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and internet system .doc
7 Feb 99 LAR, v1.6

The Combined Digital Satellite Broadcast and Internet System

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Summary

This report starts with a summary of the existing TSS satellite network, where digital TV with pay-per-view and nearly-video-on-demand is introduced. Included is a DVB data carousel for cyclic output of content to larger user groups. Furthermore, a test version of Internet access via satellite for PCs is up and running.

With existing standards from DVB, W3C and others as starting point, architectures for combined satellite broadcast and Internet systems for future multimedia services are proposed and investigated. Where specifications are missing, extensions are proposed.

High-lights:

- A network architecture combining satellite broadcast and Internet, in order to support DVB ‘Enhanced broadcast’, ‘interactive TV’ and ‘Internet access’ as specified in DVB MHP 045r12 is proposed and analysed. The terrestrial interaction network is an IPv6 intranet, connected to Internet through a IPv6/IPv4 server at the up-link sites. How the interaction network can be provided by satellite is also shown.
- The concept of layer-structured multimedia applications is introduced. The low-end user equipment can handle only the basic layers of an application, while the high-end equipment can handle all layers
- Multimedia, real time plays with geographically distributed actors are introduced, and synchronisation primitives are proposed.
- A routing scheme, which supports traffic control is introduced. The concept makes it easy to later introduce request channels via satellite by means of individual up-links from homes. The coming IPv6 protocol and Internet/Web technology are applied. The IPv6 protocol also supports authentication, encryption and conditional access.
- Adaptive algorithms and architectures for use of caches and carousels for Web objects are described. This concept takes into account the expected user demands and the actual traffic in the network, and reduces network resource usage and response times.
- The report outlines how Internet technology generally can be used in TV systems for control communication between sub-systems.
- A business concept denoted ‘TSS mall’ is introduced to support high-performance electronic commerce on the TSS network. The mall concept involves that TSS provides the business infrastructure, and that the individual front-stores buy services from the TSS mall, and else can run their businesses independently. Web/internet technology is applied.
- At last, the business structure of combined-service systems like the future TSS network is considered. An important issue is the user satisfaction, which is affected by the number of business access points the user has to face when buying a combined service. The Business Management System concept is applied to optimise the total quality of service.

Contents

Introduction (1)

Digital TV via satellite and cable has been in operation for some time. The terrestrial version is about to be introduced. Telenor Satellite Services (TSS) has also a test version of Internet access via satellite to PC up and running. The natural next step is to integrate enhanced broadcast, interactive TV and Internet access in one network, as defined by DVB MHP045.

The obvious strength of satellite compared to earth-bound transmission, is that the generic transmission cost is the same whether a certain content is sent to one customer or to millions, and particularly when the customers are spread over large geographic areas.

This document does not focus on specifications. The intention is to propose architectural solutions that can full-fill the functional requirements. In most cases, complete specifications can be found elsewhere, and are merely referenced. However, the IPv6 and HTTP/1.1 protocols are essential for the proposed functionality and architectures, and are therefore treated in detail.

The proposal for the combined network is based upon standards as far as possible, particularly DVB, W3C/Internet and IEEE standards. Where existing standards do not meet the expectations, extensions are proposed.

This document can be read in several ways. Chapters 2 and 3 are meant to be introductory, that is, can be read and give a good understanding of the system. The other chapters are intended for specialists. For those who are interested in electronic commerce, Chapter 2, 3 and 7 could be read.

Chapter 2 gives a short introduction into the TSS digital satellite network established so far. It includes standard TV channels and NVOD, with subscription and pre-booked pay-per-view payment. Internet access to PC with responses via satellite, data carousels and TV guides are also provided.

Chapter 3 introduces new features like enhanced broadcast, interactive TV and Internet access. The concept of layer-structured multimedia applications, and synchronisation between distributed acting groups in addition to studio groups in TV plays, are proposed. Payment principles applied to e-commerce and multimedia services are discussed. Furthermore, routing, caching and protocols are shortly described. At last, issues around remote download of software are touched.

Chapter 4 handles in-depth of issues regarding routing, caching and 'carouselling'. A mathematical model of performance of TCP over satellite is also included. The IPv6 and HTTP/1.1 protocols are essential for the architectures derived for the network, and are therefore treated in detail.

Chapter 5 describes the proposed picture-in-picture features, using various protocols, and applied especially for layer-structured multimedia applications, e.g., Web browsing.

Chapter 6 outlines the basic principles for communication between sub-systems, and the sub-systems themselves. Internet technology is used.

Chapter 7 shows how existing techniques can be utilised to establish Web malls to handle e-commerce in the network. Payment principles and mall architectures are proposed.

Chapter 8 addresses the roles of business organisations involved, and the fronting of the customers in a combined digital satellite TV and Internet system. Furthermore, the total quality of service as experienced by the user is focused.

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RFC 2068 Hypertext Transfer Protocol - HTTP/1.1. http://www.ripe.net/rfc

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List of abbreviations

BER	Bit Error Ratio
DVB	Digital Video Broadcasting
DVB-C	DVB-Cable
DVB-S	DVB-Satellite
DVB-T	DVB-Terrestrial
ETS	European Telecommunication Standard
FEC	Forward Error Correction
MPEG	Moving Picture Experts Group
PID	Program Identifier
CA	Conditional Access
CRC	Cyclic Redundancy Check
EBU	European Broadcasting Union
EIT	Event Information Table
EPG	Electronic Programme Guide
ETSI	European Telecommunications Standards Institute
IEC	International Electrotechnical Commission
IRD	Integrated Receiver Decoder
ISO	International Organisation for Standardisation
JTC	Joint Technical Committee
NVOD	Near Video On Demand
PID	Packet IDentifier
PSTN	Public Switched Telephone Network

The existing TSS network (2)

Introduction

In this chapter we give a short overview of the existing TSS satellite TV network, and also 'Turbo Internet' for Web browsing on PCs.

Structure and behaviour

Figure 1 shows the present principal digital interactive TV broadcast network architecture of Telenor Satellite Services, with focus on the Multimedia Home Platform (MHP), the Interaction Network (telephone network and Internet) and the corresponding transmit-end servers. Note that presently the MHP is either an IRD for normal TV, or a PC using 'Turbo Internet'. The system provides subscription and pre-booked PPV TV services, NVOD included, Turbo Internet via satellite for fast access to Internet Web pages, and Data Carousels for cyclic broadcast of heavily used applications. Note that all services provided by Web servers/Internet (commerce, banking, education, information retrieval, etc.) become available to the user. On the other hand, content and information providers, and service and business organisations have got the same possibilities to present and sell their information or products to very large populations.

As seen in Figure1, the MHP (PC or IRD) is connected to an Internet Access Server (part of the ISP's domain) through the telephone network (PSTN, ISDN or other). Standard Internet protocols, TCP/IP/PPP are used on top of standard modems (V22bis/V32bis, ISDN or other). The MHP Web browser that supports HTML 'talks' to Web servers by means of the HTTP/1.0 client-server protocol. The MHPs in the TSS network (currently Nokia Mediamaster 9610S) supports the TCP/IP/PPP protocols and use Conax pre-booked PPV protocols (proposed to DVB as standard) towards the Conax PPV Server.

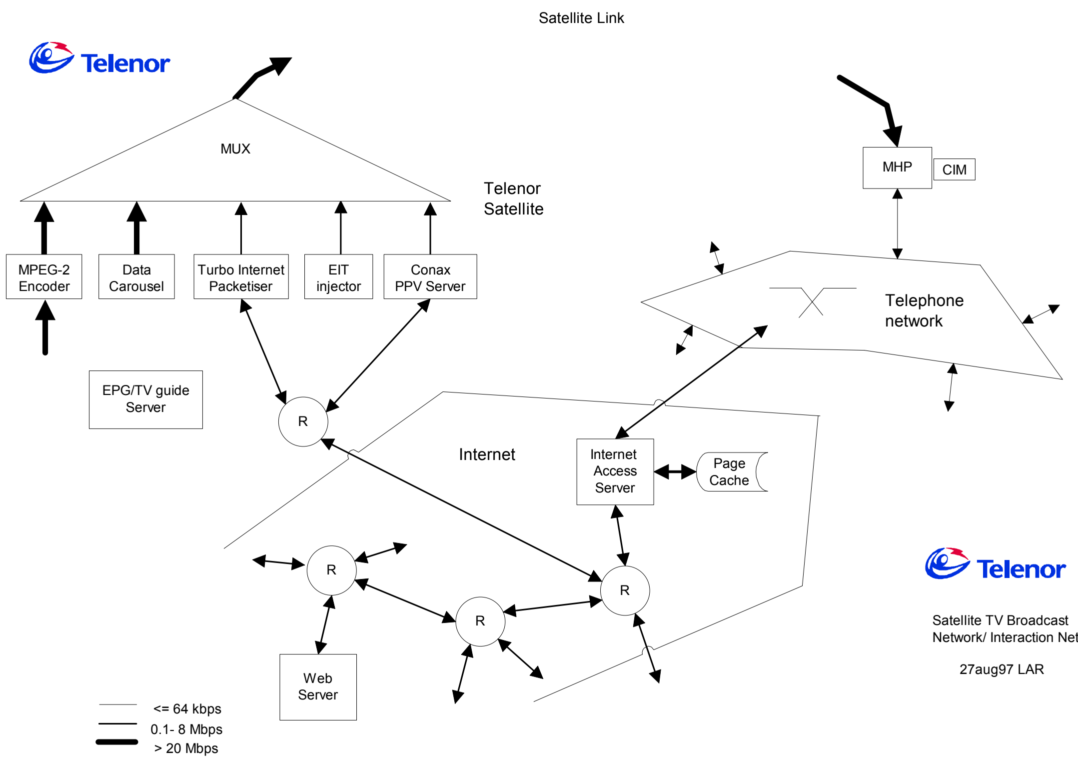
Turbo Internet requests from the user goes via the telephone network, while responses are routed via satellite. Functionally, the user will experience Turbo Internet just as terrestrial Internet, but with reduced delay. The 'Turbo effect' is obtained when high data rate per user all the way from where pages are cached to where the pages are shown is provided. Figure 1 shows a special case of caching (to be extended), when the cache is part of the Internet Access Server. When Web pages are cached in the Access Server, the time delay for fetching pages becomes much smaller.

For the time being, payment for the Turbo Internet service is based on fixed subscription, independent of use (to be enhanced, see Chapter 7).

On the broadcast link, the DVB Multiprotocol Encapsulation protocol is used under the TCP/IP protocols.

The DVB Carousel (DSM_CC based protocol) is used to cyclically output HTML pages, still pictures, video and audio clips, and other data. Seen from the user, applications from the Carousels are 'offline interactive' (like text TV).

The EPG/TV guide server is used to store EIT formatted data. The EIT Injector outputs the data cyclically to the multiplexer. This server is located close to the up-link site, and 'Turbo effect' can easily be obtained.



Abbreviations: MHP - Multimedia Home Platform (IRD)
CIM - Common Interface Module
R - Router

Figure 1. The Telenor Satellite digital TV and data broadcast platform. Functional description

For more details about the several subsystems shown in Figure 1, see Conax, W3C and maXware.

The future TSS network (3)

Introduction

This chapter is meant to give a short introduction to the new TSS network for those who do not want to go too deep into the matter. Other chapters go into detail on some of the issues that are specific for the TSS network.

Figure 2 shows a proposal for the extended principal digital interactive multimedia/TV/data broadcast network architecture of Telenor Satellite Services (sub-systems will be explained in following sections). The figure shows only one up-link site, but several with same functionality (load-sharing and specialisation of content) will be placed in several countries in Europe, and connected together through Internet and satellite links. The network combines digital satellite broadcast, interactive TV and Internet/Web access in one network. The interaction network will be provided using an Intranet, ether terrestrially or via satellite as shown in the figure. Services and technical quality provided by the network shown in Figure 1 have been extensively enhanced. DVB broadcast standards, Web/Internet standards and new standard proposals are used.

Broadcast to cable networks or other terrestrial networks are not treated in this document, but are regarded as important services provided by TSS.

In order to perform services or sub-services, a number of subsystems have to play co-operative roles. This co-operation is treated in this chapter. Each subsystem will be described in more detail in a separate chapter.

Standard TV and HDTV, enhanced broadcast

Standard digital TV has been in operation for some time in several countries in Europe and America. All of these follow the MPEG-2 standards. There are some differences in the RF part, Europe follows the DVB recommendations for both terrestrial, cable and satellite broadcast. The services include standard TV with video (mp@ml), sound, subtitling, text-TV, conditional access (CA), subscription, pay-per-view (PPV) and nearly-video-on-demand (NVOD)[1]. The services also include a navigator with present/following EPG connected to pay-per-view. Several CA-systems are in use (Viacess, Conax, etc.). The NorDig I specification specifies an IRD that includes the service repertoire referenced above. Some service operators also include an eight days EPG.

Each network operator (like TSS) has its own specification and rules of operation for the broadcast network.

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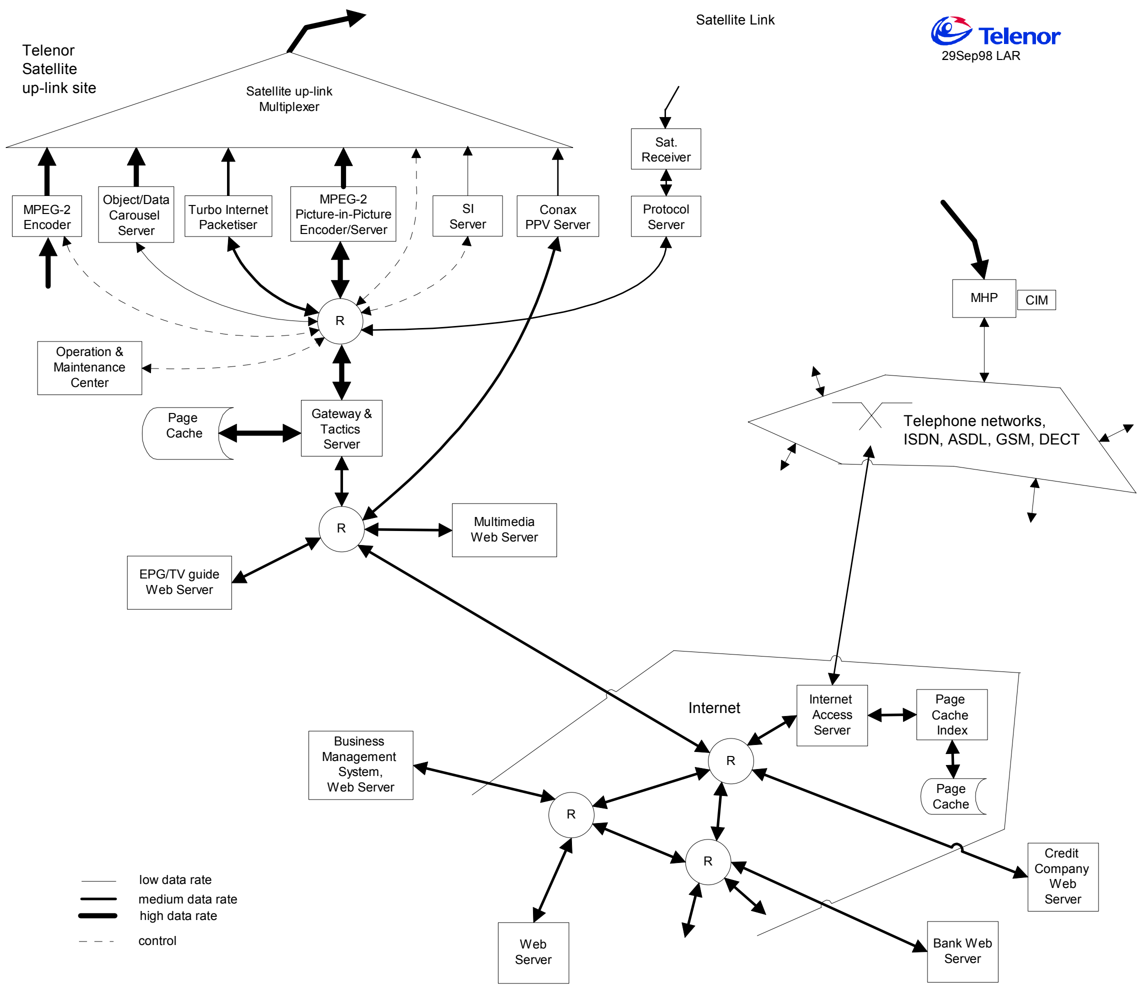
[1] PPV and NVOD are defined as part of Enhanced Broadcast, even there are good arguments consider them as part of Interactive TV



Abbreviations:	R	router
	MHP	Multimedia Home Platform
	GTS	Gateway and Tactics Server
	ODC	Object and Data Carousel
	TWS	TSS Multimedia Web Server
	PIP	MPEG-2 Picture-In-Picture Encoder/Server
	BMS	Business Management System
	CIM	Common Interface Module
	IAS	Internet Access Server
	OMC	Operation and Maintenance Center

Figure 2. Proposed future TSS platform for digital satellite broadcast and Web/ Internet access.

USA has introduced HDTV in November 1998. The receivers are quite expensive, varying from about $7,000 to about $9,000 (Nov 98). The HDTV offer will be about five hours a week in ten of the most TV-successful cities. In a year or two, the price for the HDTV set is expected to get below $2,000 for the cheapest sets.

A problem with the GA-HDTV (Grand Alliance) standard used in USA is the large number of variable parameters, which make it difficult to get the hardware cost down

For future NorDig standards, the proposal here is to limit the number of levels to three, and use ASICs for most functions:

- Spatial and temporal resolution
  1280(hor) x 720(vert) pels, 25 and 50 Hz progressive scan (Level I)
  1920 x 1080 pels, 25Hz (Level II), 50 Hz (Level III) progressive scan
- 16:9 aspect ratio
- 4:2:0 chrominance sampling
- 10 bits luminance and 10 bits chrominance resolution per pel
- I, P and B pictures
- Compressed data rate, 10-45Mbps

The specification shall include main profile @ main level, used for standard TV.
The audio shall support the MPEG-2 5.1 standard. The DSD standard is optional.

Enhanced broadcast, interactive TV and Web/Internet access

As described in this report, the intention of TSS is to combine the basic TV service with interactivity and Web/Internet access. This can be done for both normal TV (NorDig I) and HDTV.

A new feature is the conversion of pictures and videos of any format in a Web page to parallel video MPEG-2 PES streams in real time at the satellite up-link site, and let the MHP handle the decoding in hardware (see next section).

Another new feature is to use object and data carousels in co-operation with up-link site caching of Web objects, in order to increase performance. The GTS sub-system handles this together with the ODC (Object and Data Carousel Server) sub-system.

Note that the TSS Web server, TWS, has a high-capacity link to GTS, which assures short response time for Web objects that are not cached by GTS.

The Internet access includes at least Web browsing, email and file transfer.

Parallel Picture-In-Picture (PIP) streams and Web access

The MPEG-2 standard permits several video PES streams, each occupying rectangles on the screen, to be transmitted in parallel. The receiver hardware shall be designed to decode this in addition to normal TV.

All Web objects routed via the broadcast channel shall be examined at the up-link site, and all pictures, videos and audio shall be converted to MPEG-2 PES before broadcast. The GTS (Gateway & Tactics Server) sub-system handles this together with the PIP (MPEG-2 Picture-in-Picture Encoder/Server) sub-system.

Both GTS and the TWS shall use MPEG-2 PES format for video and audio. GTS includes play-out equipment for MPEG-2 PES video, that can be accessed only by 'turbo users' (response always via satellite). The TWS can be accessed also through the terrestrial Internet.

Scaleable, Layer-structured multimedia applications

The basic idea behind scaleable and layer-structured multimedia applications is that they can run on all levels of Multimedia Home Platforms. The low-end digital TV receiver shows only the basic layer, while the high-end MHP can show all layers. The applications build upon a combined use of DVB carousels, Internet/Web access and MPEG-2 Picture in Picture playout systems. Applications can be written in several combinations of HTML, Java, Javascript Quicktime, and others.

Typical layer-structured multimedia applications are:

> A live TV program from studio, for example extended 'Kontrapunkt', where two teams (from two Nordic countries) compete on presenting details about musical compositions played to them, and one or more teams (established via Internet/TSS Web server) sit at home and take part in the competition using Interactive TV/Web. There may also be low-rate video channels from the homes to the studio, which may be shown in a window on the TV screen. All teams have the possibility to access Web to retrieve more information about the compositions etc. The progress/status of each team is presented as multimedia applications, controlled partly from the studio, partly by the home teams.
>
> A live TV program from an event, say the European Song Contest where the singers, musicians and other actors are real, but the background is synthesised using virtual reality (VR) techniques. The background can be transmitted using vector representation and presented as graphics. This reduces the required data rate dramatically.
>
> A movie - the viewers can influence the coming scenes (a number of pre-programmed choices) using a window (HTML 'forms') on the screen to input their choice.
>
> A football match – the user may divide the screen between the main picture and several other pictures and text windows, showing associated or other information.

News - the user get the headline news live, and he can if he wants, fetch explanatory text and short videos from carousels, and even more details from Web, and show in separate windows on the screen.

Flash advertisements – A tour operator sells out the last aeroplane seats/hotel rooms at special prices via Web, first come first served.

Other advertisements designed for TSS network, using combinations of TSS play-out systems.

The TSS Web Mall, using different TSS servers in co-operation, see Chapter 7.

Multimedia applications for PC, fetched from Web/Internet, adapted for TSS network

Multimedia applications for PC, fetched from CD-ROM and Web/Internet, adapted for TSS network

Standard TV programmes as sent today.

Radio channels playing different type of music, with multimedia presentation of composers, compositions, singers, orchestras, etc.

Synchronisation of defined events in random time is required. The studio control can use the Web/Internet and/or the broadcast channel for synchronisation of events. A proposal is to use primitives defined by simulation programming languages like Simula and Demos. More will be said about this in later sections.

The basic layer

In Figure 3, the basic layer consists of a number of HTML pages only with text, and multi-dimensional hyperlinks to other pages within the same layer and layers above. The pages are played out from a DVB Carousel. There is no interaction channel, but the user can interact (click on a link symbol) with the MHP to select other pages from the Carousel (just like text TV). This is denoted 'interactive offline'.

The basic TV control or Navigator, and standard digital TV programmes belong to this layer.

From the basic layer, the user can also activate the PPV (including NVOD) server (see Chapter 7) and order and pay for the wanted service.

With HTML 3.2, the look and feel of the text cannot be altered by the MHP, it is determined by the page itself. However, by linking in local MHP files with different backgrounds, the appearance can be personalised. The 'style sheet'- feature of HTML 4.0 enables the MHP to define its own look and feel of text, background and layout.

For existing (low-end) IRDs with text based EPGs (EIT or other format) it is simple to locally convert the HTML format into EIT, or an internal IRD format (download the converter using bootloader or module loader). The look and feel can be as before.

Layer 1

Layer 1 can be reached via links from the basic layer. This layer contains a number of HTML pages with text and JavaScript, and multi-dimensional links to other pages within the same layer and layers above and below. The text pages can be played out from a DVB Carousel, or since an interaction channel is available, can be fetched from Web/Internet. This is denoted 'interactive online'. This layer has got links to still pictures, video and audio clips, and applets.

Layer 2

From layer 1 still pictures and applets can be loaded automatically, or the user has to go to Layer 2 by selecting a link. The stills (files) can be stored on a Web server, or on a Carousel. Since video and audio clips require much more capacity than text and stills, the user that wants them has to click on their link symbols. Stills and videos can be resized and placed arbitrary by the user. Video and audio files are normally fetched from the Web, but very popular clips can also be put on the Carousel. The accepted still formats are JPEG, GIF, and MPEG-2. The video format shall be MPEG-2 and others as options.

Layer 3

On this layer, MPEG-2 still pictures, video and audio clips, and applets can be activated. The advanced PIP features as described above can be used. The user can resize and replace all picture windows. With HTML 4.0 the MHP screen look and feel can be determined locally (using style sheets).

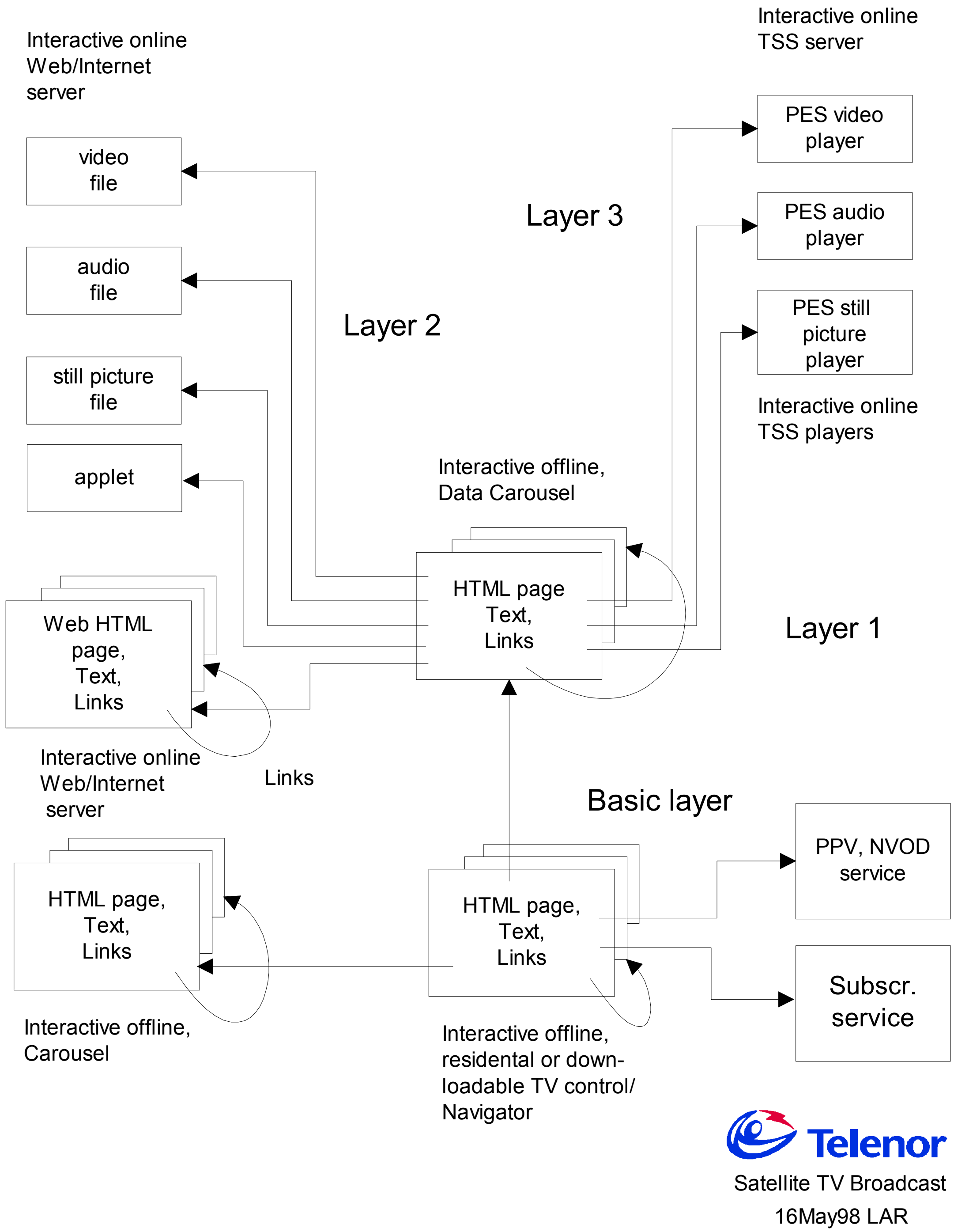


**Figure 3. Layer-structured interactive multimedia applications,
using carousel, Web/Internet servers and
MPEG-2 PES play-out systems in co-operation**

Synchronisation of Layer-structured Multimedia Plays

As pointed out in the previous section, the components of multimedia applications have to be synchronised. For synchronisation of Web/Internet multimedia components, several software support packages are available, e.g. Quicktime and Java Media Framework. These tools support only parts of what we are looking for; a general tool for synchronisation of plays performed by geographically distributed actors using multimedia resources. Such synchronisation has always been practised in TV studios and theatres, but only with locally distributed actors, and considerable manual support.

Figure 4 shows a very general situation. In TV studio there are one studio control group and several studio acting groups. In addition, several remote acting groups participate. The remote acting groups may be formed of normal TV viewers, that 'log into' a group before start of programme (rules TBD). The remote acting group may also be a TV/multimedia team acting at geographically distributed sites, together with viewer groups. Each group has a range of multimedia resources available. Each group normally consists of persons, computers or other technical systems that have the ability of acting. Together, the acting groups perform a play, directed by the studio control group. During the play there are a lot of discrete and sometimes random, event points where synchronisation have to take place. The author's experience from discrete event modelling and simulation (Ronningen) has shown that the following synchronisation events often are encountered, and may be adapted for our purpose:

- Resources (R) are produced by one group and consumed by other groups. Two primitives are needed,

  give(R) The producing group puts the resource into a resource queue, and wakes up any waiting groups.

  take(R) The consuming group tries to take a resource out of the resource queue. If the queue is empty, the group is put into a wait queue until a resource has been produced.

- Resources (R) stored in a pool are requested by a group. Two primitives are needed,

  acquire(R) The group tries to get a resource. If no available, the group waits passively in a wait queue until a resource is released by another group.

  release(R) A group releases a resource to the pool, and wakes up any waiting group.

- All groups have an input message queue, which all groups can put messages into. Three primitives are used,

  wait (que) Messages wait passively in the queue until fetched

  fetch(que) A group fetch the message from the queue, or wait passively until a message has arrived *find(que, m)* A group search the queue for a message m, and leaves if m not found.

- Groups wait until a certain condition is fulfilled. The group that sets the condition, wakes up any waiting groups with a signal.

  waituntil(que, cond) A group waits in a queue until the condition is fulfilled.

  signal(que) A group sets the condition, and wakes up any waiting groups with signal.

- Groups are initially activated by the primitives *schedule(group)* and passivated with *cancel(group).*

- The groups may use *sequencers*, which are devices that can output messages, set conditions and send signals according to a configured sequence. Timers and 'tick clocks' are special cases of this. The overall sequence of the play has to be controlled by the studio control group.

- Passive waiting can in general be avoided by using an *empty_queue* test before calling the synchronisation primitive.

Note that audio/visual perception of events are special cases of the above. Pressing a key or pointing to a hyperlink, etc, are also special cases of the above.

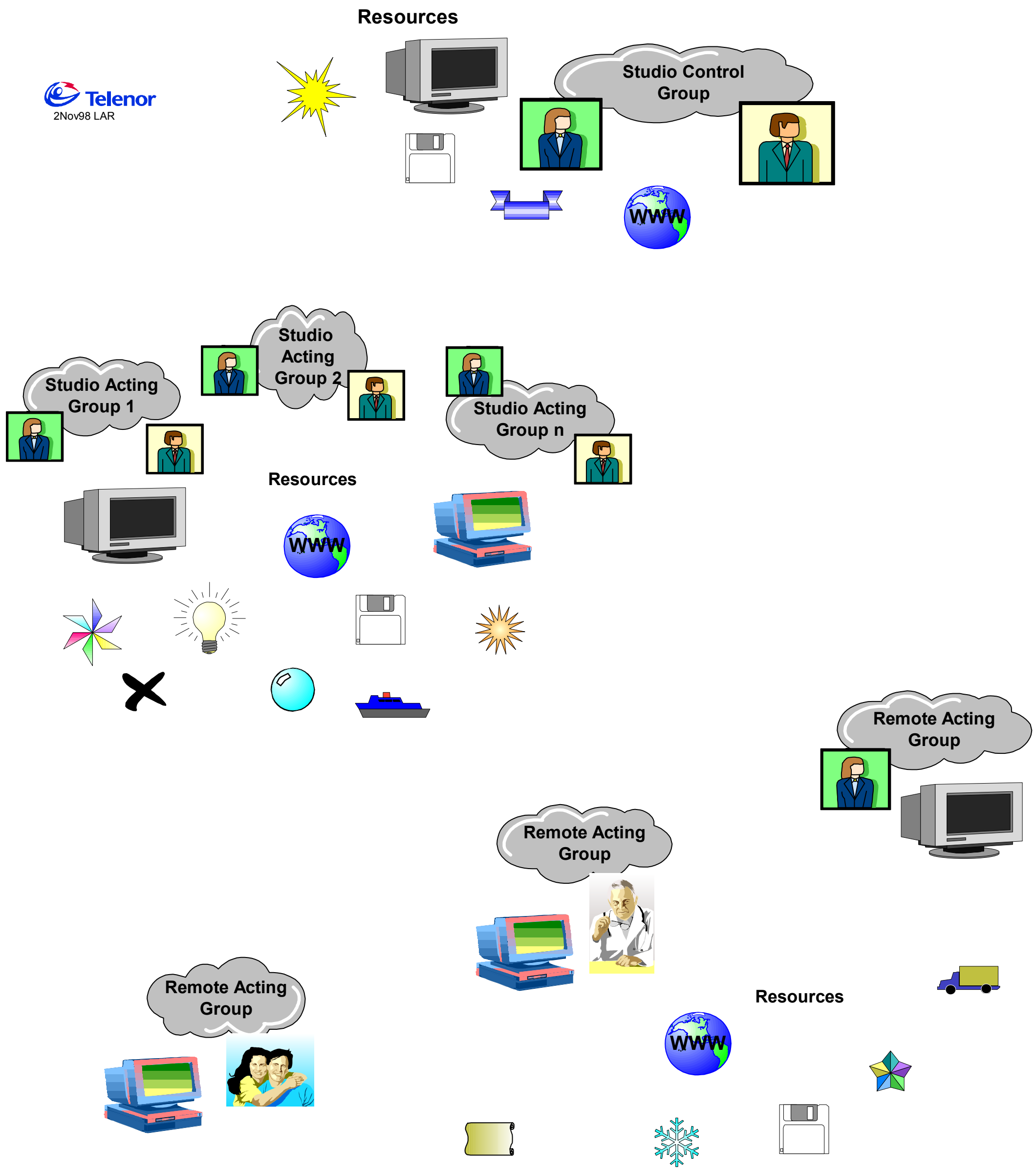


Figure 4. Multimedia control group, distributed acting groups and resources.

Games

Games are presently distributed via CDs for multimedia PCs, or via Web/Internet as downloadable software. In addition, there are special play machines in the market designed for games only (e.g., Nintendo 64 and Sony Playstation), and with private cassette or diskette solutions for storage of the game firmware. The PC may or may not have hardware support for 2D and 3D games, which result in varying and unsatisfactory performance. The play machines have very efficient hardware for 'playing around' with 2D and 3D objects, but when connected to standard PAL TV, the resolution is not impressing.

With digital TV this can be changed. It is possible to use progressive scan, and MPEG-2 video data rates of up to at least 15 Mbps for normal TV. When HDTV is introduced, both the data rate (10 - 45 Mbps) and the resolution can be substantially increased, giving excellent quality for graphics and games. Instead of placing the extra cost of advanced graphics processing on all viewers, plug-in modules or 'side-cars' to the set-top box or TV will be proposed. The Common Interface, either with PCMCIA or IEEE 1394, is ideal for this purpose.

There are several options using Common Interface and Common Interface Modules (CIM):

- Modify existing play machines so they can output MPEG-2 with up to HTDV quality to Common Interface. The input from the user can be direct to the play machine or via the MHP.
- Build new play machines with MPEG-2 output, and that can download parallel MPEG-2 streams and other data streams from satellite (from TSS Web servers, Web in general (maybe cached) and from carousels). The input from the user can be direct to the play machine or via the MHP.
- Same as above, but using low-level transfer of processed graphics data from play machine into the Command Bus of Common Interface, and close co-operation between the MHP and CIM graphics processors.
- Other solutions

Commerce on digital TV/ Internet/ Web

Money in the near future will be bits and bytes in networks and databases. Money is leaving the physical world and entering virtual reality. Several potential problems, e.g. regarding fraud and copy-write protection, have to be addressed. But, the introduction of e-money gives new possibilities for adequate international value-measurement of products and services, and for example, automatic payment of value added taxes (my proclamation, to be followed up).

Separately, digital TV and Web provide a lot of possibilities for remote, electronic commerce. On the Web, several common frameworks for small and large firms called Web malls, have been in operation in USA for some time, with great success. See Chapter 7. Together, they are unrivalled (my proclamation), because the customers can be made aware of products and services through flash presentations on TV, and then given the hyperlinks to the malls. The proposal is to apply existing and coming Web mall technology, secure Web payment technology, commerce on TV and conditional access schemes for TV. The commercial part of the TV services can be handled by the Business Management System, BMS, that in turn can be regarded as part of the TSS Web mall server, see Chapter 7. The mall server will be placed on TSS Web servers and carousels, and with hyperlinks to the general Web.

The basic TV services have for some time been offered as combinations of:

Subscription
Impulse and token Pay-Per-View (PPV)
Free of charge – financed by commercials.

Invoices for payment of subscribed services are today sent by post to the users. But in addition, payment can already now be made using secure Web technology. Both the marketing, ordering and payment can be included in a Telenor Web Mall, see Chapter 7. Below, this is described for PPV.

Pre-booked PPV and token PPV

With pre-booked PPV the users can buy TV programmes online (from BMS) in advance. Most users buy just before start of programme (Canal+), and all sub-systems have to be dimensioned to handle the peak traffic. An advantage is that the operator immediately can get figures of the popularity of programmes

With the extended token PPV, tokens or coins can be withdrawn from the users bank account and deposited in the user's smart-card in advance (see below). The time to receive service becomes short, and the user discounts his smart card as he views programmes. Payment can be made to BMS on request when an agreed credit and/or time limit is reached. An alternative to credit is the 'prepaid' scheme. These schemes effectively spread the extremes of the interaction traffic, which in turn reduce the need for equipment investment. The viewing rate for each programme can be estimated by storing the viewing history and using classical statistics on the data. The accumulated data can be transferred to the service operator in low-traffic periods. Transactions are secured using authentication and encryption.

Payment on Web/Internet

Internet access is normally offered as subscription by an access provider, with or without limited access time per month. Content and service operators handle the commercial process. This process can be implemented as multimedia presentations/ searches/ordering (using HTML 'forms') combined with different payment schemes, placed on the TSS Web mall servers.

Service, content and other product providers can use the system to market any product, tangibles and non-tangibles. This is similar to selling TV services. The TSS Web mall server shall handle the payment.

Three different categories for electronic payment on Web are used:

'The credit card category':
The customer validates the purchase by sending his encrypted credit card number and details about the payment electronically to the vendor. The vendor forwards an electronic invoice to the credit-card company, who can decrypt the credit card number, and send a secured electronic invoice to the user. Then the user pays and gets a receipt, all electronically. Note that the credit-card company controls the transactions, but the vendor or a third person does not get hold of the credit card number.

'The cheque category':
A person X sends a secure electronic cheque to another person Y, and informs his bank about the transaction. Y can then cash the check or make an electronic transfer to his bank account. The bank controls the transactions.

'The cash category':
A person X withdraw some tokens (cash money) from his bank account and deposit in his electronic purse/smart-card using secure electronic transfer. When a bargain is closed between X and another person Y, X sends secure tokens to Y. Y may deposit the tokens in his bank account, or use them in a bargain with a company Z. This is very much the same as using physical cash. The advantage of the cash scheme is that the transactions only can be traced if someone tries using the tokens more than once.

Multimedia Home Platform

The MHP shall support Enhanced Broadcast, Interactive TV and Web/Internet access, that is, multimedia services of any layer-structured combination as described above. The basic TV control/Navigator is also a Web browser that sends requests to Web Servers terrestrially, using HTTP/1.1/TCP/IPv6/PPP as described in later sections, and receives responses via satellite (selected by user) by means of the HTTP/1.1/IPv6/MPE/MPEG-2 protocols. Several TV or multimedia PIP MPEG-2 PES streams can be synchronised with the browser actions. The MHP shall decode PIP MPEG-2 PES in hardware. The services have to be signalled in SI.

Together with fast Web/Internet via the broadcast channel and the advantages of broadcast carousels, the TV set becomes a real contender to the PC (performance and price).

Business Management System – BMS

For the time being, the role of BMS includes only that of the SMS (subscriber management system) operators. BMS functions beyond the level of SMS are defined in Chapter 8.

With existing practice, the user must have direct business relationship with SMS operators, local ISPs and/or local PSTN-providers and other companies, to search into, order and pay for use of different TV channels, telephone, Internet access and products in general.

To maximise user-friendliness, it is important to reduce the number of user/business access points (for ordering, payment, info, etc.) to the combined TSS system. The user shall receive *one* bill for all sub-services, however with a hierarchical specification of used resources and corresponding payment.

The functionality in BMS can be based on Web server technology and extended to handle the combined user/business access point. This involves implementation of TCP/IPv6 and HTTP/1.1protocols. BMS can also be regarded as part of the TSS Web server system, described in more detail in Chapter 7.

The user shall have the choice if he wants to interact with BMS using a Web browser, the telephone with 'push-a-number-guide' and automatic answering, the telephone and conversation with a 'customer care person', or by visiting a customer care desk in Telenor's or representative's retail shops.

The payment system of services shall be based on combinations of fixed monthly fees, resource usage fees (for processing, storage and transport), and acceptance of advertisements. If the user do not want to see advertisements, he pays maximum price for the service. In the other end, the service is free of charge if the user accepts to receive all sent commercials. The user shall also have to possibility to choose something in between.

The resource usage shall be registered in each actual sub-system, and reported to BMS regularly.

The BMS organisation shall also take care of marketing of services, in co-operation with the service providers involved.

Security

Security is concerned about how to protect a system against any type of attack. Cryptographic systems are an important part of security. Normally, it is very difficult to build a system that can withstand every type of attack.

The experience has shown that secure algorithms are secure only for a certain period of time. Both symmetric encryption algorithms and public-key crypto systems can be attacked systematically, and have been broken. The consequence is that security systems should be substitutable, low-cost plug-in modules

Conditional Access is applied to assure that only those who are permitted for a service get access. Authentication is used to assure that the source of messages etc., has the expected identity. Encryption is used to make content readable only for wanted persons. Encryption also prevents unwanted persons to change the content of messages.

Ari Luotonen has described several solutions of firewalls. The simplest is a single router that can filter out unwanted IP packets, and a more sophisticated solution consist of a proxy with a router on each side. The latter, applied in Figure 2, gives security both on network, transport and application levels.

The cryptographic schemes used in addition to standard TV conditional access in the TSS network, are Ipv6 authentication and encryption.

Routing and Caching schemes

The present "Turbo Internet" see Chapter 2, uses IPv4 for addressing and routing, and the DVB Multiprotocol Encapsulation for transport via satellite. Dynamic allocation of user (source) IP addresses is used, due to shortage of available addresses. There is no caching in the system, so the "Turbo effect" is obtained only for Web pages stored in Telenor Nextel's Web server.

In this document, the new IPv6 protocol with extended IP address lengths (128 bits) is applied. Each user and subsystem can be allocated several fixed IP addresses, and it is shown how controlled routes for requests (terrestrially) and responses (via satellite) can be realised using existing features of IPv6.

HTTP/1.1 has got a lot of support for caching, which will be used for satellite up-link caching, together with controlled routing as mentioned above. A new feature described in this document is the tactical use of up-link caching and carousels in combination. The scheme is based on estimation of traffic and standard caching schemes in Internet, and when a URL object requested by a large number of users simultaneously, the object is put on a carousel and broadcast to their user group.

Data Broadcast Carousels and protocols

DVB Data and Object Carousels

The DVB Data and Object Carousels are specified in TM1659 Rev 5. NorDig specifies a one-layer data carousel for MHP software bootloading. The data carousel cyclically plays out data structures, e.g., files, organised in a one-level structure. When the data structure has IPv6 packet format, then authentication, message encryption and message integrity can be handled as defined in Chapter 4 of this document.

An object carousel is included in the DVB MHP API specification (not finalised). The object carousel cyclically plays out objects, structured as e.g., a hierarchical file catalogue structure, streaming data or data organised as described in TM 1659. The objects can also be MEPG-2 PES packets, UDP/IPv6 or IPv6 packets. When the objects contain IPv6 packets, then authentication, message encryption and message integrity can be handled as defined in Chapter 4 of this document. Conditional access for PES packets can be handled as for normal TV.

DVB Multiprotocol Encapsulation - MPE

The TSS implementation of DVB Multiprotocol Encapsulation, specified by DVB in TM 1659, is documented by maXware, and supports IP packets. In the steady state, only one MPE packet is sent for each IPv6 packet. The encapsulation involves translation of 128 bits IPv6 addresses into 48 bits MAC addresses. When the payload is IPv6 packets, then authentication, message encryption and message integrity can be handled as defined in Chapter 4 of this document.

TheTCP/ IPv6 protocol stack

TCP is an end-to-end, client - server, transport protocol, providing window flow- and error control. Even if TCP often is used together with IP, it is a stand-alone protocol. TCP is used in Internet and other systems. The UDP protocol is the unreliable ‘twin’ to TCP. It is a datagram protocol, without flow- or error control, but it’s ‘ports’ can be used for sub-addressing of applications in MHP.

IPv6, the Internet Protocol version 6, is a protocol intended for routing and addressing of datagrams. No flow- or error control is supported. The most important improvements over version 4, are he increased IP address space from 32 to 128 bits, the performance enhancement and the caching support.

The extended IP address space permits each user to have several IP addresses. This is convenient for individual MHPs and broadcast to groups of MHPs: Use fixed IP addresses, one for terrestrial internet access, one for satellite transmission and several broadcast group IP addresses. Since the satellite channel is (for the time being) one-way for responses, requests have to be sent terrestrially.

The limitation of TCP via satellite

As shown in Chapter 4, the window flow control mechanism, together with propagation and processing times, limits the average data rate per TCP connection via satellite to about 400 kbps.

Transfer of Audio-Visual content using UDP

Audio-visual streams can be transferred via satellite using UDP. The scheme is described in Chapter 5. The actual transfer rate are limited by the satellite channel and the receiver capabilities.

Note that the UDP layer can be omitted using IPv6 ‘flow’ directly. See Chapters 4 and 5.

The HTTP1.1 Web protocol

The HTTP/1.1 protocol is documented in RFC 2068 titled “Hypertext Transfer Protocol – HTTP/1.1”.

Since the HTTP/1.1 protocol is applied in an extended mode for caching and transfer to carousels in this document, parts of it are described in detail.

The HTTP/1.1 protocol is quite new and has been introduced by several vendors in their Internet/Web equipment, but is not yet widespread. There are several good reasons for using version 1.1 (and not 1.0) in the TSS network: The mechanisms for caching control, and that each connection (normally TCP) permits pipelined HTTP/1.1 requests.

HTTP/1.0 is currently the most widespread protocol for transferring Web documents.

See Chapter 4 for application of HTTP/1.1 in the TSS network.

The main characteristics are:

HTTP/1.1 is an ASCII text based request/response protocol. The client sends a request to the server, and the server sends back a response. Most often, HTTP/1.1 uses a TCP/IP connection through a network of routers and proxy servers, between the client and server.

Typical HTTP/1.1 requests and responses go like this:

> A Web browser client (type Mozilla/4.0) requests the TSS Web Server for an HTML page. Images of type gif and jpeg are accepted. Note that the destination IP address (www.ttsws.no) is part of the URL.

```
GET  http://www.tssws.no/mydir/mypage.html  HTTP/1.1
User-agent: Mozilla/4.0
Accept: text/html, image/gif, image/jpeg
```

> The server (type Netscape,,,) sends back a HTML page of length 3417. The status-code 200 means Ok. The explaining text ‘Ok’ follows.

```
HTTP/1.1 200 Ok
Server: Netscape-Enterprise/3.0
Date: Sun, 5 Jun 1998 07:33:24 GMT
Content-type: text/html
```

Content-length: 3417

The HTTP/1.1 specification defines an number of different headers, that describe the content of request and resource entities (content), respectively. Headers important for caching are treated in Chapter 4.

Remote downloading of software

In this section the focus is on issues of the actual downloading of software from one sub-system to another. It is assumed that the quality of the software itself is controlled before the actual download takes place.

The main issues of downloading of software are about security and versions. Software is normally structured in a hierarchy of modules, and the configurations of versions of modules shall have a well-defined behaviour. The set of allowable configurations of software shall be approved a priori.

The download of software into sub-systems (MHPs included) shall be controlled from OMS. OMS shall maintain a database on existing configurations, configuring history and approved configurations for all sub-systems. Each sub-system shall also itself maintain existing and approved software and hardware configurations.

Before a download of software modules takes place, the configuration shall be checked by OMC. When the modules are received by the sub-system the configuration shall be approved by the sub-system, and a status report shall be sent to OMC. Not all MHPs shall do this, only a selection (TBD). Some MHPs will not perform download they are expected to. If a user have problems with his MHP, it shall be possible to request the MHP via Internet to send a copy of the current configuration to OMC. It shall also be possible to download all software via Internet, if the user accepts this. See NorDig I.

To prevent that unwanted software modules are downloaded, authentication shall be applied (e.g. Ipv6 authentication). In some cases, the content/payload can be encrypted for privacy. Only authorised personnel shall have access to OMC download equipment (password, physical secured equipment

Routing, Caching, Carouselling - Performance (4)

Introduction

The present "Turbo Internet" uses IPv4 for addressing and routing, and the DVB Multiprotocol Encapsulation for transport via satellite. This was shortly described in Chapter 2. The TSS implementation is described in detail by maXware. In the existing "Turbo Internet" dynamic allocation of user (source) IP addresses is used, due to shortage of available addresses. There is no caching in the system, so the "Turbo effect" is obtained only for Web pages stored in Telenor Nextel's Web server.

Existing Web implementations use HTTP/1.0, which has only rudimentary support for caching. However, several private solutions have been introduced.

TSS has also implemented the DVB Data Carousel, with manual upgrade of the carousel. The carousel has been used many times for software boot-loading of IRDs.

In this document, the new IPv6 protocol with extended IP address lengths (128 bits) is applied. Each user and subsystem can be allocated several fixed IP addresses, and it is shown how controlled routes for requests (terrestrially) and responses (via satellite) can be realised using existing features of IPv6.

HTTP/1.1 has got a lot of support for caching, which will be used for satellite up-link caching, together with controlled routing as mentioned above. A new feature described in this document is the tactical use of up-link caching and carousels in combination. The scheme is based on estimation of traffic and standard caching schemes in Internet, and when a URL object has been requested by a large number of users simultaneously, the object is put on a carousel and broadcast to a user group that has been set up in advance.

The DVB Object and Data carousels, shortly described in Chapter 3, will be extended with possibilities for automatic update. This does not effect the standardised play-out operation of carousels.

The new Internet/Web protocols are described in some detail below, especially features applied for addressing, routing, caching and security.

The TCP protocol

The Transport Control Protocol, TCP, supports high-reliable end-to-end delivery of data. The protocol, defined in RFC 792 (STD7), is still up-to-date (even if TCPng is under development), and only the basic features will be reminded in this document.

The basic data transfer in TCP is continuous two-way streaming of octets. A connection can be set up using the three-way handshake procedure. When a connection is established, the protocol uses sliding window flow control (sequence numbers) with buffering and acknowledgement, which assures that data are not sent faster then they can be received, and that the sequence is correct. Acknowledgements can be sent when the first data segment of the window is received (typically 1kByte segments, and 64 segments window size) fraction. This also involves error control. If data are lost or wrong (checked by CRC) acknowledgement will not be sent. A timeout on the send side will elapse, and the buffered data according to the 'window' will be re-sent.

TCP used together with the IP protocol, supports identification of and parallel connections between processes on computers, using the doublet (port number, IP address).

When the network layer (ICMP protocol) reports heavy load on a router, TCP can avoid congestion by reducing the traffic temporarily by reducing the window size temporarily. See RFC 1122.

A thorough description of the TCP format and behaviour (a Finite State Machine) can be found in RFC 792 and (Siyan).

The TCP/IPv6 protocols are accessed through standardised interfaced, e.g. the 4.3 BSD and 4.4 BSD socket specifications. See RFC 1883.

The IPv6 protocol

The Internet Protocol, version 6, IPv6, is a stand-alone, bit-oriented datagram (connection-less) protocol specified in RFC 1883.

Even if IPv6 has been around for some time, IPv4 is still the commonly used protocol (version) in Internet. Sisco provides a Beta version IOS software for routers.

The most important improvements over version 4 are the increased IP address space from 32 to 128 bits and the Extension Headers. Some simplifications are also introduced, see (Huitema).

The IPv6 Header, Routing Header and payload

The IPv6 format is shown below. The IPv6 Header consists of six control fields followed by the IP source address and the IP destination address, altogether 40 bytes. After the IPv6 Header one or more Extension Headers and then the payload may follow. An example of an Extension Header is the Routing Header.

The fields have the following meaning:

	meaning
IPv6 Header:	
Version (4 bits)	Protocol version (0110)

Class (8bits)	Priority class
Flow Label (20 bits)	Flow/stream identification
Payload Length (16 bits)	Length of payload (see below)
Next Header (8 bits)	Identify the type of next header or payload (43)
Hop Limit (8 bits)	Max number of hops allowed
Source Address (128 bits)	IP source address
Destination Address (128 bits)	IP destination address
Routing Header:	
Next Header (8 bits)	Identify the type of next header or payload ( )
Hdr Ext Len (8 bits)	Length, no of 64 bits words after Reserved field
Routing Type=0 (8 bits)	Default Routing Header (others are allowed)
Segments Left (8 bits)	Number of 64 bits segments left, see below
Reserved (32 bits)	Set to zero
Address[1] (128 bits)	IP address
Address[2] (128 bits)	
…	
Address[n] (128 bits)	
Extension Header:	
Next Header (8bit)	Identify the type of next header or payload (6)
…	
…	
Payload:	
(max 64 Kbytes)	Typically a TCP packet

IPv6 defines a number of Extension Headers and protocols (payload), for example 43=Routing Header, 51=Authentication Header, 53=Encrypted Security Payload, 44=Fragmentation Header, 17=UDP, 6=TCP, 2=ICMP, 45=IDRP, 89=OSPF, etc. For more details, see RFC 1883.

Class and Flow Label fields are treated in more detail in a later section.

The pointer to the next address, Address[i], of a Routing Header to be examined (by a server) = Hdr Ext Len – Segments Left. The Segments Left variable is decremented by two for each hop. The Address[i] is copied into the IPv6 Destination Address.

Routing procedures using Routing Headers in Internet and the TSS network are treated in later sections.

Error situations are handled by the Internet Control Message Protocol, see description in a later section.

Authentication Header

A typical use for this header is when we want to authenticate a TCP packet. The header is then placed between the IPv6 Header and the TCP payload. The format is as follows:

Authentication Header:

Next Header (8 bits)	Identify the type of next header
Payload Len (8 bits)	No of 32 bits words following SPI
Reserved (16 bits)	0
Security Parameters Index (SPI) (32 bits)	Agreed security configuration
Sequence Number Field (32 bits)	Used to control the uniqueness of packets
Authentication Data (variable length)	Typically a TCP packet

Before computing the Authentication Data, data that are changed in transit must be excluded from the calculation. The first 32 bits of the IPv6 Header is excluded and the hop count is set to zero. If a Routing Header is included, the IPv6 Destination Address is set to the final address, the Routing Header content is set to the ‘destination values’. Similar actions have to be taken on other headers included.

The authentication algorithm, lifetime of keys, etc. are negotiated before the set-up, and the configuration will be sent in the SPI. The authentication algorithm recommended is the keyed MD5 (Gai), calculating a 128 bits hash code, but others can be applied.

This header can be used for accessing carousels and other sub-systems with limited user access.

Encrypted Security Payload

If we want to keep the payload confidential, this header can be applied. For details, see (Huitema). The recommended encryption algorithm is the DES-CBC (Gai), but others can be used. The format of the header varies with the type of algorithm.

Hop-by-Hop Options Header

This header is used to send special information to routers, e.g. related to management and debugging.

Fragmentation Header

IPv6 packets must be fragmented before they are sent over the network. Each fragment must have a Fragmentation Header after the IPv6 Header, containing the necessary information to concatenate the fragments into a full packet at the destination

Destination Options Header

This header contains two parameters, Next Header and Hdr Ext Len (see definition above), and will be processed at the final destination. The rest contains options according to RFC 1883, for functional extensions.

Programming Interface – PI

Two socket structures are specified for IPv6, one for 4.3 BSD and one for 4.4 BSD sockets, se RFC 1883.

Address structures

IPv6 defines three different addressing categories, unicast, multicast and anycast. Unicast covers point-to-point addressing. A multicast address identifies a group of interfaces. A packet with a multicast address will be sent to all interfaces. An anycast address also identifies a group of interfaces, but a packet with such an address will be sent to the 'nearest' interface only. See RFC xxx for details.

The Domain Name Service, DNS

The Domain Name Service supports the conversion between the text notation and the numeric notation of IP addresses. The 128 bits has been divided into eight 16-bit integers separated by colons. The integers are written as four hex numbers.

Aggregatable Global Unicast Addresses

The initial address allocation within IPv6 covers a number of different address classes starting with a unique binary prefix, the most important for our use are:

Allocation	Prefix
Aggregatable Global Unicast Addresses	010
Reserved for Geographic-based Unicast Addresses	100
Link LocalUse Addresses	1111 1110 10
Site LocalUse Addresses	1111 1110 11
Multicast Addresses	1111 1111
Reserved Addresses	(several)
Unassigned Addresses	(several)

The format of the Aggregatable Global Unicast Addresses is

Prefix (3 bits)	010 fixed
TLA (13 bits)	Top Level Aggregator, identify continents, etc
NLA (32 bits)	Next Level Aggregator, long-haul providers, sites, etc
SLA (16 bits)	Site Local Aggregator, identify links within sites
Interface ID (64 bits)	Identify interfaces connected to one link

The Aggregatable Global Unicast Addresses can be used for 32 bits IP addressing by inserting 96 zeros between the prefix and the 32 lsbs.

The Site LocalUse Addresses are used for internal networks in organisations, and uses 16 bits for Subnet ID and 64 bits for Interface ID (38 bits after the prefix are 0).

The Link LocalUse Addresses are used for internal networks without a subnet ID. 54 bits after the prefix are 0, and 64 bits are used for Interface ID.

Inter-domain Routing, IDRP

If a router shall be able to select the best route to any destination, it should ideally keep information on all networks and sub-networks in its routing table. But this gives extremely large routing tables. To avoid this, the routing is made hierarchical and provider oriented, each provider controlling his domain. The backbone routers have to cope with Inter-domain routing only. Routing information is exchanged using the Inter-domain Routing Protocol, IDRP. The IDRP uses the IP datagram protocol directly (payload number=45), and identifies domains by variable-length address prefixes. See RFC xxx and ISO 10747 for details.

Intra-domain routing, OSPF

A router within a provider's domain maintains detailed routing information for that domain. Default routes are used to enter other provider's domain. IPv6 recommends the OSPF (Open Shortest Path First) protocol for controlling intra-domain routing and building an internal topology map of routers and sub-networks for the domain. Each router checks regularly the state of the links to neighbouring routers. The IPv6 OSPF uses the IP datagram protocol (payload number=89) and multicast addressing. Details can be found in RFCs 1583 and 1587.

A very simple alternative to OSPF is RIP (Route Information Protocol) for IPv6. RIP packets are carried by UDP packets, that in turn are payload in IP packets. See RFCs 1387 and 1388.

Dynamic Configuration

Configuration of TCP/IP parameters for a host can be carried out by means of DHCP (Dynamic Host Configuration Protocol). This involves procedures for allocation of IP addresses, see RFCs 1971 and 2131. One function is: The host sends out a Solicit Message as a multicast message to all DHCP servers, with source address equal to the Link-local address (e.g. Ethernet address). The servers reply with an Advertise Message using the source Link-local address, and with their own IP address as payload. Messages are sent using UDP and port numbers 547 and 546.

Internet Control Message Protocol - ICMP

The Internet Control Message Protocol, ICMP, is part of IPv6 and is used for discovery of the network neighbourhood, to report errors and to report congestion in routers, see RFCs 1885 and 1970.

The Neighbour Discovery Procedure is concerned about the relation between the IP address and the Link-local address (media address) used by the medium between servers and routers.

The ICMP Message is sent as payload after the IPv6 Header with Next Header = 2.

The format of the ICMP is:

ICMP Message:

Type (8 bits)	14 different types are defined, see ( )
Code (8 bits)	Use dependent of type
Checksum (16 bits)	Standard IPv6 checksum
Reserved (32 bits)	Dependent of type
Message body (variable length and format)	

An example of error report use is when a router discards a packet and sends an ICMP error report back to the source of the packet.

IPv6 and link protocols

Individual IPv6 packets are transferred as payload of the link protocols. Home or single office users normally just dial-up the ISP through the telephone network (analog modem or ISDN), and use a PPP link protocol. Other possibilities are ATM, token ring, ethernet, or ADSL.

Flows

IPv6 supports real time flows, combined with resource reservation using the RSVP protocol (Huitema). If TCP or UDP are used, several parameters including port numbers must be used for id of streams. The analysis in routers and servers becomes inefficient, but worst-case is when packets are encrypted, then the port numbers are also encrypted. Then the Flow Label of the IPv6 header can be used to identify the stream in a simple way.

The HTTP/1.1 Web protocol

The HTTP/1.1 (HypterText Transfer Protocol) has been introduced by several vendors in their Internet/Web equipment, but is not yet widespread. There are several good reasons for using version 1.1 (and not 1.0) in the TSS network: The mechanisms for caching control, and that each connection (normally TCP) permits pipelined HTTP/1.1 requests.

HTTP/1.0 is currently the most widespread protocol for transferring Web documents.

Ari Luotonen has given a detailed description of the HTTP/1.1 protocol applied in Web proxy servers.

The HTTP/1.1 protocol is documented in RFC 2068 titled “Hypertext Transfer Protocol – HTTP/1.1”.

Requests and responses

HTTP/1.1 is an ASCII text based request/response protocol. The client sends a request for a resource (=object) to the server, and the server sends back a response. Often, HTTP/1.1 uses a TCP/IP connection (via a BSD socket interface) through a network of routers and proxy servers, between the client and server.

An HTTP/1.1 request consists of:

METHOD URL HTTP/ *version*
... General headers ...
... Request headers headers ...
... Entity headers (optional) ...
empty line
... Request entity (if any) ...

An HTTP/1.1 response consists of:

HTTP/ *version status-code reason-line*
... General headers ...
... Response headers headers ...
... Entity headers (optional) ...
empty line
... Resource entity (if any) ...

Example of request:
A Web browser client (type Mozilla/4.0) requests the TSS Web Server for an HTML page. Images of type gif and jpeg are accepted. Note that the destination IP address (shown in blue) is part of the URL.

GET http://www.tssws.no/mydir/mypage.html HTTP/1.1
User-agent: Mozilla/4.0
Accept: text/html, image/gif, image/jpeg

Example of response:
The server (type Netscape,,,) sends back an HTML page of length 3417. The status-code 200 means Ok. The reason-line just says Ok

HTTP/1.1 200 Ok
Server: Netscape-Enterprise/3.0
Date: Sun, 5 Jun 1998 07:33:24 GMT
Content-type: text/html
Content-length: 3417
…….. HTML document content …..

Note that in this case the content was an HTML page. It could as well been a stream of MPEG-2 Video PES packets. See MIME types below.

The HTTP/1.1 request *METHOD* indicates the requested action. Some methods are standardised, but the designer is free to add new ones.

Methods

HTTP/1.1 defines a number of methods with the following meaning:

GET	retrieve a resource
HEAD	retrieve metadata
POST	form submission
PUT	upload file
DELETE	delete a resource
TRACE	trace a proxy chain
OPTIONS	query server options

The GET method is used to retrieve any type of resource (HTML page, mpeg-2 file, Java applet, or any other well-defined 'thing'). Conditional GET is very useful for caching, see later section. GET can not cause any permanent change in the server.

The HEAD method is similar to GET. Responses to HEAD do not return content.

The POST method is used for submitting HTML forms. POST is applied when a user orders a product or service (multimedia or TV-) through some Web server. POST causes permanent changes in the server database, and the user shall always be asked before a POST request can be re-transmitted. Responses from POST requests shall not be cached, if not explicitly stated in a header.

The PUT method is used to change or create new resources.

For more details, see RFC 2068

MIME media types

HTTP/1.1 support transfer of several Web resources, indicated by the MIME (Multipurpose Internet Mail Extensions) media type in the Content-type: header. For example, "text/html" means category "text" and sub-type "html". The main categories are: (( ) means example)

text/*	text data (text/html)
image/*	image data (image/jpeg)
video/*	video data (video/mpeg-2)
audio/*	audio data (audio/wav)
message/*	(message/http)
model/*	(model/vrml)
multipart/*	multipart MIME message (multipart/mixed)

application/* data not covered by other categories

Note that it is possible to transport a complete MPEG-2 TV service by using the multipart/* category. If ‘ports’ (sub-addressing) are required, the video and audio PES packets, SI, CA, and other real time date should be packed into UDP, otherwise PES packets can also be put directly into HTTP/1.1 as payload. For real time transfer, the “flow mechanisms” of IPv6 should be utilised.

Caching terms and calculations

According to the HTTP/1.1 specification, the goal of caching is to eliminate the need to send requests in many cases, and to eliminate the need to send full responses in many other cases. Note that ‘object’ and ‘resource’ have the same meaning. Some important headers for caching are described later. The specification uses the following terminology:

Freshness of Objects:
A fresh object is one that can be used without verifying that it is up-to-date. The opposite is a stale object.

Age of Objects:
The time elapsed since the time the object was originally transferred, or the time since the last up-to-date check was made. The age is an estimate since clocks in HTTP/1.1 are not synchronised. The following variables are used in the estimation for the age of object:

age_value: Value of the Age header received from the upstream proxy.
date_value: Value of the Date header, as generated by the origin server when creating the original response
expires_value: Value of the Expires header, generated by the origin server
request_time: Time when the request was initiated
response_time: Time when the response was received
now: The current time

apparent_age = max(0, response_time – date_value)
corrected_received_age = max(apparent_age, age_value)
response_delay = response_time – request_time
corrected_initial_age = corrected_received_age + response_delay
resident_time = now – response_time
current_age = corrected_initial_age + resident_time

Freshness Lifetime of objects:
The time when the object can be cached and used without carry out an up-to-date check. The following variables are used for estimating the freshness:

freshness_lifetime = max_age_value (derective specified in Cache-Control:)
freshness_lifetime = expires_value – date_value
response_is_fresh = (freshness_liftime > current_age)

Headers used for caching:

The HTTP/1.1 specification defines 46 different Headers, within the four categories shown in the request and response structures above. Entity headers describe the content of request and resource entities (content), respectively. Headers that can be used for caching are treated here, else see RFC 2068.

Age:
This header specifies the number of seconds since the response entity was generated by the origin server.

Date:
Indicates the time and date when the message was generated

Expires:
The header specifies the expiration date and time of the object

If-Modified-Since:
Can be used in conditional GET requests. Return the object only if it has been changed since the specified time.

If-Unmodified-Since:
Typically used in a PUT request for update of an object on a server. Update the object only if it has not been changed by others since specified time.

If-Match:
Can be used in conditional Get request. Return the object only if the specified tag matches the header-tag of the stored object.

If-Non-Match:
Inverse of If-Match.

If-Range:
A special version of If-Match, used to ask for a missing part of an object.

Cache-control:
This is the most important header for caching. Can be used to control caching both in proxy servers and end users. Together with its cache-directives, all caching operations can be controlled.

The HTTP/1.1 specifies the purpose of this header as:

> "The Cache-Control general-header field is used to specify directives that MUST be obeyed by all caching mechanisms along the request/response chain. The directives

specify behaviour intended to prevent caches from adversely interfering with the request or response. These directives typically override the default caching algorithms. Cache directives are unidirectional in that the presence of a directive in a request does not imply that the same directive should be given in the response."

Cache-request-directives:

no-cache	The origin server orders cache servers to perform a complete up-to-date check of the cached objects.
no-store	A cache server shall not store any part of the request or any response to it.
max-age	The maximum age of an object a user can accept.
max-stale	User can accept a stale object
min-fresh	The user requires that the object has at least a remaining freshness lifetime as indicated
no-transform	The proxy must not change anything of the entity body
only-if-cached	The user asks for those objects cached, even not complete
cache-extension	The Cache-Control header can be extended using the cache-extension directive.

Cache-response-directives:

public	Object can be cached by any cache
private	Object can not be cached by shared caches; for one user only
no-cache	The cache server shall perform a complete up-to-date check before caching the object??
no-store	A cache shall not store any part of the response or the corresponding request
no-transform	The proxy must not change anything of the entity body
must-revalidate	Forces users and cache servers to perform up-to-date check at the origin server when the cached object is stale.
proxy-revalidate	See must-revalidate, for proxy servers only
max-age	The maximum age of an object a user can accept
s-maxage	Overrides the max-age for shared caches (not for private)

For more detailed descriptions and use, see RFC 2068 and (Luotonen).

Authentication and encryption

HTTP/1.1 does not support secure authentication or encryption of content. However, end-to-end client-server security can be provided by the SSL (Secure Socket Layer) protocol. Included are authentication, privacy and message integrity (Gai). Several protocols, e.g., HTTPS, are built on SSL.

Routing, Caching and Load Distribution in TSS network

The TSS network shall support the basic future services Enhanced broadcast TV, Interactive TV and Web/Internet access on TV, and layer-structured multimedia services that are combinations of the three basic services. In addition, the TV equipment can be used for games. The traffic mix these services generate shall be handled by the network in order to optimise the user satisfaction and assure the service providers (service and network operators, content providers, equipment providers) competitiveness and a reasonable profit.

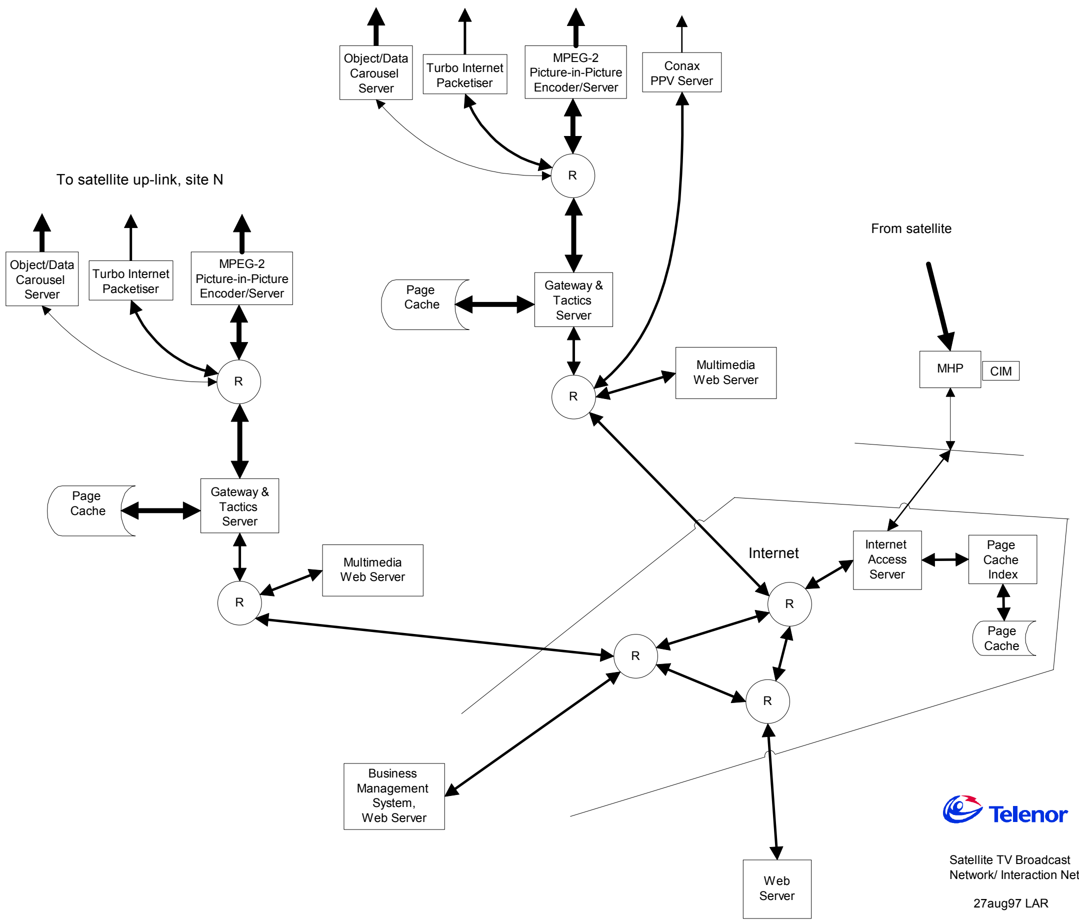
Performance provided by routing, caching and load distribution schemes, in this case the performance experienced by the user and measured by

- Time from request sent until start of reception of response - **latency**
- Time for the actual transfer of the response (the usable data, e.g. a page with pictures) – **response transfer time**

From a user's point of view, the latency time can be both local MHP latency and network latency. In both cased, the latency is often to long. The response transfer time is normally short for MHPs, but often very long for the network.

To minimise the latency in the network, the round-trip delay must be short, that is, the network must provide sufficient transmission and processing capacity all the way from the user to the server where the URL object is stored and back again, compared to the offered traffic. The second bullet requires that the transmission capacity for responses from where the URL object is stored and all the way to the user is large. If the URL object is stored in a cache 'nearby', both the latency and response transfer time become short. At the same time, some traffic is removed from the rest of the network, giving better performance or the possibility for more users on-network simultaneously. Seen from a cost point of view, the entire network has become more cost-effective and competitive. This in turn means lower cost for the users and more profit for the network operator.

As shown in Figure 5, the future TSS network requests will (at least to start with) be routed via terrestrial Internet, while responses can be routed via satellite. A question is where the caches shall be placed. In most cases, the response data are much larger the request data. This means that the traffic to the up-link cache is small, while the traffic from the up-link cache to up-link equipment is large. To minimise the transmission cost, it is proposed to place caches near up-link sites.



Abbreviations:	R	router
	MHP	Multimedia Home Platform
	GTS	Gateway and Tactics Server
	ODC	Object and Data Carousel
	TWS	TSS Multimedia Web Server
	PIP	MPEG-2 Picture-In-Picture Encoder/Server
	BMS	Business Management System
	CIM	Common Interface Module
	IAS	Internet Access Server

Figure 5 Routing and caching in future TSS network

Routing

Since the satellite channel is (for the time being) one-way for responses, requests have to be sent terrestrially. The extended IPv6 address space permits that each user can have several IPv6 addresses. This is convenient for individual MHPs and broadcast to groups of MHPs: Use fixed source IPv6 addresses, one for terrestrial internet access, one for satellite transmission and several broadcast group IPv6 addresses. Group IPv6 addresses shall be allocated for 'carousel- turbo users' on demand.

Two domains (at least) will be defined for each MHP, one for the terrestrial IAS he is connected to, and the other for the actual GTS. Corresponding Aggregatable Global Unicast Addresses (source) for the domains will be allocated to each MHP. The user may also see other up-link sites and use several source IPv6 addresses. When the user wants to use 'the Turbo' he sets his GTS source IPv6 address in all requests. Further, all requests are supplied with a Routing header with the first IPv6 address equal to the IPv6 address of the GTS. Then, all requests will be routed via GTS, and all responses will be routed to GTS, which forwards them via satellite. GTS can then always check whether the URL object has been cached in GTS or not. See header structure in the next section.

Authentication and encrypted transfer

The SSL protocol provides client-server authentication, encryption of content and message integrity, but intermediate servers can only build an end-to-end 'tunnel' for requests and responses. This means that the tunnel has to be established between the MHP and the Web server via GTS and the satellite. This, in turn, means that SSL-protected objects cannot be cached in GTS, or be forwarded to a carousel. The proposal is therefore to use the security headers defined by IPv6.

The IPv6 authentication header computed by the origin server does not prevent caching of an object in GTS. However, encrypted objects should not be cached if the encryption scheme (keys etc) has not been negotiated between the Web server and the MHP in advance (using Cache-control header with 'no-store' directive) and stored in MHP.

The authentication header shall be used for access control to the GTS. Even if a user can manually input a correct TSS source IP address (for turbo use), he has to know the secret authentication keys (TBD) to get his request accepted by GTS (TBD).
All 'turbo user' requests shall have IPv6 Authentication and Encrypted Security Payload headers. The TSS IPv6 header structure then becomes:

	meaning
IPv6 Header:	
Version (4 bits)	Protocol version (0110)
Class (8bits)	Priority class
Flow Label (20 bits)	Flow/stream identification
Payload Length (16 bits)	Length of payload (see below)
Next Header (8 bits)	Identify the type of next header or payload (43)

Hop Limit (8 bits)	Max number of hops allowed
Source Address (128 bits)	IP source address
Destination Address (128 bits)	IP destination address
Routing Header:	
Next Header (8 bits)	Identify the type of next header or payload (51)
Hdr Ext Len (8 bits)	Length, no of 64 bits words after Reserved field
Routing Type=0 (8 bits)	Default Routing Header (others are allowed)
Segments Left (8 bits)	Number of 64 bits segments left, see below
Reserved (32 bits)	Set to zero
Address[1] (128 bits)	IP address
Address[2] (128 bits)	
…	
Address[n] (128 bits)	
Authentication Header:	
Next Header (8 bits)	Identify the type of next header (52)
Payload Len (8 bits)	No of 32 bits words following SPI
Reserved (16 bits)	0
Security Parameters Index (SPI) (32 bits)	Agreed security configuration
Sequence Number Field (32 bits)	Used to control the uniqueness of packets
Authentication Data (variable length)	
Encrypted Security Payload header:	
Next Header (8 bits)	Identify the type of next header (6)
Payload Len (8 bits)	No of 32 bits words following SPI
Reserved (16 bits)	0
Security Parameters Index (SPI) (32 bits)	Agreed security configuration
Sequence Number Field (32 bits)	Used to control the uniqueness of packets
Payload:	
max 64 Kbytes of encrypted data	TCP packet (typically)

See previous sections for detailed description of each header. The Encrypted Security Payload header structure depends on the encryption algorithm in use (TBD).

Real Time Flow

Today, Internet does not support controlled real time flow. In the near future, services like telephone, videophone, videoconferencing and distant learning (all based on IP) will be introduced (Western show). To control the flow the RSVP protocol (Huitema) (Thomas) can be used. It is also possible to apply the routing header of IPv6 together with network admission control (Rønningen), in order to control the flow in reserved, prioritised parts of the network. Services like distribution of TV signals from studios to up-link sites using controlled IPv6 flow should be considered (TBD).

Actual Caching schemes

In the TSS network standard HTTP/1.1 cache control is applied. This means no private solutions, and that standard software can be used.

TSS needs the following (TBD) caching schemes:

On demand:
An object is cached only after request from a user. If GTS registers that the request rate for an object is larger that a configured value, the object is cached. If a requested object is cached by GTS when requested, the Freshness Lifetime has to be checked, and maybe updated. Secured objects are discussed above.

On command:
The GTS or other cache servers retrieve and cache certain objects at configured intervals. This shall be used for both the EPG server and the general TSS Web server.

Pre-fetching:
A cache server fetches object that are likely to be requested soon, for example, pictures belonging to a page that is requested, or other pages referenced by hyperlinks.

Load distribution

Compared to load-balancing schemes used on the Web, different terms are used here, and the functionally is extended to fit the TSS Web server system.

Load sharing:
The same object content is copied to several physical (clustered or geographically distributed) servers.

> Different IP addresses are allocated to the servers, and groups of users (under ISPs) are advised to use 'nearest' IP address (mirroring)
>
> Different IP addresses are allocated to the servers, and groups of users (ISPs) shall use pre-assigned IP addresses (Round-Robin DNS)
>
> A single IP address is allocated to all servers, and one server receives all requests and redirects them to other servers

Route distribution:
ISPs (or other user-groups) use different routes from their domain to GTS

Hierarchy, meshed networks and star networks:
Users will normally be connected to their Internet access server (IAS) in a star network. IASs with high traffic intensity between them should be interconnected in a complete (or nearly complete) meshed network. Several IAS networks can be formed in this way. Depending on

traffic intensities, the IASs can be connected together in a star (or a nearly complete) meshed network on the top of the hierarchy.

Carouselling

A 'turbo user' can subscribe on services that are output from carousels only. The content on the carousel can be addressed by UDP port number, IPv6 group address, IPv6 flow number, or by a file directory and file name. When carousels are used together with caching and normal Internet access, a group IP address will be allocated. All types of group addresses shall be broadcast to all MHPs from a carousel, using a common address_configuration_file (TBD). The MHP shall before sending a request, search the address_configuration_file. As always, requests are routed to GTS, which returns a response with the UDP port, the group IP address, the IPv6 flow number, or the file directory and file name to be used by the MHP (TBD).

The strategy for transfer from a cache to a carousel is as follows: When a URL object is very popular, that is, requested more frequently (or is expected to be) than a configurable number, transfer the object to a carousel, set the cycle time = f(popularity, etc) and start the play-out. Allocate the address identity to the carousel content, play out the address_configuration_file, and save the file for any request.

Performance of the combined network, alternative solutions

A number of papers have been presented regarding performance of Internet, e.g., (Best), (Allman98), and also of TCP via satellite (Allman97). This document models the combined network. First, a short qualitative evaluation of the network is carried out.

Performance characteristics of the network

IPv6 routing control:
IPv6 defines a routing header that can be used to direct traffic from user groups to different part of the network. Users that want to pay more can then get access to high-performance parts of the network that cannot be reached by others.

Advantages with caching:
The average number of hops used by requests and responses in the overall network are reduced. The latency time and the response transfer time are reduced. The same effect can be obtained by placing TTS Web servers close to up-link sites.

Advantages with carouselling:
When a large number of users want the same information, satellite broadcasting gives the lowest user cost and the best performance.

Disadvantages with the centralised GTS:

The GTS has to process all requests from users belonging to the satellite footprint. This may be tenths of millions users. Many, but short requests load the links to GTS.
However, the response traffic to GTS can always be routed in the most cost-effective way. When objects are cached in GTS, the capacity that else have to be used between the origin server and GTS becomes free for other use.

Alternative:
An alternative is to introduce non-standard handling of caching, and distribute the GTS handling of requests on IASs. The IASs must then maintain a register for objects cached in GTS (and also carouselled) and order GTS to send the object. A private, special protocol between GTS and IAS has to be defined. This is certainly possible, but is not standard HTTP/1.1.

Performance evaluation methodology

Even if one believes that proposed concepts for enhanced performance will be successful, experience shows that it is not always the case. Systems are often so complex that to get an overview of the consequences of the design choices in advance is difficult. The answer to this problem is application of systematic performance evaluation methods in design. For an introduction to performance evaluation theory and practice, see (Rønningen).

Performance evaluation in design has been focused for a long time, but systems are still designed with excellent functionality but unsatisfactory performance (Internet, Web). L A Rønningen puts focus on performance evaluation in design in his dr.ing. thesis.

Performance evaluation comprises a number of phases, i.e., system study, model specification, model design, model implementation, and model application. Simulation and/or analytic models are used, often in combination. Theories about systems, modelling, testing, stochastic processes, traffic, queuing, simulation, mathematics, statistics, measurements, etc., are applied.

Performance evaluation in design is characterised by that no system exists, and the performance models have to be built on design models. Of course, the model can be validated by measurements when the system is implemented and in operation. Examples of performance evaluation in design can be found in (Rønningen).

Performance of TCP in the combined network

The TCP protocol, see RFC 792, uses sliding window flow control. Figure 6 below illustrates the three-way set-up between MHP and GTS (or TSS Web mall server), cached TCP data sent via satellite and acknowledge returned via the terrestrial Internet. The figure also illustrates the slow-start scheme with gradually increasing window size immediately after a TCP connection is established. Normally, when a data segment of say 1 kbit is received, acknowledgement can start. However, the GTS processing capacity is shared between several requests, so waiting will occur between play-out of each data segment. The figure shows a case with window size equals three segments (slow start), and the acknowledgement for the first segment does not reach GTS before the sliding window stops the flow.

The performance model established so far is simplified and will include only mean value analyses. The MHP, the GTS (including multiplexer and satellite channel) and the Internet connection between MHP and GTS, can be modelled as simple M/G/1 queues (Rønningen). It is assumed that a number of independent sources send messages to the queues. Poison arrival processes are then reasonable approximations (= negative exponentially distributed inter-arrival times).

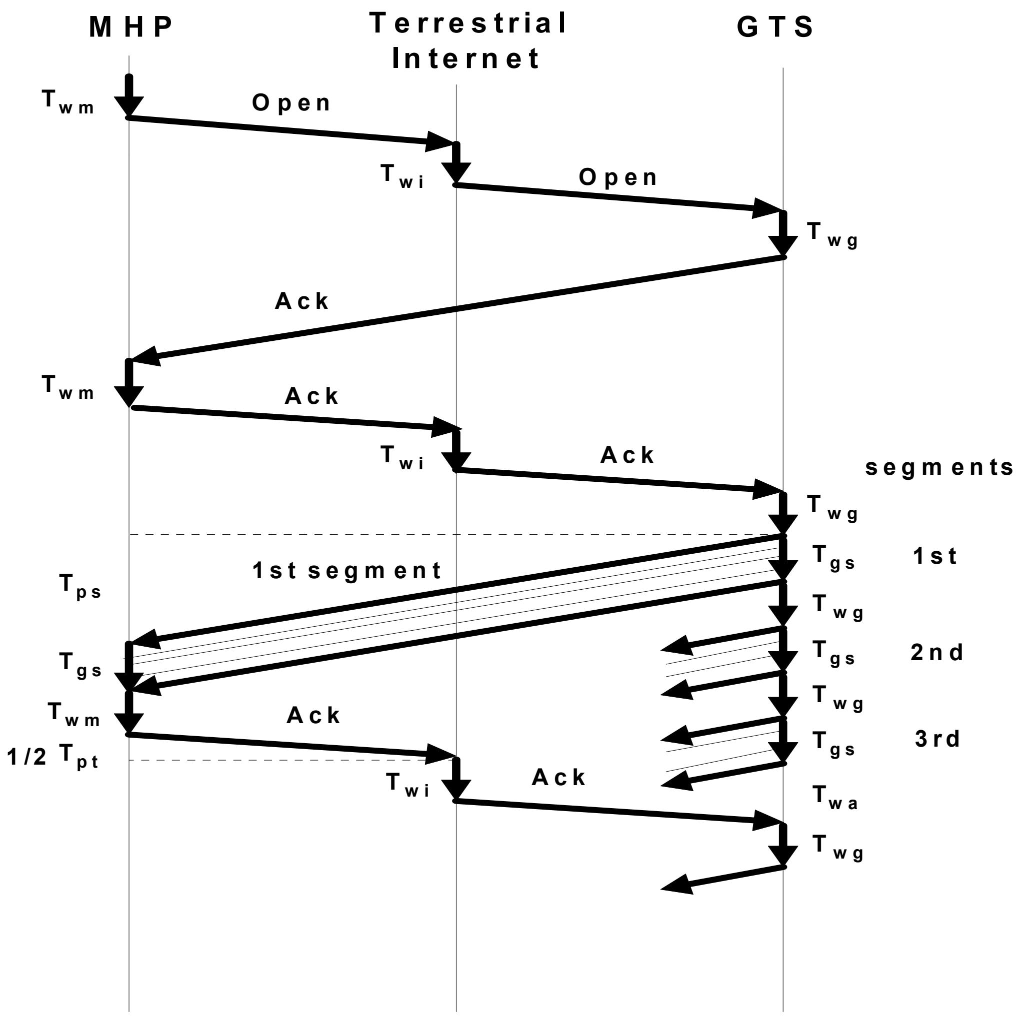


Figure 6. The flow of TCP messages in a combined network.

The following mean values and variables are defined:

Tps - The propagation time from the earth to a geo-stationary satellite and back
Tpt - The mean propagation time on terrestrial Internet
Twm - Mean waiting time after a data segment is received until ack is sent from MHP
Twi - Mean waiting time in the terrestrial Internet (aggregated)
Twg - Mean waiting time in GTS from one data segment is sent until start of next
Tgs - The time used to send N bits to the satellite
Twa - Mean time GTS has to wait for ack when 'the window is out', and the ack timeout has not expired (>= 0)
N - The segment size = the number of bits that can be sent out before acknowledge is required
M - The number of data segments in a window
C - The capacity of the satellite channel, bits/second
ρ - Utilisation of the channel for one TCP connection
Ca - Mean bit rate on the channel for one TCP connection

The mean latency time

The mean latency time (the three-way open sequence) becomes

$$2*(Twm + Tpt + Twi + Twg) + Tps. \qquad F1$$

This should not be larger than 3 seconds, where 2*Tpt + Tps contributes with maybe 0.5 seconds. The mean waiting time in MHP, Internet and GTS together, should be less than 2.5 seconds.

Maximum mean TCP bit rate

There will be no waiting for acknowledgement in GTS when Twa = 0.

Then the utilisation of the channel for one TCP connection becomes

$$\rho = Tgs/(Tgs + Twg) = N/(N + C*Twg) \qquad F2$$

The maximum mean bit rate becomes

$$Ca = \rho*C = N*C/(N + C*Twg) = 1/(1/C + Twg/N) \qquad F3$$

If Twg = 0 then Ca = C as it should be.

Mean TCP bit rate, waiting for ack

Furthermore, when GTS has to wait for acknowledgement (Twa > 0), then

$$\rho = \text{'useful time'}/\text{total time} = M*Tgs/\{M*Tgs + (M + 1)*Twg + Twa\} \qquad F4$$

or

$$\rho = M*Tgs/(2Twg + Tps + Tgs + Twm + Tpt + Twi) \quad \text{F5}$$

$$= M*Tgs/(Tgs + T1) \quad \text{F6}$$

where

$$T1 = 2Twg + Tps + Twm + Tpt + Twi \quad \text{F7}$$

$$Tgs = N/C \quad \text{F8}$$

Then the mean bit rate becomes

$$Ca = \rho*C = M/(T1/N + 1/C) = M*N*C/(T1*C + N) \quad \text{F9}$$

The time for the acknowledgement to pass through Internet (Twi) will likely be the critical factor. The examples below illustrate this.

Example 1: Assume that Twg=0.05sec, Tps=0.24, Twm=0.05 Tpt=0.05 and Twi=0.5sec. Then T1=1sec. Assume C=1Mbps, N=8kbit, M=64, then Ca=500 kbps.

Example 2: Same as example 1, but Twi=1.5sec. Then Ca=130 kbps

Example 3: Same as example 1, but Twi=4.5sec. Then Ca=100 kbps

Example 4: All delays except Tps=0.24, are zero, C > 2 Mbps, else as example 1. Then Ca=2 Mbps

There are at least three limitations with TCP that with simple means can be modified, and enhance the performance considerably (see report from TCP seminar):

- The slow-start mechanism should be by-passed when the the payload in most TCP packets are short
- The maximum window size should be extended
- Selective retransmission should be introduced when the bit error rate is high.

In Chapter 5 it is shown how TCP can co-operate with other protocols in order to increase the performance.

MPEG-2 Parallel Picture-In-Picture streams and Web access (5)

Introduction

The main advantage of the MHP compared to a TV or a PC, is that high-performance, low-cost, specialised hardware can be shared for decoding and processing of demanding multimedia services like Web/Internet access, enhanced data/TV broadcast and interactive TV. In addition to outstanding performance, the MHP retail price becomes low.

The MPEG-2 standard permits the transmission of several parallel video PES stream, each occupying parts of the screen. However, when showing Web pages, using interactive TV or playing games, the screen content has to change dynamically, initiated by the content provider or the viewer. This is not satisfactorily supported by the MPEG-2 standard, ('target_ background_grid_descriptors' and 'video_window_descriptors', sections 2.6.12-14) which apparently is specified for more static situations. In this document different schemes for using the MPEG-2 standard for dynamic picture-in-picture applications will be presented.

In the combined TSS network, the MHP sends all Web requests terrestrially through the telephone network and receives all responses via satellite. The text (and maybe the graphics) content of a HTML Web page will be transferred unaltered, while all pictures, video and sound cuts shall be converted to MPEG-2 PES at the satellite up-link site, transmitted via a fast satellite channel (up to 45Mbps), and presented in rectangular windows on the MHP screen as indicated by the HTML page. Note that with HTML 4.0, the Web page look and feel can be determined by style sheets, downloaded to the MHP in advance or on demand.

The MHP Web browser uses the HTTP/1.1, TCP, IPv6 protocol stack for terrestrial, and in addition UDP and MPEG-2 PES for satellite transfer. Below IPv6, the satellite link uses DVB multiprotocol encapsulation, and the terrestrial connection uses PPP on analog modem, ISDN or other. The MHP Web browser can also cover the basic TV navigation (control) functions.

The up-link equipment shall synchronise A/V PES streams according to the MPEG-2 standard. Synchronisation of HTML pages and MPEG-2 A/V PES streams shall be handled by the content provider, GTS and MHP. For general multimedia plays with several distributed acting groups, see Chapter 3, synchronisation signals as outlined (TBD) have to be defined in detail.

PIP via TCP

When the Web browser has fetched a Web page, the user can request pictures, video and/or sound cuts via hyperlinks (see Chapater 3). The HTTP request results in a response from a Web server, and the content of the IPv6 packet shall be converted into MPEG-2 in real time at the up-link site, and the IPv6 packet sent via satellite to the MHP Web browser. The Web browser then wakes up the MPEG-2 decoder (hardware) which decode the contents at TV speed, and places it in a window on the screen, determined by the Web page. This service can be presented on the screen together with normal TV.

Since the TCP protocol has to be satisfied, all bytes that are sent from the Web server have to be acknowleged properly from the MHP. The number of bytes in the IP packets therefore have to be maintained through the satellite network.

This scheme is functionally similar to the PC solution. The extra TCP and IP layers introduce some overhead, but supported by hardware, this still will give low cost and good performance. The intention is to design hardware for the decoding in order to increase the performance and reduce the cost. An advantage is that no changes of standards are needed..

As shown in Chapter 4 the average data rate for each TCP connection via satellite is limited by TCP itself, propagation times, channel data rates, traffic, and processing. The practical data rate per TCP connection may be 200-800 kbps. Channel capacities have to be allocated according to wanted low-traffic data rates and to actual high traffic. The processing can always be speed up using parallel processing and specialised hardware solution.

PIP via MPEG-2 directly

The user can by means of his Web browser, request pictures, video and/or sound cuts from Web servers. The request results in a response from a Web server, and the content of the IPv6 packets shall be converted into MPEG-2 PES in real time at the up-link site. However, the A/V content shall be transferred in parallel to the IPv6 stream as MPEG-2 PES streams. The MHP MPEG-2 decoder decodes the contents at normal TV speed, and places the content in a window on the screen, as indicated by the Web page.

The TCP protocol is used by Web servers and the MHP, and each byte sent must be properly acknowledged. However, to increase the performance of transfer of Web objects from TSS Web servers (with high-capacity links to the up-link site multiplexer) and also objects cached in TGS, it is desireable to avoid using the relatively slow TCP protocol on the satellite link. There are several possibilities, described in the following sections. The simplest is to consider all converted MPEG-2 PES streams as TV streams not taking part in the Web server – MHP conversation. First, MHP sends a request using the HTTP/1.1 HEAD method to TGS (always to TGS, see Chapter 4. TGS forwards the request using the GET method to the actual Web server, and receives a HTTP/1.1 response with the Web object. Between TGS and the Web server the TCP protocol is satisfied. When TGS has received the Web object, the MPEG-2 conversion of the object content is performed and the PES packet is sent via satellite. Simultaneously, TGS responds on the HEAD method with an HTTP/1.1 entity header with the PES **stream_id** used (see below), but not any content to the MHP. TGS then acts as a proxy that handles the HTTP/1.1, TCP, IPv6 protocol stack correctly towards Web servers and MHPs.

Each fetched Web object has to be identified by TGS, and the identity copied into the MPEG-2 PES header, so that the MHP Web browser can identify the objects and present them correctly in the Web page on the screen. The PES header parameter **stream_id** with values C0 to DF (audio) and E0 to EF (video) can be applied (operational rules).

This scheme gives very high performance when Web objects either are cached in TGS or are stored in TSS Web servers. The traffic in the terrestrial parts of the networks is minimized. The scheme also enhance the performance when the capacity in the backbone Internet is high, while the capacity of the terrestrial telephone line capacity is low. The overhead processing for the MHP is minimised.

An advantage is also that only standard protocols are used, nothing is new.

For synchronisation of multimedia compoenets, see section above.

PIP via IPv6

This scheme is a small extension of the 'PIP via MPEG-2 directly'- scheme above. The PES packets are transferred as payload in IPv6 packets. The identity can still be put into the PES **stream_id**, but alternatively the IPv6 **flow label** can be used.

Else, all features as outlined for 'PIP via MPEG-2 directly' are valid.

PIP via UDP

This scheme is a small extension of the 'PIP via IPv6'- scheme above. The PES packets are transferred as payload in UDP, IPv6 packets. The identity can still be put into the PES **stream_id**, the IPv6 **flow label** or the UDP **port** parameter.

Else, all features as outlined for 'PIP via MPEG-2 directly' are valid.

General requirements to subsystems

A large number of streaming and non-streaming formats may be presented to GTS. The most used on Web today are probably GIF and JPEG for still pictures, AVI for video and WAV for audio, that can be activated (automatically or manually) from an HTML page. Other used formats are PNG, Midi, DV, BMP, MPEG-1, MPEG-2 and several other formats use in professional production. Coming are IP based telephony and video-telephony (H.323 specification, etc).

QuickTime), SMIL, and Java Media Framework e.g., supports synchronisation of events and streams in multimedia plays.

TSS Web servers shall provide all pictures, video and audio objects in MPEG-2 PES formats. The objects shall be requested using the GTS – MHP protocol stack (se above), and the responses shall be sent directly to the PIP subsystem.

When a Web object is requested more frequently than a configured number, the object can be put on an object carousel. The object carousel can carry PES, UDP or IPv6 objects (TBD), but defines it own transport protocol.

MHP shall be able to handle at least three MPEG-2 video PES streams simultaneously, one of them is the main TV stream.

The MHP shall receive and show mp@ml pictures and videos on standard TV (interlaced or progressive), and full spatial and temporal resolution with progressive scan as defined for HDTV, see Chapter 3.

The window size and rectangular form can be set in steps of 8 pixels, limited by the MPEG-2 block size of 8x8 pixels. The smallest window is then 8x8 pixels while the largest can cover the whole TV screen.

The user shall be able to move and resize windows within the screen. Windows can be placed overlapping or side-by-side.

TSS Network Subsystems (6)

Introduction

The subsystems shall support the combined satellite broadcast and Web/Internet system, providing enhanced broadcast-, interactive TV- and Web/Internet services. DVB, MPEG-2 and Web/Internet standards shall be used as far as possible.

Communication between subsystems shall be based on HTTP/1.1, TCP, UDP and IPv6 protocols for primary services and for operation and maintenance of the subsystems.

Operator Interfaces shall be based on Web browser technology, including HTML with Javascript, Java, and be scalable to XML.

Physical and link layer solutions shall be based on existing equipment implementing PPP on analogue modems, Ethernet, token ring, FDDI, ATM, DSL, ISDN, leased lines, etc.

Several subsystems will include standard hardware, network operating systems (e.g., Microsoft NT 5.0, Netware 4.0, Unix), general-purpose data base machines and specific applications.

Resource usage (transport, processing, storage) and time regarded primary services shall be logged for each IP address, and be reported to BMS for billing and statistics.

Several subsystems shall be accessible by users that a priori have got permission. Other subsystems shall be accessible by authorised personnel only. The basic security shall be handled by authentication and payload encryption on the IPv6 level as described in Chapter 4. In addition, routers shall check IP source addresses and reject unwanted packets.

Gateway & Tactics Server

The Gateway & Tactics Server, GTS, is an extended proxy server that support on-demand caching and transfer to carousels when certain conditions are met. Another main function is to check all incoming IP packets carrying still pictures, video and audio, and order PIP to convert to MPEG-2 PES format in real time. Furthermore, GTS shall convey messages from Multimedia Web servers to PIP regarding play-out of PES packets from PIP (if the workload on GTS is large, a direct link may be established).

Caching shall be implemented according to HTTP/1.1. All MHP user requests are routed via GTS, and when a Web object is requested, GTS checks whether the object is in its cache or not. If the object is not in the cache, GTS decrypts the request (the IPv6 payload) and routes the request further to the destination server. When a Web object is requested more than a certain (configurable) number of times per time unit, the object is cached. If a cached object is not requested within a certain (configurable) time, the object shall be removed.

When a Web object has been requested more than a certain (configurable) number of times per time unit, GTS shall transfer the object and the wanted cycle time (configurable) to a carousel server. GTS shall also allocate a group IPv6 address to the object, and return the address to MHPs when requests (HTTP/1.1) for the object arrive.

Requests regarding operation and maintenance (TBD) shall be routed further to the destination immediately without decryption, but the authenticity shall be checked.

All MHP user and network operator requests and responses shall be authenticated and encrypted as specified by IPv6, see Chapter 4.

GTS shall log resource usage time start and stop and volume (bits) per IPv6 address. Resources are storage, processing and satellite transport. The log shall be forwarded to BMS for billing at configured times or when the log is X% full (configurable).

MPEG-2 Picture-in-Picture Encoder/Server

The MPEG-2 Picture-in-Picture Encoder/Server, PIP, converts non-MPEG-2 video, pictures and audio IPv6 packets into MPEG-2 PES stream IPv6 packets. The IPv6 packets are then sent to a packetiser, that outputs corresponding transport packets. When the TCP protocol is used, the length of the payload must be maintained (insert stuffing bits if neccessary). The size and form of the windows on the MHP screen for the video and picture streams, is determined by the associated HTML page. Details of formats used via satellite are described in Chapter 5.

Examples of incoming formats to be handled are Quicktime, GIF, JPEG, MPEG-1, WAV, PNG, AVI, DV, H.323.

PIP shall be able to handle requests from Multimedia Web servers regarding play-out of MPEG-2 PES A/V stored a priori in PIP. Details of formats that can be stored and sent via satellite are described in Chapter 5. PIP shall be able to handle start, stop, halt, fast forward, fast backward, next record, previous record, selected record, and selected sequence of records requests.

PIP shall be able to handle MPEG-2 main profile & main level and HDTV levels as defined in Chapter 4.

The window size and form can be set in steps of 8 pixels, limited by the MPEG-2 block size of 8x8 pixels. The smallest window is then 8x8 pixels while the largest can cover the whole TV screen.

Operation & Maintenance Centre

The OMC shall support the following (TBD) features:

- Report to central OMC
- Deny accessed by unauthorised personnel by means of IPv6 authentication and encrypted payload
- Download software to MHP as a service, on behalf of software vendors (see section ,,)
- Download software to other sub-systems
- Collect logs of errors
- Collect logs of traffic
- Receive alarms and warnings
-
- etc (TBD)

Multiplexing

Statistical multiplexing

In order to statistically multiplex a number of incoming MPEG-2 signals, their individual bit rates must be random and independent. However, from time to time the sum of the bit rates will exceed the maximum rate of the output channel (assumed constant). Bits can then be queued or rejected. In real time systems, the queuing size has to be limited, and bits will be lost. Within certain limits, this is acceptable with video and audio, but not with data in general.

Equipment providing statistical multiplexing, is in production from several firms, e.g. Scientific Atlanta and Philips. The scheme involves MPEG-2 encoders handling variable bit rate encoding.

Adaptive multiplexing

Adaptive multiplexing as proposed here, is based on estimating the instantaneous bit rate of the variable bit rate of each of the incoming MPEG-2 signals. This scheme is very efficient if one can queue up bit streams that do not require real time transfer, and send when there is spare capacity. The individual bit rates can be estimated by counting the number of transport packets per stream sent in a certain time. Transient problems may occur, and can be minimised by using prediction (e.g., Kalman filter).

Other sub-systems

MPEG-2 Encoder
Such equipment is supplied by a number of manufacturers, e.g. Tandberg, Philips and Tompson. Recently, HDTV encoders have been introduced in the American market.

DVB Object and Data Carousel
An architecture for carousels have been presented by Arild Hollås, TSS.

Turbo Internet Packetiser
The packetiser is described in detail in several documents from maXware.

SI Server
The existing SI servers are delivered by Tandberg.

Pay-per-view Server
Conax has developed and installed such servers in the TSS network.

Router
General purpose IPv6 routers are available, e.g. from Sisco Systems

EPG/TV guide Server
TSS has together with Tandberg developed an EPG server.

Multimedia Web Server
Multimedia Web servers are described in Chapter 7. As far as possible the servers apply standard, available technology.

Commerce on digital TV/Internet/Web (7)

L A Ronningen, TSS, 26nov98. version 1.1

Introduction

In this document the concept of electronic commerce includes marketing and presentation of, search for, selling, buying and payment for products by the combined TSS TV/Internet platform described in the previous chapters. 'Product' is an umbrella concept which includes all sorts of tangibles and intangibles, such as TV programmes, multimedia (layered-) applications, multimedia games, multimedia presentations, software, hardware, food, cloths, cars, communications, tourism, projects, education, housing, energy, reports, newspapers, information, and what else thinkable. The products can be bought/sold according to two main principles: subscription and impulse-buy. Payment can be carried out as credit-, up-front- or immediate payment. The only difference between the commercial handling of these products should be the way they are transported and presented to the customer. The TSS Web mall handles all electronic commerce as described in the following sections.

Most annoying are systems with excellent functionality but bad performance. WWW/Internet is presently such a system. The capacity is too low for so many users! The combined TSS platform increases capacity, performance and functionality, and provides a unified user interface for the customers.

Electronic Payment Principles

Electronic payment whether it is credit, up-front or immediate, has to support several basic requirements, e.g., secure transfer, authentication, protection of user privacy and low overhead. A number of different implementations are in use today, all based on the possibility to keep some keys (and maybe algorithms) secret to other than authorised personnel, and that the encryption algorithm is irreversible. An introduction to the subject can be found in http://www.counterpane.com .

Subscription, pre-booked PPV and token PPV for TV

The basic TV services have for some time been offered as combinations of:

- Subscription, credit or up-front payment
- Pre-booked and token Pay-Per-View (PPV), credit or up-front payment
- Free of charge – financed by commercials.

Access control is carried out as specified by DVB ( ). The IRD implements access control by means of a Common Interface module with smart-card, or by a smart-card that directly can be inserted into the IRD.

Credit and up-front payment invoices are normally transported by physical post, but can already be paid using secure Web technology.

Pre-booked PPV, using Telenor Conax/TSS/Nokia technology was introduced in the TSS satellite network in October 1997. This scheme allows users to buy TV programmes in advance. Experience from practical life has shown that most users buy programmes just before start (Canal+). For popular programmes the interaction traffic will be large. To provide a satisfactory performance for the users, all sub-systems have to be dimensioned to handle the top traffic. This is an expensive solution. An advantage with the scheme is that the operator can get immediate figures of the popularity of programmes. A disadvantage of the existing solutions using analog modems, is the long set-up delay.

The extended token PPV service as proposed here, can withdraw tokens or coins from the user's bank account and deposited in the smart card. The user discounts his smart card as he views programmes, and the delay from selection of programme to access becomes short. Payment is made to the Business Management System (BMS) on request when an agreed credit and/or time limit is reached. This scheme effectively spreads the extremes of the interaction traffic. This means reduced system cost for both service providers and the end user. The principal flow of messages for token PPV is outlined in Figure 7.

To measure the popularity of each TV programme, the CIM can log the viewing history (sliding window principle). BMS samples a number of CIMs as soon as needed after a programme, but when the traffic in the Interaction Net is low. Note that it is not necessary to request all CIMs, but rather a representative (random) selection from the whole population to obtain wanted confidence interval and level. The size of the selection determines the confidence interval. Normally a size of a few hundreds is enough. The traffic from the requests then becomes quite small.

In near future most TV applications will be written in Java and HTML, which makes it easy to reuse technology from- and inter-operate with the Web/Internet.

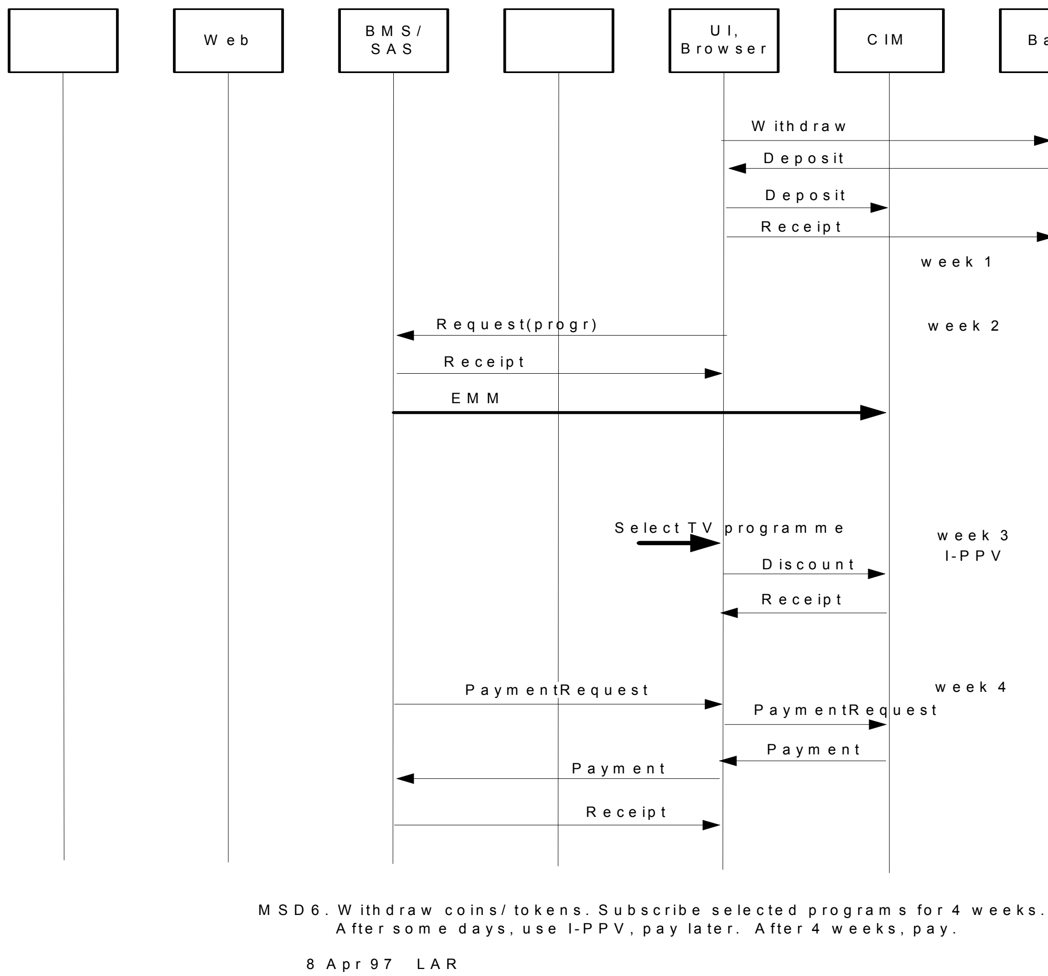


Figure 7. Token PPV

Payment on Web/Internet

Use of Internet/Web for marketing, ordering and payment in USA has 'taken off' during 1998 (http://www.emarketer.com). Since the Nordic countries are among the most advanced regarding Internet, one would expect a similar tendency there. So far, this has not happened, and maybe the insecure payment systems can explain parts of it (hypothesis).

Internet access is normally offered as subscription by an access provider, with or without limited access time per month. The process of commerce can be implemented as multimedia presentations/ searches/ordering (using HTML 'forms') combined with different payment schemes, managed by Web server owners or brokers. Product providers can use the system to market any product (as defined in the introduction to the chapter), TV services included.

Three different categories for electronic payment on Web are considered here:

> *'The credit card category'*:
> The customer validates the purchase by sending his encrypted credit card number and details about the payment electronically to the vendor. The vendor forwards an electronic invoice to the credit card company, that can decrypt the credit card number, and send a secured electronic invoice to the user. Then the user pays and gets a receipt, all electronically. Note that the credit card company controls the transactions, but the vendor or a third person do not get hold of the credit card number.
>
> *'The cheque category':*
> A person X sends a secure electronic cheque to another person Y, and informs his bank about the transaction. Y can then cash the check or make an electronic transfer to his bank account. The bank controls the transactions.
>
> *'The cash category':*
> A person X withdraws some coins (tokens, cash money) from his bank account and deposit in his electronic purse/smart-card using secure electronic transfer. When a bargain is closed between X and another person Y, X sends secure tokens to Y. Y may deposit the tokens in his bank account, or use them in a bargain with a company Z. This is very much the same as using physical cash. The advantage of the cash scheme is that the transactions only can be traced if someone tries using the tokens more than once.

SET is a credit card category payment system introduced by credit card companies.
See http://www.visa.com/cgi-bin/vee/nt/main.html?2+0 .

One actual payment system of the cash category is **ecash**, providing three different transfer schemes (http://www.digicash.com/index_e.html):

- Withdraw cash from own bank account and store in PC.
- Send payment from person X to person Y
- Answer a request for payment, after ordering of products or services

Anonymity and untraceability are built into the protocol by means of 'blind' signatures. When X withdraws a cash coin from a bank, X draws a random number associated with the coin. The bank adds a public key digital signature to the coin, encoded by means of the random number from X, and sends it to X. For a transaction to Y, the validity of the coin is checked by Y's bank. Y's bank request X's bank to verify the digital signature by means of the associated public key. This scheme is similar to that shown for Token PPV in the previous section.

All information regarded as private is normally secured on transport layer using SSL (secure socket layer), see xxx.

Most security schemes are based on public key cryptography. To obtain a satisfactory security level the key length should be more that 1kbits, see http://www.counterpane.com .

Commerce on basic TV

TV programmes are sold to viewers as subscription with or without conditional access, or Pay-Per-View using smart cards. Bills are normally paid via other media.

TV is used for marketing products, while the customer uses his telephone to buy. Commercials are presented in between programmes in some countries, and also within programmes in other countries. Research has shown that TV is a strong marketing medium ( ) compared to other media.

Commerce on Web/Internet

The Web is a great way to connect people, also for sellers and buyers. For the buyers the store is open 24 hours per day, information about products can be analysed according to needs and the order placed when it is convenient. The seller can reach customers everywhere, and it is very much cheaper than opening a physical store.

Market research shows big interest in commerce on Web. World wide 1997, goods worth about $1.8 billion were sold on-line. Projections indicate $4.5 billions in 1998, and $35 billions in 2002. More than one-third of large corporations in USA already uses Internet for sales (http://www.emarketer.com).

The commerce on Web/Internet today is roughly of two types, individual Web shops or common Web malls as described below.

The Web mall

The idea behind the Web mall is the same as for the physical mall. The retailer is off-loaded by the mall owner who establishes the infrastructure needed to run a retail business. The retailer can establish a complete business in a few hours.

A Bebak (http://www.currents.net/covr) has compared four different e-commerce solutions (see references below), and concludes that they all can do the job quickly, cheaply, and fairly completely, and with Jahoo! Store as the preferred choice. Furthermore, PC Computing ( ) picks Yahoo! Store as one of the top 10 products of 1998. Overall, Yahoo! Store seems to be considered the best choice, and will be described shortly here.

Yahoo! Store 4.1 features:

Yahoo! Store 4.1 is stored on Yahoo!'s Web server, and each retailer gets his own URL.

The buyer interface is good-looking, and intuitive and easy to use.

The order, inclusive credit card details are secured by SSL

Yahoo! Store 4.1 makes is very easy and fast to set up an electronic store (less than an hour).

Yahoo! charges the retailer $50 per month for up to 50 products, $300 per month for up to 1000 products, and plus $100 per month for each additional 1000 items.

The sales catalogue can be filled out using a Web browser and HTML forms for each product, or imported as a CSV-formatted data base file. There is also freedom to personalise the look and feel. Pictures and graphics can be inserted.

Twelve different shipping methods can be selected, including electronic transfer, standard post and express. Tax and shipping costs are added automatically.

All type of products, intangibles included, are handled.

In addition to the standard (manual) credit card payment, Yahoo! Store offers several types of ordering, e.g. billing orders. Yahoo! Store does not process credit cards, this has to be handled by the retailer. Yahoo! supports the back-end credit-card processing system **PC Charge,** which can be bought separately (http://www.hallogram.com/pccharge/intrface.html) for about $ 330. Major credit cards are supported. Payment via electronic cash (e.g. **ecash**) is not yet supported.

Yahoo! Store provides a lot of sales statistics of very high value to the retailer.

For more information, see Yahoo! Store 4.1
http://store.yahoo.com

Some other available solutions and addresses:

ShopZone 2.0
http://www.breakthroughsoftware.com

iCat Commerce Online 1.0
http://www.icat.com

ShopSite TX 4.0.1
http://openmarket.com

Individual shops

Development of a new, highly automatic Web shop will probably cost more than $100,000 ( ). Product catalog, HTML forms for ordering and payment, shipping system, back-end payment system, and statistics system have to be developed. However, most ISPs offer some support for this at a low cost.

Commerce on the combined TSS TV/Internet platform

A strength of the combined platform is that products can be marketed using flash presentations on the TV in the living room, interleaved with TV/multimedia programmes, and that hyperlinks can be established directly to the TTS Web mall. Furthermore, the combined platform offers 'turbo' performance and low-cost broadcast to groups. All parts of the platform, MHP included, are shared between more services, which means lower usage cost.

Business development

The mall system shall provide multimedia services as outlined in Chapter 3 and general e-commerce as described in this chapter.

Buyers shall use the living-room Multimedia Home Platform (MHP) for all multimedia services, commerce included. This gives low cost per service.

Both credit card schemes and the ecash scheme should be extended and realised using Common Interface and smart-cards for the MHP. All 'secrets' and user personal data (including IP addresses) should be stored in the smart-card, and handed over to the MHP when necessary. This opens up the possibility for mobile usage (should be handled as roaming in GSM). Furthermore, the access control functions for normal TV should be implemented on the common smart-card.

The TSS Web mall shall include multimedia Web servers, EPG servers and BMSs, and provide access to general Web servers. Frequently used information can be fetched from Web into the mall on command (see caching).

The TSS network supporting the mall, shall provide enhanced functionality and performance compared to terrestrial networks.

All Telenor companies (as retailers) shall be offered to use the TSS Web mall (BMSs) for commerce (in addition to their present marketing and sales) ('Telebutikkene', Telenor mobil, Net, etc)

Buyers shall meet Telenor through a Web browser front page, communicated by the TSS Web mall. Hyperlinks to multimedia servers, EPG servers and BMSs shall provided.

Retailers shall pay to BMS for use of storage, transport and processing

Buyers shall pay the retailers for products, and BMS (as a special retailer) for A/V PES products, EPG service, Internet access, usage of cache and carousel storage, satellite transport and processing.

ISPs shall charge BMSs for buyer's terrestrial Internet access.

Capacity and functionality of the TSS Web mall shall be offered firms and organisations in Europe.

Jahoo! Store or other, shall be licensed

ecach or other, and credit card back-end payment systems shall be included

In the next section one possible distributed organisational structure of the TSS Web mall is described.

The TSS Web Mall Architecture and Performance

The TSS Web mall includes multimedia Web servers, BMS servers, EPG servers and carousel servers. In addition, Internet Web servers can be accessed. The distinction between the servers has its background in the integration of two different systems, and the difference is on the application level only. The multimedia Web servers, BMSs and EPG servers can be based on the same hardware, the same operating system and the same Web/Internet protocols (HTTP/1.1, TCP, IPv6). Standard Web browsers can be used when accessing the servers.

Objects that are fetched from remote Web servers can be cached in the GTS. It is, however, of no value to cache objects from the TSS Web mall in GTS, because there is already high capacity all the way from the TSS Web mall via satellite to the end user. But when an object is requested more frequently than a certain value [a configurable parameter] within a certain [configurable] time, it shall automatically be put on a carousel.

TSS BMS:
The TSS BMS shall implement the following application functionality (see also http://www.conax.com):

- Customer registry for subscription and PPV
- Product registry for each customer
- Accounts
- Encryption key authorisation, output of smart-cards, output of entitlements,
- End user/buyer payment system for A/V PES and multimedia services, GTS cache-, carousel- and satellite channel usage.
- Retailer payment system for mall services, GTS cache-, carousel- and satellite channel usage.
- Co-operating partner payment system
- Online payment via credit cards and electronic cash, and payment as today.
- Customer care functions, based on telephone – manual and talk-machine guidance, fax, Web access and email

- Statistics and reports

Other BMSs:
(TBD)
Web/Internet technology

Multimedia Web servers:
The multimedia Web servers shall provide the following applications:

- Telenors front page presentation, hyperlinks to TSS BMSs, other Telenor BMSs, EPG servers
- Front page for retailers
- Functionality as described for Jahooh! Store in earlier section
- Electronic cash payment and credit card payment support
- Output of flash presentations to TV studio and directly to mux
- Put objects on carousel when requested more often than at a certain rate.
- Route all turbo user responses via satellite

Carousels:
The carousels can be DVB data or object carousels with the following functions:

- Out-cycling of objects received from Multimedia Web servers, GTS or EPG servers, or directly from customers with access permission.
- Register users and usage, report to BMS for payment

EPG server:
The EPG server has the following functions:

- Output of EPG objects to carousels when requested more often than at a certain rate
- Response to terrestrial Web users
- Receive input from operator or customers with access permission
- Register users and usage, report to BMS for payment
- Links to the PPV sub-system

The simple mall network shown in Figure 2 can be used for a ‘slow-start’ business. When the traffic in the network increases, the high-performance architecture in Figure 8 is effective, but can be used via satellite only. It is, however, possible to make all connections two-way, in order to serve also terrestrial Web users. Other architectures are of course possible.

To ensure the performance of the terrestrial request network, it is recommended to build a parallel net to existing Internet (using Internet technology), reserved for users that want to pay for high performance. This will give better service to the others too.

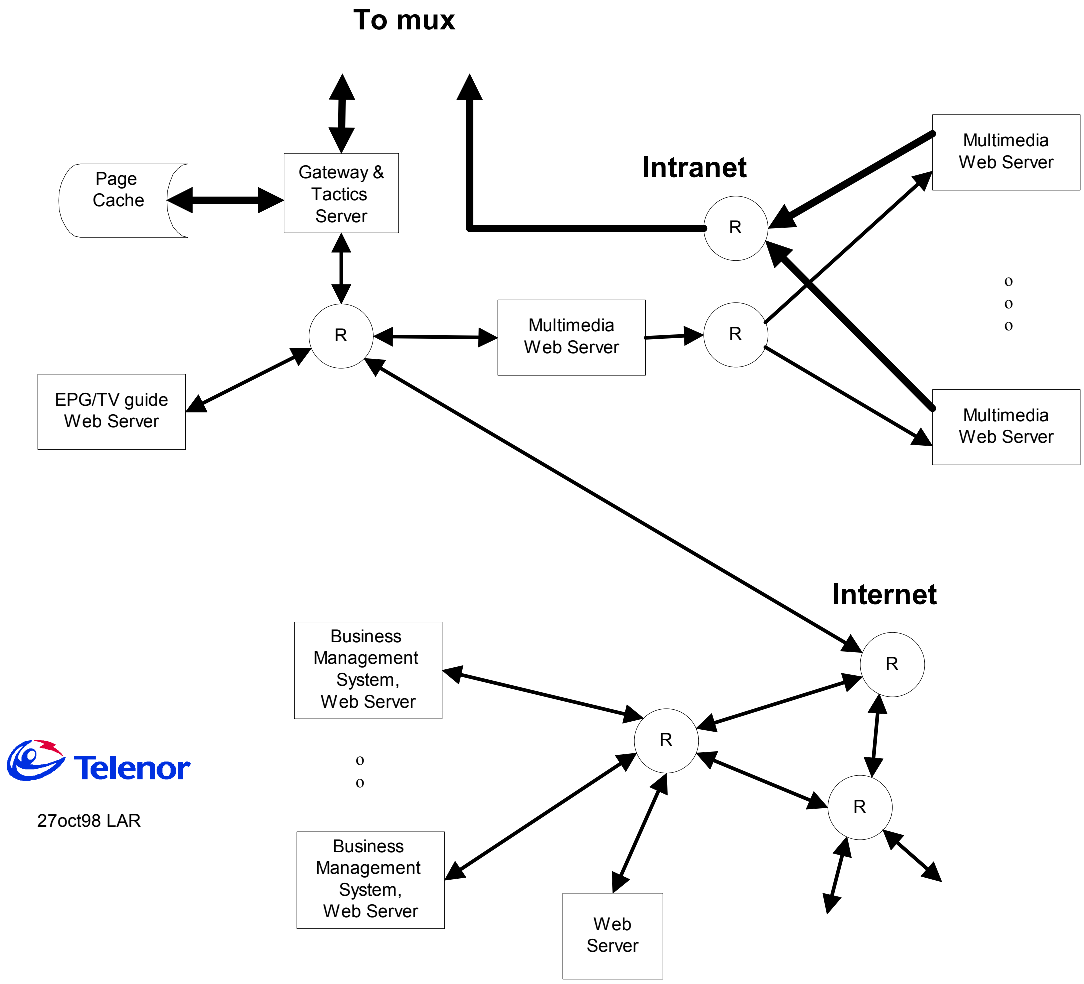


Figure 8. **The TSS Web mall service system (at one up-link site) consists of TSS Multimedia Web servers, EPG servers, distributed BMSs and Web/Internet in general.**

Business Structure between ISP, BMS and TSS (8)

Introduction

This chapter puts focus on functional business entities, not on actual companies running the business. The internal business structure of the combined TSS network should not be visible to the end customer.

For the time being, the role of BMS includes only that of the SMS (subscriber management system) operators. BMS functions beyond the level of SMS are defined here.

SMS operators market and sell TV programmes to the users, as bundles of single channels, or as nearly video on demand. Subscription and PPV are used. SMS operators maintain customer databases, which are their real assets. They buy content from content providers, and transport and conditional access services from network operators.

With existing practice, the user must have direct business relationship with SMS operators, local ISPs and/or local PSTN-providers, companies using Web for commerce, and other companies, to search into, order and pay for use of TV channels, telephone, Internet access, multimedia services and products in general.

To maximise user-friendliness, it is important to reduce the number of user/business access points (for ordering, payment, info, etc.) to the combined TSS system. The user should receive *one* bill for all sub-services, however with a hierarchical specification of used resources and corresponding payment. However, the Web commerce has to be handled separately, as described in Chapter 7.

The functionality in BMS can be based on Web server technology and extended to handle the combined user/business access point outlined above. This involves implementation of TCP/IPv6 and HTTP/1.1protocols. BMS can also be regarded as part of the TSS Web server system, see Chapter 7.

The user shall have the choice if he wants to interact with BMS using a Web browser, the telephone with ‘push-a-number-guide’ and automatic answering, the telephone and conversation with a ‘customer care person’, or by visiting a customer care desk in Telenor’s or representative’s retail shops.

The payment system of services shall be based on combinations of fixed monthly fees, resource usage fees (for processing, storage and transport), and acceptance of advertisements. If the user do not want to see advertisements, he pays maximum price for the service. In the other end, the service is free of charge if the user accepts to receive all sent commercials. Or the user will have the possibility to choose something in between.

The resource usage shall be registered in each actual sub-system, and reported to BMS regularly, when the traffic else in the system is low, or when the amount of stored data exceeds a configured level. When IPv6 is used, the resource usage shall be registered per IP address (always unique per user) together with the time start and duration. The user name can be used when the IP address is not available.

The BMS organisation shall also take care of marketing of services, in co-operation with the service providers involved.

In a system providing combined TV and Web services, there are at least five actors: users, service and network operators (distributors), content providers (producers), equipment providers, and external society actors.

A number of characteristics of the services and the equipment presenting the services are common to all actors, but are experienced by the users and offered by the others. The 'godness' of these characteristics can be summarised in the concept of Quality of Service, QoS:

- Service repertoire/functionality
- Easy to buy, install, maintain and upgrade
- Usability, appearance, easy-to-learn
- Performance
- Reliability
- User initial cost, usage cost and upgrade cost

Content providers, service and network operators and equipment providers have to focus on

- QoS
- Customer satisfaction
- Competition
- Investments
- Operation and maintenance cost
- Income and profit

This involves

- Research
- Development (and/or purchasing)
- Production
- Marketing

of services and products

Business structure in Norway/ Sweden and other countries

As pointed out above, the number of business access points between the customer and the service providers should be as small as possible, and generally show the right level of QoS compared to the competitors. A business structure that satisfies this requirement is shown in Figure 9. In those cases when Telenor /Telia provide a complete service including satellite, cable and terrestrial transport, and ISP, SMS and PSTN business functions, the control of QoS- and cash flows is an internal organisational matter. It should then be stright-forward to introduce the BMS functionality as described above and in Chapter 7.

It is convenient to divide the ISP functions into Internet access functions, caching functions, and Web services functions. In the combined TSS network, both caching and Web servers are planned, and also general access to Internet. As long as TSS has not established interaction channel via satellite, the user equipment has to be connected to a terrestrial network (ISDN or other). In this case, the intention is to implement the interaction network by means of terrestrial Internet technology, and TSS then have to make agreements with ISPs to deliver Internet access, or establish own Intranets. When the interaction channel is provided by satellite, the roles of the ISP as well as PSTN, are not longer needed in the satellite network. The GTS (see Figure 2) takes the role as access provider, and BMS becomes the only business access point.

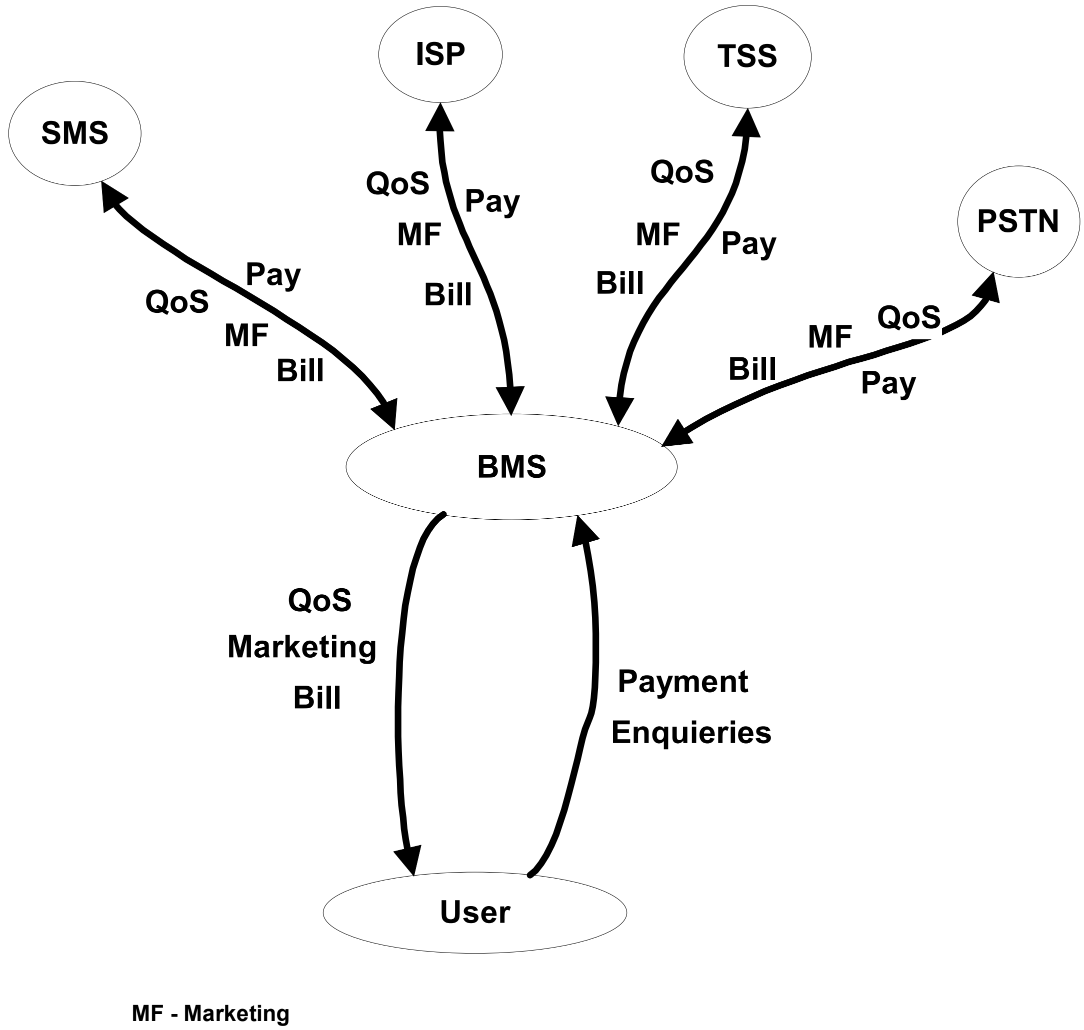


Figure 9. The TSS combined network business relations.

BMS fronts the users, i.e., performs marketing of multimedia services with a certain QoS, and billing. The user pays the bills, and may from time to time direct enquiries about the services to BMS. SMS operators, ISPs, TSS and PSTNs have commercial relations with BMS. This comprice billling and payment for services/QoS, and marketing towards BMS and end-users. Contracts have to be closed to regulate the commerce.

BMS could be established as a limited company, with several SMS operators, TSS and others investors as owners.

When the interaction network by satellite is introduced, the business structure becomes as shown in Figure 10. The sub-system GTS, see Chapter 3, has taken the role as access provider.

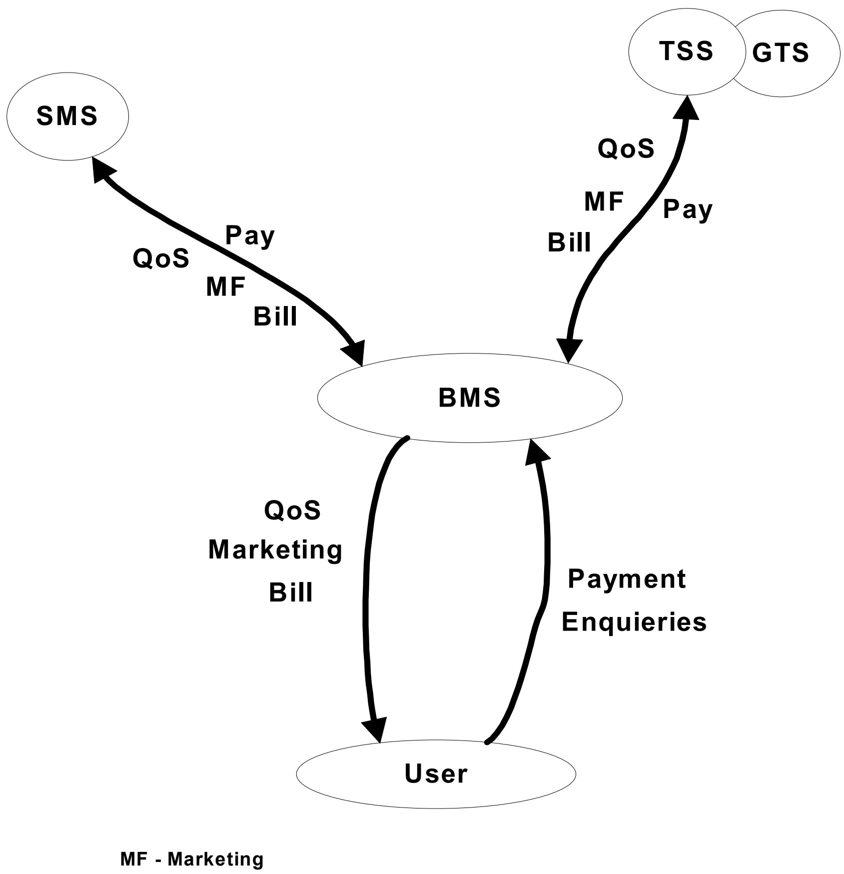


Figure 10. The TSS combined network business relations when interaction networks via Satellite are introduced.