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Configuration Guide

T.38 Protocol in AOS

This configuration guide describes the T.38 fax protocol and its use on ADTRAN Operating System (AOS) voice products including a protocol overview, common applications, and an example configuration using ADTRAN's command line interface (CLI).

This guide consists of the following sections:

Review of Fax Technology

Facsimile, or fax, is a technology used widely since the 1970s to send electronic copies of documents over a telephone network. Faxes are sent through a fax machine, usually containing a scanner, modem, and a printer. To send a fax, the scanner converts a physical document into a digital image and sends the image over a phone line via the modem to another device, which then prints the digital image as a physical printed document.

Fax Classifications

There are several classifications of fax machines based on fax capabilities including group, class, and data transmission rate.

Group

Fax machine groups deal with whether the machine transmits data using analog or digital transmission. Currently, most fax machines use digital formats; digital fax group designations are Group 3 and Group 4. Group 3 is the most common and uses ITU recommended T.30 protocols for transmission and T.4 protocols for vertical and horizontal resolutions.

Group 3 faxes transmit a single page in approximately 6 to 15 seconds, not including the time it takes for fax machines to handshake and synchronize. Group 3 devices typically operate at 14,400 bits per second (bps).

Class

Class designations for faxes are determined by how much computer processing is off-loaded from the computer's central processing unit (CPU) to the fax modem. There are two main classes of fax for computer modems:

- Class 1 fax machines transfer data by using computer controlled software for data compression and the implementation of T.30 session management protocol.
- Class 2 fax machines implement T.30 session management internally, but compress data through the use of a computer.

Data Transmission Rate

The transmission rate for fax data varies by the type of fax machine used. Several different transmission techniques are employed by fax machines. The technique used is negotiated during the fax/modem handshake. When fax machines connect, the highest data rate that both devices will support is used (usually at least 14.4 kbps for a Group 3 fax).

T.38 Fax Protocol Overview

In 1998, the T.38 fax relay standard was created to allow existing Group 3 fax devices to send faxes across IP networks. Until the development of T.38, faxing was not optimal on Voice over Internet Protocol (VoIP) networks that did not have end-to-end quality of service (QoS) because most VoIP systems are optimized for voice rather than data calls.

The T.38 protocol supports the use of the standard T.30 protocol in both sending and receiving fax devices, but encapsulates the T.30 data for transmission over the IP packet network in real time. T.38 was developed as an implementation of the real time fax over IP for machines that currently only support public switched telephone network (PSTN) connections.

Because fax data is modem transmitted, missing packets and delay are not tolerated as they are with VoIP. In traditional voice transmissions, voice packets are accumulated by the AOS product from the IP connection and then metered out through smooth, controlled time-division multiplexed (TDM) network connections to a human ear. The human ear does not detect occasional missing or repeated packets, so through packet management, VoIP technology produces a quality voice communication. For fax data, however, modem transmissions often fail if packets are lost, delayed, or out-of-order.

T.38 Protocol Network Function

The AOS product serves as an interconnection of the PSTN with IP packet network by supporting TDM voice on the PSTN connection and VoIP and Fax over Internet Protocol (FoIP) on the IP connection.

The function of the T.38 protocol is to provide techniques for correcting network delays and managing missing or delayed packets during the transition from TDM transmission to FoIP (or vice versa). The T.38 protocol achieves this purpose by modifying the protocol commands and responses on the TDM transmission side, keeping IP network delays from failing the transaction, and using fax-aware buffer-management techniques to correct for missing or delayed packets. The following illustration demonstrates T.38's place in the network:

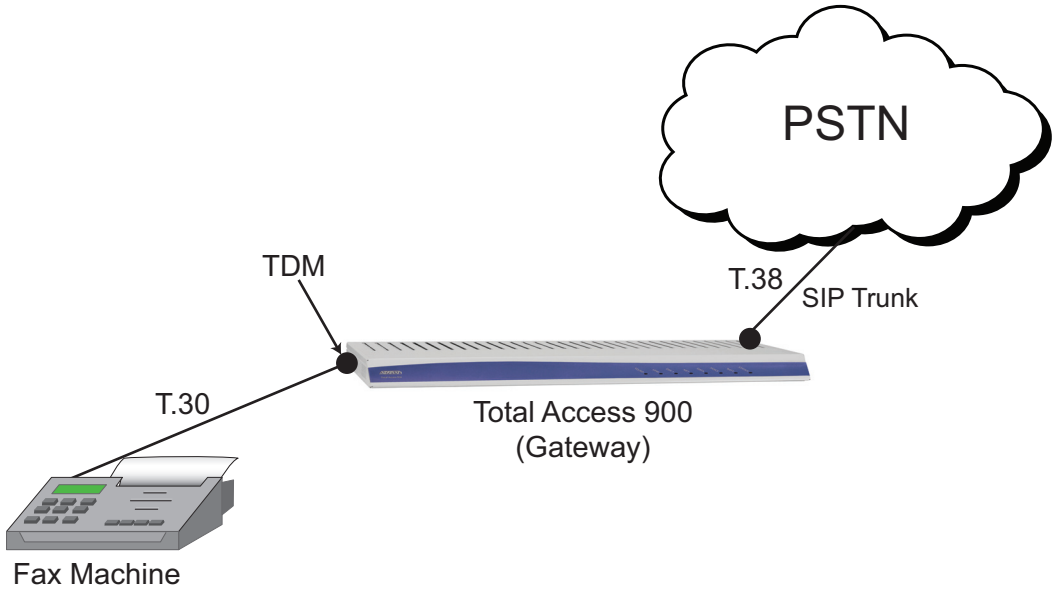

Figure 1. T.38 Protocol Network Function

Benefits of Using T.38 Protocol

Before the implementation of the T.38 protocol, the G.711 audio coder-decoder (CODEC) was used for FoIP transmissions. G.711 carries T.30 protocol over VoIP encoded as audio, rather than data. Transmitting fax data this way results in a high sensitivity to packet loss, jitter, and clock synchronization causing FoIP networks to be difficult and of poor quality without end-to-end QoS. The following sections describe the benefits of moving from a G.711 pass through fax mode to a T.38 fax mode in a network.

Bandwidth Reduction

By employing T.38 for FoIP rather than G.711, the total network bandwidth required for fax transmissions is greatly reduced. Because the fax data is converted to digital data with T.38, rather than audio as with G.711, the data can be transmitted at the typical 14,400 bps, plus overhead, instead of the 64,000 bps required for audio data.

Packet Loss and Jitter Mitigation

The T.38 protocol reduces the effects of packet loss during transmission by employing data redundancy and error correction. In doing so, the T.38 protocol allows the receiving device to correctly assemble the packet stream and reduces the number of failed transmissions due to instability in the IP network.

Hardware and Software Requirements and Limitations

The T.38 protocol is only available on ADTRAN voice-capable products running AOS firmware versions 16.02 or later. For a complete list of supported platforms, refer to the *Product Feature Matrix* (article number 2272) available online at http://kb.adtran.com.

The T.38 protocol is an additional feature for trunk and user configurations. Trunks and users must be configured before T.38 can be employed.

Only T.38 over User Datagram Protocol Transport Layer (UDPTL) is supported.

The number of simultaneous calls for AOS voice products are outlined in *Table 1*.

Table 1. Number of Supported Simultaneous T.38 Calls Per Platforms

Platform	Number of Calls
NetVanta 7000 Series	1
NetVanta 6310/6330	4
NetVanta 6335	4
NetVanta 6200 Series	60
NetVanta 640 Series	120
1st Generation Total Access 900(e)	1
2nd Generation Total Access 900(e) running AOS firmware A1 or prior	1
2nd Generation Total Access 900(e) running AOS firmware A2 or higher	4

If the AOS unit receives a T.38 call without T.38 enabled, the call will be rejected. Similarly, if the AOS unit attempts to initiate a T.38 call to another device without T.38 enabled, the call will fail. In these cases, the AOS device attempts to fall back to G.711 with modem passthrough.

Only the Total Access 900(e), NetVanta 6310/6330 Series, NetVanta 6355, and NetVanta 7000 Series products support forward error correction (FEC). In addition, some commands only apply to these products. These commands include **t38 ced auto-generate**, **t38 ced length**, **t38 generate-cng**, **t38 v21-preamble-timeout**, and **t38 error-correction fec**. These commands are outlined in *Troubleshooting T.38 Interoperability Issues on page 10*.

Configuring T.38 Using the CLI

To configure the T.38 feature using the CLI, follow these steps:

- Configure the trunks and users on which to employ T.38
- Enable modem passthrough
- Enable the T.38 protocol
- Optionally, specify the T.38 error correction mode
- Optionally, specify the T.38 redundancy rate
- Optionally, specify the maximum fax rate
- Optionally, specify the fallback method for fax transmission if T.38 fails
- Optionally, specify the T.38 buffer size
- Optionally, specify the T.38 datagram size

Configuring Trunks and Users

The T.38 protocol functions on voice trunks, as well as users associated with an analog station. For T.38 to be enabled, trunks and users must be configured.

Once the trunk configurations and users have been configured, access the trunk's or user's configuration mode from the Global Configuration mode prompt:

```
(config)#voice trunk t02
(config-T02)#
```

T.38 is configured on the TDM trunks and users, NOT the SIP trunk.

Enabling Modem Passthrough

Enabling modem passthrough allows the unit to detect fax and modem tones. Modem passthrough allows modem and fax calls to maintain a connection without the signals of the voice transmissions being altered by echo cancellation, voice activity detection (VAD), automatic level control (ALC), or packet loss concealment (PLC). To enable modem passthrough, enter the following command from the trunk configuration mode:

```
(config)#voice trunk t02
(config-T02)#modem-passthrough
```


By default, modem passthrough is disabled.

Enabling the T.38 Protocol

To enable the T.38 protocol for a specific trunk or user, enter the **t38** command from the trunk or user configuration mode as follows:

```
(config)#voice trunk t02
(config-T02)#t38
```

Using the **no** form of the **t38** command disables T.38 functionality. By default, T.38 is disabled.

Once T.38 is enabled, it can be employed as a fax transmission protocol. All other configurations are optional.

T.38 Error Correction Mode (optional)

The type of error correction used by the T.38 protocol is specified using the **t38 error-correction** command. There are two error correction methods that can be used by T.38. The two methods are forward error correction (FEC) and **redundancy**.

FEC is a system of error control where the sending T.38 endpoint adds error correction data to its messages, allowing the receiving fax device to detect and correct errors (within certain bounds) without the need to request additional data from the sender. To set the T.38 error correction mode to **fec**, enter the command in the trunk or user configuration mode as follows:

```
(config)#voice trunk t02
(config-T02)#t38 error-correction fec
```

Only the Total Access 900(e), NetVanta 6310/6330 Series, NetVanta 6355, and NetVanta 7000 Series products support FEC.

The second error correction method is **redundancy**. Redundancy allows the sending fax device to replicate the fax packets a user-specified number of times to determine if errors are present. Once redundancy is specified, the number of times to replicate the packets can be configured (detailed in the next section). To set the T.38 error correction mode to **redundancy**, enter the command in the trunk or user configuration mode as follows:

```
(config)#voice trunk t02
(config-T02)#t38 error-correction redundancy
```

Using the **no** form of the **t38 error-correction** command returns the setting to the default. By default, the T.38 error correction mode is set to **fec** on platforms that support it.

T.38 Redundancy Rate (optional)

Once the T.38 error correction method is set to **redundancy**, the number of redundant packets sent can be configured through the **t38 redundancy** command. The redundancy rate includes two options: **high-speed** and **low-speed**.

High-speed redundancy specifies the number of redundant T.38 packets to be sent for the data messages (high-speed fax machine image data). The range of redundant packets is **0** (no redundancy) to **4** packets. To set the redundancy rate for **high-speed** redundancy, enter the **t38 redundancy** command in the trunk or user configuration mode as follows:

(config)**#voice trunk t02**
(config-T02)**#t38 redundancy high-speed 3**

Low-speed redundancy specifies the number of redundant T.38 fax packets to be sent for the signaling messages (low-speed fax machine protocol). The range of redundant packets is **0** (no redundancy) to **5** packets. To set the redundancy rate for **low-speed** redundancy, enter the **t38 redundancy** command in the trunk or user configuration mode as follows:

(config)**#voice trunk t02**
(config-T02)**#t38 redundancy low-speed 2**

By default, both high- and low-speed redundancy values are set to **0**, or no redundancy. Using the **no** form of the **t38 redundancy** command returns the redundancy rate to the default value.

T.38 Maximum Fax Rate (optional)

Using the **t38 max-rate** command specifies the maximum fax rate for T.38 fax transmissions. The fax transmission rates are **2400**, **4800**, **7200**, **9600**, **12000**, and **14400** baud or bps.

The actual transmission rate could be lower than the specified rate if the receiving device cannot support the maximum transmission rate.

To set the maximum fax transmission rate, enter the **t38 max-rate** command from the trunk or user configuration mode as follows:

(config)**#voice trunk t02**
(config-T02)**#t38 max-rate 4800**

By default, the maximum fax rate is set to **14400** bps. Using the **no** form of the **t38 max-rate** command returns the maximum rate to the default value.

T.38 Fallback Mode (optional)

Using the **t38 fallback-mode** command configures a fallback mode when a T.38 call is delivered to the data network and rejected. T.38 SIP calls could be rejected with a 606 or 488 rejection message if T.38 is not supported by the receiving SIP endpoint. If a call is not successfully negotiated, using a fallback method allows the call to be reinvited or allowed to fail. The fallback mode option is G.711.

If the SIP call is rejected with a 606 or 488 rejection message and G.711 is used as the fallback method, the call will be reinvited immediately using analog mode (the G.711 protocol). To enable G.711 as the fallback method, enter the **fallback-mode** command from the trunk or user configuration mode as follows:

(config)**#voice trunk t02**
(config-T02)**#t38 fallback-mode g711**

If the AOS product receives a T.38 call on an endpoint without T.38 enabled, the call will be rejected with a 488 message.

Use the **no** form of the **t38 fallback-mode** command to return to the default value. By default, the fallback mode is set to G.711 fallback.

T.38 Maximum Buffer (optional)

Using the **t38 max-buffer** command specifies the maximum number of bytes that can be received before an overflow condition occurs. The size of the buffer is set as the **max-buffer** attribute in the Session Description Protocol (SDP) when the AOS product initiates a T.38 session. The buffer size is defined in bytes, and can range in size from **0** to **800** bytes. The default value is **200** bytes.

To change the maximum buffer size, enter the command from the trunk or user configuration mode as follows:

(config)**#voice trunk t02**
(config-T02)**#t38 max-buffer 300**

Use the **no** form of this command to return the buffer size to the default value.

T.38 Maximum Datagram (optional)

Using the **t38 max-datagram** command specifies the largest size UDPTL packet that will be accepted. The size of the packet is set as the **max-datagram** attribute in the SDP when the AOS product initiates a T.38 session. Packet size is defined in bytes, and can range in size from **0** to **300** bytes. The default value is **72** bytes.

To change the maximum datagram size, enter the command from the trunk or user configuration mode as follows:

(config)**#voice trunk t02**
(config-T02)**#t38 max-datagram 100**

Example T.38 Configuration

The following is an example configuration of the T.38 configuration process, including configuring the T.38 protocol for a previously established analog voice trunk, labeled **t02**. It configures T.38 to operate using the default error correction mode (**redundancy**) with a data redundancy of **3** packets and a signal redundancy of **2** packets. The configuration also keeps the maximum transmission rate at the default **14400** bps and uses the G.711 protocol as a fallback mode should the T.38 SIP call be rejected.

(config)**#voice trunk t02**
(config-T02)**#modem-passthrough**
(config-T02)**#t38**
(config-T02)**#t38 redundancy high-speed 3**
(config-T02)**#t38 redundancy low-speed 2**
(config-T02)**#exit**

T.38 Command Summary

The following table describes each command for T.38 configuration.

Table 2. T.38 Command Summary

Access Prompt	Command	Command Description	Default Value
(config-Txx)#	**modem-passthrough**	Enables passthrough fax or modem tone detection.	Disabled
(config-Txx)#	**t38**	Enables T.38 functionality.	Disabled
(config-Txx)#	**t38 error-correction [fec | redundancy]**	Specifies the error correction method for the T.38 protocol. The **fec** parameter adds error correction data to T.38 messages, allowing the receiving fax device to detect and correct errors. The **redundancy** parameter allows the sending fax device to replicate the fax packets a user-specified number of times to determine if errors are present.	Default is **fec** for Total Access 900(e), NetVanta 6310/6330, NetVanta 6355, and NetVanta 7000 Series products, and **redundancy** for NetVanta 6200 Series and NetVanta 640 Series products.
(config-Txx)#	**t38 redundancy [high-speed | low-speed]** <*value*>	Specifies the number of redundant packets to be sent for data and signaling messages. The **high-speed** parameter specifies the number of redundant packets sent for data messages, and the **low-speed** parameter specifies the number of packets sent for signaling messages.	**0** (no redundancy)
(config-Txx#	**t38 max-rate** <*value*>	Specifies the maximum fax transmission rate in bps.	**14400** bps
(config-Txx#	**t38 fallback-mode g711**	Specifies the transmission mode used when T.38 SIP calls are rejected.	**g711**

Table 2. T.38 Command Summary *(Continued)*

Access Prompt	Command	Command Description	Default Value
(config-Txx)#	**t38 max-buffer** <*value*>	Specifies the maximum number of bytes that can be received before an overflow condition occurs, and defines the max-buffer attribute in the SDP offer when the T.38 session is initiated. Range is **0** to **800** bytes.	**200** bytes
(config-Txx)#	**t38 max-datagram** <*value*>	Specifies the largest size UDPTL packet that can be received, and defines the max-datagram attribute in the SDP offer when the T.38 session is initiated. Range is **0** to **300** bytes.	**72** bytes

Troubleshooting T.38 Interoperability Issues

The following table lists commands that can be useful in troubleshooting T.38 interoperability issues. These commands were added in AOS firmware release A4.08, and should be issued only when following the advice of ADTRAN technical support. These commands are not available on the NetVanta 6200 Series and the NetVanta 640 Series.

Access Prompt	Command	Command Description	Default Value
(config-Txx)#	**[no] t38 ced length** <*time*>	Sets the maximum duration of a regenerated Called Station Identifier (CED) signal, in milliseconds, from the DSP toward the TDM endpoint when a T.38 session is active. Setting this value to **0** effectively prevents any CED generation. The <*time*> range is **0** to **4000** ms. The **no** version of this command resets the value to the default.	**3000** ms

Access Prompt	Command	Command Description	Default Value
(config-Txx)#	**[no] t38 ced auto-generate**	Specifies when the DSP should regenerate the CED signal toward the TDM endpoint. If auto-generate is enabled, the DSP generates the CED signal only when it does not receive CED indicator packets from the VoIP endpoint. If auto-generate is disabled, the DSP generates the CED signal only when it does receive CED indicator packets from the VoIP endpoint. The **no** version of this command disables CED auto-generate.	Disabled
(config-Txx)#	**[no] t38 generate-cng**	Specifies whether the DSP will begin a T.38 session by generating the calling signal (CNG) toward the TDM endpoint. The **no** version of this command disables the CNG generation.	Disabled
(config-Txx)#	**[no] t38 v21-preamble-timeout** <*value*>	Sets the maximum amount of time (in milliseconds) that the DSP waits for peer device activity after starting to transmit a V.21 preamble event before spoofing a response to the TDM endpoint. The <*value*> range is **1** to **3000** ms. The **no** version of this command returns the value to the default.	**1700** ms