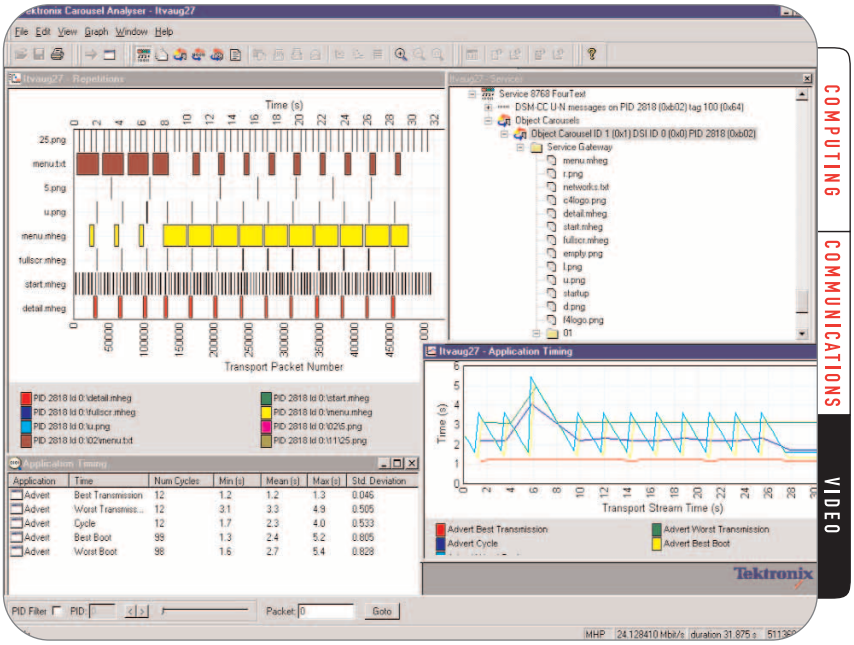
# Testing the MPEG2 Transport Stream






## Carousel Testing with the AD960

### Introduction

The primary use of the MPEG2 transport stream, to date, has been for the delivery of compressed audio and video services to end users from a central service provider. MPEG2 is at the core of digital television transmission. However, as MPEG2 transport streams effectively just move data bits around, it also makes sense to make the most of what is described as data broadcasting, which broadly covers just about every other application that is not focused directly on video and audio.

### Digital Television Today and Tomorrow

In the world of digital television, the most obvious example to anyone using a digital TV set or digital set top box (STB) are the enhanced and interactive TV applications now becoming available. In the future, a major use of data broadcasting will be as an enabler for interactive TV (iTV) that will also include links to the Internet.

Data broadcasting applications also include downloading software upgrades to the set top box itself, as well as other software downloads to enable applications such as games, along with picture or text data. Internet services, extended advertising information, and extended service information and program guides can also be served by data broadcasting (see Figure 1).

### MPEG2 Standards

MPEG2 standards provide a number of different ways that the large variety of data types needed for these different applications can be encapsulated for transmission on a transport stream. These include data piping for simple asynchronous delivery of data to a target on the network – this is typically used for closed proprietary systems.

Data streaming is used for the end-to-end delivery of data in asynchronous, synchronous or synchronized ways – this is how audio and video is carried in the MPEG2 transport stream.

Multiprotocol encapsulation (MPE) is a means of incorporating datagrams of any network protocol onto a transport stream. The most common application of MPE is “IP over DVB” where Internet traffic is carried in the MPEG2 transport stream.



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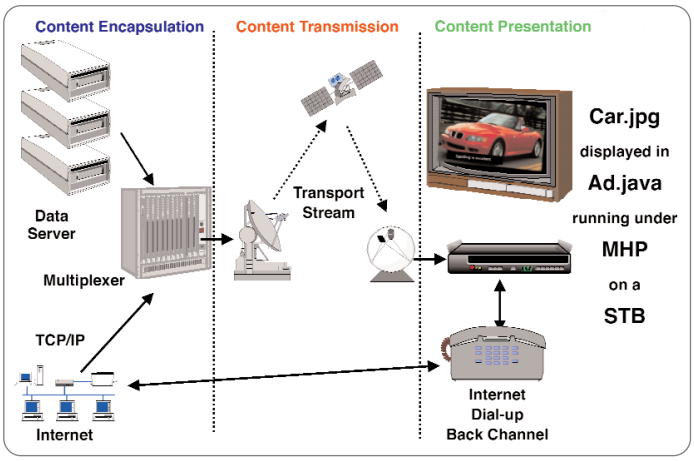



***Figure 1.*** *Delivering iTV Applications.*

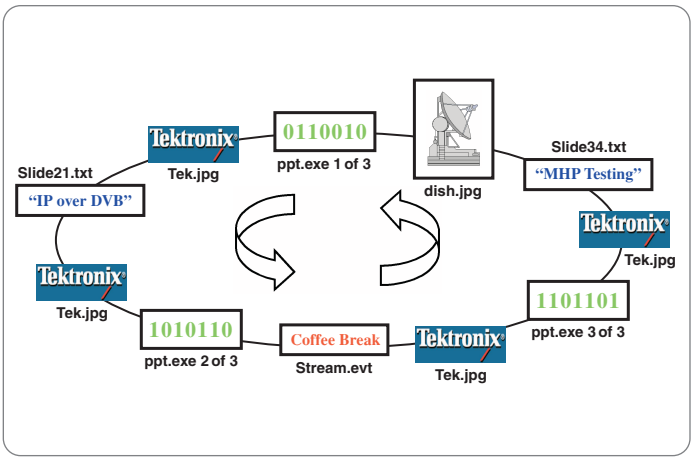



***Figure 2.*** *DSM-CC Carousels.*

The MPEG2 DSM-CC specification (Digital Storage Medium Command and Control) provides further ways of broadcasting data in MPEG2. Originally devised to support video on demand delivery, DSM-CC has been extended to enable periodic delivery of data. DSM-CC carousels are used for the repetitive transmission of data, as they reduce the need for the TV to store data, and they enable faster random access on channel change.

## Carousels

Two different types of carousels are used — object carousels and data carousels. Data carousels only contain data of unspecified content, so the receiver has to know what to do with it when it is received. Data carousels are often used for downloading new system software to a set top box, whereas an object carousel is used for game delivery, shopping services, electronic program guides and other iTV functions the user can access from his TV screen. On the other hand, object carousels contain identifiable data objects such as pictures, text files or executable application files, along with a directory listing all objects in the carousel (see Figure 2).

While in both data and object carousels, items are repeated at periodic intervals, object carousels make it much easier to vary the repetition rate of individual objects, which can serve the requirements of broadcaster and end user in giving higher repetition rates to objects that are used more often. For example, in an electronic program guide (EPG), the details of the next hour's viewing would have a much higher request rate, therefore would be given a higher repetition rate in the carousel.

An example of an interactive application using the various types of data types including object carousels is this iTV screen shot for BB Services (see Figure 3).


▶ ***Figure 3.*** *BB Services.*

## Issues with Interactive and Enhanced Applications

In the past, a major problem with interactive and enhanced applications was that an application developed for one set top box might not appear the same on a different STB. In many cases, applications may not have run at all, assuming that they even used the same data broadcasting method in the first place. Applications must therefore be written many times for all the types of STBs in use, as each box had a different application programming interface (API).

There has been some standardization through the emergence of several competing proprietary APIs, which has at least reduced the number of versions that needed to be written. In the long term, however, the interactive/enhanced TV standard formulated by the DVB Project offers the best promise for cross platform compatibility of iTV and eTV applications.

The DVB system was developed as the standard MPEG2 based compression and transmission system for Europe's digital TV systems, including terrestrial, satellite and cable, and has since been taken up virtually worldwide as the standard for the delivery of digital TV services. Looking to the future of TV services, the DVB Project went on to develop a standard for interactive TV that has also drawn widespread international support.

## Multimedia Home Platform

Just as DVB was mandated for digital broadcasting in Europe, the multimedia home platform (MHP) has been developed as a common pan European API for STBs, which will allow any MHP application to work on any MHP receiver. A further boost to MHP is the fact that most of the services currently running proprietary interactive TV systems such as OpenTV, Liberate and Mediahighway have also committed to offer MHP compatibility by the end of 2002.

MHP is now the de facto standard in Europe and services officially started in Finland in August 2001. There are a large number of test services currently being broadcast in other parts of Europe. Germany will use MHP from the middle of 2002, with other countries following over the next few years.

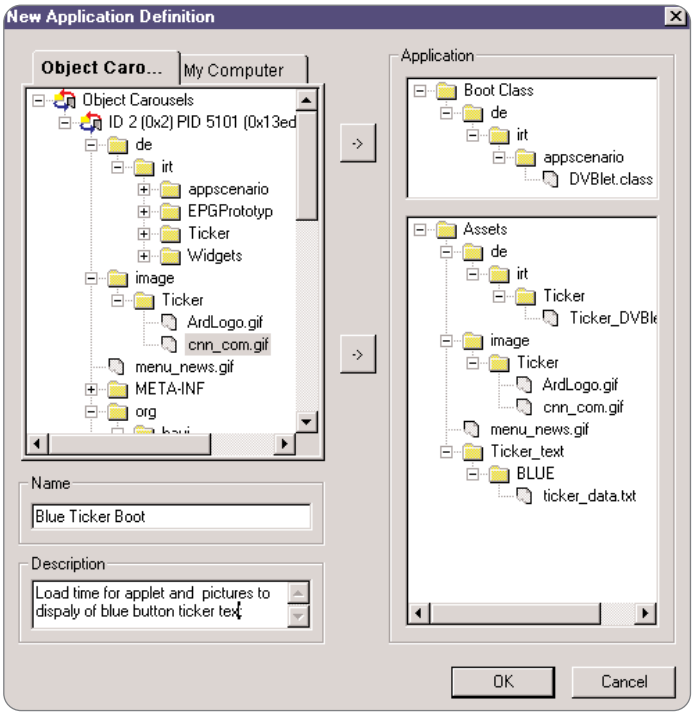
MHP has also been adopted outside Europe – in South Korea it has been mandated for satellite data broadcasting and in Australia for terrestrial broadcasting. MHP has also been adopted as the US standard for digital cable TV, and many other countries are expected to adopt MHP, as they have already adopted DVB.

Data broadcasting and MHP are very complex systems, however, and therefore it is important to ensure that implementations of iTV services using MHP can be achieved as reliably and efficiently as possible by equipment suppliers, service creators and service providers.

In order to guarantee that applications can be cross platform, the MHP logo is protected; so set top boxes must undergo a compliance process before they can be sold with the MHP logo. Applications must also be tested to ensure that they are safe and do not contain viruses. A compliance test suite is being developed, since receivers and applications must get official approval – and currently the Tektronix AD991 is the only generator with a remote control interface to test the accurate delivery of streams.

MHP uses object carousels as the basic data delivery mechanism for iTV applications, since the key requirement for iTV is that a viewer can press the right buttons on a remote control and call up, apparently instantly, the relevant information required, following onscreen prompts.

This is not easily achievable by data piping or data carousels. So for iTV, the set top box has periodic access to information held in a constantly “rotating” carousel, in effect just seconds away from deployment by users pressing their remote control. This information is being broadcast constantly, therefore it is the wait to receive such information once a user has pressed a button on the remote control that will determine the success of any iTV application – viewers do not like to wait, and just like Internet users, too much delay equals dissatisfaction with the service.



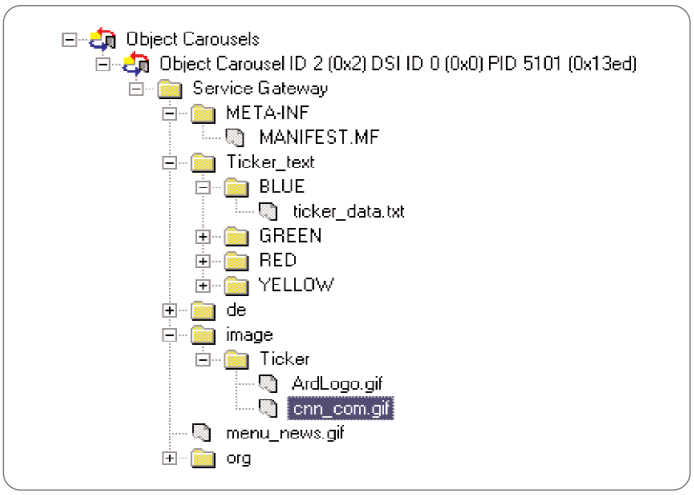

▶ ***Figure 4.*** *MHP Application Definition.*

Tektronix has formulated a number of test systems that are currently unique in their ability to aid users of data broadcasting to compile and perform their iTV services as seamlessly as possible. These systems include the analysis of data and object carousels, including those used specifically for MHP.

## The Heart of iTV Testing

In addition to testing the various transmission protocols, Tektronix systems also test the application load times; i.e., the delays as viewed by the user before they can use the application. This analysis will enable iTV transmissions to be made as efficient as possible. This is the heart of iTV testing, since DVB MHP application delivery timing is key to user satisfaction of iTV.

It is accepted that the viewer has a limited attention span and may channel hop in less than 5 seconds if nothing interesting appears. Thus, application load time is a critical parameter for service creators and providers to know, as it is essential that the viewer get a response quickly – so the time taken to load all the elements that enable interactive applications must be considered (see Figure 4).

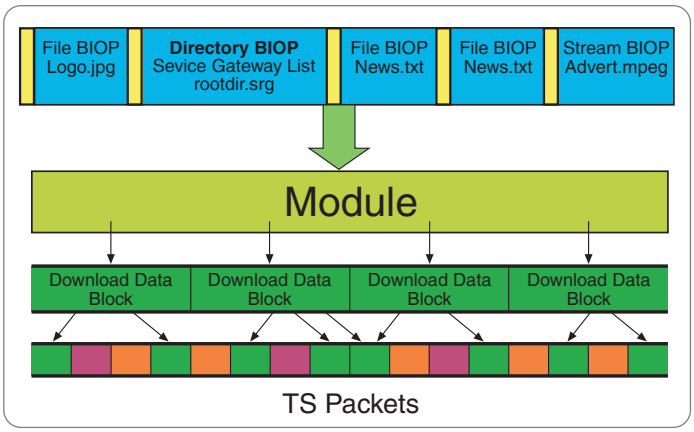



▶ ***Figure 5.*** *Object Carousel Logical Structure.*

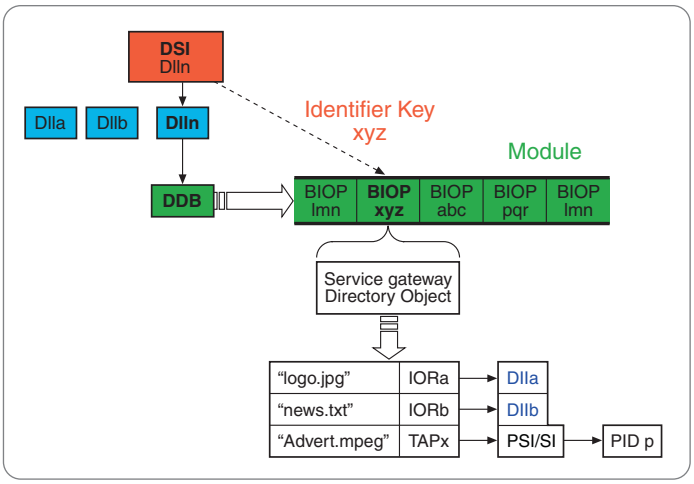
The object carousels used by MHP contain identifiable data objects such as .jpg or .txt files, the root directory (service gateway) can include real time stream events and pointers to other objects and streams, as well as the application software needed to use other objects. The directory structure enables any STB to find an object, extract and download its associated application software and then use the object.

The contents of carousels are sent in various user to user (UU) and user to network (UN) messages, the high level details that can be identified and displayed by a transport stream analyzer such as the Tektronix TS Analyzer. However, carousel contents can only be viewed by a tool designed specifically for that task — the data analyzer. So, a structure is needed to identify which objects are in the carousel, how to find the objects, and what the objects are.

The objects on a server at a broadcaster can be accessed through the object carousel mechanism. The server may be a virtual system, with objects that point to a broadcast video channel for example, as well as a basic disk system. All accessible objects grouped and sent together form the service domain – and the service gateway object provides the root directory of the service domain. The service gateway points to other files or subdirectories and is the key to finding out what is being broadcast in the carousel (see Figure 5).




▶ ***Figure 6.*** *BIOP/DDB Diagram.*




▶ ***Figure 7.*** *Object Carousel Structure.*

## Carousel Testing

A key feature of object carousels is that all objects are sent using the broadcast inter-object request brokerage protocol (BIOP), which supports the identification and use of objects in a broadcast environment across different networks, from different service providers. BIOP is a method to exchange information about an object being broadcast in the carousel – it may contain the object or simply provide a pointer to the object, and can indicate how to use the object.

Directory, file and stream objects are broadcast using the same method as data carousels – in modules, which group objects together, split into blocks and sent as sections in the payload of a Download Data Block (DDB) (see Figure 6).

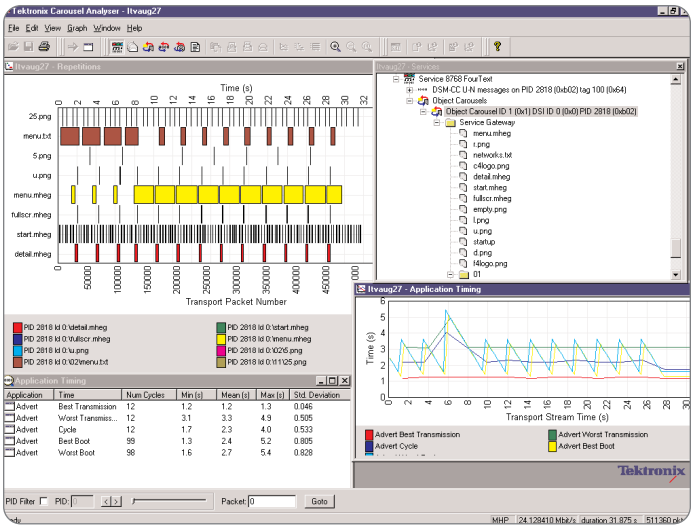
Objects are referenced in a directory object using interoperable object references (IORs), which contains all the information needed to access an object in the same service domain or in another object carousel, including those broadcast on other transport streams (see Figure 7).

Some data broadcasts for iTV (such as quiz programs) have to be synchronized with the programs being broadcast, but it is not practicable to use real-time delivery, except for non critical applications such as updating sports scores where sync to video or audio is not necessary.

However, a second or two delay could impact seriously in an application such as calling up answers to questions asked on TV quiz shows – for example by revealing the answer too early. Object carousels contain a special object called a stream event that contains timing information relative to the normal play time (NPT) of an individual TV program, which allows for the pauses due to ad breaks and other interruptions of the program's runtime. Therefore, full synchronization can be maintained between the iTV data and the program timeline.

The way in which the different data objects are structured and prioritized for delivery makes a substantial difference to performance – which is one of the main areas that Tektronix test systems are addressing. The Tektronix AD960 carousel analyzer can check the syntax and protocols of the object carousels used to deliver MHP applications. It can check whether the data is being sent correctly, at protocol level, which is vital information to manufacturers making carousel generators and set top boxes.

The AD960 can also view and save carousel content and individual objects and display the object display repetition rates. It allows easy definition of multi file applications and can perform timing analysis on the stream.




▶ ***Figure 8.*** *MHP Application Timing Displays.*

For those designing MHP applications, the carousel analyzer allows a look at how the objects are put inside the transport stream, and in what order – and how often they are being repeated inside it. It is not always intuitive how object order and repetition should be structured to minimize time delays – but these issues are important for those designing the carousel generator hardware, as well as for those writing the application software.

There are many different strategies for inserting the objects into the carousel, and different strategies can significantly affect the time taken to download an application. Therefore, the order in which objects are inserted into the carousel and the repetition rates for these objects are two vital areas where the carousel analyzer can help designers (see Figure 8).

Although at first glance this looks like a simple process, in practice, this is not the case. There may be cross-network differences in the performance of MHP applications where an application may work efficiently on one network, but not on another — perhaps because it has been re-multiplexed, or it has been inserted using a different carousel generator. The carousel analyzer can help determine where the problem lies.

## Carousel Generation

It is not intuitively obvious how to optimize a carousel because of the variety of different advanced optimization schemes possible. These range from repeating individual objects or modules more frequently to splitting the application components across multiple DIIs, PIDs or even multiple carousels.

It is a basic requirement when devising an optimization scheme that a carousel generator is used that offers a wide variety of optimization methods. However, it is essential that the carousel generator user interface is simple and intuitive to use, thus permitting fast and repeatable experimentation with all the various parameter settings.

The Tektronix Carousel Generator has been designed to make all its extensive parameterization settings easily available so that "what if" optimization can take place quickly, easily and repeatably. It gives precision control over repetition rates of user-definable "collections" of objects, as well as enabling the allocation of objects into different carousels, DIIs, or PIDS, as required.

A simple "drag and drop" interface means that application contents can be added directly from local or network drives, or indirectly by extracting them from a broadcast carousel using the Carousel Analyzer. Objects are assigned as required – again via "drag and drop" – into "collections" of objects with similar repetition rate requirements. A simple synchronization procedure enables the carousel to be quickly updated and recreated should an application change.

The resultant output transport stream file contains all the necessary SI information, including the AIT table for MHP applications to allow it to be broadcast via a conventional transport stream multiplexer or the Tektronix software multiplexer. However, as the Carousel Generator is directly linked with the Carousel Analyzer, full analysis of application load times can be quickly undertaken to see the effects of a particular optimization strategy. The ability to run the analyzer and the generator side by side greatly reduces the iteration time needed to arrive at the optimal transmission solution.

## Conclusion

The protocols involved in iTV are very complex. A full understanding of them is necessary, not only to ensure that iTV can be delivered in a flexible way, but in a way that provides the responsiveness that a consumer expects and ultimately pays for.

Test systems such as the AD960 DataStation enable service providers to check various stages in the iTV chain in order to improve their own services – and to help the network operators who set up carousel generators to determine the most efficient way of structuring their data. It achieves this by focusing on the one parameter that will affect the user iTV experience – customer satisfaction. After all, it is only satisfied customers that will provide the much needed revenue to the service providers, application developers and network operators.

## To order more material on MPEG products

Visit www.tektronix.com/morempeg to get your free copies of this educational material:

– MPEG-2 Transport Stream Poster – DVB or ATSC PSIP Tables

– AD920 Technical Application Note “MPEG Confidence Testing Using the AD920”

– MPEG Technology Primer “A Guide to MPEG Fundamentals and Protocol Analysis”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