MEGACO Correlation Method

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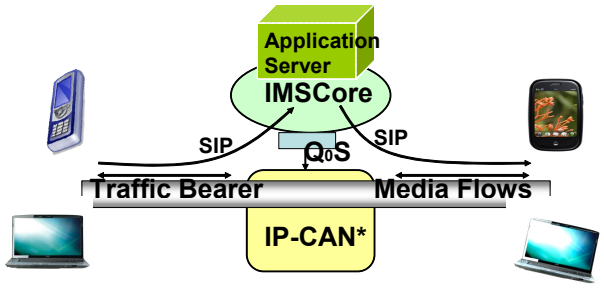
Abstract: - Starting from Rel4 appears a separation of CP (Control Plane) and UP (User Plane) management within the networks. MEGACO protocol plays an important role in the migration to the new releases or from monolithic platform to a network with distributed components. MEGACO or H.248 is a protocol enabling a centralized Softswitch (or MGC) to control MGs between Voice over Packet (VoP) networks and traditional ones. To analyze 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-H.248 it is necessary to find the right method of correlation with all protocols involved.

Key-Words: - MEGACO, Correlation, Identifier, Trace, SCTP, Mediagateways, Media Gateway Controller, IMS

1 Introduction

Mobile networks have gone through a major transition in the past 20 years. First generation systems (1G) offered basic services, on speech and speech-related services. Second generation systems (2G) added data services and some supplementary services. The third generation (3G) is now enabling faster data rates and various multimedia services. Now it is a fast convergence of fixed and mobile networks as the developing of mobile devices. They are always-on and always-connected application devices. This redefines applications that are no longer isolated entities exchanging information only with the user interface, but peer-to-peer entities which facilitate sharing: shared browsing, shared two-way radio session, etc. The concept of being connected will be redefined; dialing and talking will became a narrow subset of networking and the ability to establish a peer-to-peer connection between the new Internet Protocol (IP) enabled devices is the key required condition. The IP connectivity capability is offered only in isolated and single-service provider environment in the Internet. We need a global system, the IP Multimedia Subsystem (IMS) that allows applications to establish peer-to-peer or peer-to-content connections easily and securely. IMS – see Figure 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 [8].

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.



IP-CAN-IP Connectivity Access Network
QoS-quality of services
Rel5 -3G CAN (SGSN-GGSN basic IMS architecture and functionality)
Rel6-I-WLAN (adds interworking with WLAN)
Rel7-DSL - CAN (adds interworking with fixed broadband networks)
Rel8-LTE (ePS, ePS-Core enhanced Packet-Switched Core Network (will be present in LTE/SAE; In LTE/SAE ePS have the role of SGSN/GGSN together)

Fig. 1 IMS Network

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 Rel4 and Rel5. Finally, 3GPP Rel5 introduced the IMS, a standardized access-independent IP-based architecture which interworks with existing voice and data networks for both fixed and mobile users [3, 5, 6].

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 we have presented the network and tests traces used for our study. In Section V are presented some correlation methods with other protocols and in Section VI conclusions are drawn.

2 MEGACO Protocol

MEGACO (Media Gateway Control) protocol was designed for the media gateways with distributed subcomponents required in complex networks. IETF (Internet Engineering Task Force) 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 [1, 2, 3]. 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 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 Rel 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 at the high prices.

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 [3].

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: they are used to manipulate the logical entities - terminations and contexts - described in the connection model. Each command can carry a number of parameters, called descriptors, consisting in a name and a list of items, some of which may have values. A command may also return descriptors as output [8].

3 MEGACO Correlation Method

We have identified the following problem in the MEGACO protocol: it doesn't have identifiers related to the public or private User_ID. For this reason, in order to be able to correlate MEGACO traces with traces from other interfaces or protocols we should find a rule. This first observation regarding missing of Users_ID must be completed with the fact that MEGACO is based on TermIDs.

During our study we made a separation of the issues for MEGACO correlation of IP, ATM media and TDM. Based on the specifications and of our practically observation using Wire-Shark Traces we clarified that the correlation of CP protocols with MECACO for media IP/ATM (or UP IP/ATM) is much easier. There are common identifiers used in the same time at level CP protocols (i.e. SIP/BICC/RANAP), MEGACO and UP Media, comparing with ISUP and GSM-A protocol where the situation is different; no common protocol identifiers are available at traces level for these and MEGACO. This problem is very important to be solved for following networks type and topologies:

a) Rel4 networks where it can see TMD technology, in access and networks interconnect with other operators,

b) Interconnect under IMS of different networks like REL4 and ALL-IP,

c) Interconnect of IMS with PLMN (Public Land Mobile Network) and PSTN (Public Switched Telephone Network) on ISUP-TDM.

Based on these considerations we have started from RFC.3525 where we have found the important information. Terminations are referenced by a TermID, which is an arbitrary schema chosen by the MG. TermIDs of Physical_Terminations are provisioned in the MG. The TermIDs may be chosen to have structure. For instance, a TermID 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 TermID,
- there are internal TermIDs (subject of provisioning) and external TermIDs present in MEGACO traces,
- we should identify the conversion rule of intern_TermIDs to extern_TermIDs

For a human operator in Telco Network is very important to be able to find the problems from the network. That became much easier using a Protocol Analyzer (Trace) with possibility of E2E inter protocols and interface correlation starting from what is easy to know, problem of Network Users and in direct connection with Users–Identifiers (IMSI/MSISDN).

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 this traces. From these parameters we can find the internal TermIDs and finally, based on the rule of conversion, we can have then external TermIDs. The logical chain is:

User-IDs (IMSI, MSISDN-Calling, Called) → BSSAP/ISUP-TDM-Traces (Parameters) → Parameters from these trace → Int_TermIDs (conversion rule) → Ext-TermID (from MEGACO Traces) → MEGACO Traces.

Regarding ISUP and BSSAP (E1-TDM) correlation with MEGACO, one problem is to find the TermIDs structure and the possibility to identify these using the information from trace A-BSSAP and ISUP. That depends of the implementation. The TermID 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 TermID structure follows the Termination naming convention for TDM circuit bearer. It uses the ASN.1 (Abstract Syntax Notation.One) coding.

The general structure of TermID **i**s {4 octets must be used for the TermID; the following defines the general structure for the TermID; termination_type, 3 bits (000 Reserved, 001 Ephemeral termination)}:

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), 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 we should extract from BSSAP (A interface) traces the information which can help us to identify the Internal_TermIDs provisioned inside of MGC/MGW and after conversion to find the External_TermIDs from MEGACO.

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

(*3) For PCM (Pulse Code Modulation) system usage is unspecified. 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/ending to one BSC (Base Station Controller). Like example we have used traces from Core Rel4 based on MGC&MGW Nokia. From A interface are useful the parameters: {PCM-Trunk Number, Timeslot Used (CIC-Circuit Identification Code-like in trace), Time (because the TermIDs is used only at this moment), SPC (OPC or DPC) (Signaling Point Code; Originating Point Code; Destination Point Code)}. Based on them we can identify the internals TermIDs (subject of provisioning). With SPC (DPC or OPC), PCM-Trunk Number and TS (Time Slot) we can find in the MGC or MGW → TermIDs (Internal)[10].
Example: OPC=701 PCM=11 TS=25 → TermIDs (Internal) = 01346–025 meaning that 01346 it is subject of provisioning and 025 is TS (CIC).
Example of conversion Int_TermIDs → Ext_TermIDs: TermIDs_Intern = 01346-025. TermIDs_Ext (from MEGACO Trace) = 4000A859H.
Using the rule from Terminations_Name ASN.1 documents we found the following association:

1) Conversion from TermIDs_Int in TermIDs_Ext

TTT(TermType)	=010	→ TDM
PCM System	=000000000000 010101000010	→ 01346
TS (CIC)	= 11001	→ 025
All Toghether:	=0100000000000000 1010100001011001	→ 4000A859h

2)Conversion from TermIDs_Extern in TermIDs_Intern:

4000A859h (from HEX in BIN)	→0100000000000000 10101000010 11001
010	= Term Type- TDM (3bits)
000000000000 0010101000010	=1346-Channel System (24bits)
11001	=25 TS (5bits)

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

4 Network and Traces

For our study we have collected traces from an REL 4 network:

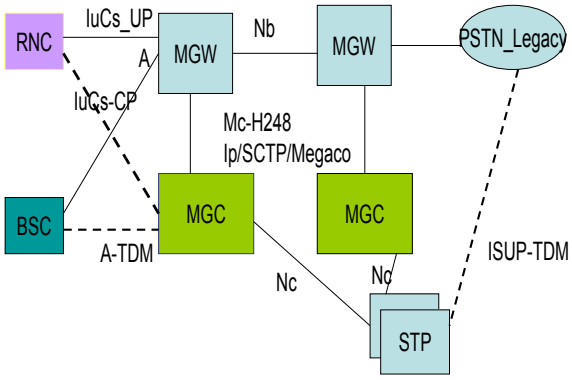


Fig. 2 REL 4 Network

Below are the most important parameters selected to link the protocols from GSM-A/TDM, BSSAP and from MC/SCTP-IP, MEGACO. In this way will be starting the correlation for example for the MTC-GSM-A and associated H248- MEGACO Traces.
Based on these parameters we can identify the internals TermIDs (subject of provisioning). With SPC (DPC or OPC), PCM-Trunk Number and TS (Time Slot) we can find in the MGC or MG → TermIDs (Internal). Example from that trace: Destination Point Code - DPC=111 PCM=11 TS=25 → TermIDs (Internal) = 01346–025 meaning that 01346 is subject of provisioning and 025 is TS (CIC).

Trace-MTC-GSM-A (26.6 sec)
Time: 11 OCT 2009 15:39:24.245-15:39:50.893

IMSI: xxxxxxxxxxxxxxx IMEI/IMEISV: None TMSI(hex): 2266ce3
Calling: xxxxxxxxxx
PCM Mux used (Trunk Number): **11*****
Timeslot used(CIC): **25********
CC Disc.Cause: Normal call clearing - 16
CDR type: Call MS Terminated RR Cause: Normal event
LAC Serving: 40111 CI Serving: 47111
OPC: **11111 = MGC ** DPC: **111 = PC- NE ***
Orig.Cref: 5718489 Dest.Cref: 9833964
Answered: 11 OCT 2009 15:39:42.694
Disconnection: 11 OCT 2009 15:39:50.597 Disconnecting OPC: 11111
Channel: Dual rate supp. MS/full rate pref.

Trace-H.248 (26.6 sec)
Time: 11 OCT 2009 15:39:24.234-15:39:50

Context IDs: 109984407
Orig IP Address: 10.111.65.137 Orig Port: 2945
MG1 IP Address: 10.111.65.23 MG1 Port: 8010
MG2 IP Address: 10.111.65.23 MG2 Port: 8010
Termination IDs: 4000C1EB, **4000A859 *****
Termination IDs: 29B21B00
Disconnection Cause: Normal Call Clearing

Conversion: Int_TermIDs(=01346-025) → Ext_TermIDs (from MEGACO Trace) = 4000A859H. Using the rule from Terminations_Name ASN.1 documents we found the following association:
Conversion from TermIDs_Intern in TermIDs_Extern:

TTT (Term Type)	=010	→ TDM
PCM System	=000000000000 010101000010	→ 01346
TS (CIC)	= 11001	→ 025
All Together:	=0100000000000000 10101000010 11001	→ 4000A859h

All that conducts to the idea to use an external table like bridge between GSM-A trace and H248 trace which help us to correlate them. During our study we used the format:

PC-NE	PC-MGC	PCM-Trunk-Num	Int-TermID	Ext-TermID
111 *	11111 **	11 ***	01346-25 ****	4000A859 *****

Parameters marked with: *, **, ***, ***, **** will be found also in the GSM-A trace (and ISUP); ***** will be found in the H248 trace. Int-TermID, subject of provisioning, is extracted from MGC or MG configuration. Using these parameters for correlation we have retrieved the right MEGACO messages but during our tests it happened sometimes to find also other MEGACO messages from other MGs and MGCs because of the same Termination IDs in use more or less in the same range of time. They appear after 10 or 20 Calls, in big networks of big operators.

We didn't invest time to measure the probability of this event, but we have searched an improvement for the method of correlation discovering and using supplementary parameters from the traces. We did that to find the parameters used like unique link (correlate) for GSM-A/ISUP messages with H248.

The improvement should give a possibility to find a combination of parameters which during a call is unique. We observed that in the low layer protocol which parameters with the already specified assure a final and sure method of correlation. During the tests and our observation we take the decision to use supplementary fields in the external tables like below:

PC-NE	PC-MGC	PCM-Trunk-Num	Int-Term_ID	Ext.-Term ID	MGW IPs-SCTP	MGC IPs-SCTP

The last two new columns are referring to IPs SCTP (Stream Control Transmission Protocol) association in use for MEGACO protocol (MGC-MGW) and the presence in MEGACO messages. That means the external format table in our case will be:

PC-NE	PC-MGC	PCM-Trunk-Num	Int-Term Id	Ext-Term Id	MGW IPs-SCTP	MGC IPs-SCTP
111 *	11111 **	11 ***	01346 -25 ****	4000 A859 *****	10.111. 65.23 MG2*	10.111. 65.137 MGC*

MG2* and MGF* are new being part of provisioning and are present in the trace of MEGACO.

Based on of a lot of tests traces we no longer received wrong messages in our correlation.

Trace-H248 (26.6 sec)
Time: 11 OCT 2009 15:39:24.234-15:39:50.872

Context IDs: 109984407
Orig IP Address: 10.111.65.137 Orig Port: 2945
MG1 IP Address: **MGC *** 10.111.65.23 MG1 Port: 8010
MG2 IP Address: **MG2 *** 10.111.65.23 MG2 Port: 8010
Termination IDs: 4000C1EB, **4000A859 *****
Termination IDs: 29B21B00
Disconnection Cause: Normal Call Clearing

5 The Correlation Ways

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 TermIDs. Based on the rule of conversion we will have the external TermIDs used in MEGACO (Traces). The begin and the end of the call will be helpful to identify the right TermIDs in use.

Actually, like tracing systems, we can speak about sniffer systems like Wire-shark (open system) used for small networks and local traces, where we can't have inter protocols E2E correlation and is not necessary. But anyway our method can be implemented also in this case.

The big Telecomm operators have deployed big tracing systems using E2E inter protocols correlation, building large databases with the most important parameters, identifiers extracted from CP/UP messages necessary for the correlation. These can be named like system based on CDR (Call Data Records or Call Details Records after model of billing) in the case of calls and of mobility also. These systems can use our method starting to do a correlation using this large database and from there to retrieve on demand the associated messages saved in the same hardware or in a distributed system. In our case we can say that database is a way to obtain the correlated traces. We can use a supplementary external table with the following structure:

PC-NE	PC-MGC	PCM-Trunk-Num	Int-TermID	Ext-TermID

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 = from MGC/MGW provisioned data
Ext-TermID = after conversion of Internal TermIDs

For a small network or when the tracer will be in use on isolated networks, the upper correlation could work without problems. Practically from our tests we discovered that, based only on External TermID (and time) we can meet the situation, having in use (between different MGC and MG) the same number like Term-ID in different MG. That can create a wrong inter-protocol correlation or can bring in the correlated messages also wrong MEGACO messages. To avoid this kind of situation an important modification must be done in this external table structure based on provisioning information also:

PC-NE	PC-MGC	PCM-Trunk-Num	Int-Term ID	Ext-Term ID	MGW IPs-SCTP	MGC IPs-SCTP

The columns are referring to IPs SCTP association in use for MEGACO protocol (MGC-MG) and presence in MEGACO messages. Based on these new columns could be reached the right of inter-protocols correlation.

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

This method of correlation can be used in tracing systems based on centralized data base or could be propagated in each distributed analyzer/probe, depending on vendor implementation. That means to provide for TDM case the information in the analyzers-probes level and in the same time using the same idea and in the end to push in the MEGACO CDRs the Users identifiers (Calling, Called, IMSI) from BSSAP and ISUP traces WCDMA (Wideband Code Division Multiple Access) radio access was the most significant enhancement to the GSM-based 3G system in Rel99. 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. Speech transcoding for Iu is performed in the core network, but in the GSM it was a Base Transceiver Station (BTS) functionality. 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: is used the

command BindingID, 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 begin time and the end time of the calls are subject of this correlation.

Regarding the correlation for BICC with MEGACO, we know that BICC (Bearer Independent Call Control) and MEGACO are doing the tunneling and that means we will find there RTP_DestinAddress and RTP_DestinPort. Using the begin 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, the RTP_Dest_Address and the RTP_ Destin_Port will be part of XDR and the correlation will be very easy.

In the same way the correlation could be done in the case of using SIP (Session Initial Protocol) instead BICC (in the SIP messages are present the RTP Dest_Address and the RTP Dest_Port in use in MEGACO also).

6 Conclusion

Starting from Rel4 appears a separation of CP and UP management within the network. Very helpful in this new concept implementation is MEGACO protocol, which plays an important role in the migration to the new releases or from monolithic platform to a network with distributed components. MEGACO is a protocol enabling a centralized SoftSwitch (Media Gateway Controller) to control Media Gateways between Voice over Packet (VoP) networks and traditional ones. To analyze deeper the real implementations it is indicated to use tracing system with intra and inter protocols correlation [10]. For MEGACO-H248 it is necessary to find the right method of correlation with all protocols involved. 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/MG)
MEGACO TerminIDs (or Ext-TermID)
Rule of conversion (Int-TermID ↔ Ext-TermID) &
MGC-IPs-SCTP and MG-IPs-SCTP

The right correlated messages can be retrieved using these parameters, the begin_time and the end_time of the call. Important is that, using "Traces Parameters", to be able to find the "Provisioned Dates" and after that the logical chain is complete.

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