Tracing Method with Intra and Inter Protocols Correlation

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***Abstract* – MEGACO or H.248 is a protocol enabling a centralized Softswitch (or MGC) to control MGs between Voice over Packet (VoP) networks and traditional ones. To analyze much deeper the real implementations it is useful to use a tracing system with intra and inter protocols correlation. For this reason in the case of MEGACO-H.248 it is necessary to find the appropriate method of correlation with all protocols involved. Starting from Rel4 a separation of CP (Control Plane) and UP (User Plane) management within the networks appears. MEGACO protocol plays an important role in the migration to the new releases or from monolithic platform to a network with distributed components.**

***Keywords:* MEGACO, Correlation, Identifier, Trace, TerminationID, Mediagateways.**

I. INTRODUCTION

Fixed and mobile networks have gone through a major transition in the past 20 years. In the mobile world, first generation systems (1G) were introduced in the mid-1980s. These networks offered basic services for users, the main emphasis being on speech and speech-related services. Second generation systems (2G) in the 1990s brought some data services and more sophisticated supplementary services to the users. The third generation (3G) is now enabling faster data rates and various multimedia services. In the fixed side, traditional Public Switched telephone Network (PSTN) and Integrated services Digital Network (ISDN) networks have dominated traditional voice and video communications. In recent years the usage of Internet has exploded and more and more users are taking advantage of faster and cheaper Internet connections such as Asymmetric Digital Subscriber Line (ADSL). These types of Internet connections enable always-on connectivity, which is a necessity for people to start using real-time communication means – e.g., chatting applications, online gaming, Voice over IP (VoIP).

At the moment we are experiencing the fast convergence of fixed and mobile networks as the penetration of mobile devices is increasing on yearly basis and soon we will have more than 2 billion mobile device users. These mobile devices have large, high precision displays; they have built-in cameras and a lot of resources for applications. They are always-on and always-connected application devices. This redefines applications. Applications are no longer isolated entities exchanging information only with the user interface. The next generation of more exciting applications is peer-to-peer entities, which facilitate sharing: shared browsing, shared whiteboard, shared game experience, and shared two-way radio session (i.e., Push to talk Over Cellular). The concept of being connected will be redefined. Dialing a number and talking will soon be seen as a narrow subset of networking. The ability to establish a peer-to-peer connection between the new Internet Protocol (IP) enabled devices is the key required condition. These new features of communications reach far beyond the capabilities of the Plain Old Telephone Service (POTS).

In order to communicate, IP-based applications must have a mechanism to reach the correspondent. The telephone network currently provides this critical task of establishing a connection. By dialing the peer, the network can establish an ad-hoc connection between any two terminals over IP network. This critical IP connectivity capability is offered only in isolated and single-service provider environment in the Internet; the closed systems compete on user base, where user lock-in is key and interworking between service providers is an unwelcome feature. Therefore, we need a global system, the IP Multimedia Subsystem (IMS). It allows applications to establish peer-to-peer or peer-to-content connections easily and securely. IMS – see Fig. 1 – is a global, access-independent and standard based IP connectivity and service control architecture that enable various types of multimedia services to end-users using common Internet-based protocol [1].

GSM (Global System for Mobile Communications) was defined by ETSI (European Telecommunications Standards Institute) during the 1980s and 1990s. ETSI also defined GPRS (General Packet Radio Service) network architecture. The last GSM-only standard was produced in 1998, and in the same year the 3GPP (Third Generation Partnership Project) was founded by standardization bodies from Europe, USA, China, Japan and South Korea to specify 3G mobile systems. After Release 1999, Release 2000 started to include All-IP that was later renamed IMS. The developing of IMS was not complete at the end of year 2000, therefore Release 2000 was split into Release 4 and Release 5. Finally, 3GPP Release 5 introduced the IMS, a standardized access-independent IP-based architecture that interworks with existing voice and data networks for both fixed and mobile users [4,6,7].

The paper has the following structure. Section I describes the evolution and integration of mobile and fixed networks as the penetration of mobile devices. Section II describes MEGACO protocol and Section III justifies the problem of correlation between MEGACO traces with traces from other interfaces or protocols. In Section IV are presented some correlation methods with other protocols and in Sections V conclusions are drawn.

II. MEGACO PROTOCOL

The MEGACO (Media Gateway Control) protocol was designed for the media gateways with distributed subcomponents required in complex networks. It is specified in RFC.3015 later replaced by RFC.3525 and aligned with ITU-T specification H.248, which itself supplements the earlier H.245 gateway component of the H.323 videoconferencing standard [2,3,4]. MEGACO is used between a media gateway (MG) and media gateway controller (MGC) to handle signaling and session management during a multimedia conference. The media gateway controller and the media gateway share a master/slave relationship.

The connection model for the protocol describes the main objects within MGs as terminations and contexts that can be controlled by the MGC. A termination sources or sinks (either originates or terminates) one or more streams, and each termination holds information about the actual media streams. Different terminations are linked together by a context. The set of terminations that are not associated with other terminations are defined as being represented by a special type of context (namely, the null context). A context describes the topology of terminations associated with it: for example, it includes parameters about mixing in case the context contains more than two terminations.

The MEGACO protocol is used in the 3GPP-IMS Mn and Mp reference points [9]. The Mn interface is the control reference point between the MGCF (Media Gateway Control Function) and IMS-MGW (Media Gateway Function). The Mn interface controls the user plane between IP access and IMS-MGW (Mb reference point). Also, it controls the user plane between CS (Circuit Switched) access (Nb and TDM interfaces) and IMS-MGS. The Mn interface is based on H.248 and is equivalent to the usage (encoding, decoding, etc.) of the Mc interface specified to control the CS-MGW. The difference between these two interfaces is that Mn interface introduces new H.248 procedures for handling IP access end termination and also some additional procedures for CS end termination handling. The H.248 is primarily used to perform the following tasks: reserve and connect terminations, connect or release echo canceller to terminations, connect or release tones and announcements to terminations, send/receive DTMF tones.

Mp reference point: when MRFC (Multimedia Resource Function Controller) needs to control media streams (e.g. to create connections for conference media or to stop media in MRFP- Multimedia Resource Function Processor) it uses the Mp reference point. This reference point is fully compliant with H.248 standard. However, IMS services may require extensions. This reference point is not standardized in Release 5 nor in Release 6.

MEGACO is as an open standard meaning that Telcos and others can now purchase their media gateways (MG) and gateway controllers (MGC) from different vendors with lower costs. It also allows possible the addition of extra MG of a common type running under the same controller, instead of replacing low-capacity gateways by high-capacity specimens.

A 3G mobile network will have to interface to external services over a variety of media, using *formats that require conversion to enable effective communication*. The MEGACO Protocol provides a framework for the operation of MG and specifies how they interact with a MGC for connection control. The basic concepts used to define connection control are terminations and contexts [4].

A *termination* acts as the source or the sink for one or more media streams or control streams, while a *context* is an association of a number of terminations. The context defines who sees or hears whom and also covers any mixing or switching parameters that are required between different terminations. The number of terminations per context is a characteristic of an individual media gateway. An MG that handles access and conversion for point-to-point links may be restricted to two terminations, whereas an MG for multipoint processes will normally have to support at least three. A termination can either represent a physical entity, such as a trunk interface port or channel on that trunk, or an information flow, such as RTP. A termination has two main features: *TerminationID* and *Properties and descriptors*.

TerminationID is an identifier issued by the MG, according to its own scheme, when the termination is created and may be structured, for example, to indicate channels within a trunk. The characteristics of a termination are given as properties that have an ID and a description. For the descriptors MEGACO provides two styles of expression: *textual* or *binary-encoded*. The textual format uses abbreviations of the field names based on System Description Protocol (SDP) rules, while the binary option uses concise tag values to express the Property_ID for local or remote descriptors accompanied by binary tag values in defined field sizes and format. The Property_ID tag values are divided into specific groups according to the type of descriptor. The parameter values associated with these tags define the characteristics of the media streams sent or received by the media gateway. Some of the types of specific importance to 3G networks are general media and AAL2 and AAL5 (ATM Adaptation Layer) attributes.

The MGC controls its media gateways by means of the MEGACO commands. The commands are used to manipulate the logical entities described in the connection model, namely, terminations and contexts. Each command can carry a number of parameters, called descriptors. Descriptors consist of a name and a list of items, some of which may have values. A command may also return descriptors as output [1].

III. MEGACO CORRELATION METHOD

The identification of problem: MEGACO doesn't have identifiers related to the public or private User_ID. For this reason, we propose a method to correlate MEGACO traces with traces from other interfaces or protocols. First observation regarding missing of Users_ID must be completed with the fact that MEGACO is based on TerminationIDs. We have started from RFC.3525 where we have found an important information. Terminations are referenced by a TerminationID, which is an arbitrary schema chosen by the MG. TerminationIDs of Physical_Terminations are provisioned in the MG. The TerminationIDs may be chosen to have structure. For instance, a TerminationID may consist of trunk group and a trunk within the group. At the beginning we have identified the problems:

- user identifiers are not present in MEGACO Protocols,
- in MEGACO one important parameter on TDM (Time Division Multiplexing) is TerminationID,
- there are internal TerminationIDs (subject of provisioning) and external TerminationIDs present in MEGACO traces,
- we should identify the conversion rule of internal_TerminationIDs to external_TerminationIDs.

Correlation can be done starting from User_Identifiers (IMSI/MSIDN, Calling, Called) (International Mobile Subscriber Identity / Mobile ISDN) to find the traces related to BSSAP/ISUP (Base Station System Acces Point / ISDN User Part) and from some parameters from these traces. From these parameters we can find the internal TerminationIDs and finally, based on the rule of conversion, we can have then external TerminationIDs. The logical chain is:

User-IDs (IMSI, MSISDN-Calling, Called) → BSSAP/ISUP-TDM-Traces (Parameters) → Parameters from these trace → Internal TerminationsID (conversion rule) → External TerminationsID (from Megaco Traces) → Megaco Traces.

Information regarding ISUP and BSSAP (E1-TDM) correlation with MEGACO: one problem is to find the TerminationIDs structure and to identify these using the information from trace A-BSSAP and ISUP. That depends of implementation. The TerminationID structure has to follow the guidelines of H.248 and the structure is either relevant or irrelevant for MGC and MGW. When bearer type is physical timeslot within TDM circuit, the TerminationID structure follows the Termination naming convention for TDM circuit bearer. It uses the ASN.1 (Abstract Syntax Notation.One) coding.

General Structure of TerminationID: {4 octets must be used for the TerminationID; the following defines the general structure for the TerminationID; termination_type, 3 bits (000 Reserved, 001 Ephemeral termination)}:

TABLE 1. 010 TDM_terminations.

011 110 Reserved, 111-Reserved for ROOT_Termination_ID (=0xFFFFFFFF)
X: usage dependent on Termination_Type (*1)
MGC: S (*2)

(*1) For Termination_Type is specified only TDM_terminations, other usage being unspecified. Terminations for TDM are specified by "Termination naming convention for TDM_terminations".

(*2) MGC=PS (Packet switched), only 16 bits are used. MGC=S, that means to correlate all the information from BSSAP (A interface) traces which can help us identify the Internal_TerminationIDs provisioned inside of MGC/MGW; after conversion we can find the External_TerminationIDs from MEGACO.

TABLE 2. Termination naming convention for TDM_terminations.

Termination type (010 for TDM)	PCM system (24 bits) (*3)	Individual (5 bits) (*4)

(*3) For PCM (Pulse Code Modulation) system, the usage is unspecified. It uniquely identifies PCM interface in MGW.

(*4) Individual: maximum of 32 individuals (timeslots) per PCM system (or maximum 24 individuals for a 24 channel system).

Let's take a case for MOC (Mobile Originating Call) or MTC (Mobile Terminating Call) starting or ending to one BSC (Base Station Controller). Like example we have used traces from Core Rel4 based on MGC&MGW Nokia. From A interface the following parameters are useful:

{PCM-Trunk Number,

Timeslot Used (CIC- Circuit Identification Code-like in trace),

Time (because the TerminationIDs is used only at this moment),

SPC (OPC or DPC) (Signaling Point Code; Originating Point Code; Destination Point Code)}.

Based on these parameters we can identify the internals TerminationIDs (subject of provisioning). With

SPC (DPC or OPC), PCM-Trunk Number and TS (Time Slot) we can find in the MGC or MGW → TerminationIDs (Internal).

Example:

OPC=701 PCM=11 TS=25 → TerminationIDs (Internal) = 01346–025

meaning that 01346 it is subject of provisioning and 025 is TS (CIC).

Example of conversion

Internal_TerminationIDs ↔ External_TerminationIDs:

TerminationIDs_Intern = 01346-025.

TerminationIDs_Extern (from MEGACO Trace) = 4000A859H.

Using the rule from Terminations_Name ASN.1 documents we found the following association:

1) Conversion from TerminationIDs_Intern in TerminationIDs_Extern

TTT (Termination Type)	=010	→ TDM
PCM System	=000000000000010101000010	→ 01346
TS (CIC)	= 11001	→ 025
All Toghether:	=010 000000000000010101000010 11001	→ 4000A859h

2) Conversion inverse from TerminationIDs_Extern to TerminationIDs_Intern

4000A859h (from HEX in BIN)	→010 000000000000010101000010 11001
010	= Termination Type-TDM (3bits)
000000000000010101000010	=1346-Channel System (24bits)
11001	=25 TS (5bits)

From ISUP traces we can use the following parameters: SPC (OPC or DPC), CIC.

Example:

SPC=11361, CIC=1562

3) CIC must be converted in binary and the last 5 bits give us the TS and the others are the PCM trunk number.

With all this information (SPC, CIC=PCM trunk number and TS) we are able to find the Internal_TerminationIDs from MGC/MGW. All the others are identically like for A interfaces. PCM trunk number (and TS) is subject of provisioning and the name depends on the implementation.

IV. OTHER APPROACHES FOR CORRELATION

To be able to correlate BSSAP and ISUP (TDM) traces with MEGACO we should use the indicated parameters from the traces. Using these parameters (already provisioned to MGC) it is easy to find the internal provisioned TerminationIDs. Based on the rule of conversion we will have the external TerminationIDs used in MEGACO (Traces). The beginning and the end of the call will be helpful to identify the right TerminationIDs in use. For the tracing systems based on XDR's (eXternal Data Representation) and database the best way to obtain the correlated traces is to use a supplementary external table with the following structure:

PC-NE	PC-MGC	PCM-Trunk-Num	Internal-TerminId	External-TerminId

PC-NE = Network Element Point Code (from BSSAP or ISUP Trace)

PC-MGC = Point Code of MGC involved (from BSSAP or ISUP Trace)

PCM-Trk-Num = PCM Trunk number

Int-TermId = Internal TerminationIDs (from MGC/MGW provisioned data)

Ext-TermId = External TerminationIDs (after conversion of Internal TerminationIDs)

Based on BSSAP and ISUP traces, where we have PC's, PCM trunk number and TS, we can find Internal_TerminationIDs and External_TerminationIDs already converted. We would like to mention that with External_TerminationIDs we can start the correlation. Another helpful parameter is Context-ID, that should be used to identify all others operations/messages from MEGACO and to build the MEGACO XDRs.

WCDMA (Wideband Code Division Multiple Acces) radio access was the most significant enhancement to the GSM-based 3G system in Release 1999. In addition to WCDMA, UMTS Terrestrial Radio Access Network (UTRAN) introduced the Iu interface as well. Compared with the A and Gb interfaces, there are two significant differences. First, speech transcoding for Iu is performed in the core network. In the GSM it was logically a Base Transceiver Station (BTS) functionality. Second, encryption and cell-level mobility management for Iu are done in the Radio Network Controller (RNC). In

GSM they were done in the Serving GPRS Support Node (SGSN) for GPRS services [9].

We have to say something about the correlation between IuCS-ATM and MEGACO: the command BindingID is used and it is present in the IuCS traces as well as in MEGACO. For the systems with XDRs this must be enclosed to the XDR's. This parameter is unique during the call, meaning the beginning and the end of the call are subject of this correlation.

For the correlation of BICC with MEGACO, we use the information that BICC (Bearer Independent Call Control) and MEGACO are doing the tunneling. That means we will find RTP Destination Address and RTP Destination Port. Using the beginning time and the end time of the calls we will be able to correlate also these traces without failure. For the Tracing system based on XDR's RTP Dest_Address and RTP Destination_Port will be part XDR's and the correlation will be very easy.

V. CONCLUSION

Starting from Rel4 appears a separation of CP (Control Plane) and UP (User Plane) management within the network. Very helpful in this new concept of implementation is the MEGACO protocol. This protocol plays an important role in the migration to the new releases or from monolithic platform to a network with distributed components.

MEGACO or H.248 is a protocol enabling a centralized Softswitch (or Media Gateway Controller) to control Media Gateways between Voice over Packet (VoP) networks and traditional ones. The MEGACO protocol is a joint work of IETF and ITU-T. It is named MEGACO in IETF document and H.248 in ITU-T document, but the content is exactly the same.

To be able to analyse much deeper the real implementations it is indicated to use tracing system with intra and inter protocols correlation. For this reason in the case of MEGACO-H248 is necessary to find the appropriate method of correlation with all protocols involved.

The correlation of BSSAP and ISUP traces on TDM with MEGACO needs:

- User identifiers (to have the traces BSSAP/ISUP)
- Traces Parameters (from BSSAP/ISUP)
- Provisioned Dates (Int-TermID from MGC/MGW)
- MEGACO TerminationIDs (or Ext-TermID)
- Rule of conversion (Int-TermId ↔ Ext-TermID)

It is important to be able to find the "Provisioned Dates", using "Traces Parameters"; and after that the logical chain is complete.

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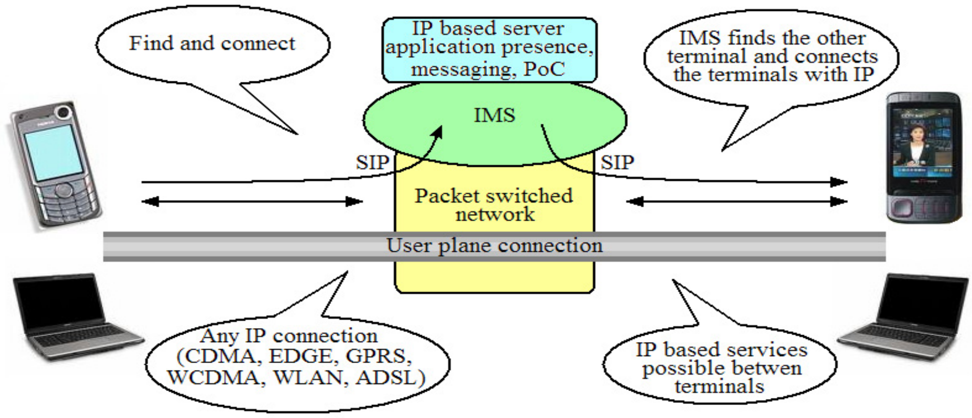

Figure 1. IMS and packet switched networks.