

Enhancing the Video-telephony User Experience

A key factor in the mass deployment of video-telephony

White paper

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Abstract

The uptake and popularity of 3G conversational video-telephony services will greatly depend on the quality of the user experience. This White Paper discusses some of the innovations brought by Dilithium Networks that enhance the quality of the user experience in a number of application domains. These technologies are being deployed in handsets as well as in multimedia transcoding gateways that connect the mobile 3G subscribers to a variety of other landline and wireless networks. The benefits of the Dilithium Networks solutions include faster call setup time, shorter voice and video delays, better video recovery in the presence of noise, better lip synchronization and greater interoperability.

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2.5G

The present state of mobile wireless communications is often called 2.5G

3G

3G is a short term for third-generation wireless, and refers to near-future developments in personal and business wireless technology, especially mobile communications.

3GPP

The 3rd Generation Partnership Project (3GPP) is a collaboration agreement that brings together a number of telecommunications standards bodies including ARIB, CWTS, ETSI, T1, TTA, and TTC.

Air Interface

The air interface is the radio-frequency portion of the circuit between the cellular phone set or wireless modem (usually portable or mobile) and the active base station.

Algorithmic Delay

Algorithmic delay is delay that is intrinsic to the algorithm of a system, and is independent of CPU speed. It is generally expressed in terms of the time by which a system's output lags behind the corresponding input.

AnswerFast

Dilithium Networks' AnswerFast feature in the H.324M/3G-324M stack reduces call setup time by up to 50% resulting in a major improvement over current conventional H.324M call setup methodology.

AMR

Adaptive Multi-Rate

Bit Error Rate

The bit error rate (BER) is the percentage of bits that have errors relative to the total number of bits received in a transmission.

CODEC

A data compression algorithm. The name is composed by the merging of enCODing and DECoding.

Decoding

The process of mapping from a parameter space to a signal space

Video is an Essential ingredient of 3G services

Third generation (3G) mobile operators around the world are focusing on video as a key ingredient of new wireless service offerings. These operators are looking to offer new, higher revenue generating services that will help them recuperate their heavy investment in new technology and wireless spectrum licenses. While traditional voice will continue to be an important part of an operator's service offering, conversational video services like video telephony and video conferencing are new applications that are not possible on older wireless networks. These video services differentiate 3G from 2G/2.5G and are essential for operators to draw their user base to the new technology.

New Video Applications over 3G

We show in Figure 1 various applications of 3G-324M video-telephony. These applications include:

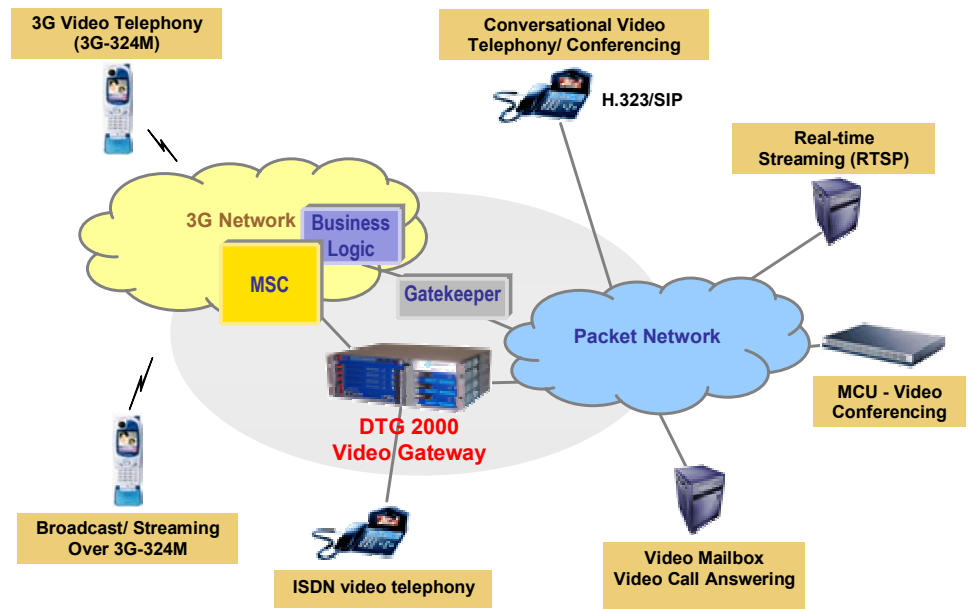


Figure 1. 3G video-telephony applications.

Conversational video telephony/conferencing: A service that enables users to communicate with each other using both voice and video. This leads richer and more fulfilling communication and can serve as an alternative to in-person meetings, expensive

DSP

Digital signal processing

DTG

Dilithium Networks Transcoding Gateway

E1

2Mbit/sec ISDN link supporting 30 telephone lines with the A-law encoding (Used in Europe)

Encoding

The process of mapping from a signal space to a parameter space

EVRC

Enhanced Variable Rate Codec for use in CDMA telephony

FOMA

FOMA is NTT DoCoMo's 3G service, the first in the world based on the W-CDMA system, which complies with IMT-2000, an international standard for 3G mobile communications.

Gateway

A gateway is a network point that acts as an entrance to another network.

G.711

ITU-T standard for 64kbps transmission of speech signals using μ -law and A-law. Audio codec used in H.320 and H.323.

G.723.1

ITU Recommendation G.723.1, Dual rate speech coder for multimedia communications transmitting at 5.3 and 6.3 kbit/s, 1996

GSM

Global System for Mobile communications

GSM-AMR

(Global System for Mobile communication, Adaptive Multi-Rate coding). ETSI Adaptive Multi Rate speech coder. GSM 06.90: "Digital cellular telecommunications system (Phase 2+); AMR speech transcoding", 1998. Provides

corporate travel, etc. Video conferencing enables multiple parties to communicate with each other using voice and video.

Video mailbox services / call answering: A service similar to voice mail that allows users to leave in real-time, a video message that is stored in a server or an inbox and can be accessed from another handset or a suitable multimedia device. This is different from multimedia message service (MMS) where the message is recorded locally on the handset, transmitted to an MMS server from which the called party can download the message to the handset and play the message.

Automated announcements: Automated announcements are one-way video announcements that could convey service access announcements ("The number you have dialed is not in service. Please check the number and call again...")

Real-time streaming: A service that enables users to receive rich content from a media source or content server in real time. Examples include streaming of distance learning, sports broadcast, news, advertisements, movie clips, animations, and other real-time events and content.

The Dilithium Networks Technology Advantage

We describe below the advantages that the Dilithium Networks technologies embedded in the DTG 2000™ bring to the user and how they enhance the experience. The expectation of most users will be derived from their voice-only mobile experience and hence the aspects described below may be critical to the success of video-telephony services over 3G.

Faster Connection Time - Dilithium Networks' AnswerFast™

Video calls are notoriously lengthy to setup due to the exchange of information that needs to take place according to the 3G-324M/H.324M protocol and can take between 6 – 12 seconds to complete for users to hear voice and see video.

Dilithium Networks is today the leading vendor of the ITU-T 3G-324M/H.324M multimedia protocol stack. Dilithium Networks was the first to offer a 3G-324M protocol stack to customers more than 4 years ago, and has added a number of key enhancements to the protocol including AnswerFast. AnswerFast technology reduces call setup time by up to 50% resulting in a major improvement over current conventional H.324M call setup methodology. The Dilithium Networks' AnswerFast feature is incorporated into its protocol stacks as well as the DTG 2000 Multimedia/Video Gateway.

When used with a handsets and/or equipment that support AnswerFast technology, the DTG 2000 can reduce call setup time for calls by almost 50% which is a significant boost to user experience.

coding for bit rates between 4.75 and 12.2kbps

GSTN

General Switched Telephone Network

H.223

Multiplexing protocol for low bit rate communications. Multiplexer used in H.324, H.324M, 3GPP-324M and H.324I

H.225.0

Specifies messages for call control including signaling, registration and admissions, and packetization/ synchronization of media streams

H.245

Command and control protocol between multimedia terminals. Used in H.323 and H.324M/3G-324M protocol stacks.

H.248

An enhanced version of a Media Gateway Control Protocol

H.323

This standard is used in VoIP and multimedia communications over the Internet and local area networks. Include H.245 and H.225.0 ITU Recommendation H.323, Packet-based multimedia communications systems, 1998.

H.324 and H.324M

This standard is used in multimedia communication (voice and video) over the public switched telephone network and the mobile network (H.324M == mobile).

Interoperability

Interoperability is the ability of a system or a product to work with other systems or products without special effort on the part of the customer.

Products achieve interoperability with other products by adhering to published interface standards and/or by making use of a "broker" of services that can convert one product's interface into another product's interface "on the fly".

Shorter voice and video delays - Dilithium Networks Unicoding™

Dilithium Networks has developed a breakthrough transcoding technology called Unicoding that performs fast, efficient transcoding while using only a fraction of the resources consumed by traditional tandem transcoding methods. Dilithium Networks Unicoding performs intelligent mapping between media (voice and video) standards in the compressed domain without undergoing a decode and re-encode process that is the hallmark of all media transcoders in the market today. Dilithium Networks' Unicoding technology is available for most common media formats for voice and video markets.

The intelligence of the Dilithium Networks' technology lies in its ability to perform the translation without loss in quality. In addition to the reduced computational resource requirement, another very important advantage of the Dilithium Networks Unicoding™ technology is the significantly smaller delays incurred by the transcoding in contrast with competing techniques. For example, in contrast with the Tandem voice transcoding technique which incurs between 10 to 30 milliseconds of algorithmic delays, the Dilithium Networks voice Unicoding™ technology has zero algorithmic delays because it does not involve re-encoding as competing Tandem techniques do.

Similarly for video, the Dilithium Networks video Unicoding™ technology incurs significantly smaller delays than the competing Tandem video transcoding methods.

The Dilithium Networks' breakthroughs in transcoding techniques directly translate into reduced equipment footprint, higher channel density, lower capital costs and lower operational costs.

Better Synchronization between Voice and Video (Lip Sync)

The processing of voice and video media streams by gateways can incur delays. Until recently the amount of delays introduced by gateways from different vendors was nearly the same substantial amount because of the use of tandem transcoding technology. Furthermore, gateways that make use of tandem transcoding approach introduce very different delays for voice and video and therefore have to compensate and align voice and video. This synchronization is not simple because media streams originating from the H.324M side do not incorporate timestamps and hence lip-sync issues often surface.

The Dilithium Networks Unicoding technology has minimal delays for voice and video compared to competing gateways. Another advantage is that the delays are almost identical for voice and video streams and therefore synchronization issues are kept to a minimal.

IP

Internet Protocol

ISDN

Integrated Services Digital Network

ISUP

ISDN User Part is a module of the SS7 signaling protocol.

ITU

International Telecommunication Union

ITU-T

International Telecommunication Union – Telecommunication standardisation sector

MG

Media Gateway

MGC

Media Gateway Controller

MPEG

MPEG (pronounced M-peg). Moving Picture Expert Group, part of the International Standard Organization. MPEG is the nickname given to a family of International Standards used for coding audio-visual information in a digital compressed format. The MPEG family of standards includes MPEG-1, MPEG-2, and MPEG-4.

MPEG-4 Video

MPEG audiovisual standards 14496 (1-5) The MPEG-4 standard provides scalability in bit rate and bandwidth, as well as the ability to generate bit streams at arbitrary bit rates. The MPEG-4 CELP coder supports two sampling rates, namely, 8 and 16 kHz. The associated bandwidths are 100-3400 for 8 kHz sampling rate and 50-7000Hz for 16 kHz sample rate.

MSC

Mobile Switching Centre

MUX

Multiplex

Packet

Better Video Quality in Messaging Applications

Dilithium Networks Local Video Fast Update

We discuss in this section the effect of transmission noise/errors on the user experience in the context of messaging applications. We use the video call answering service as an example of how the Dilithium Networks technologies overcome transmission noise/errors. The benefits apply to other applications, in particular to real-time streaming.

Overcoming Noise and Errors in Video Transmission

The voice bitstreams transmitted by the 3G-324M handset can be in the compressed format of GSM-AMR or G.723.1 (EVRC for 3GPP-2). The video bitstreams can be in the compressed format of H.263 (3GPP) or MPEG4 (optional in 3GPP but recommended in 3GPP-2). The 3G-324M service makes use of transmission mechanisms that do not employ “retransmission requests” in the presence of noise/errors. This applies for both voice and video. The absence of “retransmission request” in voice communication is not unusual. However for video, corruptions in the bitstream of a video frame not only affect the present picture being processed, but can also affect many subsequent video frames that are being encoded using predictive coding.

Predictive video coding is a key technique in modern video compression that allows an encoder to remove temporal redundancy in video sequences by compressing video frames utilizing information from previous frames. Most video communication protocols (including that used in 3G-324M/H.324M) do not rely on “retransmission requests”, because their command and control protocol includes an error recovery scheme based on what is called “video-fast-update” request, which requests the transmitter side to encode the next video frame using the so-called intra-mode (encoding utilizing the content of the current video frame only).

The “video-fast-update” technique limits any corruption to a very short period of time, hopefully not noticeable by the user, allowing the video quality to be restored quickly.

Message Deposit Bit-Error Management

When a handset transmits its video over the air-interface bit-errors can be incurred leading to information payloads being irreversibly corrupted. Depending on the capabilities of the video gateway, the errors may be detected and the gateway may request the handset video codec to perform a “video-fast-update” so the video picture quality can be recovered.

When the video is being passed in a “transparent” fashion by the gateway (no transcoding taking place), the gateway may not be capable of detecting errors as it simply relays the video bitstream it receives as is, without any error detection.

Dilithium Networks’ pass-through video processors (and video transcoders) are equipped with unique patent pending technologies capable of detecting video corruption. They can

A packet is the unit of data that is routed between an origin and a destination on the Internet

PCI

PCI (Peripheral Component Interconnect) is an interconnection system between a microprocessor and attached devices in which expansion slots are spaced closely for high speed operation.

Protocol

A formal set of procedures that are adopted to ensure communication between two or more functions within the within the same layer of a hierarchy of functions

PRI

Primary Rate Interface is an ISDN defined level of service for high end users

PSTN

Public Switched Telephone Network

Q.931

Call setup and termination in H.323 calls

RTSP

Real Time Streaming Protocol

Smart Transcoding

The process of mapping between two codecs so that speech encoded by one codec can be decoded by a different codec. Smart transcoding achieves the same goal as tandeming but in a much more efficient way.

SS7

Signaling System Seven SS7 is a common channel signaling system developed by CCITT. This means that one channel is used only for sending the signaling information, whether the system has one bearer channel or multiple bearer channels. The hardware and software functions of the SS7 protocol are divided into layers which loosely correspond to the OSI 7 layer model.

Tandem Transcoding

The process of connecting two

immediately, and without the intervention of the video-mail server, request the handset to perform a “video-fast-update”. Local detection of the errors by the video gateway not only simplifies the function of the video-mail server (which typically is not geared for real-time bitstream processing dictated by 3G-324M), but also minimizes the duration of video corruption (round-trip time will be longer if the video-fast-update requests have to travel to the video-mail server and back). This ultimately leads to a significant reduction in the exposure of the mailbox subscriber user to corruption in the video retrieved from the video-mail server. It also eliminates the need to incorporate video decoders in the video-mail servers.

Message Retrieval Bit-Error Management

Analogous to the case above, bit errors during the message retrieval phase need to be managed. During retrieval, a clean stored video bitstream is transmitted by the video-mail server through the video gateway, the MSC, to the handset. The transmission from the MSC (through the radio-interface) may incur bit errors. The video bitstream on the message store of the video-mail server is most likely stored in a compressed format.

Uncompressed video requires a significant amount of storage space, and near-real-time compression is too computationally expensive to be performed on the video-mail server. If the video decoder in the handset detects errors due to the radio-interface conditions, it will transmit a “fast update” request to the transmitter. Because the video-mail server is transmitting pre-stored compressed bitstreams, it has no way of handling “video-fast-update” requests which require real-time encoding/response of uncompressed video content.

The ideal place for dealing with “video-fast-update” requests is in the gateway whether they do transcoding or serve to do pass-through of voice and video. In the case of pass-through or transparent video transmission mode, most gateways typically relay only the bitstreams, and are not capable of dealing with “video-fast-update” requests.

The Dilithium Networks DTG 2000 video gateway is a unique exception as its pass-through transcoders are equipped with patent-pending technologies capable of responding locally to “video-fast-update” requests leading to minimal video corruption and better user experience.

Greater Interoperability

Dilithium Networks occupies a unique position in terms of Interoperability. Dilithium Networks is a founding member of the H.324M IMTC activity group, and constantly performs interoperability with operators and equipment suppliers.

Furthermore, Dilithium Networks’ 3G-324M/H.324M networks analysis and troubleshooting tool, DNA, gives Dilithium Networks a unique position as far as interoperability is concerned. DNA is the only 3G video-telephony test tool on the market and is used widely by operators, infrastructure and handset suppliers.

codecs in series so that the input speech is encoded by the first codec, transmitted through a channel, decoded by the first codec, encoded by the second codec, transmitted through another channel, and finally decoded by the second codec to produce output speech.

Unicodeing

Dilithium Networks proprietary version of smart transcoding.

UMTS

Universal Mobile Telephone System, the telecommunications system, incorporating mobile cellular and other functionality that is the subject of standards produced by 3GPP

Video-telephony

Video telephony is full-duplex, real-time audio-visual communication between or among end users.

VoIP

Voice over the Internet Protocol

Since its launch in November 2002, DNA has become the default industry 3G video-telephony test tool that allows users to test compliance of 3G-324M equipment, troubleshoot connectivity between other equipment using its non-invasive traffic analysis capability, and its ability to exercise the protocol support capability of handsets and infrastructure equipment.

Dilithium Networks is therefore in a unique position in terms of interworking with the variety of 3G-324M/H.324M infrastructure and user-equipment on the market. The DTG 2000 gateway benefits directly from this awareness. Dilithium Networks goal is to ensure that all interoperability issues raised on the field are accommodated by the DTG 2000 gateway in order to make it the most interoperable gateway on the market. This means that the gateway is engineered to be aware of the limitations and shortcomings of other equipment and handsets on the market, and interoperate silently with them.

Advantages of Dilithium Networks' DTG 2000 by Application

The DTG 2000 gateway is capable of supporting a wide range of applications for 3G video communications including real time streaming, video telephony/video conferencing and video mail/call answering. Below is a table summarizing the unique benefits of the Dilithium Networks DTG 2000 by application.

Dilithium Advantage	Description	Video mailbox/ Video Call answering	Video Telephony	Video Conference	Video streaming
Improved User Experience	Reduced Call setup time	√	√	√	√
	Lower transcoding delay/ improved Quality	NA	√	√	NA
	Local Video Fast Update Support for (message) deposit	√	NA	NA	NA
	Local Video Fast Update Support for (message) retrieval	√	NA	NA	√
	Voice and Video Bandwidth tradeoff	NA	√	√	NA
Financial Benefit	Lower Deployment Cost	√	√	√	√
	Lower Operating Cost	√	√	√	√

General Benefit	High Interoperability with UMTS and FOMA equipment	√	√	√	√
	High Reliability	√	√	√	√
	High Scalability SS7/ISUP as well as PRI ISDN.	√	√	√	√

Economic/Financial advantages of the DTG 2000

In addition to the above advantages, the DTG 2000 also offers the following unique advantages that no competing solutions can match:

Financial Benefits/ Better Return on Investment (ROI)

The DTG 2000 leads to better Return on Investment (ROI) for the following reasons

Lower Deployment Cost: The DTG 2000 achieves high channel density over the same hardware resources. This drives down the cost per channel of voice and video systems and lowers capital outlays. The DTG 2000 achieves channel densities that are as high as 800% higher (depending on specific media standards) than those achieved by competing gateways using tandem transcoding technology

Lower Operating Cost: Equipment using Unicoding incurs less recurring cost since it consumes less resources itself. Unicoding lowers maintenance, power, leasing cost, real-estate costs as well as minimizes expenditure in professional staff, training, spares etc.

Leads to Faster deployment of 3G services

Unicoding drives down the cost of multimedia communications and therefore makes multimedia services more affordable and therefore widely deployable. Operators can lower their price points for their customers leading to faster acceptance of the services.

Summary

Video is a vital component of 3G services. Operators see video based services like video telephony/video conferencing, video mail and real time streaming as essential for the migration of their existing 2G/2.5G customer base to 3G. Video Gateways that enable connecting 3G video phones to the broader IP world are necessary for widespread adoption and use of 3G services.

The Dilithium Networks DTG 2000 is a multimedia gateway that offers a rich set of video-telephony functions. In addition, the DTG 2000 incorporates a range of Dilithium Networks breakthrough technologies which enable it to deliver improved user experience and better financial return on investment making it an attractive choice for 3G operators today.

Appendix - The 3G-324M Standard and Video Gateways

3G-324M Mobile Video Telephony Standard

3G based conversational video services like video telephony and video mail are delay sensitive applications. For these services, operators typically follow either the Release 99 or Release 5 architectures – both defined by the 3GPP consortium. Most 3G Mobile networks today are based on Release 99 architecture although they are likely to migrate to Release 5 once measures to provide quality of service guarantees and reliable billing over packet transport is possible.

3G-324M is the current protocol of choice for Release 99 networks. It is a derivative of the existing ITU-T H.324 standard for low bit rate multimedia communication. H.324 and its annexes (A, B and C, also known as Mobile Levels 1, 2 and 3) are usually referred to as H.324M. The 3GPP (<http://www.3gpp.org>) and 3GPP2 (<http://www.3gpp2.org>) standards bodies have modified H.324M to create the 3G-324M standard. H.324M and 3G-324M specify the use a dedicated 64kbps bearer to transmit multiplexed voice, video as well as control and signaling information.

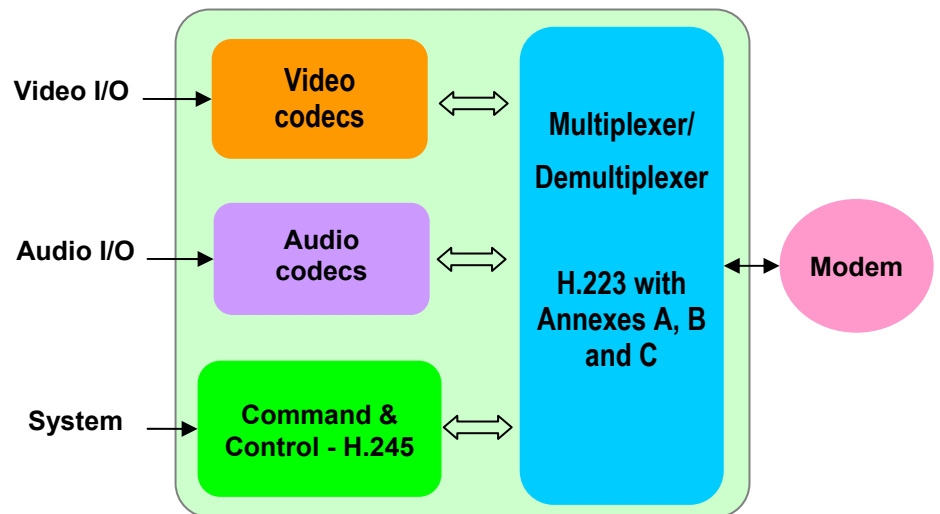


Figure 2 The 3G-324M/H.324M Protocol.

The 3G-324M is an “umbrella standard” referencing other standards which specify mandatory and optional video and audio codecs, the messages to be used for call set-up, control and tear-down (H.245) and the way that audio, video, control and other data are multiplexed and de-multiplexed (H.223).

For 3G phones to support the enhanced video services (like those described in previous section), they need to support the 3G-324M protocol.

Needs for 3G-324M Video Gateways

Operators have realized that 3G users not only need to talk to one another, but also need to be able to communicate with a variety of services such real-time streaming servers, multipoint conferencing units, video call answering services, packet based video-telephony and conferencing systems. Because many of these services have packet interfaces, interworking functions between the 3G video-telephony service (3G-324M) and other packet oriented multimedia communication systems are required. Such interworking functions perform protocol conversions for call signaling/control, command and control and media (voice and video) compression. Interworking functions may also be required to perform transcoding, rate control and some other adaptation. The need for interworking functions is driven by users who are demanding more widespread interconnectivity and operators have recognized this additional revenue potential.

The Dilithium Transcoding Gateway (DTG 2000)



The Dilithium Networks DTG 2000™ wireless multimedia gateway is an interworking function enabling the connectivity of 3G video-telephony users to a wide range of real-time multimedia communication services, while providing unique features enabled by some breakthrough technologies from Dilithium Networks. The DTG 2000™ can be used as a 3G-324M/H.324M gateway for real-time streaming applications, video call answering services, video-telephony and videoconferencing.

The DTG 2000 provides transcoding between common voice and video standards, and proxy functions which help translating control and signaling information between 3G-324M networks and IP packet networks. Since different networks have different protocols and support different voice and video standards, such a transcoding gateway is necessary to help terminals on diverse networks communicate.

The DTG 2000™ can be deployed as a standalone system using integrated SS7/ISUP or PRI ISDN signaling. It performs all necessary negotiation and mediation between network entities and client devices to allow effortless communications across network boundaries including Circuit Switch to Packet Switch Mapping, Capability Negotiation, Command Mediation and Media Transcoding. The DTG 2000 transcodes in real-time and on-the-fly

between major voice and video standards and protocols including the GSM-AMR, G.723.1, G.729, and G.711 voice codecs, and the H.263 and MPEG4 video codecs.

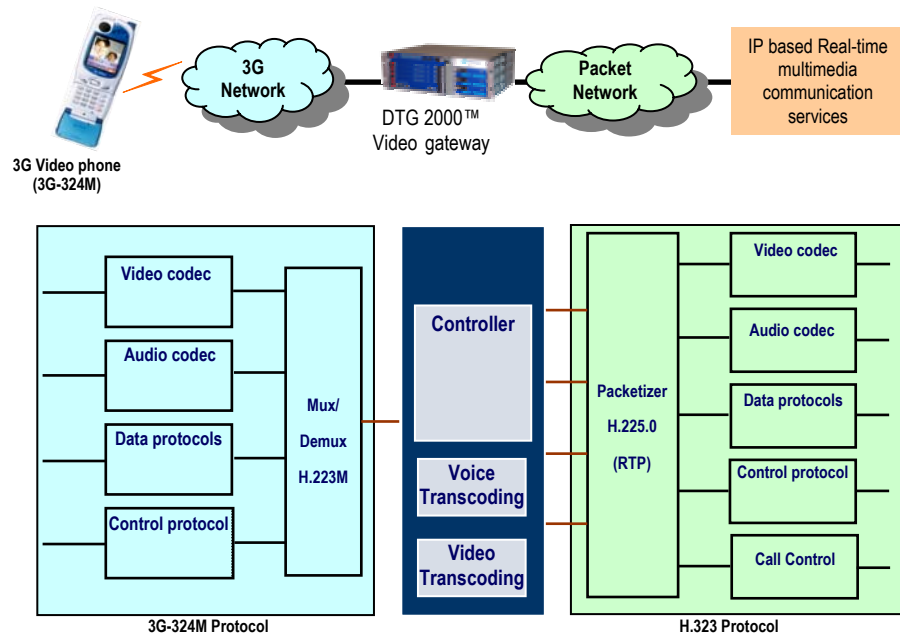


Figure 3 Transcoding and gateway/proxy function between 3G-324M and H.323

The DTG 2000™ is based on a 4U Compact PCI chassis and is highly scalable. It is capable of supporting small deployments, handling only a few hundred concurrent bi-directional calls, and large systems supporting many thousands of connections.

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