Procedures for Megaco/H.248 controlled Voice Media Gateways for Autonomous Switchover to Fax Relay Service

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Abstract

This document describes the handling of realtime fax calls in Megaco/H.248 controlled MGs. The call setup and capability negotiation is done with support of the control domain with Megaco commands. The switch over to fax or modem, upon detection of the relevant tones, is done in an autonomous way, without intervention of the control domain. In the Appendix, the Megaco messages for a call setup scenario with capability negotiation are shown, to point out the structure of the SDP sessions in the local and remote descriptors. Call flow diagrams are given as example:

In the first flow, a T.30 CNG tone is generated by the transmitting terminal, the transmitting MG signals the detection towards the receiving MG. Switching to T.38 is done by both MGs as soon as possible.

In the second example, a T.30 CED tone is sent by the receiving terminal. As this tone is no clear indication that a FAX will be sent, the receiving MG will switch to VBD after signaling this event.
to the transmitting MG. Switching to T.38 is done after reception of V.21 flags.
In the other flows, T.38 is not enabled, both MGs switch to the fallback case, fax pass-through mode.

This document is based on the superior framework (reference [2]).
The reader should be familiar with [2].

Conventions used in this document

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC-2119 [3].

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Acknowledgments..................................................

Author’s Addresses................................................
1. Definitions

Following general terms are used in this document, see also [2] respectively reference model and terminology.

1.1 Gateway Types

Gateway: A gateway converts media provided in one type of network to the format required in another type of network. For example, a gateway could terminate bearer channels from a switched circuit network (e.g., DS0s) and media streams from a packet network (e.g., RTP streams in an IP network).

Emitting Gateway: The access point that is called by a sending fax equipment that interfaces to the IP network. (Abbreviated to MG1)

Receiving Gateway: The access point that is called by a receiving fax equipment that interfaces to the IP network. (Abbreviated to MG2)

1.2 Packet Network Transport Services

Dialed Digits Relay: The transportation of multifrequency audio tones (e.g., DTMF) across a packet network using specific packet formats (e.g., RFC 2833 for IP networks) in the packet-switched network transport domain.

Fax Relay: The transportation of fax modem traffic across a packet network using fax demodulation/remodulation techniques at the network access points.

Tone Relay: The transportation of general audio tones (e.g., telephony tones and telephony signals) across a packet network using specific packet formats (e.g., RFC 2833 for IP networks) in the packet-switched network transport domain.

1.3 States of MCUs and MGs

The basic state definitions are provided by a companion document, see [2]. The purpose of this section is to detail the definition of the VBD state (also called Pass-Through mode).

VBD has following characteristics:
- A voice codec is used which passes voice band modulated signals with minimal distortion, i.e. G.711 coding.
- have end-to-end constant latency => minimum jitter
- Static de-jitter buffer configuration = non adaptive mode: the last value before switchover to VBD is frozen.
  In case of immediate switching to VBD, the default value is taken.
- Disable Voice Activity Detection (VAD) and Comfort Noise Generation during data transfer phase => VAD = off
- Disable any DC removal filters that may be integral with the speech encoder used.
- EC = off
- Be capable of tone detection
- Forwards error Correction (FEC) = off
- Deactivate PLC algorithm
- Open parameter: A-law or u-law (fixed value)

2. Abbreviations

B-INF  Bearer Interworking Function
C2P     Circuit-to-Packet (direction)
CED     Called terminal identification, see [7]
CNG     FAX Calling tone, see [7]
DCE     Data Circuit-terminating Equipment (Modem)
DCN     Disconnect, see [7]
DSP     Digital Signal Processor (Europe)
         Digital Speech Processor (North America)
DTE     Data Terminal Equipment
DTMF    Dual Tone Multi-Frequency
EC      Echo Cancellation
E-MG    Emitting Media Gateway
FSK     Frequency Shift Keying
FoIP    Fax over Internet Protocol
FR      Frame Relay
GW      GateWay
IP      Internet Protocol
ISDN    Integrated Services Digital Network
MCU     Media Conversion Unit (e.g., DSP channel)
MG      Media Gateway (= via Megaco/H.248 controlled MG)
MGC     Media Gateway Controller
MMF     Media Mapping Function
MMSF    Media Mapping and Switching Function
NAS     Network Access Server
NGN     Next Generation Network
NTE     Named Telephone Events
P2C     Packet-to-Circuit (direction)
PLC     Packet Loss Concealment
PSTN    Public Switched Telephone Network
R-MG    Receiving Media Gateway
3. Motivation and Problem Definition

The handling of FoIP in MGs, which are controlled with Megaco/H.248 [6] is described in T.38 Appendix III ref [4], and supported by H.248 with help of the packages defined in H.248 Annex F., see ref [5].

In the above scenario, the MGCs have the knowledge of the capability of the MGs to support T.38, by means of audit commands. Call set-up is done as usual, enabling resources for voice. Additionally, events are enabled as defined in the FAX packages. Upon detection of FAX signals, the MGC is notified by the emitting MG about the event, and gives the command to the receiving part via its controlling MGC to generate the signals. Answering signals are handled in the same way. When all signals needed are communicated between both FAX terminals via the MGs and MGCs, the MGCs will modify the contexts to put them into fax-mode. This scenario can take up to 20 Megaco commands, see T.38 Appendix III, [4].

This document proposes a more direct handling of the fax-switchover, without intervention of the control domain, but by means of interchanging RFC2833 events between the two gateways. For reasons of robustness, as soon as a MG switches in T.38 mode, also T.38 messages are sent of type T30_indicator, to indicate the detection of the signals CNG, CED or V.21 preamble flags.

As long as a MG is in VBD mode, signals are also passed inband, in VBDoIP.

If for some reason, during the negotiating phase of the call set-up, one gateways signals not to be able to support T.38, an automatic switchover to Fax-pass-through will occur upon detection of Fax tones.
3.1 Architecture Overview

This overview contains the involved network elements like MGCs and MGs. The MG contains a Bearer Interworking function, for the translation between DS0 channels and IP packets. It contains a MCU, a Media Conversion Unit with a B-IWF split for the 2 directions, C2P and P2C. For voice and FAX, both B-IWF parts will be synchronous, they will pass different states for receive and transmit in the same way.

In this document, the MG1 will take the role of the Emitting Gateway and the MG2 will be the Receiving Gateway.

The MGs are controlled by MGCs, via the Megaco protocol, [6]. In the figure 1, the general case is drawn, for which both MGs are controlled by different MGCs. The communication between the two MGCs is not scope of this document.

Figure 1: Reference Network Architecture

= 1 bi-directional DS0 bearer channel
3.2 Major States of a Media Gateway

At any given time, each direction of the B-IWF is in exactly one state. The states of the MGs are considered to be the states of the MCU.

All states are quoted in Figure 2, the state transitions are simplified. All possible transitions and the conditions for which they occur are described in Appendix A.

<table>
<thead>
<tr>
<th>IDLE</th>
<th>&lt;--------------------</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>Call set-up (ADD)</td>
</tr>
<tr>
<td></td>
<td>Call release (SUBTRACT)</td>
</tr>
<tr>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>--------------</td>
</tr>
<tr>
<td></td>
<td>- compressed (Vc)</td>
</tr>
<tr>
<td></td>
<td>- uncompressed (Vu)</td>
</tr>
<tr>
<td></td>
<td>Fax end</td>
</tr>
<tr>
<td></td>
<td>no T38 enabled</td>
</tr>
<tr>
<td></td>
<td>VBD</td>
</tr>
<tr>
<td></td>
<td>------</td>
</tr>
<tr>
<td></td>
<td>T.38 enabled</td>
</tr>
<tr>
<td></td>
<td>Fax Relay (FR)</td>
</tr>
<tr>
<td></td>
<td>------</td>
</tr>
</tbody>
</table>

Figure 2: MCU states

4. Scope

The scope of this document is limited on T.38 Media Gateways capable of autonomous transition between VoIP and FoIP.
5. Description of Phases

The different phases for handling of a FAX call follow the time sequence as described in T.30 [7], preceded by the Megaco/H.248 audit capability sequences, see [6].

Figure 3: Phases of a Fax call
5.1 Audit of the Capabilities by the MGC

At some point before a call establishment, the MGC will have sent an audit capabilities command to the MGs, and will know the capabilities of each MG. For connections whereby one of the MGs is not able to support T.38, the T.38 capability will not occur in the negotiating phase, and fax modem and data modem services will only be possible in Pass-through mode.

5.2 Megaco/H.248 Call Establishment Procedures

Triggered by a Call Control signaling message, the MGC will set up the call by creating a context, taking care that all resources needed to support the voice call and a possible FAX call can be supported by both sides. Following actions has to be done:
- Negotiating about the codecs to be used for voice
- Negotiating about the ability to use T.38 for fax relay, and the values of the mandatory attributes.
- Interchange of the address information of both sides, IP address and UDP ports. Note that for voice and FAX, different UDP ports can be chosen.

Because of the fact that the switchover to FAX is done internal in the MGs, and no notification is generated towards the MGC, the packages defined in H.248, Annex F, are not needed, and no FAX related Event detectionAs are enabled at the TDM termination at call set up.

Remark: if the event detection for FAX signals as described in the FAX packages is enabled, switchover supported by the control domain will be enabled. The use of these packages can be considered as mode selection between autonomous switchover and MGC-controlled switchover.

In the following example, the local control parameters ReserveGroup and ReserveValue are used as described in H.248, chapter 7.1.8, see ref [6], to request media streams and their values in the ADD and MODIFY commands.

As an alternative, the principle of grouping of media lines in SDP as described in [8], using the group attribute "FID" and "mid" could be used.

In the following example of a Megaco command sequence, the situation that one MGC controls both MGs is taken, as the communication between the two MGCs is not scope of this document.
MGC -> MG1:
==========
MEGACO/1.0 [123.123.123.4]:55555
Transaction = 11 {
  Context = $ {
    Add = DS0/1/1
    Add = $ {
      Media {
        LocalControl{
          Mode = ReceiveOnly,
          ReserveGroup = true,
          ReserveValue = true}; The MG1 should reserve all
          Codec and sessions it
          can support, see [6], 7.1.8
        Local{
          v=0
          c=IN IP4 $
          m=audio $ RTP/AVP 4 0
        v=0
        c=IN IP4 $
        m=image $ udptl t38
        a=T38FaxRateManagment:localTCF
        a=T38FaxUdpEC:t38UDPFEC
      }}}}
    MG1 -> MGC:
==========
Megaco/1.0 [124.124.124.222]:55555
Reply = 11
  Context = 2000{
    Add = DS0/1/1
    Add = RTP/1{
      Media{
        Local{
          v=0
          c=IN IP4 124.124.124.222
          m=audio 2222 RTP/AVP 4 0 ; MG1 can support both codecs
          v=0
          c=IN IP4 0.0.0.0
          m=image 1111 udptl t38 ; other UDP port chosen for fax
          a=T38FaxRateManagment:localTCF
          a=T38FaxUdpEC:t38UDPFEC
        }}}}

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MGC -> MG2:
------------
MEGACO/1.0 [123.123.123.4]:55555
Transaction = 12 {
    Context = $ {
        Add = DS0/2/2
        Add = $ {
            Media {
                LocalControl{
                    Mode = SendReceive,
                    ReserveGroup = true,
                    ReserveValue = false}; The MG2 should choose
                    out of the list of codecs
                    with decreasing priority
                }
                Local{
                    v=0
                    c=IN.IP4 $ 
                    m=audio $ RTP/AVP 4 0
                    v=0
                    c=IN.IP4 $ 
                    m=image $ udptl t38
                    a=T38FaxUdpEC:t38UDPFEC
                    a=T38FaxRateManagement:localTCF
                }
                Remote{
                    v=0
                    c=IN.IP4 124.124.124.222
                    m=audio 2222 RTP/AVP 4 0
                    v=0
                    c=IN.IP4 0.0.0.0
                    m=image 1111 udptl t38
                    a=T38FaxRateManagement:localTCF
                    a=T38FaxUdpEC:t38UDPFEC
                }}}
}

MG2 -> MGC:
------------
Megaco/1.0 [125.125.125.555]:55555
Reply = 12
    Context = 5000{
        Add = DS0/2/2
        Add = RTP/2{
            Media{
                Local{
                    v=0
                    c=IN.IP4 125.125.125.555
                    m=audio 5555 RTP/AVP 4 0
                    ; MG2 can support the codec which
                    ; had the highest priority
                }
            }
        }
    }

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v=0
c=IN.IP4 0.0.0.0
m=image 4444 udptl t38 ; other UDP port chosen for fax
a=T38FaxRateManagment:localTCF
a=T38FaxUdpEC:t38UDPFEC
}
Remote{
 v=0
c=IN.IP4 124.124.124.222
m=audio 2222 RTP/AVP 4 ; the MG2 updated the remote
 ; descriptor also
 v=0
c=IN.IP4 0.0.0.0
m=image 1111 udptl t38
a=T38FaxRateManagment:localTCF
a=T38FaxUdpEC:t38UDPFEC
}}}}

MGC -> MG1:
============

MEGACO/1.0 [123.123.123.4]:55555
Transaction = 13 {
 Context = 2000 {
 Modify = RTP/1{
 Media{
 LocalControl{
 Mode = SendReceive,
 ReserveGroup = true,
 Local{
 v=0
c=IN.IP4 124.124.124.222
m=audio 2222 RTP/AVP 4 ; value to be updated
 v=0
c=IN.IP4 0.0.0.0
m=image 1111 udptl t38
 }
 Remote{
 v=0
c=IN.IP4 125.125.125.555
m=audio 5555 RTP/AVP 4 ;
v=0
c=IN.IP4 0.0.0.0
m=image 4444 udptl t38 ;
a=T38FaxRateManagment:localTCF
Leurs Expires - April 2003 [Page 12]
a=T38FaxUdpEC:t38UDPFEC

MG1-> MGC:
==========

Megaco/1.0 [124.124.124.222]:55555
Reply = 13
Context = 2000{
    Modify = RTP/1}
5.3 Autonomous Switchover from Voice to Fax Relay

Following functions are needed to enable the autonomous switch over:
- The detection of tones
- The passing of the tones to the peer fax terminal, which includes signaling of the tones between the MGs.
- The switching to from Voice to VBD or FAX Relay

5.3.1 Fax Tones

Tones used to signal the presence of a fax modem and data modem are (see also [7]):

- CNG tone at the transmitting terminal: After dialing the called fax machine's telephone number (and before it answers), the calling Group III fax machine (optionally) begins sending a calling tone (CNG) consisting of an interrupted tone of 1100 Hz. This is a certain indication that a FAX is going to be sent. It is however an optional signal. But when it is present, it has to be transmitted to the receiving terminal.
- CED tone transmitted by the receiving terminal. This 2100 +/- 15 Hz tone is called terminal identification answer tone. This tone is not always present, it is an optional signal. Note: In case of Data Modems, this tone is called ANS, and used to disable echo suppression.
- V.21 preamble flag sequence, sent by the receiving terminal. The preamble is always present. It is the only mandatory signal during fax establishment.
  V.21 is a mean for data transmission up to 300bit/s in both directions simultaneously using FSK modulation. Two channels are defined:
  - Channel 1: calling to called station:"0" as 1180Hz,"1" as 980Hz
  - Channel 2: called to calling station:"0" as 1850Hz,"1" as 1650Hz
  Preamble flags are send for 1 sec (+/- 15%). In other words, flags ("0111 1110") are consecutive sent on the V.21 channel for at least 850ms. In order to discriminate clearly between data modems and fax modems, a non ambiguous detection of the preamble has to be guaranteed by the receiving MG.

5.3.2 MG-to-MG Signaling

Following methods exist to pass information about the detected signals and tones to the peer fax terminal over the packet network:
(Note: meant here are not the MG capabilities exchange procedure as described in [2].)
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Method 1:
Tone pass through: The tone is sent inband (e.g. TONEoG.711oRTP/UDP/IP)
Upon detection of a tone, the MG switches autonomous to VBD, in which mode an appropriate codec is used, and passes the tone in the voice RTP payload. The receiving Gateway has to detect the tone, and has to switch to VBD, to pass the signal to the fax terminal.

Method 2:
Tone relay (RFC 2833 RTP Payload Format for Telephony Tones), see ref [9].
All information needed to regenerate the tone are passed in the RTP payload. The B-IWF in the peer MG has to generate the tones towards the fax terminal.

Method 3:
Tone detection indication (RFC 2833 RTP Payload Format for Named Telephone Events):
Event messages (NTE) are used to pass events. as described in RFC 2833 [9], chapter 3.11 (Data modems and Fax Events). The peer MG shall use this message to switch to VBD or T.38, dependent of the current state, and shall generate the tones with the characteristics as described in T.30 [7].

For redundancy reasons, it is proposed to send triplicate RFC2833 events.

Following events are to be sent, as defined in [9], Table 3:
- ANS (=CED): encoding 32(decimal)
- CNG: encoding 36
- V.21 ch2,"0"bit: encoding 39
- V.21 ch2,"1"bit: encoding 40

For the V.21 flags, there exist no RFC2833 event. Only V.21 ch2, bit"0" and bit"1" events exist, which are proposed to be sent after detection of a specified number of V.21 flags, needed to discriminate between fax calls and data calls.

After the switchover to T.38, the V.21 flags are passed over UDPTL.

Note: It would be more appropriate if RFC2833 could be extended by an own event for T.30 preamble, instead of misusing the V.21 events.

Method 4:
After switch over to T.38, it is possible to send T.38 packets of Type T_30 indicator, to signal the presence of facsimile signals.
In case, a different UDP port is chosen for T.38 transport, these packets can be detected at the packet side as UDPTL packets, and can be used to trigger the switchover to T.38 mode.

To be able to have compatible Gateways, it is proposed to follow the rule: "Send as much as possible, understand at least one":
- to pass the information, all possible relevant methods are used which means
  - In Voice and VBD mode:
    - RFC2833 NTE messages are sent (method 3)
    - the signals are sent inband, VBDoIP. (method 1)
  - In T.38 mode:
    - T.38 packets are send with T_30 indicator messages (method 4)
- at the receiving packet side, the MG must be able to evaluate at least one of the messages.

RFC2833 payload type:
It is also proposed to use a fixed payload type. The dynamic payload type value 96 is proposed.
As an alternative, the payload type could be negotiated during call set-up.

5.3.3 Switching to T.38

Due to the fact that the V.21 flags are the only signals which are not optional, it is recommended to switch to Fax Relay mode in the backwards direction upon detection of these flags. Upon detection of an sufficient number of V.21 flags at the TDM side, the receiving MG will switch to T.38 mode, after he has sent a RFC 2833. Being in T.38 mode, the receiving MG will also send a T.38 packet with the T30 indicator message with preamble V21 flag indication. The transmitting MGC can choose which message it uses as trigger to make the switchover. (method 3 or method 4).
The transmitting MG must generate V.21 flags towards the transmitting Fax machine.

However, to avoid timeout of the sending Fax machine, also the CNG signal is used as trigger point to switch to T.38 if enabled.
In this case, after detection of the CNG tone, the transmitting MG will do following:
- send and RFC2833 NTE message with CNG event
- switches to T.38 mode
- send a T.38 packet with T30 indicator message with CNG indication.
The receiving MG will use either the NTE message or the presence of a T.38 packet to switch over to T.38, and regenerates the CNG tone towards the receiving FAX.

5.3.4 Switching to VBD

The CED tones at the TDM side trigger the receiving MG to switch to VBD mode, this tone, sent inband to the transmitting MG or the associated RFC2833 NTE message will trigger the transmitting MG to do the same. In case, T.38 is not enabled during call establishment, all Fax tones at the TDM side, and the tones passed inband to the peer side, or their related RFC2833 NTE messages will trigger a switch to VBD.

5.4 Termination of the FR Phase

The sending FAX sends a DCN (DisCoNnect). Upon detection of this tone, the MGs should go back to voice mode, with the same voice codec as before. Note that this DCN tone is not confirmed by the receiving FAX, so that the receiving gateway has to react at the packet side on the DCN signal encoded in T.30.

An alternative is to switch back to voice mode after a well defined time-out period.

5.5 Call Release

The call is released by the MGC. This is possible after switching back to voice mode, or directly from the FAX state.

6. Summary

The recommended scenario is described in detail with a state diagram and in an example of a call scenario in the Appendix A.

Security Considerations

Security considerations are addressed as per Section 10 of RFC-3015.
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References

1 Bradner, S., The Internet Standards Process -- Revision 3, BCP 9, RFC 2026, October 1996.


3 Bradner, S., Key words for use in RFCs to Indicate Requirement Levels, BCP 14, RFC 2119, March 1997


8 The RFC that will come out of draft-ietf-mmusic-fid-06.txt, Gonzalo Camarillo, February 2002.


Informative reference:

Appendix A Scenarios for FoIP

A.1 MCU States

Figure A1: MCU states with transitions
### Table A1: MCU state transitions

<table>
<thead>
<tr>
<th>Transition</th>
<th>MG1_MCU</th>
<th>MG2_MCU</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>H.248:Add(RTP/TDM)</td>
<td>H.248:Add(RTP/TDM)</td>
</tr>
<tr>
<td>(2)</td>
<td>RFC 2833 (CED event) or (T.38 disabled and RFC 2833 (V21 event))</td>
<td>CED or (T.38 disabled and RFC 2833 (CNG event)) and V.21 flags)</td>
</tr>
<tr>
<td>(3)</td>
<td>RFC 2833 (V21 event) or T38(T30 V21flag indic.) and T38 enabled</td>
<td>V21 flags and T38 enabled</td>
</tr>
<tr>
<td>(4)</td>
<td>RFC 2833 (V21 event) or T38(T30 V21flag indic.) and T38 enabled</td>
<td>RFC 2833 (CNG event) or T38(T30 CNG indication) or V21 flags) and T.38 enabled</td>
</tr>
<tr>
<td>(5)</td>
<td>DCN or timeout</td>
<td>T.30 DCN or timeout</td>
</tr>
<tr>
<td>(6)</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>(7)</td>
<td>DCN or timeout</td>
<td>T.30 DCN or timeout</td>
</tr>
<tr>
<td>(8)</td>
<td>H.248:Subtract</td>
<td>H.248:Subtract</td>
</tr>
<tr>
<td>(9)</td>
<td>H.248:Subtract</td>
<td>H.248:Subtract</td>
</tr>
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</table>
A.2 Scenario for call set-up with T.38 enabled

<table>
<thead>
<tr>
<th>IAM</th>
<th>MGC</th>
<th>MG2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Add(TDM/RTP(G 729,G 711).T.38)</td>
<td>Note:[1,4]</td>
</tr>
<tr>
<td></td>
<td>Reply</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Add(TDM/RTP(G 729+G 711).T.38)</td>
<td>Note:[2,4]</td>
</tr>
<tr>
<td></td>
<td>Reply</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Modify(G.729/T.38)</td>
<td>Note:[3,4]</td>
</tr>
<tr>
<td></td>
<td>Reply</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Active Voice call</td>
<td></td>
</tr>
</tbody>
</table>

Figure A2: Scenario for call setup

[1]: ReserveGroup = true, ReserveValue = true
[2]: ReserveGroup = true, ReserveValue = false
[3]: ReserveGroup = true
[4]: G.727*G.711: AND function, G.729+G.711: OR function
A.3 Scenario with for Autonomous Switchover to T.38

<table>
<thead>
<tr>
<th>MG1</th>
<th>MGC</th>
<th>MG2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

Active Voice call

---

RFC 2833 NTE(event=36)

---

switch to T.38

---

T38(T30 indicator: CNG)

---

Fax mode

---

T38(T30 indicator: CED)

---

CED

---

T38(T30 indicator: V.21 preamble flags

---

V.21 flags

---

V.21 flags

---

CNG :note [1]

---

CNG :note [2]

---

T.38 note [3]

---

CED

---

and so on

[1]: CNG generated if RFC 2833 is used as trigger
[2]: CNG generated if T38 indicator message is used as trigger
[3]: Switch to T38 after RFC 2833 NTE or after T38 indicator message dependent on choice of trigger

Note: all RFC 2833 messages are sent triple

Figure A3: Scenario for switching to T.38
Figure A4: Scenario for switching to T.38, no CNG

[1]: CED generated after reception of RFC2833 event or passed inband.
[2]: switched to VBD after reception of RFC2833 event or after detection of CED tone at the packet side
[3]: V21 flags generated after RFC2833 event or after T38 indicator message
[4]: switched to T.38 after RFC2833 event or after T38 indicator message

Note: all RFC 2833 messages are sent triple
A.5 Scenario for Autonomous Switchback to Voice

MG1                  MGC                  MG2
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>DCN</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Switch to Voice mode</td>
<td>detect DCN and switch to Voice mode</td>
</tr>
<tr>
<td>Voice mode</td>
<td></td>
</tr>
<tr>
<td>&lt;=========================================&gt;</td>
<td></td>
</tr>
</tbody>
</table>

Figure A5: Scenario for switching back to Voice mode

A.6 Scenario for Call Release

e.g. REL

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Subtract</td>
<td>Subtract</td>
</tr>
<tr>
<td>Reply (statistics)</td>
<td>Reply(statistics)</td>
</tr>
<tr>
<td>&lt;--------------------</td>
<td>--------------------</td>
</tr>
</tbody>
</table>

Figure A6: Scenario for Call Release
A.7 Scenario for call set-up with T.38 disabled

<table>
<thead>
<tr>
<th>MG1</th>
<th>MGC</th>
<th>MG2</th>
</tr>
</thead>
<tbody>
<tr>
<td>IAM</td>
<td>Add(TDM/</td>
<td>Reply</td>
</tr>
<tr>
<td></td>
<td>RTP(G.729.G7.11).T.38</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Note:[1,5]</td>
<td></td>
</tr>
<tr>
<td>Reply</td>
<td>Add(TDM/</td>
<td>Reply</td>
</tr>
<tr>
<td></td>
<td>RTP(G.729+G.711).T.38</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Note:[2,4]</td>
<td></td>
</tr>
<tr>
<td>Modify(G.729)</td>
<td>Add(TDM/</td>
<td>Reply</td>
</tr>
<tr>
<td></td>
<td>Reply</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Voice call</td>
<td></td>
</tr>
</tbody>
</table>

[1]: ReserveValue = true, ReserveGroup = true  
[2]: ReserveValue = false, ReserveGroup = true  
[3]: MG2 can’t support T.38, the RTP termination in MG1 has to be adapted accordingly  
[4]: G.727*G.711: AND function, G.729+G.711: OR function

Figure A7: Scenario to switch to/from VBD, because T.38 disabled
A.8 Scenario for Autonomous Switchover to/from VBD (T.38 not enabled)

Voice call

<table>
<thead>
<tr>
<th>Voice call</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFC 2833 NTE(event 36)</td>
</tr>
<tr>
<td>Switch to VBD</td>
</tr>
<tr>
<td>CNG over VBDoIP</td>
</tr>
<tr>
<td>RFC 2833 NTE(event 32)</td>
</tr>
<tr>
<td>CED over VBDoIP</td>
</tr>
<tr>
<td>CED</td>
</tr>
<tr>
<td>RFC 2833 NTE(event 39)</td>
</tr>
<tr>
<td>all further T30 signaling transparent</td>
</tr>
<tr>
<td>V21 flags: note [1]</td>
</tr>
<tr>
<td>Fax over VBDoIP</td>
</tr>
<tr>
<td>DCN</td>
</tr>
<tr>
<td>T.30(DCN)</td>
</tr>
<tr>
<td>Switch to Voice mode</td>
</tr>
<tr>
<td>Voice mode</td>
</tr>
<tr>
<td>detect DCN and</td>
</tr>
<tr>
<td>switch to Voice mode</td>
</tr>
<tr>
<td>and so on etc</td>
</tr>
</tbody>
</table>

[1]: tone generated after RFC2833 event or passed inband
[2]: switched to VBD after RFC2833 event or after detection of CNG tone at the packet side

Note: all RFC 2833 messages are sent triple

Figure A8: Scenario to switch to/from VBD, because T.38 disabled
Acknowledgments

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