PacketCable™ NCS Basic Packages Technical Report

PKT-TR-MGCP-PKG-V01-020315

Notice

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1 SCOPE

PacketCable™ is a set of protocols developed to deliver enhanced services using packetized data transmission technology to a consumer's home or business over the cable network. The "PacketCable Architecture Framework" (PKT-TR-ARCH-V01-991201) is the starting point for understanding PacketCable Interface Specifications, Technical Reports, and other PacketCable documents.

When using Network-Based Call Signaling for voice-based, telephony-like communications, the NCS Protocol is the principal protocol used in the PacketCable architecture to manage these telephony connections. This protocol is used for exchange of signaling information between the Call Management Server (CMS) and the embedded Multimedia Terminal Adapters (E-MTA). The E-MTA reports *events* to the CMS, and generates *signals* on behalf of the CMS. The definitions of events and signals are collected into *packages*. The primary method for extending and enhancing the NCS protocol is through addition of packages and modifications to existing packages, rather than modifying the basic protocol. This document identifies and describes the basic NCS packages for PacketCable.

1.1 Purpose of document

This document is considered part of the PacketCable suite of documents. This specification is designed to coordinate with MGCP 1.0, which is an IETF Informational RFC, on the Basic MGCP Packages <draft-foster-mgcp-basic-packages-01.txt>, which is an Internet Draft, and on the pending MGCP Version 1.0bis, an IETF Information Draft <draft-andreasen-mgcp-rfc2705bis-02.txt>. However, this document will not be submitted for formal review by the IETF until it is approved by the PacketCable project members.

2 REFERENCES

[1]   "PacketCable 1.0 Architecture Framework Technical Report," PKT-TR-ARCH-V01-991201, December 1, 1999, CableLabs, available at **www.packetcable.com**

[2]   "PacketCable Network-Based Call Signaling Protocol Specification," PKT-SP-EC-MGCP-I04-011221, December 21, 2001, CableLabs, available at **www.packetcable.com**

[3]   "PacketCable PSTN Gateway Call Signaling Protocol Specification" PKT-SP-TGCP-I02-011221, December 21, 2001, CableLabs. **www.packetcable.com**

[4]   Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997. **www.ietf.org**

[5]   Arango, M., Dugan, A., Elliott, I., Huitema, C., and Pickett, S., "Media Gateway Control Protocol (MGCP), Version 1.0", RFC 2705, October 1999. **www.ietf.org**

[6]   "PacketCable Line Control Signaling (LCS) Architectured Technical Report" PKT-TR-LCS-V01-010730, July 30, 2001, CableLabs, available at **www.PacketCable.com**

[7]   ITU-T Recommendation T.38 **http://www.itu.int/**

[8]   ITU-T Recommendation T.38, Annex D, "SIP/SDP Call Establishement Procedures" **http://www.itu.int/**

[9]   ITU-T T.38 Amendment 1, 4/99 **http://www.itu.int/**

[10] "SIP T.38 Call Flow Examples and Best Current Practices," <draft-mule-sip-t38callflows-01.txt>. **www.ietf.org/**

[11]   F. Andreasen, "SDP Simple Capability Negotiation," <draft-andreasen-mmusic-sdp-simcap-04.txt>. **www.ietf.org/**

3   ABBREVIATIONS AND ACRONYMS

This document uses the following abbreviations and acronyms.

CMS	Call Management Server. Controls the audio/video call connections. Also called a Call Agent in MGCP/SGCP terminology.
CMTS	Cable Modem Termination System. The device at a cable head-end which implements the DOCSIS RFI MAC protocol and connects to CMs over an HFC network.
DNS	Domain Name System. See www.ietf.org or RFC 1034 and RFC 1035 for details.
E-MTA	Embedded MTA – a single node, which contains both an MTA and a cable modem MAC/PHY.
H.248	A protocol for media gateway control being developed by ITU. See www.itu.int.
IANA	Internet Assigned Numbered Authority. See www.iana.org or www.ietf.org for details.
IVR	Interactive Voice Response System
MEGACO	Media Gateway Control IETF working group. See www.ietf.org for details.
MGCP	Media Gateway Control Protocol. Protocol follow on to SGCP.
MIB	Management Information Base
MSO	Multi-System Operator, a Cable company that operates many head-end locations in multiple cities or locales.
MTA	Media Terminal Adapter – contains the interface to the physical telephony or video equipment, a network interface, CODECs, and all signaling and encapsulation functions required for VOIP transport, class features signaling, and QoS signaling.
PSTN	Public Switched Telephone Network.
RTP	Real Time Protocol, a protocol defined in RFC 1889 for encapsulating encoded voice and video streams.
SDP	Session Description Protocol.
SGCP	Simple Gateway Control Protocol. Earlier draft of MGCP.
SID	Service ID. A 14-bit number assigned by a CMTS to identify an upstream virtual circuit. Each SID separately requests and is granted the right to use upstream bandwidth.
S-MTA	Standalone MTA – a single node which contains an MTA and a non-DOCSIS MAC (e.g., Ethernet).
SNMP	Simple Network Management Protocol. See www.snmp.org and www.ietf.org more details.
TN	Telephone Number
VoIP	Voice over IP

4   TECHNICAL OVERVIEW

4.1 Introduction

This document defines an initial set of packages for the various types of endpoints currently defined by PacketCable for embedded clients. These packages are optional unless stipulated otherwise in PacketCable specifications that reference this document.

Each package defines a package name for the package, event codes and definitions, local connection options, or other parameters defined by the package. In the tables of events/signals for those packages that define these parameters, there are five columns:

Code	The package unique event code used for the event/signal.
Description	A short description of the event/signal.
Event	A check mark appears in this column if the event can be requested by the Medial Gateway Controller. Alternatively, one or more of the following symbols may appear:
"P"	Indicating that the event is persistent,
"S"	Indicating that the event is an event-state that may be audited,
"C"	Indicating that the event/signal may be detected/applied on a connection.
Signal	If nothing appears in this column for an event, then the event cannot be signaled on command by the Media Gateway Controller. Otherwise, the following symbols identify the type of the event:
"OO"	On/Off signal. The signal is turned on until commanded by the Media Gateway Controller to turn it off, and vice versa.
"TO"	Timeout signal. The signal lasts for a given duration unless it is superseded by a new signal. Default time-out values are supplied. A value of zero indicates that the time-out period is infinite. The provisioning process may alter these default values.
"BR"	Brief signal. The event has a short, known duration.
Additional info	Provides additional information about the event/signal, e.g. the default duration of TO signals.

Unless otherwise stated, all of the events/signals are detected/applied on endpoints and audio generated by them is not forwarded on any connection the endpoint may have. Audio generated by events/signals that are detected/applied on a connection will however be forwarded on the associated connection irrespective of the connection mode.

4.2 List of Packages

Table 1. List of Packages

Package Name	Description	Status
L	Line Package	Mandatory
TFM	Simple Data Tone Package	Optional
FM	Media Format Package	Optional
LCS	Line Control Signaling Package	Optional
FXR	Fax Relay Package	Optional

5 PACKAGES

5.1 Line Package

Package name: **L**

The MTA MUST support the Line Package as defined in the PacketCable Network-Based Call Signaling Specification [2].

5.2 Simple Data Tones Package

Package Name: **TFM**

The following codes are used to identify events and signals for the "data tones" package for "analog access lines":

Text/Fax/Modem Tone (dtfm): The text/fax/modem tone event is generated whenever a text, fax or modem call is detected. Detection of one of these tones signifies a text, fax or modem call:

- V.21 fax preamble flags or calling tone

- V.18 1400 Hz or 1800 Hz tone, Annex A

- V.8/V.25 2100 Hz answer tone, with or without phase reversal

V.21 fax preamble calling tone is an 1100 Hz tone optionally transmitted by the originating device while waiting for answer tone from the terminating device. Early detection of calling tone MAY be used by an endpoint for data mode optimizations. See ITU-T Recommendation V.21.

V.18 carrier tones are 1400 Hz or 1800 Hz tones generated by Telephony Devices for the Deaf (TDD) text telephones – see ITU-T recommendation V.18, Annex A.

Answer tone is a V.8 or V.25 tone that may be provided by a modem or fax that answers an incoming call. The tone consists of a sinewave signal at 2100 Hz, with or without phase reversals – see ITU-T recommendations V.8 and V.25. Answer tone with phase reversals signifies that the fax or modem device does require echo cancellation to be disabled.

The endpoint MUST supply the event with a parameter to indicate the detected tone. The parameter shall be one of:

CNG	**V.21 fax calling tone**
V21flags	**V.21 answer tone and flags**
V18txp	**V.18 1400 Hz or 1800 Hz tone**
ANS	**V.8 ANS (T.30 CED) or V.25 ANSam without phase reversal**
ANSbar	**V.8 ANS or V.25 ANSam with phase reversal**

5.3 Media Format Package

Package Name: **FM**

This package provides support for the media format Local Connection Option, and is identical to the package of the same name in the Basic MGCP Packages, as described in < IETF draft-foster-mgcp-basic-packages-02.txt>.

5.4 Line Control Signaling (GR-303) Package

Package Name: **LCS**

This package provides support for transport of line supervision signals in the media stream using RFC2833 event packets in PacketCable GR303 switched IP systems. The required signals are a subset of the RFC2833 ABCD codes in the event range 144-159. The media format local connection option is used to describe the events that are detected by the MTA and signaled to the MG, and also to describe the events that are relayed by the MG to the MTA from the GR303 interface. The use of the events in this package is described in detail in [6].

The definition of this package assumes that only loop start signaling is supported by MTA devices. The following telephone events must be supported by devices that implement this package:

Table 2. Telephone Events

RFC2833 Event	Description	Direction	Comments
144	ring	MG → MTA	-R ring from GR303 interface
149	on hook	MTA → MG	LO to GR303 interface
159	open signal interval	MG → MTA	LCFO from GR303 interface

The line control signaling package local connection option is defined using the MGCP extension mechanism as described in <draft-andreasen-mgcp-rfc2705bis-01.txt>. The use is identified by the package name LCS. The supported events are specified using the fmtp parameter with the keyword "telephone-event" followed by the comma separated list of supported events. For example:

   L: a:PCMU;telephone-event, fmtp: "telephone-event 144,149,159"

5.5 Fax Package

A package is defined for fax relay. The package defines new LocalConnectionOptions, events signals, and connection parameters as detailed below.

Package Name: **FXR**

5.5.1 LocalConnectionOptions

A new *Fax* LocalConnectionOptions parameter is defined for fax handling. The Call Agent supplies this fax LCO to indicate the desired fax handling to the Media Gateway. The fax parameter contains an ordered list of desired fax handling options. When the parameter is explicitly included, the gateway MUST be able to use at least one of the listed options for the command to succeed. The list may currently contain one or more of the following:

T.38 Strict   Use T.38 for fax relay controlled by the Call Agent. Assuming the procedure can be used, a switch to T.38 procedures will be initiated upon fax detection and a "t38(start)" event will be generated (see Section 5.5.2). This mode requires an indication of T.38 support from the remote side in order to be used.

T.38 Loose   Identical to T.38 Strict mode, except that an indication of T.38 support from the remote side is not required for the mode to be used.

Off   Don't invoke any special procedure for fax.

Gateway   Let the gateway control and decide how to handle fax calls without Call Agent involvement. This includes the case where the gateway doesn't do anything special for fax[1]. If the gateway does invoke a special procedure upon detection of fax, it will generate a "gwfax(start)" event so the Call Agent can be notified about it (see Section 5.5.2). The Call Agent should then refrain from issuing potentially conflicting commands to the gateway until the gateway ends it's special fax handling.

A gateway that ends up not being able to invoke any special procedure for fax will generate a "nopfax(start)" event upon detection of fax.

The set of possible values for the Fax LCO is extensible. The prefixes "x-" and "x+" are reserved for vendor specific use. In CreateConnection, the Fax LCO defaults to "gateway". In ModifyConnection, it defaults to its current value on the connection. If LocalConnectionOptions are either omitted or the fax parameter is not included, the previous fax parameter value will thus be retained, but without affecting the outcome of the command[2]. If multiple fax parameter values are provided, the gateway must choose one of the values.

The fax parameter is encoded as the keyword "fx" (prefixed with the package name), followed by a colon and a semicolon separated list of values where T.38 Strict is encoded as "t38", T.38 Loose is encoded as "t38-loose", gateway is encoded as "gw", and off is encoded as "off".

The following example illustrates use of PCMU or G.729 for audio encoding and T.38 Strict fax relay (preferred) or gateway control for fax:

```
L: a:PCMU;G729, fxr/fx:t38;gw
```

When auditing capabilities, the "fax" LCO may be returned with a semi-colon separated list of supported fax handling parameters. The values "t38", "off" and "gw" may be omitted from such a list as they are always implied. Gateways that implement additional parameters SHOULD return these additional parameters when capabilities are audited as illustrated by the following example:

```
A: a:image/t38, fxr/fx:mypar, ...
```

We now provide additional detail on the above defined fax modes.

T.38 Mode (Strict or Loose)

When a gateway is instructed to operate in Call Agent controlled T.38 mode, the "m=" line in the SDP returned will not indicate T.38[3], however capability information for T.38 (if supported) using the SDP Simple Capability Negotiation extensions [[11]] should be included as illustrated in the following example - other capability information may be included as well:

```
m=audio 3456 RTP/AVP 18
a=sqn: 0
a=cdsc: 1 image udptl t38
```

A gateway operating in Call Agent controlled T.38 mode that detects a fax will:

1   Initiate the T.38 fax relay procedure and mute the media channel (unless the media channel is already using T.38).

2   Generate a "t38(start)" event.

3   Await instructions from the Call Agent to initiate the actual media change.

---

[1] Hence, by definition this option can always be supported.

[2] Consequently, the gateway may not apply any special procedure to fax. If the Call Agent wants to ensure that either a procedure is applied or the command fails, it must include the fax LCO parameter again.

[3]   Unless the gateway was also instructed to use T.38 for the media stream.

The Call Agent instructs the gateway to perform the media change by sending it a ModifyConnection command with "image/t38" listed as the encoding method in the LocalConnectionOptions[4]. Per the normal codec negotiation procedures, if a RemoteConnectionDescriptor was included as well, it must include an "m=" line listing T.38 fax relay as an acceptable media format in order for the command to succeed. If a RemoteConnectionDescriptor was not included with the ModifyConnection command sent to a gateway under Call Agent T.38 control, it is possible (in fact likely), that the last received RemoteConnectionDescriptor did not include an "m=" line listing T.38 fax relay as an acceptable media format. In that case, the endpoint cannot send T.38 media. The endpoint will instead wait for an updated RemoteConnectionDescriptor with T.38 fax relay listed as an acceptable media format for some period of time (e.g. 5 seconds). If no updated RemoteConnectionDescriptor with T.38 fax relay is received within that period of time, or the fax relay fails while waiting, a "t38(failure)" event will be generated.

Gateway Mode
A gateway operating in Gateway controlled mode may initiate special fax handling, the details of which are outside the scope of this document. Support for such special handling MUST be negotiated with the other side by passing and recognizing relevant parameters via the SDP. If the other side has not indicated support for the special fax handling desired, the gateway MUST NOT attempt to initiate it. When special fax handling is initiated, a "gwfax(start)" event is generated thereby enabling the Call Agent to differ between the Call Agent and gateway controlled mode while still being informed about the actual change to fax. The special gateway handling of fax ends when a "gwfax(stop)" or gwfax(failure)" event is generated.

Off Mode
A gateway using the "off" mode will not invoke any special procedures for fax. However, the gateway may still adjust local echo cancellation and/or switch to an alternative voice codec as needed.

For each of the above modes, the RemoteConnectionDescriptor provides information on what procedure the other side supports. The following rules are used to determine which procedure to use:

- Whatever the Call Agent specified in the Fax LocalConnectionOptions for the current command must be adhered to. If the gateway cannot satisfy any of the options, the command fails.

- If both Fax LocalConnectionOptions and a RemoteConnectionDescriptor are provided, the procedure selected must be supported by both sides - this is currently only an issue for "T.38 Strict." A procedure can be satisfied by the remote side if:

- the relevant media is included in the "m=" line in the RemoteConnectionDescriptor, or

- the relevant media is included as a capability in the RemoteConnectionDescriptor.

- If the gateway cannot select any of the procedures in the Fax LocalConnectionOptions, the command fails. Note that "T.38 Loose", "gateway", and "off" by definition will not lead to failure.

- If the Call Agent did not include any Fax LocalConnectionOptions or a RemoteConnectionDescriptor, the gateway must continue using whichever procedure it is currently using.

- If the Call Agent did not include any Fax LocalConnectionOptions, but a RemoteConnectionDescriptor was included, the gateway follows rule 2 in selecting a procedure. In so doing, the default Fax LocalConnectionOptions, i.e. "gateway" in CreateConnection, or the current value in ModifyConnection, will be used. If the gateway cannot select any of the procedures based on the default Fax LocalConnectionOptions, the command fails.

---

[4] Receipt of a ModifyConnection command without LocalConnectionOptions but with a RemoteConnectionDescriptor containing an "m=" line with t38 would achieve the same.

The following examples illustrate the use of the above rules:

- Per rule 1, a gateway that does not support T.38 fax relay will fail a command that only contains the fax option "t38" whereas it will succeed a command that contains, "gw", "off" or no Fax LCO.

- A gateway supporting T.38 that receives a CreateConnection command with Fax handling set to "t38" and a RemoteConnectionDescriptor with neither a T.38 capability nor a T.38 media stream will fail per rule 2. Had the fax handling included either "t38-loose", "gw" or "off", the command would have succeeded and either of the procedures included could have been selected.

- Assume a gateway supporting T.38 has successfully executed a CreateConnection command with Fax handling set to "t38". If the gateway now receives a ModifyConnection command without a Fax handling LCO and with a RemoteConnectionDescriptor that has neither a T.38 capability nor a T.38 media stream, the command will succeed (note that rule 1 has no effect). However, per rule 2 and 4, there will be no T.38 procedure. Had the CA instead included a Fax LCO set to "T.38 Strict" again, the command would have failed.

- Finally, it should be noted that a switch to T.38 can be initiated by either one or both of the originating and terminating gateway and hence implementations must be prepared to handle this, including the case where both sides initiate the switch[5].

5.5.2   Events and Signals

The following events are defined in support of the above:

Table 3. Events and Signals

Code	Description	Event	Signal	Additional Info
gwfax	Gateway controlled fax	✓	-	Gateway controlled fax handling
nopfax	No special fax handling	✓	-	No special fax handling upon fax
t38	T.38 fax relay	✓	-	Call Agent controlled T.38 fax relay

The definition of the individual events and signals are as follows:

Gateway Controlled Fax (gwfax) Gateway controlled fax handling. The gateway handled fax event is parameterized with one of the following:

- *start*   Gateway handled fax was initiated. The Call Agent should refrain from issuing media handling instructions to the gateway until either a "gwfax(stop)" or "gwfax(failure)" event is generated.

- *stop*   Gateway handled fax ended normally. Media parameters for the connection are as before the gateway handled fax occurred.

- *failure*   The procedure ended abnormally. Media parameters are as before the gateway handled fax occurred.

The "gwfax" event may be parameterized with additional parameters, however it is recommended that one of the above parameters will be the first parameter supplied.

The following example illustrates the encoding of the "gwfax" event:

```
O: fxr/gwfax(start)
O: fxr/gwfax(stop, foobar)
```

---

[5] This can for example occur when the originating fax generates CNG and the terminating fax detects V.21 fax preamble before the switch to T.38 has been performed on the terminating side.

No Special Fax Handling(nopfax) There is no special fax handling in place, however a fax call is now detected. This can happen either due to no special procedure being requested (including "off"), or negotiation leading to no special fax handling being possible. The no special fax handling event is parameterized with one of the following:

- *start*   No special fax handling is in place, however a fax call is now detected. The Call Agent may now have to issue commands in order to ensure a successful fax call.

Note, that this event currently cannot be parameterized with "stop" or "failure" as it only detects the beginning of a fax call.

The following example illustrates the encoding of the "nopfax" event:

```
O: fxr/nopfax(start)
```

T.38 fax relay(t38)   Call Agent controlled T.38 fax relay. The Call Agent controlled T.38 fax relay event is parameterized with one of the following:

- *start*   Call Agent controlled T.38 fax relay was initiated. The Call Agent should modify each side of the connection to start using T.38, unless they already do.

- *stop*   Call Agent controlled T.38 fax relay. The Call Agent may want to modify the media parameters of each side of the connection.

- *failure*   Call Agent controlled T.38 fax relay ended abnormally. The Call Agent may want to modify the media parameters of each side of the connection.

The "t38" event may be parameterized with additional parameters, however it is recommended that one of the above parameters will be the first parameter supplied.

The following example illustrates the encoding of the and "t38" event:

```
O: fxr/t38(start)
O: fxr/t38(foobar, stop)
```

5.5.3   Connection Parameters

The connection parameters for the connection measuring packets and octets sent and received include packets and octets for fax handling as well. Interarrival jitter and average transmission delay calculation however may not be performed while fax is in progress, e.g. if T.38 is used. In such cases, the interarrival jitter and average transmission delay calculations are simply suspended until calculations can resume, e.g. by changing back to an RTP media stream again.

In addition to these connection parameters, the fax package defines the following connection parameters, which gateways MAY support:

Number of fax pages sent (PGS):

    The cumulative number of fax pages sent by the endpoint for the life of the connection. The parameter is encoded as "PGS" and the value supplied is a string of up to nine decimal digits.

Number of fax pages received (PGR):

    The cumulative number of fax pages sent by the endpoint for the life of the connection. The parameter is encoded as "PGR" and the value supplied is a string of up to nine decimal digits.

The following example illustrates the use of these parameters:

```
P: FXR/PGS=3, FXR/PGR=0, PS=1245, OS=62345, ...
```

5.5.4 Additional Considerations

5.5.4.1 Media IP Address and Port

When an endpoint is instructed to change from or to T.38 for the media stream, it SHOULD continue using same IP address and port as this will minimize Quality of Service interactions from the change. However, if an endpoint has a good reason, it MAY choose not to follow this recommendation.

5.5.5 Call Flow Examples

5.5.5.1 Call Agent Controlled T.38 Strict

In this example, both sides are under strict T.38 Call Agent control.

#	GW-o	CA-o	CA-t	GW-t
1	<-	CRCX		
2	200(sdp-o)	->		
3		INVITE(sdp-o)	->	
4			CRCX(sdp-o)	->
5			<-	200 (sdp-t)
6		<-	200(sdp-t)	
7	<-	MDCX(sdp-t)		
8	200	->		
9				<- ANS/T.30 CED
10				<- T.30 fax p.
11			<-	NTFY(t38(start))
12			200	->
13			MDCX(t38)	->
14			<-	200(sdp-t2)
15		<-	INVITE(sdp-t2)	
16		MDCX(sdp-t2)		
17	200(sdp-o2)	->		
18		200(sdp-o2)	->	
19			MDCX(sdp-o2)	->
20			<-	200
21				(T.38 fax)
22				(fax ends)
23			<-	NTFY(t38(stop))
24			200	->
25				

Step 1:

The Call Agent issues a CreateConnection command to the gateway instructing it to use PCMU media encoding and to use the strict Call Agent controlled T.38 mode. Consequently, the Call Agent asks the gateway to notify it of the t38 event:

```
CRCX 1000 ds/ds1-1/1@gw-o.whatever.net MGCP 1.0 NCS 1.0
C: 1
L: a:PCMU, fxr/fx:t38
M: recvonly
R: fxr/t38
X: 1
```

Step 2:

The gateway acknowledges the command and includes SDP with codec information as well as capability information:

```
200 1000 OK
I:1

v=0
o=- 25678 753849 IN IP4 128.96.41.1
s=-
c=IN IP4 128.96.41.1
t=0 0
m=audio 3456 RTP/AVP 0
a=sqn: 0
a=cdsc: 1 audio RTP/AVP 0 18
a=cdsc: 3 image udptl t38
```

Step 3:

The originating Call Agent sends a SIP INVITE message with the SDP to the terminating Call Agent.

Step 4:

The terminating Call Agent issues a CreateConnection command to the terminating gateway instructing it to use PCMU media encoding and to use the strict Call Agent controlled T.38 mode. Consequently, the Call Agent asks the gateway to notify it of the t38 event:

```
CRCX 2000 ds/ds1-1/2@gw-t.whatever.net MGCP 1.0 NCS 1.0
C: 2
L: a:PCMU, fxr/fx:t38
M: sendrecv
R: fxr/t38
X: 20

v=0
o=- 25678 753849 IN IP4 128.96.41.1
s=-
c=IN IP4 128.96.41.1
t=0 0
m=audio 3456 RTP/AVP 0
a=sqn: 0
a=cdsc: 1 audio RTP/AVP 0 18
a=cdsc: 3 image udptl t38
```

Step 5:

The terminating gateway supports T.38, and the RemoteConnectionDescriptor included indicates that the other side supports T.38 as well, so the strict T.38 Call Agent controlled mode requested can be honored. The terminating gateway sends back a success response with its SDP which also includes capability information:

```
200 2000 OK
I:2

v=0
o=- 25678 753849 IN IP4 128.96.41.2
s=-
c=IN IP4 128.96.41.2
t=0 0
m=audio 1296 RTP/AVP 0
a=sqn: 0
a=cdsc: 1 audio RTP/AVP 0 18
a=cdsc: 3 image udptl t38
```

Step 6:

The terminating Call Agent sends back a SIP 200 OK response to the originating gateway.

Step 7:

The originating Call Agent in turns sends a ModifyConnection command to the originating gateway:

```
MDCX 1001 ds/ds1-1/1@gw-o.whatever.net MGCP 1.0 NCS 1.0
C: 1
I: 1
M: sendrecv

v=0
o=- 25678 753849 IN IP4 128.96.41.2
s=-
c=IN IP4 128.96.41.2
t=0 0
m=audio 1296 RTP/AVP 0
a=sqn: 0
a=cdsc: 1 audio RTP/AVP 0 18
a=cdsc: 3 image udptl t38
```

The ModifyConnection command does not repeat the LocalConnectionOptions sent previously. As far as fax handling is concerned, the gateway therefore attempts to continue using the current fax handling, i.e. strict Call Agent controlled T.38. Since the capability information indicates the other side supports T.38, the gateway will in fact be able to use strict Call Agent controlled T.38. Had there not been any support for T.38 in the RemoteConnectionDescriptor, then this command would still have succeeded, however there would be no special fax handling.

Step 8:

The gateway acknowledges the command. At this point, a call is established is using PCMU encoding.

Step 9 – 11:

First, the T.30 CED tone (aka. V.25 ANS) occurs which in this case is simply passed through the current PCMU encoding. Since both fax and modem calls can start with this sequence, it is not possible to determine that this is a fax call until step 10, where the T.30 fax preamble is detected.

Since the gateway is instructed to apply the Call Agent controlled T.38 procedure for fax calls, the "t38(start)" event occurs, which is notified to the Call Agent:

```
NTFY 2500 ds/ds1-1/2@gw-t.whatever.net MGCP 1.0 NCS 1.0
O: fxr/t38(start)
X: 20
```

Step 12:

The Call Agent acknowledges the Notify command:

```
200 2500 OK
```

Step 13:

The Call Agent then instructs the terminating gateway to change to using the T.38 codec instead:

```
MDCX 2002 ds/ds1-1/2@gw-t.whatever.net MGCP 1.0 NCS 1.0
C: 2
I: 2
L: a:image/t38
R: fxr/t38
X: 21
```

Step 14:

The gateway changes to T.38, and sends back a success response with updated SDP:

```
200 2002 OK

v=0
o=- 25678 753850 IN IP4 128.96.41.2
s=-
c=IN IP4 128.96.41.2
t=0 0
m=image 1296 udptl t38
a=sqn: 0
a=cdsc: 1 audio RTP/AVP 0 18
a=cdsc: 3 image udptl t38
```

Note, that since the gateway's current RemoteConnectionDescriptor (as opposed to the LocalConnectionDescriptor returned here) does not list "image/t38" as a valid encoding method, the terminating gateway is still muting the media and is now waiting for an updated RemoteConnectionDescriptor with "image/t38".

Step 15:

The terminating Call Agent sends a re-INVITE to the originating Call Agent with the updated SDP.

Step 16:

The originating Call Agent then sends a ModifyConnection command to the originating gateway:

```
MDCX 1003 ds/ds1-1/1@gw-o.whatever.net MGCP 1.0 NCS 1.0
C: 1
I: 1

v=0
o=- 25678 753850 IN IP4 128.96.41.2
s=-
c=IN IP4 128.96.41.2
t=0 0
m=image 1296 udptl t38
a=sqn: 0
a=cdsc: 1 audio RTP/AVP 0 18
a=cdsc: 3 image udptl t38
```

Step 17:

The originating gateway changes to T.38 and sends back a success response with updated SDP:

```
200 1003 OK

v=0
o=- 25678 753850 IN IP4 128.96.41.1
s=-
c=IN IP4 128.96.41.1
t=0 0
m=image 3456 udptl t38
a=sqn: 0
a=cdsc: 1 audio RTP/AVP 0 18
a=cdsc: 3 image udptl t38
```

Step 18:

The originating Call Agent sends a SIP 200 OK response with the updated SDP to the terminating Call Agent.

Step 19:

The terminating Call Agent sends a ModifyConnection with the updated SDP to the terminating gateway:

```
MDCX 2003 ds/ds1-1/2@gw-t.whatever.net MGCP 1.0 NCS 1.0
C: 2
I: 2

v=0
o=- 25678 753850 IN IP4 128.96.41.1
s=-
c=IN IP4 128.96.41.1
t=0 0
m=image 3456 udptl t38
a=sqn: 0
a=cdsc: 1 audio RTP/AVP 0 18
a=cdsc: 3 image udptl t38
```

Step 20, 21:

The terminating gateway sends back a success response:

```
200 2003 OK
```

Since the terminating gateway now has a RemoteConnectionDescriptor with "image/t38" as valid media, it can start exchanging T.38 with the originating gateway.

Step 22, 23:

When the fax ends, a "t38(stop)" event is generated, which is notified to the Call Agent:

```
NTFY 2501 ds/ds1-1/2@gw-t.whatever.net MGCP 1.0 NCS 1.0
O: t38(stop)
X: 3
```

Step 24:

The Call Agent acknowledges the Notify command:

```
200 2501 OK
```

The fax call is now over. The Call Agent may now decide to change back to a voice codec, delete the connection, or something different.

5.5.5.2   Multiple and Different Options

In this example, the originating gateway is instructed to use the gateway mode whereas the terminating gateway is given a choice between gateway mode and strict t38 mode. Furthermore, the originating fax machine is generating CNG tone.

#	GW-o	CA-o	CA-t	GW-t
1	<-	CRCX		
2	200(sdp-o)	->		
3		INVITE(sdp-o)	->	
4			CRCX(sdp-o)	->
5			<-	200 (sdp-t)
6		<-	200(sdp-t)	
7	<-	MDCX(sdp-t)		
8	200	->		
9	CNG ->			
10				<- ANS/T.30 CED
11				<- T.30 fax p.
12			<-	NTFY(t38(start))
13			200	->
14			MDCX(t38)	->
15			<-	200(sdp-t2)
16		<-	INVITE(sdp-t2)	
17		MDCX(sdp-t2)		
18	200(sdp-o2)	->		
19		200(sdp-o2)	->	
20			MDCX(sdp-o2)	->
21			<-	200
22				(T.38 fax)
23				(fax ends)
24			<-	NTFY(t38(stop))
25			200	->

Step 1:

The Call Agent issues a CreateConnection command to the gateway instructing it to use PCMU media encoding and to use the gateway mode. Consequently, the Call Agent asks the gateway to notify it of the gwfax event:

```
CRCX 1000 ds/ds1-1/1@gw-o.whatever.net MGCP 1.0 NCS 1.0
C: 1
L: a:PCMU, fxr/fx:gw
M: recvonly
R: fxr/gwfax
X: 1
```

Step 2:

The gateway acknowledges the command and includes SDP with codec information as well as capability information:

```
200 1000 OK
I:1

v=0
o=- 25678 753849 IN IP4 128.96.41.1
s=-
c=IN IP4 128.96.41.1
t=0 0
m=audio 3456 RTP/AVP 0
a=sqn: 0
a=cdsc: 1 audio RTP/AVP 0 18
a=cdsc: 3 image udptl t38
a=X-FaxScheme123
```

We assume the gateway supports some other fax scheme and it indicates this by including an attribute "FaxScheme123"

Step 3:

The originating Call Agent sends a SIP INVITE message with the SDP to the terminating Call Agent.

Step 4:

The terminating Call Agent issues a CreateConnection command to the terminating gateway instructing it to use PCMU media encoding and to use either the gateway mode or strict Call Agent controlled T.38 mode. Consequently, the Call Agent asks the gateway to notify it of both the gwfax and t38 events:

```
CRCX 2000 ds/ds1-1/2@gw-t.whatever.net MGCP 1.0 NCS 1.0
C: 2
L: a:PCMU, fxr/fx:gw,t38
M: sendrecv
R: fxr/t38, fxr/gwfax
X: 20


v=0
o=- 25678 753849 IN IP4 128.96.41.1
s=-
c=IN IP4 128.96.41.1
t=0 0
m=audio 3456 RTP/AVP 0
a=sqn: 0
a=cdsc: 1 audio RTP/AVP 0 18
a=cdsc: 3 image udptl t38
a=X-FaxScheme123
```

Step 5:

The terminating gateway does not support any special gateway fax handling, however it does support T.38, and the RemoteConnectionDescriptor included indicates that the other side supports T.38 as well, so the strict T.38 Call Agent controlled mode requested can be honored. The terminating gateway sends back a success response with its SDP which also includes capability information:

```
200 2000 OK
I:2

v=0
o=- 25678 753849 IN IP4 128.96.41.2
s=-
c=IN IP4 128.96.41.2
t=0 0
m=audio 1296 RTP/AVP 0
a=sqn: 0
a=cdsc: 1 audio RTP/AVP 0 18
a=cdsc: 3 image udptl t38
```

Step 6:

The terminating Call Agent sends back a SIP 200 OK response to the originating gateway.

Step 7:

The originating Call Agent in turns sends a ModifyConnection command to the originating gateway:

```
MDCX 1001 ds/ds1-1/1@gw-o.whatever.net MGCP 1.0 NCS 1.0
C: 1
I: 1
M: sendrecv

v=0
o=- 25678 753849 IN IP4 128.96.41.2
s=-
c=IN IP4 128.96.41.2
t=0 0
m=audio 1296 RTP/AVP 0
a=sqn: 0
a=cdsc: 1 audio RTP/AVP 0 18
a=cdsc: 3 image udptl t38
```

The ModifyConnection command does not repeat the LocalConnectionOptions sent previously. As far as fax handling is concerned, the gateway therefore attempts to continue using the current fax handling, i.e. the gateway mode. The SDP information returned however does not indicate support for the "FaxScheme123", and hence the originating gateway will not invoke any special fax handling for this call.

Step 8:

The gateway acknowledges the command. At this point, a call is established is using PCMU encoding.

Step 9 – 12:

First, a CNG tone is generated by the originating fax thereby indicating a fax call. If the gateway was using either of the T.38 modes, or it had negotiated support for special gateway handling with the other side, a "t38(start)" or "gwfax(start)" event would now have been generated and the switch to T.38 (or special gateway handling) could start. However, since the negotiation with the terminating gateway resulted in the originating gateway not doing anything special for fax, no such event is generated. Instead, the "nopfax(start)" event is now generated, however since the Call Agent has not requested this event, it is not detected and hence not reported to the Call Agent. Consequently, the CNG tone is simply passed through the current PCMU encoding without the (originating) Call Agent being aware of the fax call.

Subsequently, the T.30 CED tone (aka. V.25 ANS) occurs which in this case is also simply passed through the current PCMU encoding. Since both fax and modem calls can start with this sequence, it is not possible to determine that this is a fax call until step 11, where the T.30 fax preamble is detected.

Since the terminating gateway is using the Call Agent controlled T.38 procedure for fax calls, the "t38(start)" event occurs, which is notified to the Call Agent:

```
NTFY 2500 ds/ds1-1/2@gw-t.whatever.net MGCP 1.0 NCS 1.0
O: fxr/t38(start)
X: 20
```

Step 13:

The Call Agent acknowledges the Notify command:

```
200 2500 OK
```

Step 14:

The Call Agent then instructs the terminating gateway to change to using the T.38 codec instead:

```
MDCX 2002 ds/ds1-1/2@gw-t.whatever.net MGCP 1.0 NCS 1.0
C: 2
I: 2
L: a:image/t38
R: fxr/t38
X: 21
```

Step 15:

The gateway changes to T.38, and sends back a success response with updated SDP:

```
200 2002 OK

v=0
o=- 25678 753850 IN IP4 128.96.41.2
s=-
c=IN IP4 128.96.41.2
t=0 0
m=image 1296 udptl t38
a=sqn: 0
a=cdsc: 1 audio RTP/AVP 0 18
a=cdsc: 3 image udptl t38
```

Note, that since the terminating gateway's last received RemoteConnectionDescriptor (as opposed to the LocalConnectionDescriptor returned here) did not list "image/t38" as a valid encoding method, the terminating gateway is still muting the media and is now waiting for an updated RemoteConnectionDescriptor with "image/t38".

Step 16:

The terminating Call Agent sends a re-INVITE to the originating Call Agent with the updated SDP.

Step 17:

The originating Call Agent then sends a ModifyConnection command to the originating gateway:

```
MDCX 1003 ds/ds1-1/1@gw-o.whatever.net MGCP 1.0 NCS 1.0
C: 1
I: 1

v=0
o=- 25678 753850 IN IP4 128.96.41.2
s=-
c=IN IP4 128.96.41.2
t=0 0
m=image 1296 udptl t38
a=sqn: 0
a=cdsc: 1 audio RTP/AVP 0 18
a=cdsc: 3 image udptl t38
```

Step 18:

The originating gateway changes to T.38 and sends back a success response with updated SDP:

```
200 1003 OK

v=0
o=- 25678 753850 IN IP4 128.96.41.1
s=-
c=IN IP4 128.96.41.1
t=0 0
m=image 3456 udptl t38
a=sqn: 0
a=cdsc: 1 audio RTP/AVP 0 18
a=cdsc: 3 image udptl t38
```

Step 19:

The originating Call Agent sends a SIP 200 OK response with the updated SDP to the terminating Call Agent.

Step 20:

The terminating Call Agent sends a ModifyConnection with the updated SDP to the terminating gateway:

```
MDCX 2003 ds/ds1-1/2@gw-t.whatever.net MGCP 1.0 NCS 1.0
C: 2
I: 2

v=0
o=- 25678 753850 IN IP4 128.96.41.1
s=-
c=IN IP4 128.96.41.1
t=0 0
m=image 3456 udptl t38
a=sqn: 0
a=cdsc: 1 audio RTP/AVP 0 18
a=cdsc: 3 image udptl t38
```

Step 21, 22:

The terminating gateway sends back a success response:

```
200 2003 OK
```

Since the terminating gateway now has a RemoteConnectionDescriptor with "image/t38" as valid media, it can start exchanging T.38 with the originating gateway.

Step 23, 24:

When the fax ends, a "t38(stop)" event is generated, which is notified to the Call Agent:

```
NTFY 2501 ds/ds1-1/2@gw-t.whatever.net MGCP 1.0 NCS 1.0
O: t38(stop)
X: 3
```

Step 25:

The Call Agent acknowledges the Notify command:

```
200 2501 OK
```

The fax call is now over. The Call Agent may now decide to change back to a voice codec, delete the connection, or something different.

Appendix A   Acknowledgements

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