DSM-CC for World Wide Applications

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Abstract - DSM-CC (Digital Storage Media - Command and Control) is a very recent ISO/IEC standard developed for the delivery of interactive multimedia broadband services. This paper develops two themes of DSM-CC and explores issues related to its applicability to World Wide use. The first theme is that of Sessions and Resource control: tracking and controlling all resource usage goes against the prevailing approach of the Internet but will, we advocate, be required if quality of service is to be guaranteed effectively. The second theme is effect on distributed computing models of downloadable *Information Appliances* and network resource control. In this model the acquisition of an object reference also becomes the acquisition of the network resources needed to use the object's operations. Finally we suggest areas of further work.

DSM-CC Background

DSM-CC (Digital Storage Media - Command and Control) is a standard being developed by ISO SC29/WG 11, the MPEG working group [1]. It is currently at the Draft International Standard (DIS) stage and is expected to become a full International Standard in July 1996. DSM-CC provides protocols for the delivery of interactive multimedia services over broadband networks. The primary target its developers had in mind is residential broadband networks offering *Interactive TV:* the delivery of digital video though a Set top box (STB) with a back channel to give interactivity, and to realize such services as Video on Demand and Home Shopping. DSM-CC is more general than that, and the purpose of this paper is to explore the attributes of DSM-CC that make it appropriate for the "Information Superhighway"

DSM-CC covers a number of distinct protocol areas:

- Network Session and Resource Control
- Configuration of a Client
- Downloading to a Client
- VCR-like control of the video stream
- Generic Interactive Application Services
- Generic Broadcast Application Services
- Switched Digital Broadcast Channel Change

The DSM-CC standard is flexible in how much of is used. Each protocol area can be used stand alone, or in concert with other protocol areas, depending on the application(s) being addressed. An introductory overview of the different functions covered by the DSM-CC standard is given is [2]. This paper concentrates on the first area — Network Session and Resource Control — and on the underlying distributed computing model of the "Generic Interactive Application Services."

One of the first uses of DSM-CC is being defined by the Digital Audio-Visual Council (DAVIC), a non-profit association with a membership of over 200 corporations representing over 20 countries. DAVIC's charter is to ensure the success of emerging digital audio-visual applications and services over various networks, by the timely availability of internationally agreed specifications of open interfaces and protocols. DAVIC has adopted DSM-CC in its DAVIC 1.0 Specification [3] for the delivery of interactive multimedia services. As well, new work in DAVIC is applying DSM-CC to Internet access [4]. Use of DSM-CC for multimedia conferencing applications is being coordinated by the International Multimedia Teleconferencing Consortium (IMTC), a group with over 90 member companies from over 12 countries. The standards work is taking place in ITU-T Study Group 8 within the group involved in T.120 Multimedia Conferencing Recommendations.

DSM-CC Functional Reference Model

DSM-CC is defined in terms of a simple functional reference model, shown in figure 1 [1]. The model is one of Client and Server entities (jointly called Users) that use a Network to communicate with each other.

Clients are, in general, "information appliances" such as STBs, Network Computers or PCs, that consume multimedia content. Servers are entities that provide multimedia content and services. A Server may be a distributed system and contain multiple computing platforms. Some of the platforms in a Server may be functionally specialized, such as “video pumps” that source the video streams of a video on demand service. A Server thus may have multiple transport connection points to the Network.

The definition of a Network is very broad: any collection of communicating elements that provides connections for Users. The definition of connection is equally broad: a transport capability to transfer information between two or more end points. The intent is that DSM-CC be applicable to a wide range of physical networks with different realizations of connections, including one way point to multi-point (broadcast) connections. In DAVIC [3] the prime realizations of connections are as end to end bi-directional ATM Virtual Channel Connections (VCC's), and — for Hybrid Fiber Coax distribution networks — as part ATM and part MPEG-2 Transport Stream. However at the DSM-CC level connections are just a handle for a group of network resources. "Flows" as identified in the IETF's RSVP work are a very pertinent type of connection.

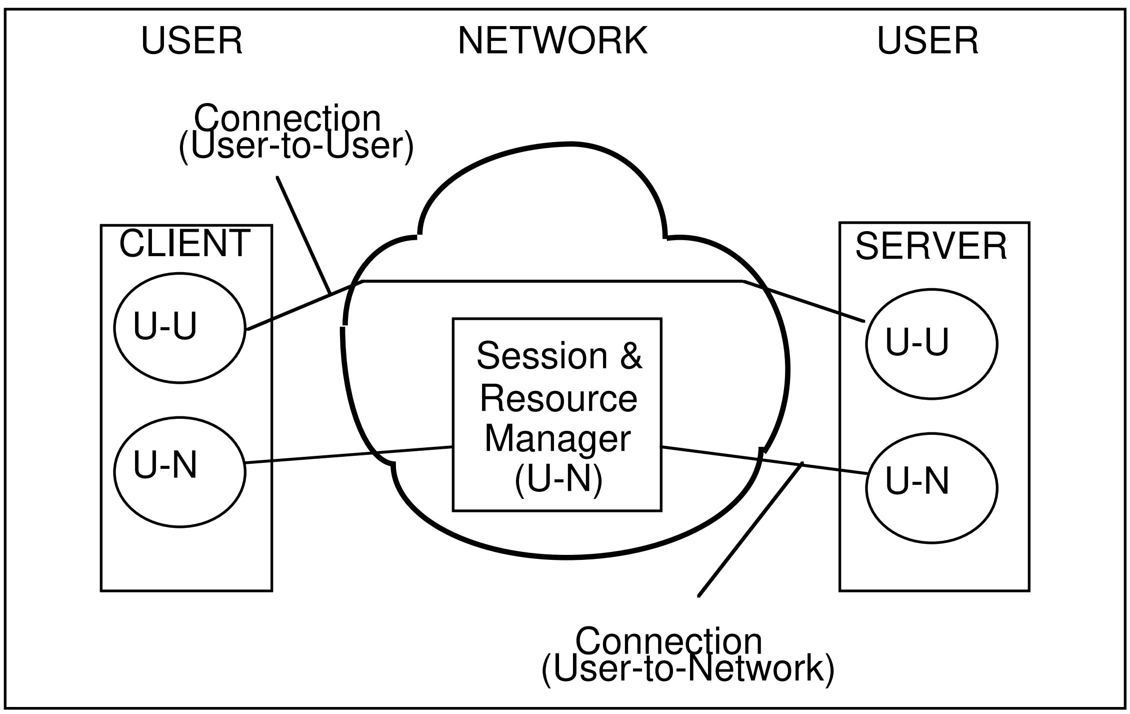

Figure 1: DSM-CC Functional Reference Model

Figure 1 shows connections for carriage of User-to-Network (U-N) information and User-to-User (U-U) information. User-to-User information flows are direct between Client and Server entities (labeled U-U in Figure 1). While a User-to-User part of the DSM-CC standard does defines potential content on U-U connections, our concern here is with the User-to-Network part of DSM-CC. This part is concerned with the dynamic acquisition and control of the network resources needed for U-U connections, not with the information that flows over them.

The Session and Resource Manager

Figure 1 shows the Network as containing a Session and Resource Manager (SRM) functional entity. The SRM terminates U-N connections from Users (both Clients and Servers). Note that the realization of an SRM could be distributed over a wide geographical area spanning many network providers. However today DSM-CC defines only the message set for the U-N connections: it does not yet define any intra-Network communication.

The purpose of the messages exchanged between Client and Network and between Server and Network is to control sessions and network resources.

Sessions are a key concept of DSM-CC. From a user perspective a session corresponds to what the user regards as a single activity performed for some purpose. Services are delivered within sessions. A Client accesses a service, say video on demand, by setting up a session with a Server. At the end of the service, when the Client no longer needs an association with the Server, the session is taken down. Sessions group user interactions: for example, selecting and watching a movie could be a single session. When a user suspends watching the movie to access another service, say home banking, the user has suspended one session and started another. Sessions can be resumed so that the user can return to the movie after terminating the banking session.

From a network perspective sessions are tied closely to resources. The DSM-CC definition of a session is an association between two Users, providing the capability to group together the resources needed for the instance of a service. DSM-CC is intended to operate in an environment where network resources are not necessarily either free or bountiful. Rather it is assumed that resources will be acquired when needed to deliver a service, and released after a service has finished. Different sessions will require different resources. During a session the Server can request that the Network add to the session more resources (or remove existing resources), depending on the phase of the service.

A Network-wide unique Session Id identifies a session in the Network. All resources associated with a session tagged with the Session Id, and can thus be easily identified. This is useful for billing and administration by the Network. It is alos useful for disposing of all resources associated with a session when the session is torn down, and for recovering from failures.

Figure 2 shows the DSM-CC U-N messages used for session setup. The session setup protocol, while not complex, is designed to ensure that the Client, SRM and Server are all aware of the session being set up. The SRM may perform various extra management functions related to Sessions and Resources. It may authenticate the

Client, and ensure that the access Server is legitimate. It can police requests for U-U connection resources based on policies set at service subscription.

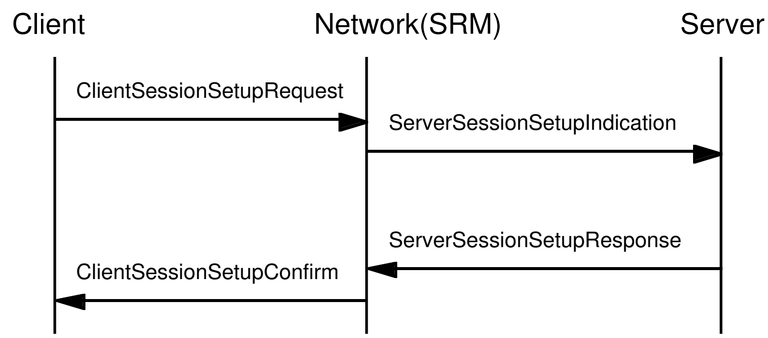

Figure 2 U-N Session Setup

Using DSM-CC Sessions and Resource Control

A very interesting question about the Information Superhighway is whether, in its final form, it will look more like today's Internet or more like the phone network. The current Internet model can be characterized by minimal service management and flat usage fees. Users love the flat usage fee but there is a growing chorus of complaints about unpredictable response times and lack of bandwidth. Even if a user were prepared to pay for guaranteed throughput (to, for example, watch a movie) there is no mechanism on today's Internet to allow him to do so. Today's phone network is characterized by a high degree of service management (including quality of service guarantees and overload controls) and usage based billing. Users are not enamored of the time and distance sensitive tariffs, but the mechanisms exist for them to receive more bandwidth if they are prepared to pay for it. Users receive a very predicable service. They appreciate priority treatment being given to 911 emergency calls, and the tracking down of and denial of service to "heavy breathers" and other nuisances.

While we are sure that tomorrow's Information Superhighway will evolve out of today's Internet, we do believe it will need to acquire a lot of the attributes of the phone network on the way. It is our position that the Information Superhighway will not be fully realized without resource usage based billing. DSM-CC's sessions are a powerful mechanism for the first step: tracking resources usage and assigning its costs to end users. A DSM-CC session serves to group together all the resources required to deliver a particular instance of a service to a user. Sessions allow a network to allocate resources for connections on the basis of what the user is prepared to pay. When there is a failure, sessions allow the network to know what resources it should recover and, perhaps more importantly, sessions form the unit for the refund applied the user's account.

We also feel strongly that wide spread usage of the Information Superhighway by the technophobic will not occur without far stronger service management and customer support. Sessions and the DSM-CC model form a good basis for these activities. Sessions provide a structuring to interactions. A session mechanism can simplify authentication of clients to servers and facilitate the tailoring of services to individual clients. They also provide a handle for customer support personnel, who through service management interfaces, can determine what a user is doing when he or she asks for assistance.

A Distributed Computing Model in a Resource Controlled World

Assuming that sessions and resource control are part of a network, questions arise about existing distributed computing models.

The DSM-CC committee has not explicitly formulated a computing model. It used the OMG Client-Server model of CORBA 2.0 as a staring point for its work. However existing CORBA compliant Object Request Brokers (ORBs) only work in a distributed processing environment (DPE) that provides a fully connected address space and uniform transport facilities (such as exists in a LAN or IP network). In such a DPE if the client has an object reference for a server object it can invoke an operation on the object (subject to authorization rules). The DSM-CC environment differs from this in three fundamental respects.

The first difference is that DSM-CC does not assume unlimited connectivity for RPCs. Until it has set up a session with a Server, a Client device cannot access any of the Server's objects. DSM-CC defines the term *service domain* to mean the collection of server objects accessible by clients once they have set up a session with a Server.

The second difference is that client and server are more tightly coupled. In setting up a session the client nominates a primary service, such as home shopping or perhaps a navigator to chose another primary service. The first action in the new session is to download to the Client device (e.g. a STB) the client code for the primary service. This part is similar to how Java applets are downloaded when an URL is resolved — and DAVIC is adopting Java as its choice of execution environment for Clients. Since the client code is delivered from the server it can be developed as a piece with the server objects' code. Standard client server computing has the two parts developed autonomously. (DSM-CC does define a standard library of interoperable server object interfaces, for these the server side implementation is independent of client code)

The third difference is that the client side ORB (called the U-U library in DSM-CC) and server side object "factories" both have to be network resource aware. The operation of resolving a name to a server object interface not only needs to return an object reference, but also a transport path. An object "factory" on a Server needs to acquire a U-U connection between the client a newly created object before it gives the client back the new object reference.

Object instances for the same client may share the same U-U connection for the transport of RPC requests and replies. Since different object implementations may reside on different hosts within a service domain, and each host may have its own network interface, this puts an extra burden on object "factories", particularly those that want to load balance in their assignment of new object instances to hosts[8].

This explicit calling out of the RPC transport resources in the object model seems to be a necessary requirement for efficient RPC's in connection oriented networks, such as large scale ATM networks, with millions of users and servers.

It is only over the particular transport path that subsequent RPC requests to the object can be made. With the restrictions on their transferability, and their embodiment of rights to use network resources, DSM-CC object references are very similar to *Capabilities* of twenty years ago [6,7,8]. Perhaps it time to rehabilitate Capabilities.

Future work

At Nortel, our current work with DSM-CC is centered around its deployment in the Nortel Broadband Interactive product line of broadband data and multimedia services delivery networks. As well, we contribute heavily to the DSM-CC standard and are active in the DAVIC industry forum.

We are actively investigating how DSM-CC can be merged with the Internet, particularly the World Wide Web. We want to be able to bring to the Internet the values of Sessions and Resource management within the frame work of its existing applications and protocols (and anticipated protocols such as RSVP). Nortel broadband residential access networks, and those from other companies will provide residential Internet users with very high speed access. We are working on how this affects the protocols used and the operations of Internet Service Providers. Further out, but required before full DSM-CC can be used for world wide applications, is the standardization of Network to Network Session and Resource Control.

Another interest we would like explored is the modeling of streams in distributed computing systems. Although not discussed above, DSM-CC server objects may embody other network transport resources, such as a MPEG stream. Not only does the *signature* of an object interface define attributes and operations but also streams. An object with a stream in its interface is the Server side controller and manager of the stream. Object "factories" need to acquire the network resources for the stream(s) as well as the RPC transport when they create new instances of objects for Clients. However representing a stream just by its source controller doesn't seem adequate. We are searching for the right abstraction. One particular challenge is in how to abstract quality of service (QOS). Today QOS specifications for a stream depend on the technology deployed in a network. We would like it if the server object "factories" can be network technology independent in their requests for resources for streams.

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