

Thin Technology for a Mobile World

A Technical Whitepaper

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Introduction

This paper provides a complete overview of thin multimedia's end-to-end product suite for the management, encoding, delivery, and playback of digital multimedia through mobile networks and on mobile handsets. tmi offers a comprehensive, flexible, and dependable solution for media, entertainment, and enterprise customers, and tmi has a product solution for every step in the technology value chain. At thin multimedia we are seeing the arrival of our corporate vision: Converging Multimedia for the Mobile World, and fulfilling our corporate mission: To be the Global Leader Providing Mobile Multimedia Communication Solutions & Services.

thin multimedia is a technology leader in the mobile multimedia industry. We are licensed by world-class carriers, handset manufacturers and chip vendors. We have 2G, 2.5G, EDGE and 3G network scalability and complete end to end solutions with both standard and non-standard codecs. These codecs achieve the best benchmarking performances and high performance up to 30 fps in commercially proven applications. tmi is a market leader in the mobile multimedia industry, having:

- Launched the world's first wireless multimedia service
- Nine carrier customers on three continents
- Mass market deployment with over 25 million handsets worldwide

thin multimedia's products are completely software-based end-to-end solutions that provide wireless video download and streaming over existing 2G/2.5G networks and future 3G networks. At the beginning of the process flow, our content encoding tool encodes and uploads content to the server. Our server products manage video download, streaming and live streaming; include a robust Content Management System (CMS); and support a large number of concurrent streaming users while managing server side resources. Lastly at the end of the process flow, our multimedia player for handset manufacturers decodes, plays & captures content, and can be factory installed on a handset or by an over the air download.

It is important to emphasize the interoperability of our system components. This means that thinVideo/thinAudio can also be adjusted to work with other broadcasting or streaming servers, and other players (e.g. Real Player).

The following graphic illustrates the process from a standard video source to viewing on a mobile device.

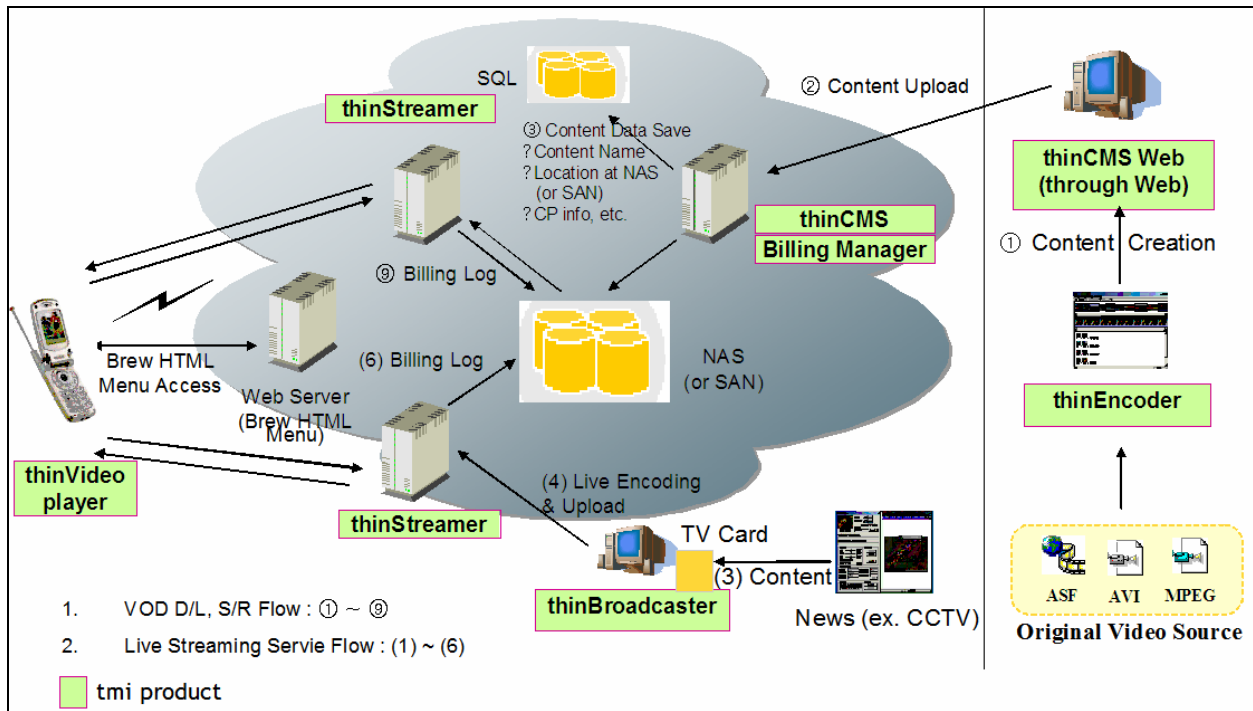


Figure 1: End-to-End System Overview

Preparing Content for Mobile Consumption

Encoding Engine

The *thinEncoder 3.0* is tmi's content encoding tool. It converts standard audio and video files into mobile streaming media clips. Utilizing a simple Windows™ based interface, thinEncoder is perfect for either novice or advanced content creators. thinEncoder can convert any video files that are available in all video formats. In a typical scenario, video files are first edited using high performance video editors such as Adobe Premiere or Pro Tools. Using thinEncoder, content professionals can convert original audio or video files or any format, for example *.mpg, *.mpeg, *.avi, *.asf, *.wmv, *.mp3, *.wav, *.wma, to files ready for delivery to a mobile handset.

thinEncoder supports the following input/output file types:

Input	
Video	MPG, MPEG, AVI, ASF, WMV
Audio	MP3, WMA

Output

System	3GPP
Video codec	MPEG-4, H.263, H.264, No Video
Audio codec	AMR NB, AAC, AAC+
Resolution	112x96, 128x96, 128x112, 176x144, 320x240

thinEncoder System Requirements

- CPU:** Intel Pentium4 3.0GHz above
- RAM:** 512MByte above
- OS:**
- 1) Windows2000 + SP 4 + DirectX 9.0 or higher
 - 2) Windows XP Home Edition + SP2 + DirectX 9.0 or higher
 - 3) Windows XP Pro + SP 2 + DirectX 9.0 or higher
 - 4) Windows2003 + SP1 + DirectX 9.0 or higher
- Others:** Windows Media Player 10 should be installed

thinEncoder Architecture

The thinEncoder architecture is shown in the following figure.

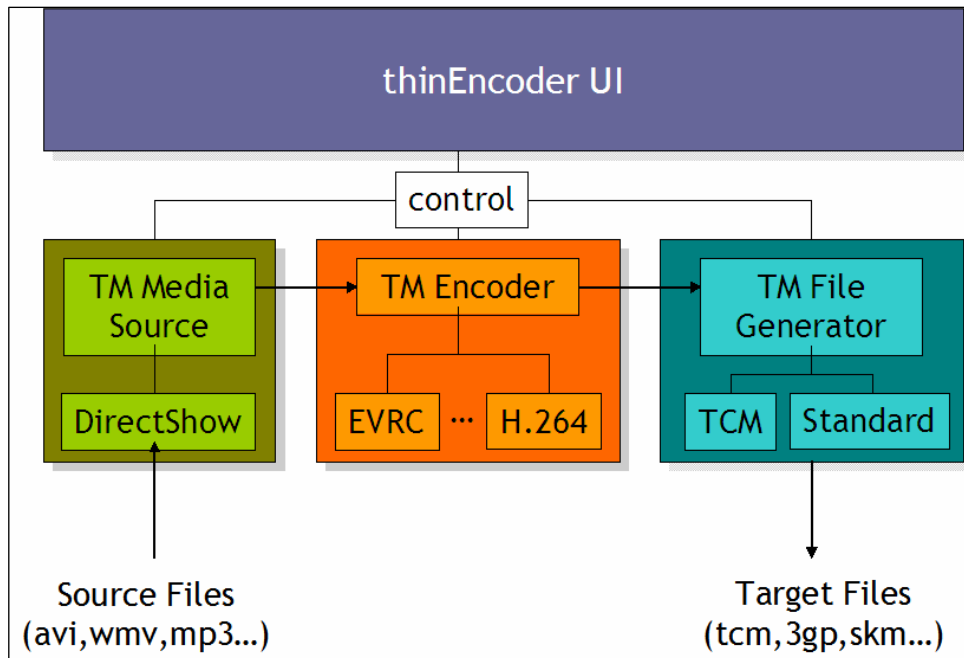


Figure 2: thinEncoder Architecture

The thinEncoder is a fully functional authoring tool, able to preview source audio and video quality, preview target audio or video quality and speed; highly proficient in high speed encoding, low & high end content creation and multiple file support. It has various screen size support, supporting frame sizes from 128 x 96 to 320 x 240, and multi encoding methods supporting a multi-bit-rate encoding mode.

Functional Features Summary

- View the source audio or video clip to be converted
- View converted audio or video clips on simulated a screen of a target mobile handset
- High-Speed encoding optimized for Intel Pentium4 Processor
- Support both high end (MPEG4/H.263/H.264) and low end (TCM3) encoding processes
- thinEncoder supports all types of video & audio file formats such as
*.mpg, *.mpeg, *.avi, *.asf, *.wmv, *.mp3, *.wav, *.wma.
- thinEncoder supports multi encoding methods such as multi-bit-rate encoding mode.
- Image processing such as 'Blur', 'Sharpen', 'Gamma', 'Smoothness', etc. is supported.
- Audio processing such as 'Bandpass filter', 'Amplifier' or 'Volume control' is supported.

thinEncoder Implementation Options

thinEncoder is available as a stand alone web based application, a tmi hosted back-end server, or as an SDK which is fully integrated into a service or content provider's current content production and encoding tool. These three options provide the customer with a highly flexible and customizable implementation of the thinEncoder.

Implemented as a back-end server or as an SDK, tmi's best in class encoding technology and encoder engine is easily accessed through standard API calls. This command line interface (CLI) implementation provides the user with easy, automated, efficient world class encoding capabilities.

Implemented as a stand alone web based application, the thinEncoder allows direct access to encoding parameters for test and development environments as well as some commercial applications through a straight forward GUI.

thinEncoder User Interface

The thinEncoder web application offers an easy to use interface. The main Window has four components:

- Source Window
- Encoding Option Window
- Batch Process Window
- Project Property Window

The Source Window allows you to import media clips. You can open several different media clips at the same time, play them back, and review their file properties in this Window.

You can choose a variety of encoding options in the Encoding Option Window including file type, video and audio encoding options, frame rate, sampling rate, and screen size. Additional video/audio codecs will be added as new rich media types are created.

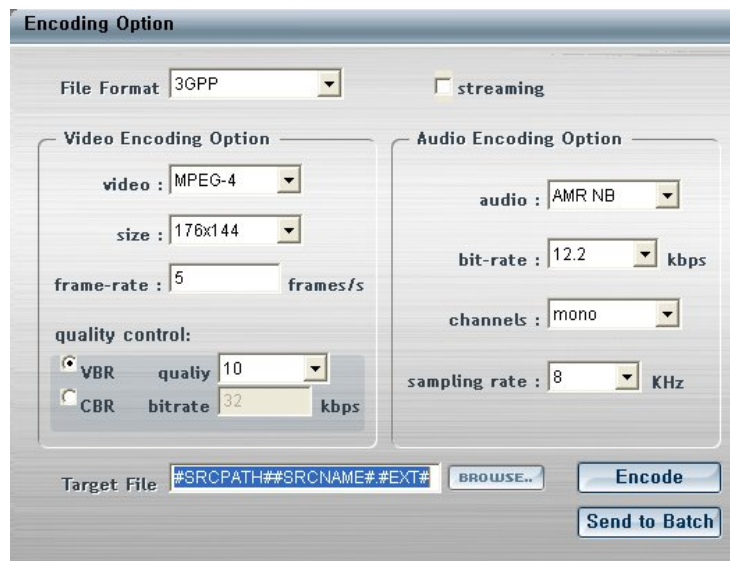


Figure 3: Encoding Option Window of thinEncoder 3.0

The Batch Process Window enables you to encode several video clips at the same time. thinEncoder allows you to batch process multiple media files at one time. You can select different encoding options for each file and schedule a batch process at a later time.

The Project Property Window allows you to review all the properties for each media file in the batch process window.

Examples of Content Creation

- H.264 Content: 15fps, 176 x 144, Converted size less than 500K
 - MPEG4 Content: 5fps, 176 x 144, Converted size less than 400K
- * Original content: .avi format, 12MB, 45 sec length.

thinEncoder Content Authoring tool snapshot

Input File Format	Avi, wmv, mpeg, mpg, asf, wav, mp3, wma, ogg, etc All formats supported by DirectShow filter	
Output File Format	RTP	3GPP(.3gp, .mp4), 3GPP2(.3g2), SKT(.skm) ISMA(.mp4), KWISF(.k3g)
	TCM	TCM(.tcm/.tmd)
Options	Support local play and streaming with one file Audio only, Video only, Audio & Video Support progressive download	
	Batch encoding UI Support hint track	

Video Codec	Standard	MPEG-4 Simple profile, Level 0 H.263 Profile 0(baseline) H.264 Profile 0(baseline) support both VBR and CBR Mode
	tmi	TCM2, TCM3, TCM4 (support only VBR Mode)
Options	Encoding Resolution	SQCIF(128x96), 128x112, QCIF(176x144), QVGA(320x240), CIF(352x288), Multiple of 16
	FPS	1 fps ~ 30 fps
	Options	Key frame interval

Audio Codec	Audio	AAC-LC, AAC+ (8kbps ~) Enhanced AAC+
	Speech	EVRC(8kbps), AMR NB(4.75~12.2kbps), 13K QCELP
Text	Caption	TCM, 3gpp, 3gpp2

CPU	Intel P4 2.0GHz or higher (Intel P4 3.0GHz or higher recommended)
Hard Disk	30 GB free space
Memory	128 MB RAM or higher (512 MB or higher recommended)
Video Card	16-bit color graphics card with 1024x768 resolution 64 MB Video RAM or higher
Required OS	Windows 2000 Pro or higher (Windows XP Pro recommended)
Pre-Requisite S/W	DirectX 9.0 or higher Windows Media Player 10 should be installed Codec package (optional)

Real Time Encoding for Live Streaming

thin multimedia's live broadcast encoding system named *thinBroadcaster* allows you to create a live mobile broadcast by capturing a live broadcast signal (satellite or cable) and transcode it for playback on a mobile device. The technology supports 3GPP, 3GPP2 standards and is compatible with any 3GPP, 3GPP2 compliant system.

thinBroadcaster requires thin multimedia's RTP based *thinStreamer* server. The Technical Specifications are given in the following tables.

thinBroadcaster Technical Specifications and System Requirements

Input	DirectShow compatible capture device
	<ul style="list-style-type: none"> - TV Capture Card - USB PC Camera/Camcorder - IEEE 1394 PC Camera/Camcorder
	All file formats supported in thinEncoder
Output	RTP
Output (Cont'd)	Audio only, Video only, Audio & Video, multiple codec/resolution Compatible with thinBroadcaster and thinStreamer Server
Monitoring	Encoded Video preview
	Real-time statistics of audio/video bit-rate, fps Logging for access and error

Video Codec	Standard	MPEG-4 Simple profile Level 0 H.263 Profile 0(Baseline) H.264 Profile 0(Baseline) support both VBR and CBR Mode
	tmi	TCM2, TCM3, TCM4 (support only VBR Mode)
	Encoding Resolution	SQCIF(128x96), 128x112, QCIF(176x144), QVGA(320x240), CIF(352x288), Multiple of 16
	FPS	1 fps ~ 30 fps (except for H.264)
	Options	Key frame interval
	Audio Codec	Audio
Speech		EVRC(8kbps), AMR NB(4.75~12.2kbps), 13K QCELP
Text	Caption	None

CPU	Intel P4 2.0GHz or higher (Intel P4 3.0GHz or higher recommended)
Hard Disk	30 GB free space
Memory	256 MB RAM or higher (512 MB or higher recommended)

Video Card	16-bit color graphics card with 1024x768 resolution 64 MB Video RAM or higher
TV Tuner	TV Capture Card supported by DirectShow
Required OS	Windows 2000 Pro or higher (Windows XP Pro recommended)
Pre-Requisite S/W	DirectX 9.0 or higher Windows Media Player 10 should be installed

Features & Functions

- Infinite loop – continuously stream video to a mobile device.
- View – preview the video feed in thinBroadcaster, ensuring that thinBroadcaster is capturing and encoding the video.
- File – simulate a live broadcast with a selected source file.

Encoding Options

Video – thinBroadcaster supports H.264, H.263, MPEG4, TCM (HiQ, UhiQ).

Audio – thinBroadcaster supports EVRC, AMR, QCELP, AAC, AAC+

Resolution – thinBroadcaster supports 112X96, 128X112, 176X144, and 320X240.

Frame Rate – Set the frame rate per second for your mobile broadcast.

VBR (Variable Bit Rate) or CBR (Constant Bit Rate) – the encoder can choose either option to ensure a high quality broadcast over a wireless network. This number will vary depending upon the mobile operator's network bandwidth.

Audio Encoding Options – Choose the bandwidth for your audio signal. The appropriate audio encoding options depend on the network performance. In EVDO or UMTS networks, higher performance specs can be used.

Video Statistics – Manage your mobile broadcast bandwidth. View current and average bit rates per second, as well as maximum and minimum bit rates per second.

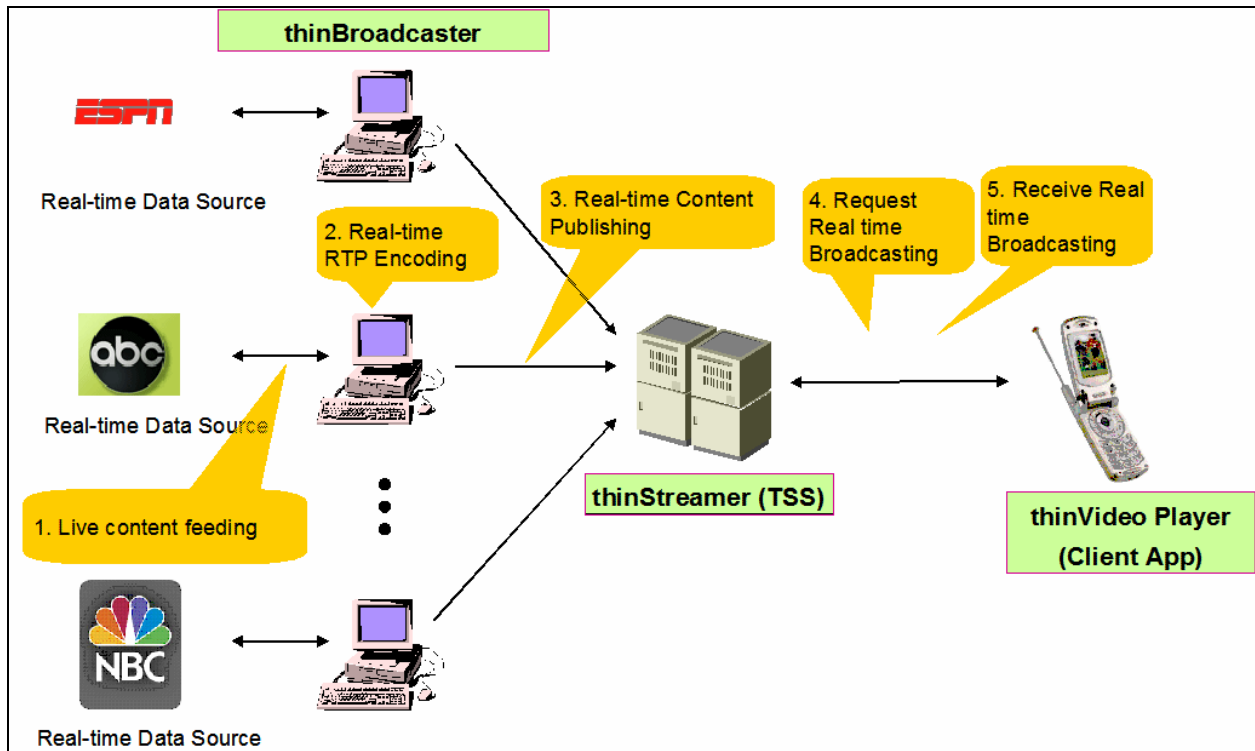


Figure 4: Real Time Encoding System 1

Content Management System

tmi's *thinCMS* system is specifically designed to manage TCM & 3GPP services from a single entry point. *thinCMS* system is made up of several components which are discussed in more detail as follows.

At the core of the *thinCMS* system, is the *thinCMS* Middleware server. It is where all the business logic for handling the database is implemented. It is based on a 3-tier architecture, separating the presentation layer from the business logic layer. It is designed to make it possible to share the business logic and resources among multiple clients. *thinCMS* Middleware server also provides easily accessible SOAP based APIs, which allows external components to invoke its functions. Those APIs provide all the functions needed to perform menu & content management such as registration, modification and elimination. *thinCMS* Middleware server uses standard SOAP based protocols for its interface and so the APIs are easily accessed using high level programming languages such as Java, PHP & C/C++, as well as across multiple platforms.

thinCMSWeb is a web application that provides the user (usually a content provider) an interface to the thinCMS system. It accesses the business logic in the thinCMS Middleware server to enable users to manage menus & contents. It is written in PHP and allows easy customization by exploiting the 3-tier architecture. thinCMSWeb offers content management functionality for both TCM and 3GPP content.

TMFileServer is another component in the system that stores and manages mobile media content, including both TCM & 3GPP files in storage. thinCMSWeb interacts with TMFileServer to upload, modify or delete physical media files in storage. TMFileServer analyzes the metadata of a media file and gives the file a name reflecting its video & audio codec, resolution and unique numerical id consisting of CID (CP ID) & SID (Content Sequential ID). The thinCMS system assigns 5 CIDs to each CP to be used for identifying contents and menus.

TCM & 3GPP files are stored in the same content storage and share the same CID & SID space. But, they are streamed or downloaded to mobile phones by different types of media servers, *thinDownload Server* & *thinStreamer*, respectively. Both servers can be run either from different ports on the same machine, or on different machines.

The content storage is composed of multi-levels of folders and each content file occupies its own folder. This storage structure distributes contents across multiple folders, making retrieving a content file a seamless operation through locating a specific content file based on the content's CID & SID.

thinCMS Web is a software tool for content professionals to manage MPEG4/H.263/H.264 content:

- Registering and uploading contents to thinCMS Server (with FileServer)
- Deleting and modifying existing content
- Registering new menus
- Deleting and modifying existing menu items
- Uploading content is a two step process: registering content, and creating a menu item (called content page) for the content.

thinCMS Web provides a web based UI for the users to manage menus and contents. System requirements of the thinCMS Web tool are simply internet access on any terminal. However, we recommend that the terminal support at least 32bit color with 1024x768 screen size in order

to experience the rich graphical features. thinCMS is based on a 3-tier architecture for flexibility & efficiency as shown in figure 5.

thinCMS System 3-Tier Architecture

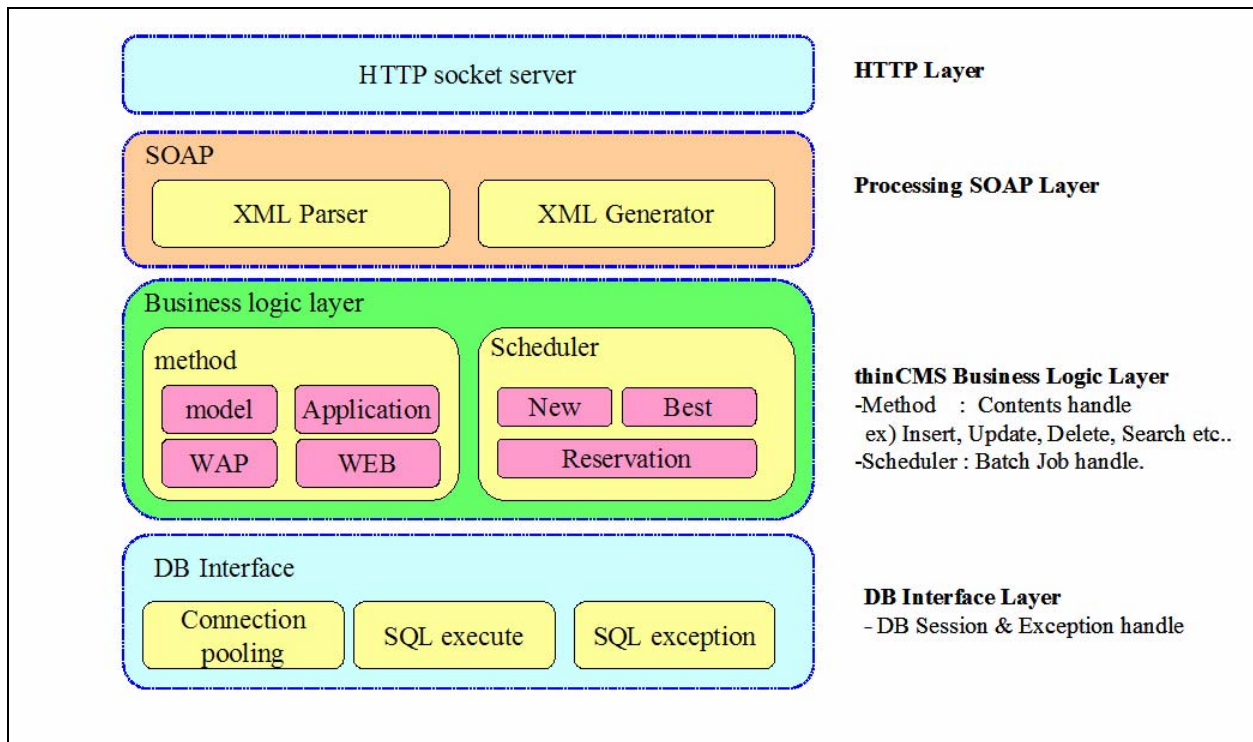


Figure 5: thinCMS System Architecture

Functional Features of tmi's thinCMS System

- **Resource Sharing**

Multiple clients can share resources on the thinCMS middleware server such as DB connections.

- **Reusability**

Business logic doesn't have to be implemented by each client. Clients share the same business logic on the thinCMS so that reusability increases.

- **Abstraction**

thinCMS middleware server provides an abstracted view of business logic without revealing detailed table structures, which makes client-side jobs simple.

Content Delivery System to Mobile Devices

Download and Streaming Server

thin multimedia, inc. offers the *thinStreamer*, a complete video download/streaming server. Our server is implemented with scalability in mind, and it is designed to run in multi-CPU systems. As the number of subscribers increases, thinStreamer will load-balance the threads effectively to other CPUs using its thread-scheduling mechanism.

Streaming Features

- thinStreamer transmits the stored/live MPEG4/H.263/H.264 files in download / streaming mode, or media streams progressing in real time.
- The streaming protocol is based on the 3GPP standard (RTP/UDP, RTSP).
- Bit-rate support: various like 16kbps ~ 1Mbps.
- thinStreamer incorporates a bit rate adaptation mechanism, which matches the encoded frame rate and bit rate with the network transmission performance capabilities.

Download Features

- thinStreamer's download protocol has been designed based on HTTP, and it is a lossless protocol even under unreliable wireless networks.
- thinStreamer's download protocol supports the continuation of download after disconnection when a download is in progress, and so that the second download can start where the first download dropped off.
- Download TCM3 & MPEG4/H.263/H.264 files.
- Lossless media download.
- Download from the middle of a file (download with reconnect).

Server Technical Specifications

The server technical specifications are given in the following tables.

File Format	MPEG4(.mp4), 3GPP(.3gp), 3GPP2(.3g2), Quicktime(.mov)
Protocols	RTSP(RFC2326), SDP(RFC2327), RTP(RFC3550 & RFC3551), HTTP(RFC2616)
Performance	Can support more than 600 concurrent connections on one Pentium III 933MHz machine (CPU average usage just around 10% in case of 600 connections) Note: the performance may depend on the content bit rate)
Architecture	Multi-thread & Multi-process & Hybrid

CPU	Intel P3 1.0GHz or higher (Intel Xeon 2.8GHz or higher, 2 CPU recommended)
Hard Disk	1 GB available disk space
Memory	512 MB RAM or higher (1 GB or higher recommended)
NIC	100/1000 Mbps
Required OS	Windows NT/2000, Linux, Unix

thinStreamer System Architecture

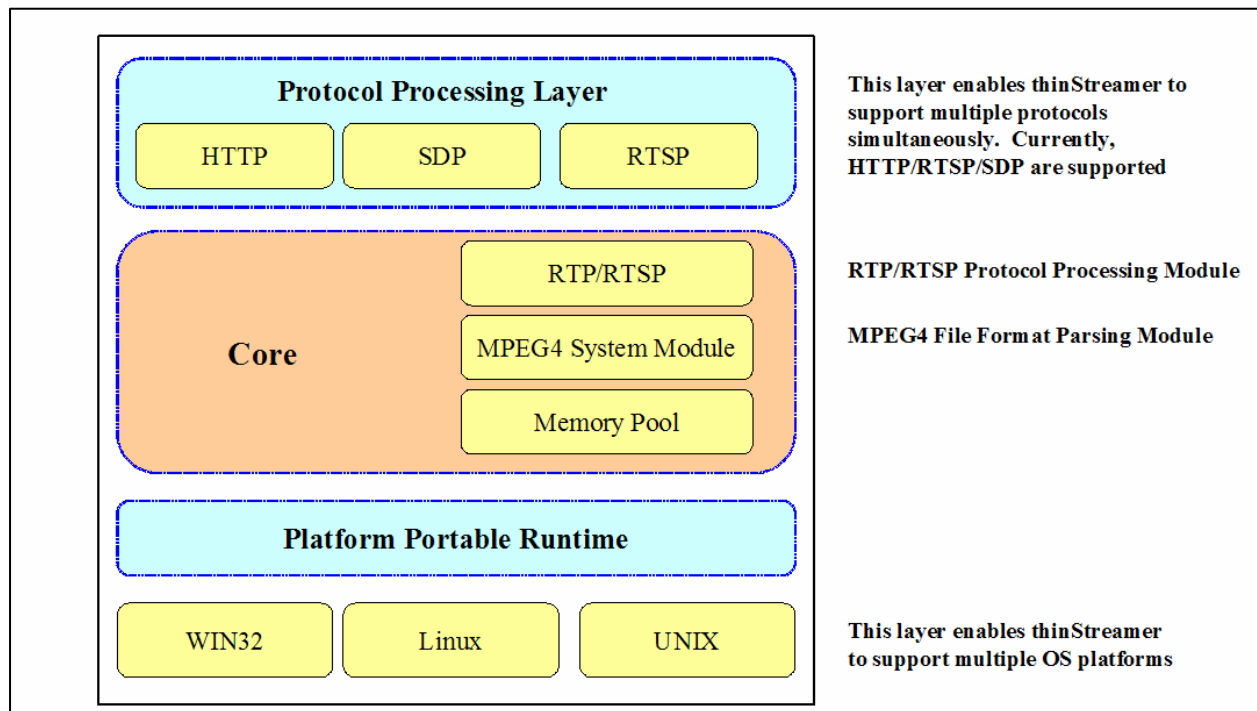


Figure 6: Streaming Server Architecture

Mobile Client Applications

tmi Downloadable Player

The tmi client player is an integrated multimedia engine designed for mobile handsets and devices. It can be configured in three modes – *thinVideo*, *thinAudio* and *thinBroadcast* for streaming and downloaded video, or streaming and downloaded audio or for live TV respectively. The client player, *thinVideo*, combines the *thinPlayer* and *thinCoder*, and supports all standard and tmi proprietary codecs, using common delivery protocols to act as one integrated general player

The *thinVideo* player was developed with the following goals in mind: to create an integrated multimedia engine, compatible with standard video and audio content, utilizing standard delivery protocols, while exhibiting performance characteristics which are superior to any standard

player available in the market today. Additionally, the following were incorporated as essential design characteristics:

- Ease of Portability
 - Simple interface
 - Standard protocol
- Provide Extendable Solution
 - Codec, Delivery, Data IO, Data Type utilizing standard plug-ins
- Eliminate Platform Dependencies
 - Unified interface removes dependency between the application and OS
 - Modular structure via an internal Platform Adaptation Layer (PAL)
- Reusability
 - Reuse of application according to different platform requirements
 - Integrate once, and reuse on another platform reduces overall integration time
- Efficient ROM usage by sharing application code
- Minimal Total Development Time

Downloadable Player Architecture and Technical Specifications

The tmi client player architecture, technical specifications and supported services are detailed in the following figure and tables.

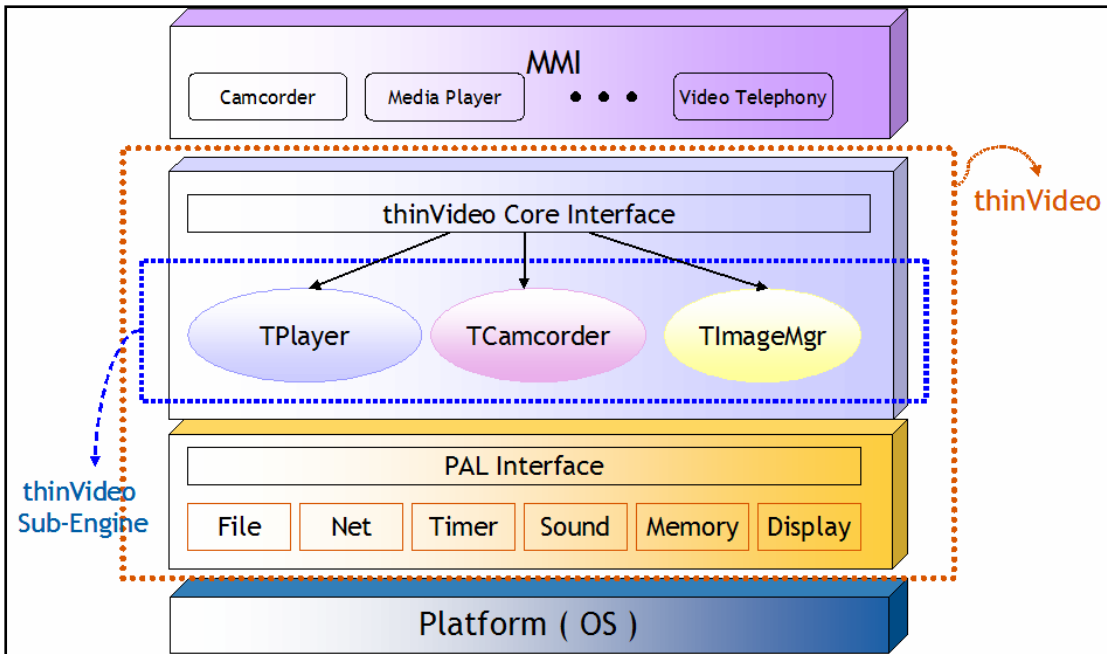


Figure 7: Client Video Player Architecture

thinVideo Player Technical Specifications

Video Codec	Standard	MPEG-4, H.263, H.264 (S/W Codec)
	tmi	TCM2, TCM3 (S/W Codec)
	Encoding Resolution	112x96, SQCIF(128x96), QQVGA(160x120), QCIF(176x144), QVGA(320x240)
Audio Codec	Music	MP3, AAC-LC (S/W codec), AAC+, Enhanced AAC+
	Speech	EVRC, AMR, FR, QCELP
Image Codec	Standard	JPEG, BMP, WBMP, PNG, GIF
	tmi	HIF (phone image Codec Encoder/Decoder)
Protocol	Transport	RTP/RTSP/RTCP, Interleaved TCP, TCM protocol
File format		3GPP(.3gp, .mp4), 3GPP2(.3gp2), ISMA(.mp4), SKT(.skm), TCM(.tcm/.tmd)
S/W Platform		Native ARM Environment, Brew, Symbian, WIPI, Java, WinCE(Pocket PC Series)
H/W Platform		ARM, Intel, TI

thinVideo Player Service Support

	Service	Multimedia Related	Image Related
Decoder	Basic function	<ul style="list-style-type: none"> ● Local play ● Download ● Streaming 	JPEG/PNG/BMP/GIF Image display
	Extra function	<ul style="list-style-type: none"> ● Screensaver ● Ringtone ● Interaction ● Voice Record ● Video Telephony ● MOD 	HIF decoding - Icon decoding - Default UI image decoding
Encoder	Basic function	<ul style="list-style-type: none"> ● Camcorder ● Video Telephony ● MMS 	HIF encoding - JPEG/PNG/BMP/GIF HIF encoding

- Standards-Based A/V Data Type Support
 - Video : H.263, H.264, MPEG4 and TCM(MQ, HIQ, HIS)
 - Audio : MP3, AAC, AAC+, EVRC, AMR, FR, MA, QCELP
 - Image : GIF, BMP, JPEG, PNG and HIF

- RTSP/RTP/RTCP/SDP Network Playback
 - The Real Time Streaming Protocol (RTSP)
 - The Real Time Transport Protocol (RTP) - a packet format for multimedia data
 - The RTP Control Protocol (RTCP) - to monitor "QoS" and transfer information
 - The Session Description Protocol (SDP)

- Audio and Video Services
 - Audio mixing

- Data Type Interfaces

- *thinVideo* offers APIs for developers to create plug-ins to support their favorite file formats or client renderers.

Downloadable Player Functional Features

The tmi client player has many functional features that make it the most attractive player in the market today. *thinVideo* Player has a small footprint, taking very little space in the handset storage (the approx. size of *thinVideo* Player: 350KB which includes UI, engine and video/audio software codec's). Other features include:

- **Scalable Network Support**

thinVideo Player supports streaming video content over network bandwidths from 5 kbps to 384 kbps. In a 2G network, such as GSM or CDMA, only the download service is available. However, in 2.5G networks and beyond, both streaming and download services are available.

- **Scalable Frames per Second**

thinVideo Player supports from 0.5 to 30 fps (frames per second). Currently, in a live 2.5G network, we are seeing around 3fps/15 fps for downloaded video clips and 2~3 fps/6~8 fps for streaming, running over Arm7/Arm9 processors of a mobile handset while the phone is actively connected to the wireless network.

- **Multiple Video/Audio Support**

MPEG4, H.263, H.264/EVRC, MIDI (MA3), QCELP, AMR, AAC-LC, AAC+ and enhanced AAC+

- **Multiple Screen Size Support**

thinVideo Player supports a variety of screen sizes from 112 x 96, SQCIF (128x96), 128x112, QCIF (176x144), QVGA (320x240).

- **Downloadable Media Player**

thinVideo Player is downloadable over the air on mobile platforms such as BREW, Java (J2ME) and Symbian and provides flexible use cases and user experiences for end users who do not have embedded media players in their mobile devices.

Customizable Downloadable Player

The thin multimedia downloadable player provides a method of customizing the experience of the end user. Content providers can differentiate their service by choosing and designing the look and feel of the player to match their corporate brand guidelines. This allows the content provider the ability to provide a unique, branded and customized user experience to their customers / subscribers.

In addition to designing the look and feel of the client player, the content or service provider has the ability to customize the player to conform to desired business requirements, for example, the tracking of usage data can be expanded or restricted as required.

The architecture of the client player facilitates porting to many different handsets because of the modular structure which contains an easily adapted interface layer. This adaptability extends the content or service provider's reach to many more subscribers, especially since support for 3GPP / 3GPP2 multimedia services is limited on current phones.

Component Interoperability

Dynamic Bit Rate Adaptation

The dynamic bit rate adaptation mechanism works to automatically adjust the encoding and transmission parameters of the mobile delivery system based on network performance characteristics and terminal capabilities. The adaptation functioning is activated by the server after receiving feedback information from the client. For example, if the client moves from a UMTS network to a GPRS network during streaming, the streaming server will switch from a high bite rate service to a low bit rate service seamlessly. In order to do this the tmi encoder has built-in to it the ability to provide multi-track content to store alternative encodings useful for stream switching; i.e. dual tracks – one of high bite rate data and one of low bit rate data. The streaming server then switches tracks as indicated by the feedback information from the handset.

tmi clients/handsets with PSS (Packet-switched Streaming Service) provide the basic information on the status of network and client/handset to the thinStreamer servers through

RTCP and RTSP. The main information would be: Link-rate estimation, Transmission adaptation, and Signaling for client buffer feedback. Based on such information from clients/handsets, the service servers change and optimize transmission speed and content delivery rates accordingly.

3GPP Rel. 6 specifications define a stream rate adaptation algorithm that allows the server to switch encodings during a streaming session. thinStreamer servers will support stream adaptation of 3gp files that have the streaming server extensions in accordance with the release 6 guidelines.

System Reporting and Monitoring Capabilities

tmi offers application and service level reporting through a web browser with a secure login. The data can be saved in CSV format for easy export into other applications. Reports can be created to retrieve information on a particular service and its subscriber base. In addition, customized reports can be created for most information available to the server and/or the thinCMS system.

Below are typical data points available.

- Total number of orders - How many content orders were delivered during the period of the report. An order is composed of one request for content.
- Total of new content pieces - How many content pieces were added during the period of the report.
- Content types delivered – What types of content were delivered over a period of the report.
- Total of content deleted – How many content pieces were deleted during the period of the report.
- Total number of hits - How many content pieces were selected but not purchased for delivery.
- Time of streaming – The time of day that content was streamed to a consumer.
- Category of content - The type of content streamed (news, sports, etc.) over the period of the report.
- Streams per User – How many content streams were delivered per user over the period of the report.

- Number of download errors
- Number of cancelled download clips
- Average number of downloads per customer
- Total number of downloads by customer
- Real time monitoring on server delivery system – current connections, current streams
- Connection type
- Connection time
- Type of service by connection
- Total Users
- Content Name
- Content Service type (streaming/download)
- User information – “who is using what content”

Codecs

MPEG4

Codec	MPEG-4 Video Codec. (ISO/IEC 14496-2) Simple Profile @ Level 3		
Compression Ratio	80:1 ~ 160:1		
Video Bit-rate	60 ~ 120kbps (up to 384kbps)		
Frame-rate	Up to 30fps		
Resolution	Up to CIF (352X288)		
CPU Requirement	~25 MIPS for decoder, ~75 MIPS for encoder at QCIF15fps		
Target phone	High-end phone (ARM9 or DSP based)		
Memory Requirement	Decoder	ROM 25KB	RAM 100KB
	Encoder	ROM 30KB	RAM 130KB

H.263

Codec	ITU-T H.263 Video Codec. Profile 0 (Baseline profile) @ Level 30		
Compression Ratio	70:1 ~ 140:1		

Video Bit-rate	64 ~ 140kbps		
Frame-rate	Up to 30fps		
Resolution	Up to CIF (352X288)		
CPU Requirement	~20 MIPS for decoder, ~60 MIPS for encoder at QCIF15fps		
Target phone	High-end phone (ARM9 or DSP based)		
Memory Requirement	Decoder	ROM 20KB	RAM 110KB
	Encoder	ROM 25KB	RAM 120KB

H.264

Codec	ITU H.264 Video Codec / MPEG-4 AVC (ISO/IEC 14496-10) Baseline Profile @ Level 2		
Compression Ratio	120:1 ~ 240:1		
Video Bit-rate	40 ~ 80kbps (up to 2Mbps)		
Frame-rate	Up to 30fps		
Resolution	Up to CIF (352X288)		
CPU Requirement	~40 MIPS for decoder at QCIF15fps		
Target phone	High-end phone (ARM9 or DSP based)		
Memory Requirement	Decoder	ROM 35KB	RAM 300KB
	Encoder	N/A	

Conclusion

This paper has outlined thin multimedia's product suite in the three areas of mobile multimedia technology – encoding and content preparation, content delivery (download or streaming) and end user experience in media playback via client applications.

Each of these products is a critical component in the technology value chain, and showcases tmi's technical expertise. We invite you to contact us for further information on our products or to learn more about mobile multimedia and tmi's services.

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