Session Layer Protocols:

Facilitating Multimedia Applications

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Abstract

This paper presents a proposal for the development of a session layer based multimedia communications system to support a wide variety of multimedia services. This architecture is deployable to a wide variety of transport platforms. The uniqueness here is that the overall deployment would be via some form of applet dissemination. The session approach here is dramatically different than anything in the SIP or IMS space, which is derivative of telephone architectures. In fact, this approach is counter to those approaches which have been argued to become roadblocks controlled by the incumbent carriers. This session layer approach contained herein is an open architecture.

Contents

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1. INTRODUCTION

Multimedia communications has been evolving over the past twenty to thirty years. There is a question as to what constitutes such communications and we have addressed that at length in previous papers[2]. In this paper we look at multimedia communications in a broad and expansive manner. It is a multi user, multi location, multi media environment where all of the users are attempting and seeking to establish what would have occurred had they been at the same place at the same time. Simply it is a displaced reality of the moment.

The architecture of the protocols described herein are for the provision of multimedia-multiuser-multilocation simultaneous communications over a broadband network. We focus on the development of a session layer approach. In contrast to such recent attempts, using SIP and IMS, the approach herein avoids any of the limitations of these other approaches. SIP and IMS were developed to deal with telephony transitions to an IP based platform. In contrast we have focused on a session layer which is transport independent. Albeit functioning with an IP based platform, it can work across a wide variety of such platforms[3].

The architecture developed herein is designed so as to:

1. *Comply with common standards*
2. *Function using existing standards*
3. *Operate over a broad base of communications fabrics; wire and wireless*
4. *Allow applications developers to utilize the resources found in the architecture elements as a common interface*
5. *Act as an overall multimedia distributed operating system looking at the network as a bus*

1.1 Why The Session Layer

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 general categories[4]:

1. **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

[2] See McGarty, Multimedia Communications.

[3] We have developed a similar approach recently in our work on wireless access. See McGarty, Alternative Wireless Architectures, 2005.

[4] See Stallings, discussion on the session layer.

determines the protocol of who talks when and how this control of talking is passed from one user to another.

2. **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".

3. **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 objects is maintained throughout.

4. **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.

Here we have shown the session entity which is effectively a session service server. The entity is accesses from above by a Session_Service Access Point (S_SAP). The session entities communicate through a Protocol Data Unit (PDU) that is passed along from location to location. Logically the session server sits atop the transport server at each location.

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.

1.2 Session Structures and Paradigms

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.

1. *Session takes multimedia data objects such as video, data, voice, image from multiple users and creates a conversational and collaborative environment for the users*

2. *Session Applications Development Environment, ADE, allows developers a common interface to "feed" multimedia data objects into the network and ensure that they are coordinated*

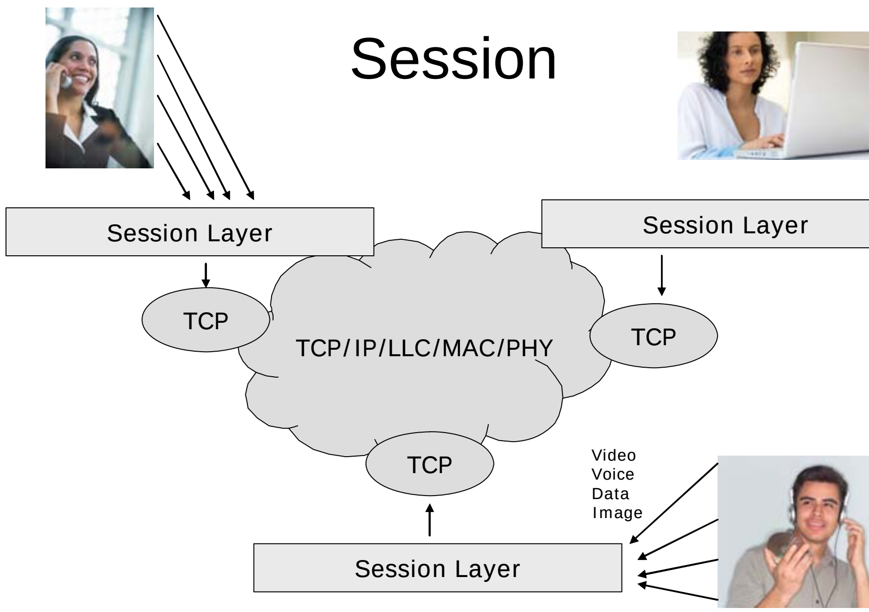
3. *Whereas TCP ensures a one to one connection, Session ensures a many to many to many connection; many users to many users with many multimedia objects*

4. *Session builds on TCP/IP by putting intelligence at the edge of the network*

5. *"Natural Location": The Session layer sits above TCP which is a natural end to end layer and Session allows for control of multi user to multi user multi-media communications. Cannot readily be done at any lower layer*

6. *Requires No Standard or ASIC Development: This is a software approach which can readily be shared amongst users not requiring establishment of standard and production of ASICs*

The construct is shown diagrammatically below.



Notice in the above caricature of the session protocol it creates an environment between and amongst multi users and with multi media elements. It sits atop of the TCP/IP stack in this example and manages the establishment and operations of the session. There may also be means for establishing sub-sessions and super-sessions as well.

2. MULTIMEDIA

"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.

2.1 Multimedia Definition

Multimedia communications is characterized by the following factors:

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

2. *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.*

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

4. *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."

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

1. *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.*

2. *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.*

3. *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.*

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

5. *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.*

6. *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.

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 paper is primarily commercial. 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. Many companies have learned the hard way that such a point replacement is unacceptable. The system that they have developed have had had limited acceptance. The systems are 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.

3. MULTIMEDIA DATA OBJECTS

We must first consider the structuring of multimedia data objects. The work on SIP and IMS generally fail to consider that they are multimedia objects with their complex structures in space and time. When working in a multimedia environment we essentially take samples of each of the media elements create by all parties in this interaction and we then break them apart and then reassemble them. We have a form of displaced conversationality. The displaced conversationality requires that we create an artificial environment of sameness, of a sense that all parties, all entities, are sharing the same nowness and presence as they would if indeed they were at the same place at the same time.

Thus we characterize Multimedia objects as;

1. *Multimedia data objects are shared amongst multiple users at multiple locations*

2. *This is NOT the TCP/IP problem, it is much more!*

3. *The objects are like instruments in an orchestra, then need some form of orchestration, otherwise cacophony; the orchestra leader is the Session layer approach we take.*

4. *This is NOT the classic approach. TCP/IP is for user to user transport of data packet; it does not enable orchestration demanded by true multimedia.*

5. *Cerf (Internet System, Lynch & Rose, 1993, p.83) totally ignores session layer in his architecture. Focus is on email delivery! World Views are critical!*

6. *That was 5 years after we had already developed first Session Layer for multimedia!*

3.1 BMO

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.

- The basic data string we call a Basic Multimedia Object (BMO).

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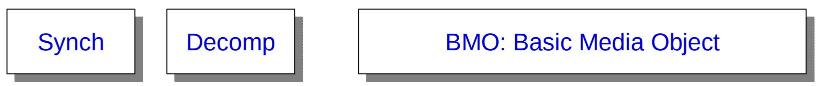
  - The second type of BMO is a streamed BMO, ST:BMO. This BMO has an a priori undetermined duration. Thus it may be a real time voice or video segment.

Basic Media Object



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.

3.2 SMO

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.

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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. 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.

SMOs are characterized as follows:

1. A simple multimedia object, SMO, is a BMO with two additional fields; a Synchronization field (Synch) and a Decomposition field (Decomp).

2. 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.

3. The Decomp field 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.

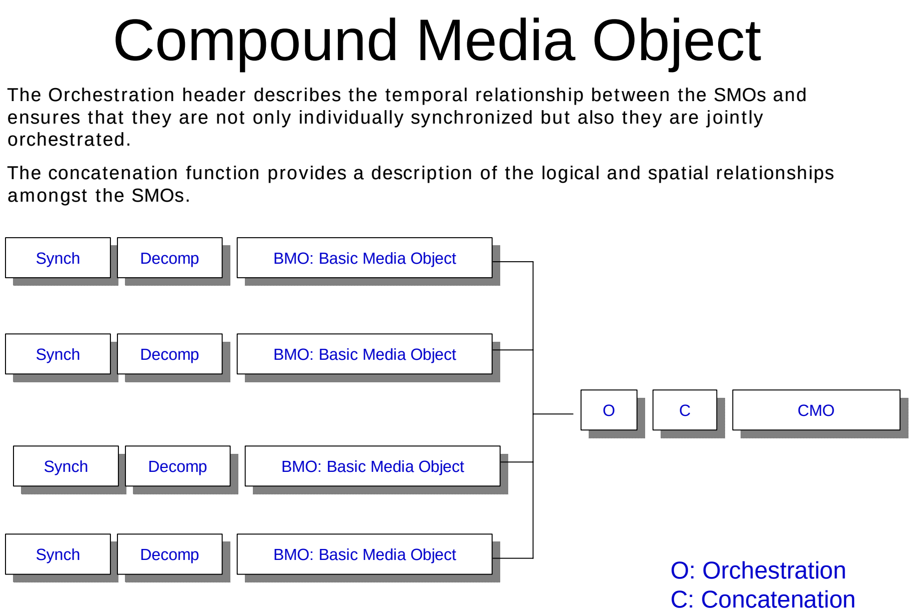
3.3 CMO

In contrast a Compound Multimedia Object can be characterized as follows:

1. A CMO has two headers, the Orchestration header and the Concatenation header.

2. 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.

3. The concatenation function provides a description of the logical and spatial relationships amongst the SMOs.



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:

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

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

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

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

5. 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.

4. SESSION LAYER

The session layer is characterized as follows:

1. Session takes multimedia data objects such as video, data, voice, image from multiple users and creates a conversational and collaborative environment for the users

2. Session Applications Development Environment, ADE, allows developers a common interface to "feed" multimedia data objects into the network and ensure that they are coordinated.

3. Whereas TCP ensures a one to one connection, Session ensures a many to many to many connection; many users to many users with many multimedia objects

4. Session builds on TCP/IP by putting intelligence at the edge of the network

4.1 Basic Objectives

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:

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

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

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

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

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

4.2 Session Functions

This section presents a summary of the key session layer functions.

4.2.1 Object Management:

Object Management is the management of the BMO, SMO and CMO in a real time manner.

1. **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.

2. **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.

3. **Synchronization**: 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 objects is maintained throughout.

4.2.2 Flow Management

Flow management is a high level session function which assures that all of the users and all of the elements are transported in a manner and quality as specified. It sits atop TCP and does what TCP does for multimedia objects in the fully distributed environment controlled by the session layer.

1. **Media Selection:** This control elements is set to ensure quality of the media element being sent.

2. **QoS:** The QoS can be sent to ensure delay and thruput as may be required. It may also enable such IP based functions as header compression.

4.2.3 User Management

User management is simply the session function which controls the user entry, control, and exit from a session. The following details the key functions covered by user management.

1. Listing: A listing of all users by IP address. This is a dynamically reconfigurable list.

2. Change List: To minimize user identification the list is updated by adds and drops.

3. Verification and Authentication: Each user is verified and authenticated.

4. Security: There is a security level on a per users and per group basis.

5. Priority: Each user has a priority level.

6. Type: This specifies the type of user

4.2.4 Layer Controls

Layer control is the function which may be considered a bit different for this session layer protocol. It established in one control element all of the trans layer control functions. It is considered critical in this development of a session layer protocol to ensure that for the quality of service required that the session layer can reach down the protocol stack and stipulate a set of possibly critical parameters which will ensure the anticipated service quality. It also provides data up to the service layer stack for the management and control of the network.

1. **TCP Control:** This controls flow to TCP elements to manage delays and thruput which may be media dependent.

    a. Push
    b. Urgent
    c. Flags
    d. Delay Control

2. **IP Control:** This is the IP element which also controls router features and functions such as QoS and routing tables.

    a. Header Compression
    b. MPLS Control
    c. Router Table Control

3. **MAC Layer Control:** The MAC layers can be controlled via Session layer such as RTS/CTS suppression.

    a. RTS/CTS
    b. others

4.2.5 Resource Management

Resource management control is a higher layer management control function. It manages three key elements; media, router and events. They are described below:

1. Media Flow Control: Multimedia flow control at the session layer for multiple media elements can be managed via this mechanism.

2. **Router Management:** The ongoing router management can be controlled via Session layer control elements.

3. **Event Management:** The monitoring of performance, isolation of problems, and restoration of service is a key element of the session service.

5. COMPARISON TO OTHER PROTOCOLS

There are several other protocols which are contending to be used in this environment. We look at two; SIP and IMS. The development of these protocols was an evolution of IP telephony and the need to enable the SS 7 services found in the classic telephone network. IP telephony initially needed to interface with SS 7 to provide overall end to end control and support all services which the classic telephone network provided, such as number identification and three party calling[5].

The following Table depicts a comparison of the three; the session layer contained herein, and SIP and IMS.

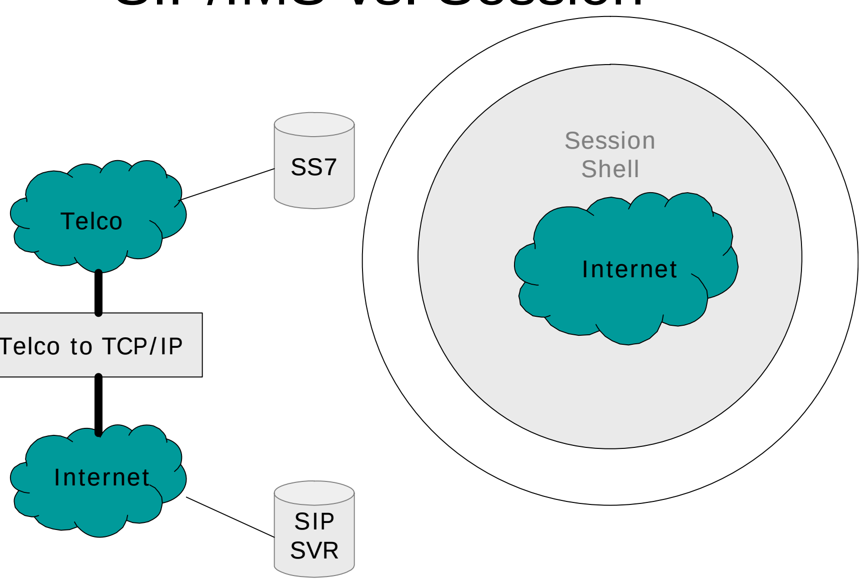
[5] See McGarty, IP Telephony, 1996. It is interesting that this paper and a few others were criticized by Internet types because the author raised the issue of SS 7. The Internet types in 1996 had no clue what these services were. The development of H.323 and similar IP telephony protocols tried to implement telephony but it fell short. The author deployed one of the first global IP voice networks in 1996, however, it required an SS 7 interface. Those who did not understand telephony fell far from the mark, The development of SIP and IMS then led to the deployment of SS 7 like services.

Session vs. SIP & IMS

	Session	SIP http://www.sipcenter.com/sip.nsf/index	IMS
End User Agents	Persons	Processors	Processors
Initial Apps	Session Layer for all multimedia	IP Version of SS7	Same as SIP
Location	Edge of TCP/IP cloud	In cloud	In cloud
Lower Layer Control	Yes	No	No
Approach	Proprietary Acts as operating system	Standard IETF Acts like SS7 interface	Standard IETF Acts on top of SIP
Deployment	applets	IP integrated with servers	IP integrated built on SIP

As we have stated elsewhere, SIP and IMS are telco based and are implementations of SS 7 functionality. We depict this construct in the Figure below. This is a key construct. SIP and IMS, albeit a "multimedia" protocol are totally deficient in actually focusing on any of the true multimedia elements which we describe herein. The protocols are point to point, like a TCP protocol. They are not focused on session multiple user sets. They also look ate data objects which are SS 7 like services. Finally they were really developed to support the mobile phone environment and the service development in that world.

SIP/IMS vs. Session



Waclawsky has stated the following in criticizing IMS:

"Besides granting network operators the ability to control and monitor Internet usage, IMS could have undesirable economic effects as well. In developing countries, where wireless Internet access is known to provide an economic, social and educational leg-up, operators could find that IMS cost and complexity reduce their ability to serve the public (see www.w2i.org/pages/wificonf0603/ index.html)."

He then goes on to show his ten reasons for why he sees IMS not being successful:

1. IMS Is Based On Shaky Premises
2. IMS Will Be Too Complex, Difficult And Expensive To Implement:
3. Wireline Carriers Won't Like IMS:
4. IMS Doesn't Really Support Infrastructure Convergence:
5. IMS Complexity Requires Built-in OAM:
6. IMS Won't Be Able To Control Existing Internet Usage:
7. IMS Doesn't Do IP properly:
8. IMS Doesn't Use SIP Properly:
9. IMS Users Will Not Feel Secure:
10. Propping Up The Failing Telco Model Is Not The Way To Go:

He then goes on to details his argument. This paper is a very persuasive argument for why there is a true need for a session layer protocol as we have developed herein. In addition, and this is par of Waclawsky argument, the reason for implementing SIP and IMS is to control user access to content. This is another was to manage the Internet Neutrality debate[6].

6. DESIGN GOALS

We can states several key design goals for the development of any set of session lever protocols. Specifically in any multimedia environment we should observe the following simple design goals:

1. **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.

2. **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.

3. **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.

4. **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.

5. **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.

[6] See McGarty, Internet Neutrality, 2006. This is a very key concern. SIP and IMS allows for the management of content access and content quality. It gets in the middle of the protocol stacks.

6. **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.

7. **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.

7. SESSION LAYER DESIGN

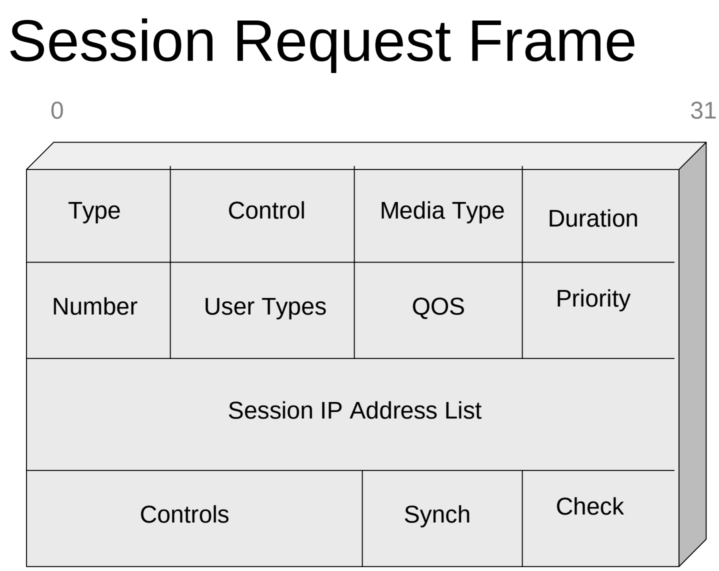
This section presents a proposed detailed session layer design. It contains a frame structure and associated fields. It also suggest but does not detail the finite state machines which embody each of the field operations and states.

7.1 Session Frame Structure

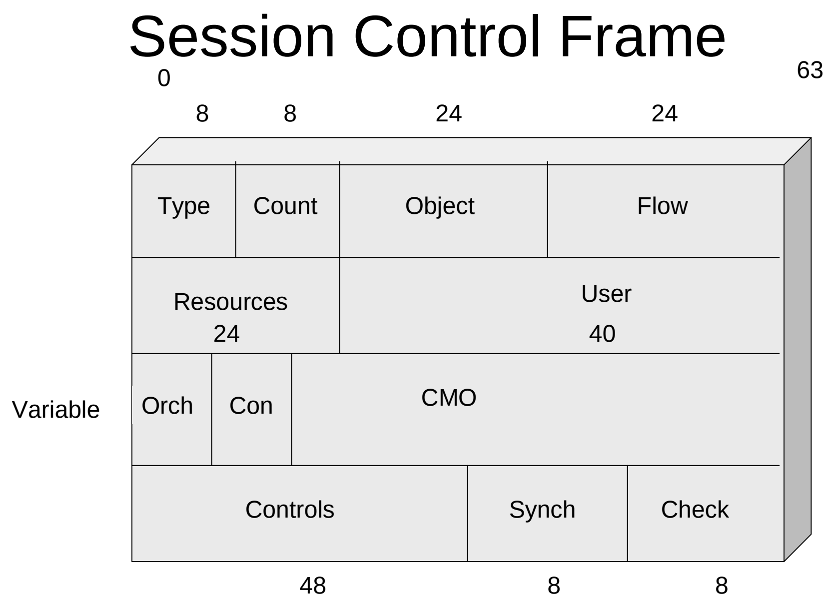
The session frame structure is proposed in this section.

We first show a Session Request Frame, SRF, and then the Session Control Frame, SCF. This is shown below. The SRF is the frame element which is used to establish a session request. The session layer approach we suggest herein is not a protocol which rides on top of every packet. We try to avoid any additional overhead. It is an event driven protocol, and events can be anticipated and managed. The protocol proposed is to be used to establish the communications of multimedia elements between multiple users or agents. As such it must establish that seamless interconnection of the multimedia data objects.

We have tried to make this protocol transparent to the lower layer protocols. However, there is a trend to allows trans layer communications. We shall show this as well in the development of the overall protocol suite.



The SCF is the key frame structure we developed in this paper. The SCF is shown below. We see that this frame structure is used on an ongoing basis when we establish such a multimedia multi-user communications environment. It is used to manage that environment on an event by event basis.



We now break out each key element of the SCF as we have presented it above.

7.2 Object Frame

The object frame contains the following sub-elements:

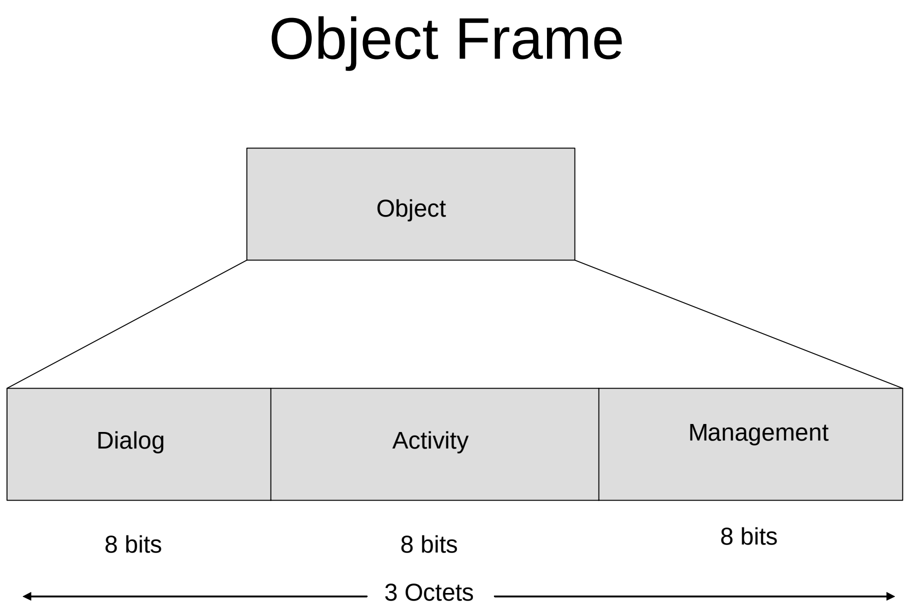
1. Dialog: This set of bits is communicated between all members of the session and establishes the type of dialog to be used. It also manages the dialog. Part of the frame is dialog specific and the remainder relates to dialog change.

2. Activity: Similar to Dialog but at the activity level.

3. Management: The Management field provides a facility to ensure overall end to end management of the session.

The Object frame structure is shown below. The frame enables the communications between and amongst the multiple users. We have developed various state mechanism for the management of a dialog and an activity[7]. There are many which exist also in the literature.

[7] See McGarty, Session Management, 1989.



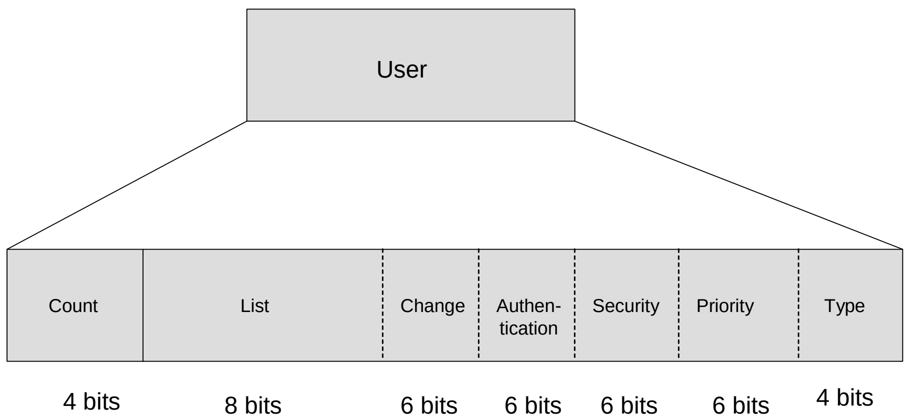
7.3 User Management Frame

The management frame is a key frame in the overall deployment. It provides a top level control over the session. Its functions are shown below:

1. Count: This is the count of participants in the session
2. List: this refers to the list of participants. The system must be able to account for them on a shortened list basis
3. Change: This specified changes between event driven messaging for session control
4. Authentication: Specifies the authentication type and number
5. Security: specifies security level required and details on security
6. Priority: specifies various priority domains and protocols for session use
7. Type: characterizes the type of session

Each of these functions are implemented by their own finite state machine implementation. For example, the authentication function authenticate users and objects. This may be accomplished with headers or via a more complex methodology. The same is the case with security and priority.

User Management Frame



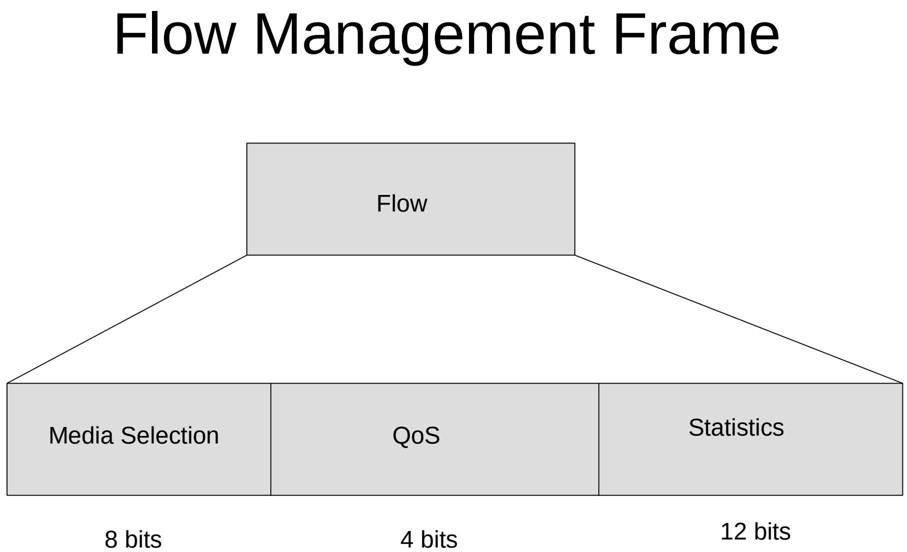
7.4 Flow Management Frame

Flow management control is an overall common control set of functions which manage the session and provide the NOC or similar data collection and management entity with the needed data.

1. Media: This specifies the types of media involved at this segment of the session and each session participant can then infer the level o QoS demanded

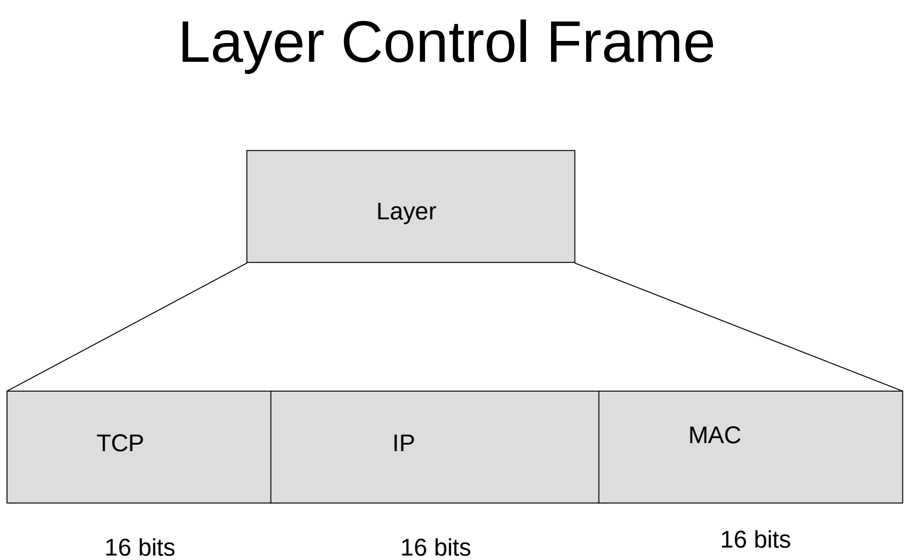
2. QoS: This specifies to the network and the session participants the desire QoS. Together with the Statistics frame element end to end session management can be controlled

3. Statistics: This set of bits characterizes the overall performance of the session at the highest level and can be used to establish alarms. The session maps the alarms into a set of session performance states



7.5 Layer Control Frame

The layer control provide trans-layer communications to effect end to end control optimization. It does so on a layer by layer basis. This flows down and across layers.



7.6 Resource Management Frame

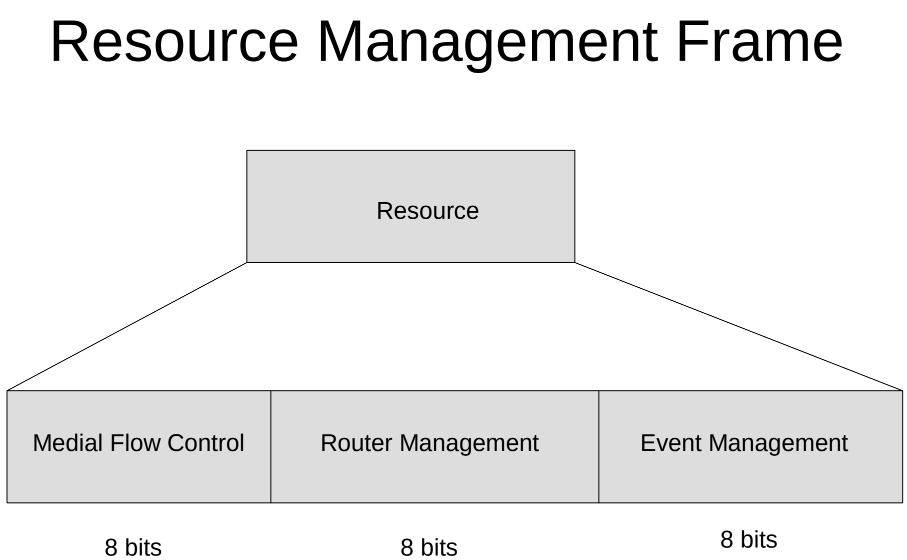
Resource management controls three key elements. They are:

1. Media Flow Control: Establishes nature of flow of media objects from set of established control schemes

2. Router Management: Provides trans layer control to and from routers to determine network utilization and in return manage flow effectiveness across the network

3. Event Management: (i) Used to manage events on the network. (ii)Part of NOC functionality, and (iii) Establishes control over SNMP flow

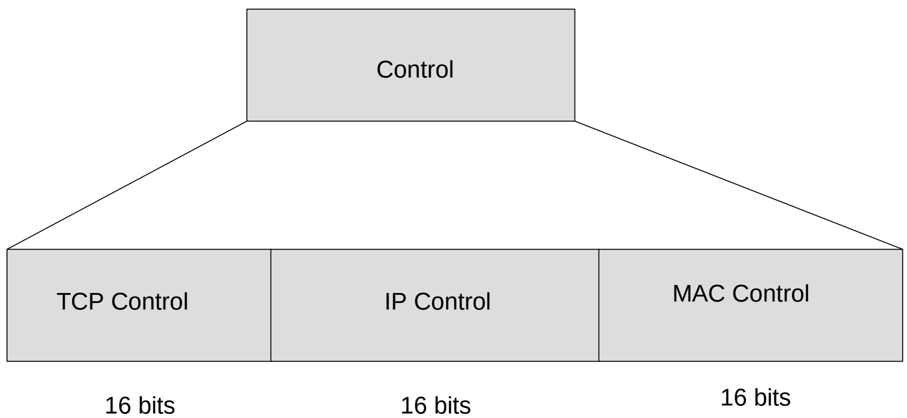
The frame is shown below.



7.7 Control Frame

These are the sub layer control elements as is common. This layer send commands down the stack to the lower layer elements. We show the three prototypical below:

Control Frame



8. CONCLUSIONS

What we have shown in this paper is that the session layer functions are key to supporting the overall needs of a multimedia communications environment. We have also developed algorithmic approaches for dialog and synchronization services and have shown that these services depend upon the lower layers for support. Specifically, we have shown that if the underlying communications network is jittery in the packet transport provided, the resulting delays associated with the synchronization process can be significant.

Architecturally, we have raised several issues as to how best to provide the session service, specifically where to place and how to communicate with a session server. The session services require considerable entity to entity communications and this may require a distributed environment of session servers all functioning in a fully distributed mode. In many of the network applications developed to date the session server has been centralized and has allowed for communications in a distributed fashion on a UNIX environment using sockets. However, in future implementations, the session server will be architects in a more distributed fashion.

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10. APPENDIX A SESSION PRIMITIVES

- S-CONNECT.request(identifier,callingSSAP, calledSSAP,qualityofservice, requirements,serialnumber,token,data)
- S-CONNECT.indication(identifier,callingSSAP, calledSSAP,qualityofservice, requirements,serialnumber,token,data)
- S-CONNECT.response(identifier, calledSSAP,result,qualityofservice, requirements,serialnumber,token,data)
- S-CONNECT.confirm(identifier, calledSSAP,result,qualityofservice, requirements,serialnumber,token,data)
- S-DATA.request(data)
- S-DATA.indication(data)
- S-Expedited-Data.request(data)
- S-Expedited-Data.indication(data)
- S-Typed-Data.request(data)
- S-Typed-Data.indication(data)
- S-Capability-Data.request(data)
- S-Capability-Data.indication(data)
- S-Token-Give.request(Tokens)
- S-Token-Give.indication(Tokens)
- S-Token-please.request(Token,data)
- S-Token-Please.indication(Token,data)
- S-CONTROL-GIVE.request
- S-CONTROL-GIVE.indication
- S-Sync-Major.request(Type,serialnumber,data)
- S-Sync-Major.indication(Type,serialnumber,data)
- S-Sync-Major.response(serialnumber,data)
- S-Sync-Major.confirm(serialnumber,data)
- S-Sync-Major.request(serialnumber,data)
- S-Sync-Major.indication(serialnumber,data)
- S-Sync-Major.response(data)
- S-Sync-Major.confirm(data)
- S-Resynchronize.request(type, serialnumber,tokens,data)
- S-Resynchronize.indication(type, serialnumber,tokens,data)
- S-Resynchronize.response(serialnumber, tokens,data)
- S-Resynchronize.confirm(serialnumber, tokens,data)
- S-P-Exception-Report.indication(Reason)
- S-U-Exception-Report.request(Reason,data)
- S-U-Exception-Report.indication(Reason,data)
- S-Activity-Start.request(activityid,data)
- S-Activity-Start.indication(activityid,data)
- S-Activity-Resume.request(activityid, oldactivityid,serialnumber,oldsessionconnectionid,data)
- S-Activity-Resume.indication(activityid,)
- S-Activity-Interrupt.request(reason)
- S-Activity-Interrupt.indication(reason)
- S-Activity-Interrupt.response
- S-Activity-Interrupt.confirm
- S-Activity-Discard.request(reason)
- S-Actvity-Discard.indication(reason)
- S-Activity-Discard.response
- S-Activity-Discard.confirm
- S-Activity-End.request(serialnumber,data)
- S-Activity-End.indication(serialnumber,data)
- S-Activity-End.response(data)
- S-Activity-End.confinn(data)

- S-Release.request(data)
- S-Release.indication(data)
- S-Release.response(result,data)
- S-Release.confinn(result,data)
- S-U-Abort.request(data)
- S-U-Abort.indication(data)
- S-P-Abort.indication(reason)