A Real Fax and Modem Solution for Asterisk®

Overcoming the Different Clock Sources Challenge

The Problem

Since Asterisk's early days, reliable fax and modem support was a challenging issue. The technical problem is due to the different clock sources of the Asterisk PC and different Zaptel devices.

Theoretically, all the clocks generate a PCM (voice) packet every 1 millisecond. In reality, because the clocks are not synchronized, one card may generate a PCM packet every 1.0001 millisecond while the other card may receive a packet every 1.0000 millisecond. (these differences always exist due to the nature of electronic devices).

As a result, once in 10,000 packets (every 10 seconds in this example) a voice packet will be lost. The packet loss has a negative effect on voice quality. In a voice call we usually ignore the minor effect – but in data transmission – fax or modem, these problems may break the fax/modem synchronization and terminate the call.

Zaptel declares one device as the "sync source". That device's clock will be used as the clock for Asterisk. This should normally be configured as the clock from PSTN, if applicable. Otherwise, this is just an internal clock from one of the cards.

The Solution

In order to eliminate this problem, clocks in all Zaptel devices must be synchronized. In other words, if we count clock cycles over time, the number of cycles for any Zaptel device should be the same.

In order to be able to synchronize the clocks, all devices are designed with a Phase Locked Loop (PLL). This electronic circuit receives a reference clock from another Zaptel device, and compares it to its own local clock. In real life, the reference clock is the rate of the PCM packets transmitted by the Asterisk server and received by the Astribank.

If the local clock is too slow, the local oscillator is accelerated. If the local clock is too fast, it is slowed. The result is that a few seconds after the Astribank is connected to the Asterisk server it synchronizes to the server's clock forever.

If the other Zaptel device is another Astribank, this Astribank is used as the clock source for the Asterisk, and the rate of PCM packets is synchronized to this Astribank as well.

Thus, all Astribank devices on a system already work with a synchronized clock. However, your system may include Zaptel hardware which is not an Astribank. For instance, a Digium E1/T1 card. In such a case, we would like to use the clock from the card as the synchronization source for the system. In order to do that, you should use a slightly modified version of Zaptel (patches are pending inclusion in Zaptel as of writing this document) to make the sync master device of Zaptel provide timing for other Zaptel devices too.

Behavior of PRI, BRI, FXO and FXS Modules

Digital lines (PRI and ISDN BRI) are usually clocked by the service provider (the PSTN). This means that – in order for all the units to be synchronized – the clock source *must* be the digital line (PRI or BRI). Consequently, the entire Asterisk IP-PBX and Astribank units will synchronize on the PSTN clock.

FXO hardware is, by design, very sensitive to clock variations (clock jittering). This behavior is typical to all the common FXO designs. As a result, the Astribank PLL circuit is muted for FXO modules, to avoid jittering.

Synchronization with FXO Modules

For an IP-PBX that includes FXS and FXO modules, the FXO will *always* be the synchronization master, and the FXS ports will sync (thanks to the PLL circuit) to the FXO clock. If more than 32 FXO lines reside on one IP-PBX, only the first 32 ports will be synchronized, as the other FXO ports (those that reside in another Astribank chassis) cannot adjust their clock (since adjustment would lead to jitter).

Another synchronization issue is observed when digital lines (PRI or BRI) reside on the same IP-PBX as the FXO module. As mentioned earlier, the IP-PBX is synchronized in this scenario with the PSTN, and the FXO cannot take the clock fixing.

The Sync light on a *synchronized* Astribank unit will blink evenly: 500 Milliseconds on, 500 milliseconds off. When the unit is *not synchronized*, the Sync light will blink 250 milliseconds on, 250 milliseconds off, 250 milliseconds on and then 500 milliseconds off.

As mentioned earlier, the IP-PBX will work fine with non-synchronized units for *voice calls*. Fax and modem calls are much more sensitive, and it is recommended to route these calls via synchronized ports.

Configuration and Synchronization Behavior Table

The following table summarizes the different configuration and the synchronization behavior:

FXO ports	FXS ports	BRI ports	PRI ports	Notes
0	Any number	Any number	Any number	Synchronized
Up to 32	Any number	0	0	Synchronized
Above 32	Any number	0	0	FXO ports above the first 32 will not be synchronized
Any number	Any number	Any number	Any number	FXO ports will not be synchronized. All the other ports will be synchronized

If the system is composed only of Astribanks, that should suffice. However, if you use a different Zaptel/DAHDI device (e.g. a Digium TE420P card), you may want to synchronize the Astribanks with its clock. In this case:

- You should check if the span of your card is marked with (MASTER) in the first line in /proc/zaptel. If it is not, you may need to make sure that it is the first Zaptel module that loads.

- Set Astribanks synchronization source to "zaptel". This is done by setting

XPP_SYNC="auto"

in /etc/dahdi/init.conf (for Dahdi), /etc/sysconfig/zaptel (for Zaptel on Debian systems) or /etc/default/zaptel (for Zaptel, on RedHat systems).

For more information about this application and or Xorcom products in general, please contact us using the details below.

Asterisk is a registered trademark of Digium, Inc.

Xorcom USA
2012 W. Lone Cactus Drive
Phoenix, AZ 85027 USA
Tel: 1-866-XORCOM1
info.usa@xorcom.com

XORCOM
www.xorcom.com

Xorcom Ltd.
Teradyon, POB 60
D.N. Misgav 20179, Israel
Tel: +972-4-9951999
info@xorcom.com