelfth century, with the rediscover of the Greeks and their thoughts, which arguable led to the enlightenment of the twelfth century itself, was a result of the translation, and not simple transliteration of the Greek texts. As Illiach and Sanders remark:[30]

" The Greek work was not to be turned into Latin verbum pro verbo. Instead, the meaning was to be detached from the words of one language and made to reappear in another; content, stripped of its form, was to be preserved. Theories about translation changed very little - translation was described as an attempt to divulge the secrets of one language into another- until the hermeneutics of the 1950s. Only then did the study of translation as applied linguistic theory become separated from literary theory."

Ironically, the twelfth century Latin of the early universities, such as those in Paris, was a Latin ready for the expansion of the new technology of Guttenberg. It was now a language whose form was prepared for text. Again Illich and Sanders remark;[31]

" Division into words first came into common use in the seventh century. It happened at the northern frontiers of the known world, where Celtic "ignoramuses" had to prepare for the priesthood and needed to be taught Latin. Division of words was thus introduced as a means of teaching Latin to barbarians as a foreign language."

The very structure of language had made a transition into a form that would allow it to be further tempered by a technology and thus be transformed into the new medium. The bilateral change of the understanding of the environment of the author and the tempering of the environment of the reader then leads to the full hermeneutic context. As Winograd and Flores remark:[32]

" .. Gadamer takes the act of interpretation as primary, understanding it as an interaction between horizon provided by the text and the horizon that the interpreter brings to it. Gadamer insists that every reading or hearing of a text constitutes an act of giving meaning to it through interpretation."

Thus the hermeneutics of Gadamer is evolutionary from the revelation of the underlying eternal truth, to the evolving interpretation.

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[29]Weizenbaum (CP&HR, p 238)

[30]:Illich & Sanders (ABC, p 54)

[31]Illich & Sanders (ABC, p 46)

[32]Winograd & Flores (UCC, p 28)

5.2 Hermeneutic Methodology Applied

In this section we take the philosophical theory developed in the prior section and address it to the problems of the multimedia methodology. We develop the design principles in hermeneutic observations. The process is to state the observation and then to reflect on the appropriate design principle.[33]

- *What we observe is a reflection of what is there filtered through the understanding of what we think should be there.*

- *Conversations have history, and the history is often unknown, and if known may not be aware to the conversant.*

- *Absolute "truth" does not necessarily exist in a conversation. Consensus may converge but convergence is not to truth. The convergence of consensus is not consistent.*

- *Tradition, authority, and history are integral elements in filtering understanding. The issue of authority is an integration of visions of the presenter and the information presented. Choice of words and language to create a "text" are the basis of power in the relationship.*

- *Communications is a sociological interpretive process that seeks to attain consensus in resolving an ambiguity. Actions are the result of that consensus becoming an agreed to common state amongst the community in the process.*

5.3 Communications at the Conversational Layer: Hermeneutics Applied

Having established the design rules and provided the understanding of the hermeneutic elements, we can now take these and place them in the context of multimedia communications. The issue is one of establishing conversationality. Coversationality is as we have defined the ability of one or more humans to enter into a dialog with a system and themselves relating to elements of information in the system adequate enough to eventually create a transaction.

The OSI layered communications architecture has evolved to manage and support the distributed communications environment across error prone communications channels. It is presented in detail in either Tannenbaum or Stallings. A great deal of effort has been spent on developing and implementing protocols to support these channel requirements. Layer 7 provides for the applications interface and generally support such applications as file, mail and directory. The requirements of a multimedia environment are best met by focusing on layer 5, the session layer whose overall function is to ensure the end to end integrity of the applications that are being supported.

Some authors (See Couloris and Dollimore or Mullender) indicate that the session function is merely to support virtual connections between pairs of processes. Mullender specifically deals with the session function in the context of the inter-process communications (IPC). In the context of the multimedia object requirements of the previous section, we can further extend the concept of the session service to provide for IPC functionality at the applications layer and specifically with regards to multimedia applications and their imbedded objects.

The services provided by the session layer fall into four categories:

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[33]The reader should note that these principles are those of the author as a condensation of the hermeneutic understandings presented in the prior section. The reader may themselves question each of the observations, and that process itself is critical to the design process. The focus is on the philosophical underpinnings of design, and then design as a result of that process. In effect it is essential t perform other acts.

o **Dialog Management:** This function provides all of the users with the ability to control, on a local basis as well as global basis, the overall interaction in the session. Specifically, dialog management determines the protocol of who talks when and how this control of talking is passed from one user to another.

o **Activity Management:** An activity can be defined as the totality of sequences of events that may be within a session or may encompass several sessions. From the applications perspective, the application can define a sequence of events called an activity and the session service will ensure that it will monitor and report back if the activity is completed or if it has been aborted that such is the fact.

For example, in a medical application, we can define an activity called "diagnosis" and it may consist of a multiple set of session between several consulting physicians. We define a beginning of the activity when the patient arrives for the first visit and the end when the primary physician writes the diagnosis. The session service will be responsible for ensuring that all patients have a "diagnosis".

o **Synchronization**: We have seen that at the heart of a multimedia system is a multimedia data object. Each of the objects has its own synchronization or timing requirements and more importantly, a compound object has the orchestration requirement. The session service of synchronization must then ensure that the end to end timing between users and objets is maintained throughout.

o **Event Management:** The monitoring of performance, isolation of problems, and restoration of service is a key element of the session service. Full end to end network management requires not only the management of transport and subnetwork, but requires that across all seven OSI layers, that overall end to and management be maintained (See McGarty and Ball).

The servers are conceptually at a level above the transport level. We typically view the transport servers as communicating distributed processes that are locally resident in each of the transmitting entities. This then begs the question as to where does one place the session servers. Are they local and fully distributed, can they be centralized, and if so what is their relationship to the Transport servers. Before answering these questions, let us first review how the session services are accessed and how they are communicated.

Session services are accessed by the higher layer protocols by invoking session service primitives. These primitives can invoke a dialog function such as Token_Give. The application may make the call to the S_SAP and this request may be answered. There are typically four steps in such a request, and these are listed in Stallings who shows that the requests are made of the session server by entity one and are responded to by entity two. The model does no however say where the session server is nor even if it is a single centralized server, a shared distributed server, or a fully distributed server per entity design. We shall discuss some of the advantages of these architectural advantages as we develop the synchronization service.

5.3.1 Dialogue Management

Dialog management concerns the control of the end user session interaction. Specifically, who has permission to speak and when, who can pass the control and how is that implemented. In this section we shall describe the environment for the dialogue management function and develop several possible options for implementing this function.

Dialog management requires that each of the virtual users have a token or have access to a baton in order to seize control of the session. In the course of a typical session, the two virtual users fist establish the initial subsession that becomes the first part of the session. The addition or binding of other virtual users through subsessions to the session allows for the growth of the session. The baton or token may be a visible entity that is handed from one to the other or it may be hidden in the construct of the applications.

Consider the session level service called dialogue. The service can be implemented in four possible schemes. These schemes are:

(1) **Hierarchical:** In this scheme there is a single leader to the session and the leader starts as the creator of the session. The baton to control the session can be passed upon request from one user to another, while full control remains with the session leader. The session leader may relinquish control to another user upon request and only after the leader decides to do so. The leader passes the baton from users to user based upon a first come first serve basis. It is assumed that each users may issue a request to receive the baton, and that any requests that clash in time are rejected and the user must retransmit. There transmit protocol uses a random delay to reduce the probability of repeated clashing. The leader always acknowledges the receipt of the request as well as a measure of the delay expected until the baton is passed.

(2) **Round Robin:** In this scheme, the baton is passed sequentially from one user to another. Each user may hold the baton for up to Tbat sec and then must pass the baton. When the baton is held, this user controls the dialogue in the session.

(3) **Priority:** In this case, all of the users have a priority level defined as $P_k(t)$, where k is the user number and t is the time. We let the priority be;

$$P_k(t) = R_k(t) + T_k(t) + D_k(t)$$

Here R is the rank of the k th user, T is the time since the last transmission and D is the data in the buffer. We assume that some appropriate normalization has occurred with this measure.

Every T_{check} seconds, each users, in sequence sends out a small pulse to all other users, on a broadcast basis, and tells them their current priority. Each user calculates the difference between theirs and all the others. User k calculates a threshold number, TR_k, which is;

$$TR_k = \max |P_k(T)-P_j(T)|$$

If $TR_k > 0$, then user k transmits its packets for T_{send} seconds.

(4) **Random Access**: Each user has a control buffer that indicates who has control of the session, namely who has the baton. The session is broken up into segment T_{sess} in length, with T_{req} seconds being relegated to a baton ownership selection period and T_{sess}-T_{req} being left for the session operation. During T_{req} , all of the users transmit a request packet that is captured by all of the other users buffers. T_{req} is broken into two parts, T_{send} and T_{eval}. These requests are broadcast in T_{send}.

Now after the sent messages are received, one of two things can happen, the message is received or it collides with another message and is garbled. If the message is garbled, the buffer is not loaded and is left empty. If it is filled, then each buffer during T_{eval} sequentially broadcasts its contents and all of the users listen to the broadcast and record the counts, N_k where N_k is the number of votes for user k in that call period.

The choice of baton control is then;

Choose user k if $N_k = \max_j | N_j |$

else restart T_{req} again.

For each of the protocols we describe the advantages and disadvantages of each in the Table.

Table: Dialog Protocol Comparison

Protocol	Advantage	Disadvantage
Hierarchical	Single Point of Control of the Session.	Lacks capability to have open discussion.
Priority	Establishes who is in charge by allocation.	Requires a scheme to give priority that may be open to compromise.
Round Robin	Everyone gets to talk. Egalitarian approach.	May be excessively time consuming.
Random	Strongest player wins.	May not permit dissent.

5.3.2 Activity Management

Activity management looks at the session as an ongoing activity that users may come and go to. This services provides an ability to easily add, delete and terminate the entire session.

An activity in the terms of the session is a total bounded event that can be compartmentalized in such a way that other events may be locked in suspension until that event is complete. Activity management is in the session layer a function similar to transaction management in a transaction processing system. It allows for the definition of demarcation points that permit suspension of activities in other areas until the activity managed transaction is complete. Activity management can also be developed to manage a set of events that can be combined into a single compound event.

There are several characteristics that are part of activity management:

o **Activity Definition:** This allows for the defining of an activity as composed of several dialogue. It allows for the defining of the activity as a key element of a single session or even to expand over several sessions.

Activity definition is the process of informing the session server of the beginning and end parts of an activity and in providing the session server with an identifiable name for the activity.

o **Activity Integrity Management**: Activities are integral elements of action that cannot be segmented. The activity management system must ensure that once an activity is defined and initiated, hat no other activity that could interfere with the existing one is allowed to function.

o **Activity Isolation:** The ability to provide integrity is one part of managing the activity. Another is the ability to isolate the activity from all others in the session. An activity must be uniquely separable from all other activities, and this separation in terms of all of its elements must be maintained throughout its process.

o **Activity Destruction:** All activities must be destroyed at some point. This is a standard characterization.

There are several sets of activities that are definable in a multimedia environment. These are as follows:

o Compound Multimedia Object Transfer

o SubSession Management

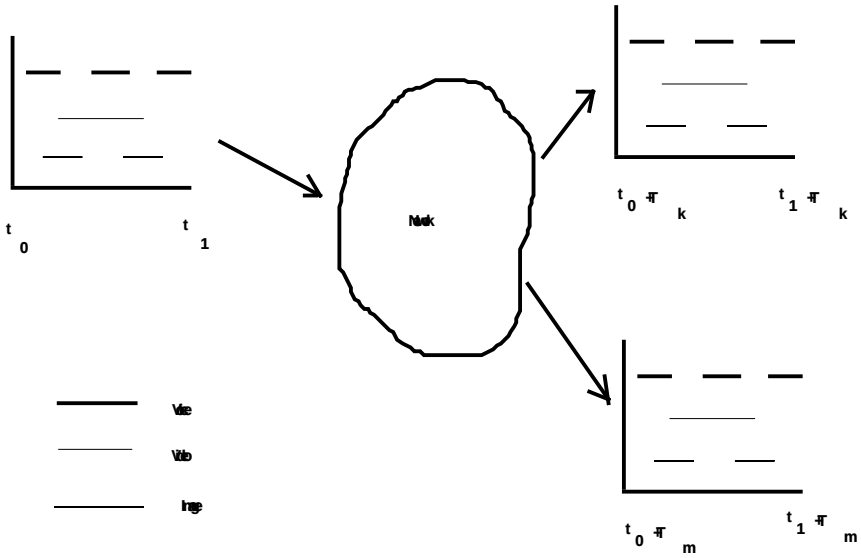
o Dialog Control

The algorithms to perform the activity management functions are developable consistent with the OSI standards. There are no significant special development necessary.

5.3.3 Synchronization Management

Synchronization is a session service that ensures that the overall temporal, spatial and logical structure of multimedia objects are retained. Consider the example shown in Figure 6.1. In this case we have a source generating a set of Voice (VO), video (VI), and Image (IM) data objects that are part of a session. These objects are simple objects that combined together form a compound multimedia object. The object is part of an overall application process that is communicating with other processes at other locations. These locations are now to receive this compound object as show with the internal timing retained in tact and the absolute offset timing as shown for each of the other two users.

Figure: Synchronization



In this example, the synchronization function provided by the session server to the applications processes at the separate locations is to ensure both the relative and absolute timing of the objects. The location of the functionality can be centralized or distributed. Let us first see what the overall timing problem is. Consider a simple SMO synchronization problem. The network than transmits the packets and they arrive either in order or out of order at the second point. The session server must then ensure that there is a mechanism for the proper reordering of the packets at the receiving end of the transmission.

Let us consider what can happen in this simple example.

o First, if the BMO of the SMO is very lengthy, then as we packetize the message, we must reassemble it in sequence for presentation. Let us assume that the BMO is an image

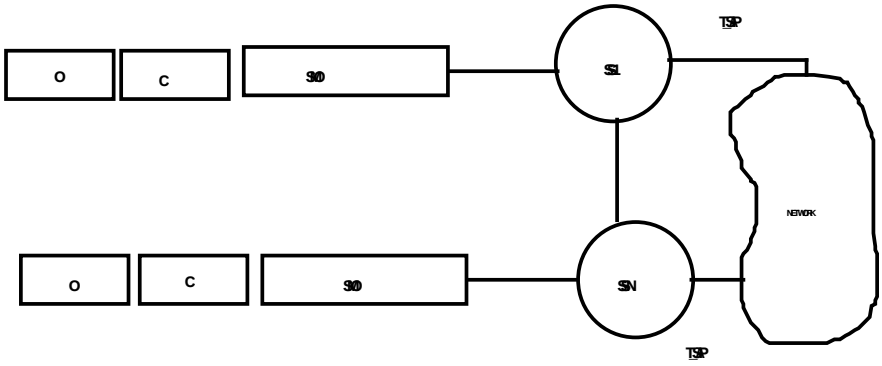
of 100 Mbits. Then let us assume that the packet network has a packet delay that will be low if there is no traffic and grows as traffic increases. Now let us assume that the network provides 500 bit packets transmitting at 50 Mbps.

o Second, let us note that there are 200,000 packets necessary to transmit the data. Each packet takes 10 microseconds to transmit. If we assume that there is a load delay of 5 microseconds per packet, then the total transmit time goes from 2 to 3 seconds.

We can also do the same with a compound object. In this case, we take the CMO and note that it is composed of SMOs. The SMOs must then be time interleaved over the transmission path to ensure their relative timing. It is the function of the session service to do this. The application merely passes the CMO and its header information as a request to the session server to ensure the relative timing is maintained.

The architecture for the session synchronization problem is shown if Figure 6.2. Here we have a CMO entering the network, knowing that the session server at Server 1 must not only do the appropriate interleaving but it must also communicate with the other servers (in this case K and N) to ensure that de-interleaving is accomplished. We show the session servers communicating with the network through the T_SAP and that in turn takes care of the packetizing. However, we also show that the session server, 1 and N, communicate in a out of band fashion, using some inter process communications (IPC) scheme, to ensure that the relative actions are all synchronized amongst each other.

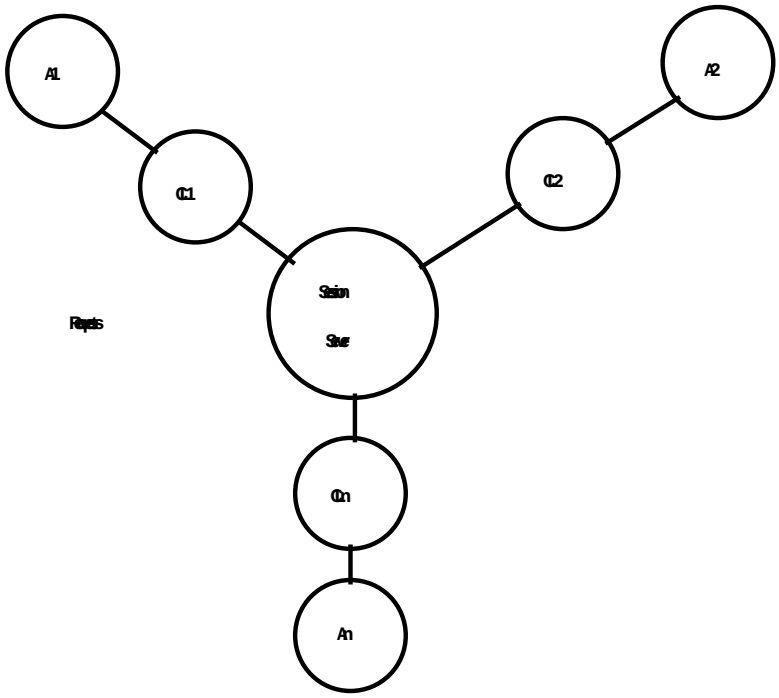
Figure: Synchronization Architecture



We can now envision how the architecture for this can be accomplished. There are two schemes:

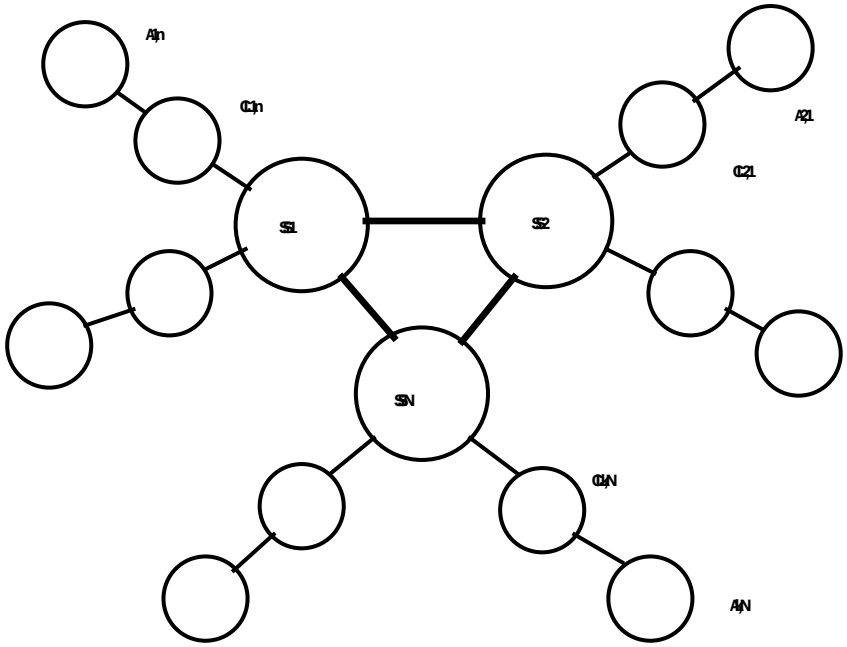
o **Centralized:** Figure 6.3 depicts the centralized synch scheme for the session service. It assumes that each application (A) has a local client (CL). The application communicates with the local client (CL) to request the session service. The session server is centrally located and communicates with the application locally by means of a client at each location. This is a fully configured client server architecture and can employ many existing techniques for distributed processing (See Mullender or Coulouris et al).

Figure: Centralized Architecture



o **Distributed:** In contrast to the centralized scheme, we can envision a fully distributed session server architecture as shown in Figure 6.4. In this case we have a set of applications, and cluster several applications per session server. We again user local clients to communicate between the session server and the applications. The clients then provide local clusters of communications and the session servers allow for faster response and better cost efficiency. However, we have introduced a demand for a fully distributed environment for the session managers to work in a distributed operating system environment. As a further extreme, we could eliminate the clients altogether by attaching a session server per applications and allow for the distributed processing on a full scale.

Figure: Distributed Architecture

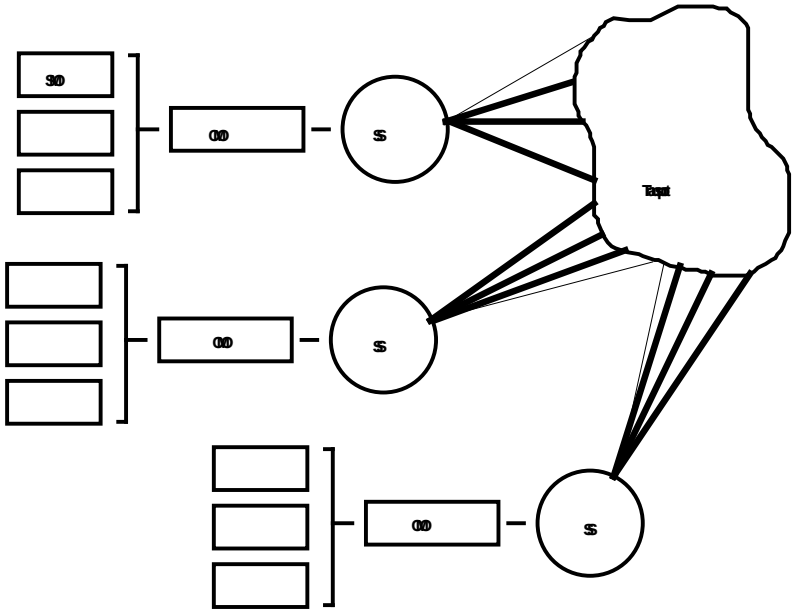


The major functions of the session server in its synch mode are:

- o To bind together simple objects into compound objects as requested by the application.
- o To provide intra object synchronization to ensure that all timing within each object is met.
- o To orchestrate amongst objects to provide inter object timing.
- o To minimize delay, slippage, between simple objects.
- o To minimize delay, latency, between different users.

To effect these requirements, we have developed and implemented a scheme that is based on a paradigm of the phased locked loop found in communications (See McGarty and Treves, McGarty). We show this configuration in Figure 6.5. Here we have a distributed session server architecture receiving a CMO from an application. The session server passes the message over several paths to multiple users. On a reverse path, each server passes information on the relative and absolute timing of the CMO as it is received using the session services primitives found in the OSI model. Generally for segmented BMOs this is a simple problem but with streamed BMOs this becomes a real time synchronization problem.

Figure: Synchronization Architecture



5.3.4 Event Management

Event Management deals with the overall end to end management of the session. It is more typically viewed as a higher level network management tool for multimedia communications. In the current sate this service is merely a reporting mechanism. Although ISO has expanded the network management functionality of the seven layers, most of the functionality is still that of event reporting. In this section we discuss how that can be expended for the multimedia environment.

Event management at the session layer provides for the in band signaling of the performance of the various elements along the route in the session path as well as reporting on the status of the session server and the session clients. We note that each entity in the session path, which is limited to all involved clients and all involved servers provide in band information on the status of the session. In particular the in band elements report on the following:

o Queue size at each client and server. The queue size can be determined on an element by element basis.

o Element transit and waiting time. For each element involved in a session, the time it takes to transit the entire block as well as the time that the block has been in transit can be provided.

o Session synchronization errors can be reported in this data slot. These errors can be compared to lower level errors and thus can be used as part of the overall network management schema.

The structure of the event management system has been effectively demonstrated. It is represented as a header imbedded in the transit of every data block. We can generate specific event management blocks that are also event driven and not data transit driven. These are generated by direct transmission of such blocks as overhead devoid of data content.

6. SEMIOTICS

The theory of semiotics is the theory of signs.[34] Umberto Eco, academician, leader in the field of semiotics, and author, has written several novels, one being the "Sign of the Rose". The novel is about the fourteenth century and about a murder in a monastery. The hero uses the signs that are left behind, the clues in common parlance, to play two roles. The fist is the common role of the clues to the murder mystery and the second as the signs to the change of the old guard to the new. It is at the steps of the Renaissance and the signs of most importance are the books of old knowledge. Thus Eco combines all elements of the deconstructionist, with those of the hermenuticist and those of the semioticist.

6.1 A Definition

Eco defines semiosis as;[35]

> *" Semiosis is the process by which empirical subjects communicate, communications processes being made possible by the organization of significant systems. Empirical subjects, from a semiotic point of view, can only be defined and isolated as manifestations of this double (systematic and processual) aspect of semiosis. ...Semiotics treats subjects of semiosic acts in the same way: either they can be defined in terms of semiotic structures or-from this point of view- they do not exist at all."*

The elements of semiosis comprises signals and signs. These Eco defines as:[36]

> *" We are now in a position to recognize the difference between a signal and a sign...as sign may be an expression system ordered to a content, but could also be a physical system without any...purpose. A signal can be a stimulus that does not mean anything...a sign is always an element of an expression plane... correlated to elements of a content plane."*

Specifically, Eco combines these as:[37]

> *"Semiotics is mainly concerned with signs as social forces."*

Semiosis is based upon the extension of Pierces concept of pragmatism. The Pierce view of pragmatism is presented by Copleston;[38]

> *" Pragmatism, as Pierce conceives it,...is a method of reflection having for its purpose to render ideas clear. ... Pierce divides logic into three main parts, the first of which is speculative grammar...concerned with the ...meaningfulness of signs. A sign...stands for an object to someone whom it arouses a more developed sign..the relation of significance, or the semiotic function of signs, is for Pierce...a relation between sign, object and interpretant."*

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[34]The Greek word semeion, is the word for sign; see De Saussure, p. 147, Taylor, Ed., Deconstruction in Context.

[35]Eco (Semi, p316)

[36]Eco (Semi, p 48)

[37]Eco (Semi, p 65)

[38]Copleston (HOP, 8-II p65)

The issue of semiosis as a carrier of information is also embedded in the issue of a code. eco defines this as follows:[39]

> *"..a code establishes the correlation of an expression plane with a content plane...a sign-function establishes the correlation of an abstract element of the expression system with an abstract element of the content system...a code establishes general types.. producing the rule which generates concrete tokens...both ...represent ...the semiotic correlation and with which semiotics is not concerned.."*

The most descriptive distinction of what semiosis does in comparison to hermeneutics is best described by Eco:[40]

> *"In order to understand the history of Christian theology, it is not necessary to know whether a specific actual phenomenon corresponds to the word, transubstantiation, ... it is necessary to know what cultural unit ... corresponds to the content of that word.*
>
> *The semiotic object of a semantics is the content, not the referent, and the content has to be defined as a cultural unit.."*

The totality of semiosis is its ability to combine its constructs with all elements of signals and signs. [41]

> *"...semiotics has been provided with a paramount subject matter, semiosis. Semiosis is the process by which empirical subjects communicate, communications processes being made possible by the organization of significant systems. Empirical subjects, from a semiotic point of view, can only be defined and isolated as manifestations of this double... aspect of semiosis. ... Semiotics treats subjects of semiosic acts...either they can be defined in terms of semiotic structures of-- from this point of view -- they do not exist at all."*

Eco has demonstrated the semiotic content in many disciplines. The following table is a summary of these results.[42]

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[39]Eco (Sem, p 50)

[40]Eco (Sem p 62)

[41]Eco (Sem p 316)

[42]Eco, pp. 9-14

Table: Semiotic Correlates

Area	Implications
Zoosemiotics	
Olfactory Signs	
Tactile Communication	
Codes of Taste	
Paralinguistics	
Medical Semiotics	
Kinesics and Proxemics	
Musical Codes	
Formalized Languages	
Written Languages	
Natural Languages	
Visual Communications	
Systems of Objects	
Plot Structure	
Text Theory	
Cultural Codes	
Aesthetic Text	
Mass Communications	
Rhetoric	

We can now develop some of the basis theory of semiotics as presented by Eco. We start with a set of definitions and then discuss some of the implications.

Expression Plane: This is the plane of understanding in which one creates meaning through and abstract expression. In physics, for example the expression plane may state the following:

$$\frac{\partial^2 E(x,t)}{\partial^2 t} = \frac{1}{c^2}\nabla^2 E(x,t)$$

This expression is the expression for the propagate of light or any other electromagnetic wave in free space. Another example is the composition of a gene;

{ATTGTAAGCCGGATTTTC}

This is a set of nucleotides that imply their complements on the opposite side of the DNA pair. This sequence means a great deal to a molecular biologist. They may imply blue eyes, green wings, or red flowers. Both of these items are in the expression plane.

Content Plane: The plane in which one creates meaning through concrete expressions expressed in a continuum of actions in the physical world. Simply put, it is everything that you can think about it..

Let us take the propagation equation. This may be the expression of a rainbow. The content plane is the rainbow and the full panoply of what it evokes. It is macro and micro in its expression. It is the emotion that it may evoke leading to poetry, the grandeur it mat evoke in nature and whatever else may do.

In the genetic case it is the fullness of the expression of the gene and its characteristics. It is the expression of what green eyes may have and the human emotions that they may evoke.

In the case of multimedia, we design and implement our systems in the expression plane. We express the in the content plane to ourselves as persons. The design problem will then be to connect the expression and content planes effectively.

Sign: An element of the expression plane correlated to an element of the content plane. It is a correlation recognized by the human.

Signal: A pertinent unit of a system that may be an expression system ordered to a content, or could be a physical system with no semiotic purpose. Units of transmission which can be computed quantitatively irrespective of their respective meaning.

Sign-Function: A relationship between system on E/C Planes, "Expression/Content".

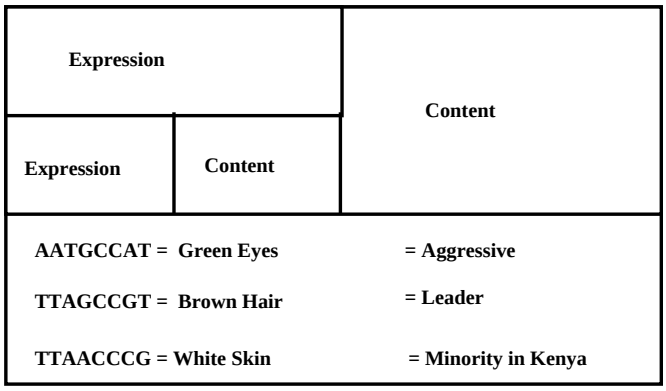
Token: Types are generated by a code.

Token-Sign: Relation between units on E/C planes.

Type: Code generates types producing a rule which generates concrete tokens.

Code: Establishes general types, therefore producing the rule that generates tokens.

Connotative Relationships: A concatenation of the E/C plane such as shown below;



This example demonstrates the concatenation possible between the Expression and the Content and how content may be concatenated upward itself. Eco makes this example one step further when he states:[43]

> *"Semiotics is mainly concerned with signs as social forces"*

6.2 Semiotic Application

As we have defined the semiotic approach it deals with the signs or externalities of the process of communications. In the multimedia world these externalities are the elements themselves, the data objects, the storage objects and the actual human interaction with devices. All are signs.

Signs are means by which we relate from one plane upward to another. Signs in the multimedia world focus on relating from the image and the test and the voice segment to the determination of the diseased state. The design problem fro the multimedia semiotician then is to go from expression to content. The design problem for the seomiotic architect is the opposite; from the content to the expression plane. How, does the semiotic multimedia architect ask, does one ensure that the expression of the multimedia system contain adequate elements to reflect the process in reverse and ensure the commonalty of expression by the richness of the expressionist?

[43]Eco, p. 65.

6.3 The Multimedia Database; A Semiotic Example

We shall use the multimedia design problem of the database as a starting point in the application of semiotic theory to the design of the system from an architectural perspective.

In a more standard computer communications environment, the data objects have significant structure and they are frequently integrated into a system wide data base management system that ensures the overall integrity of the data structures. In a multimedia environment, the data elements are more complex, taking the form of video, voice, text, images and may be real time in nature or can be gathered from a stored environment. More importantly, the separate data objects may combined into more complex forms so that the users may want to create new objects by concatenating several simpler objects into a complex whole. Thus we can conceive of a set of three objects composed of an image, a voice annotation and a pointer motion annotating the voice annotation. The combination of all three of these can also be viewed as a single identifiable multimedia object.

Before commencing on the issues of communications, it is necessary to understand the data objects that are to be communicated. We can consider a multimedia data object to be composed of several related multimedia data objects which are a voice segment, an image and a pointer movement (e.g. mouse movement). As we have just described, these can be combined into a more complex object. We call the initial objects Simple Multimedia Objects (SMOs) and the combination of several a Compound Multimedia Object (CMO). In general a multimedia communications process involves one or multiple SMOs and possibly several CMOs.

The SMO contains two headers that are to be defined and a long data sting. The data string we call a Basic Multimedia Object (BMO). There may be two types of BMOs. The first type we call a segmented BMO or SG:BMO. It has a definite length in data bits and may result from either a stored data record or from a generated record that has a natural data length such as a single image screen or text record. We show the SMO in Figure 21..

Figure: SMO Structure

The second type of BMO is a streamed BMO, ST:BMO. This BMO has an a priori undetermined duration. Thus it may be a real time voice or video segment.

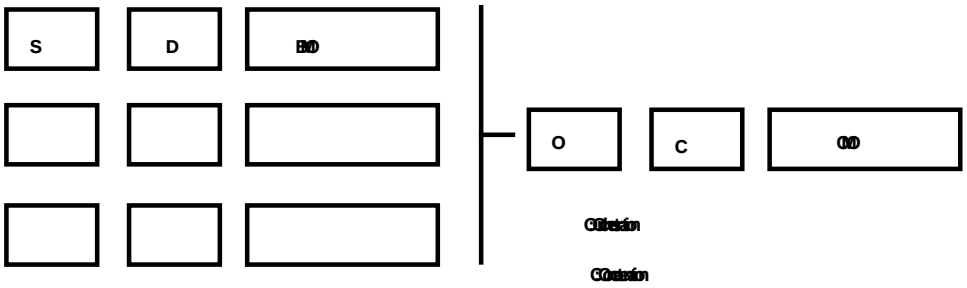
A simple multimedia object, SMO, is a BMO with two additional fields; a Synchronization field (Synch) and a Decomposition field (Decomp). Figure 2.1 depicts the SMO structure in detail. The Synch field details the inherent internal timing information relative to the BMO. For example it may contain the information on the sample rate, the sample density and the other internal temporal structure of the object. It will be a useful field in the overall end to end timing in the network.

The second field is called the Decomp field and it is used to characterize the logical and spatial structure of the data object. Thus it may contain the information on a text object as to where the paragraphs, sentences, or words are, or in an image object, where the parts of the image are located in the data field.

These fields are part of an overall architecture requirement finds it necessary to provide an "out-of-band" signaling scheme for the identification of object structure. The object structure is abstracted from the object itself and becomes an input element to the overall communications environment. Other schemes use in-band signaling which imbeds the signal information with the object in the data stream. This is generally an unacceptable approach for this type of environment.

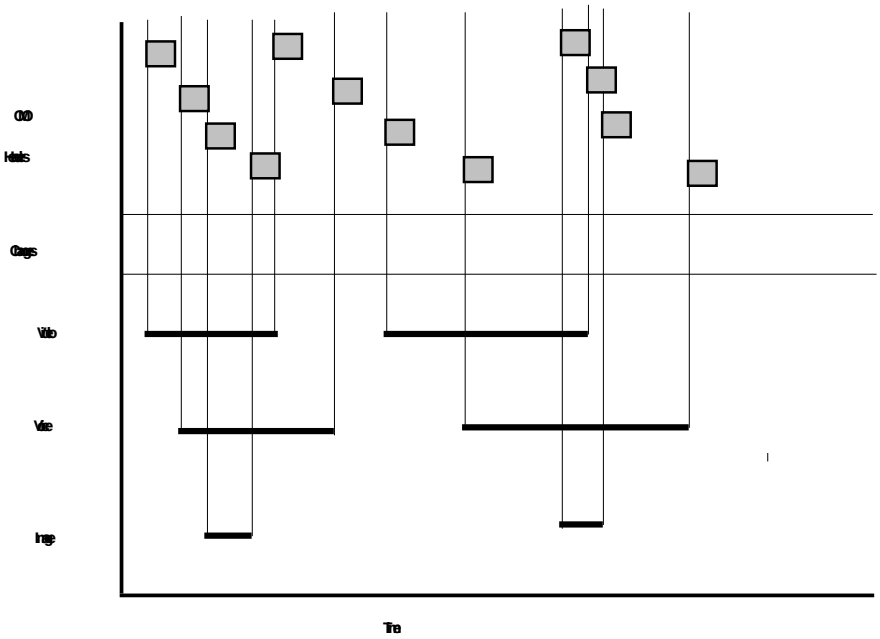
When we combine these objects together we can create a compound multimedia object. This is shown in Figure 2.2. A CMO has two headers, the Orchestration header and the Concatenation header. The Orchestration header describes the temporal relationship between the SMOs and ensures that they are not only individually synchronized but also they are jointly orchestrated. The orchestration concept has also been introduced by Nicolaou. In this paper we further extend the orchestration function beyond that of Nicolaou. The concatenation function provides a description of the logical and spatial relationships amongst the SMOs.

Figure: CMO Structure



These concepts have been further developed in McGarty[2] and there we have provided more detailed structure to the multimedia data objects. We can now add dynamics to this process and we show this in Figure 2.3. In this Figure we show first the real time display of video, voice, image, pointer and text. In the Figure we depict the time that these object are involved in the system dynamics. We then also plot the times that the CMO, the concatenation of all simultaneous objects, change in this system. In Figure 2.5 we depict 21 change element. Then we also show the CMO headers that are flowing in the network at each change interval. It is this dynamic process of data elements that must be controlled by the session layer to be discussed in the next session.

Figure: Temporal Interaction of CMOs



We can also expand the concept of a CMO as a data construct that is created and managed by multiple users at multiple locations. In this construct we have demonstrated that N users can create a CMO by entering multiple SMOs into the overall CMO structure.

The objectives of the communications system are thus focused on meeting the interaction between users who are communicating with CMOs. Specifically we must be able to perform the following tasks:

o Allow any user to create an SMO and a CMO.

o Allow any user or set of users to share, store, or modify a CMO.

o Ensure that the user to user communications preserves the temporal, logical and spatial relationships between all CMOs at all users at all times.

o Provide an environment to define, manage and monitor the overall activity.

o Provide for an environment to monitor, manage and restore all services in the event of system failures or degradation.

We shall see in the next section that the session layer service address all of these requirements.

7. CONCLUSIONS AND OBSERVATIONS

We have introduced a new paradigm of viewing information and have developed a world view to place that construct in. The construct tries to relate the human interface problem and the structure of both information and knowledge of events into a single schema. We have addressed the issue of what is multimedia communications, what are the elements of the design process in this new medium, what are the design dictates of the total environment, and what rules for design can be abstracted from the change in the experience in interacting with media.

Whatever the ultimate design factors that may evolve, there are certain obvious design observations that can be made based upon the current understanding of the multimedia area. We must consider that in designing in a multimedia world we are doing so in a distributed service environment. It is not a manufacturing business where the product is assembled in a factory under the control of the owner and where quality can be carefully maintained and managed. It is a service assembled in the hands of a user in an environment that is neither predictable nor constant. Thus the design challenge is to incorporate the stochastic nature of the shared user environment.

To this end there are several design rule that have evolved in the process of understanding such systems. Specifically:

o The next step should always be obvious.

Whenever designing a multimedia system, the presentation to the user, through whatever senses, should clearly indicate what the next step should be. Where should I type next, where can I place the pointer, which device do I use, what should I say? All too often designers let the user have the freedom to create. This results in ambiguity, frustration and visual, aural and tactile dissonance.

o Form matches function.

What are we using the system for and why. What is the function and the form of the system should match the function that it has been designed for.

o There should be consistent paradigms.

When the system is designed to edit images, the editing tools should be the same in all configurations. The access mechanisms, if they are on the left should always be on the left.

o Execution should be smooth.

Tactile and visual dissonance are common factors in poor design. A smooth design should be such as to enhance the conversationality mode of the session.

o The question should always be obvious.

State what you want. The statement should be clear and not allow for any secondary interpretation. If the question is complex, then it should be broken down into smaller segments and simpler questions. To paraphrase Wittgenstein, the essence of true understanding is the ability to pose the question in such a way that the answer is clearly yes or no.

o The answer should always be obvious.

When answering a question, the answer should always be clear and obvious. Again if a complex answer is to be presented it too should be segmented.

o There should be no ambiguity of expectations.

The users and the designer should have the same set of expectations for the deployment of the system. "I never thought they would do that with it!" is a common complaint. If all else fails, listen to the customer, user, etc.

If we can develop systems that follow these guidelines in all of there dimensions, than there should be a smooth road to transition in the multimedia area.

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