Set and Maintain Accurate Time on DM3730/AM3703 SOMs

Application Note 583

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Abstract

This document explains how to set and maintain accurate time on the DM3730/AM3703 SOM-LV, DM3730/AM3703 Torpedo SOM, and DM3730/AM3703 Torpedo + Wireless SOM.

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Table of Contents

1 Introduction 1
1.1 Nomenclature 1
1.2 *DM3730-AM3703_SOM_Set_Maintain_Accurate_Time_Files* Directory 1
2 Set Time at Command Line 1
3 Set Time Zone 1
4 Set Time Using Network Time Protocol 2
4.1 Set Up NTP on Host PC 2
4.2 Set Up NTP on DM3730/AM3703 SOM 4
4.3 Synchronize Time to Remote Servers 6
4.4 Maintain Synchronization 7
5 Set Time Using GPS 8
6 Summary 10

1 Introduction

This document explains the various methods available to accurately set and synchronize time on the DM3730/AM3703 SOM-LV, DM3730/AM3703 Torpedo SOM, and the DM3730/AM3703 Torpedo + Wireless SOM.

Setting time from the command line is included as an option mainly for completeness, since this method is not practical for devices in the field. Using techniques such as Network Time Protocol (NTP) and GPS are more sophisticated methods that enable devices in the field to maintain accurate time with automated setups that can be set in motion when the unit is programed.

1.1 Nomenclature

This document applies to the DM3730/AM3703 SOM-LV, DM3730/AM3703 Torpedo SOM, and DM3730/AM3703 Torpedo + Wireless SOM. Use of “DM3730/AM3703 SOM” suggests text that applies to all three platforms; information specific to one platform will call out the precise name.

1.2 *DM3730-AM3703_SOM_Set_Maintain_Accurate_Time_Files* Directory

Accompanying this application note within the *1024515A_AN583_DM3730-AM3703_SOM_Set_Maintain_Accurate_Time.zip* file is a directory containing software files to be used with the instructions found here. The *DM3730-AM3703_SOM_Set_Maintain_Accurate_Time_Files* directory should contain the following files that will be referenced throughout this document:

```
gpsdemo.spec
gpsdemo-1.1.tar.bz2
gpsdemo-1.1.tar.bz2.md5
```

2 Set Time at Command Line

The simplest method of setting the time is directly at the command line. The following example sets the time to January 3, 2012, at 7 pm:

```
DM-37x# date -s 2012.01.03-19:00
Tue Jan  3 19:00:00 UTC 2012
DM-37x#
```

3 Set Time Zone

By default the DM3730/AM3703 SOM's root filesystem will not contain the correct time zone specification. So, even if you get the proper clock setting, sometimes calculations may be incorrect. Without the time zone set, your system time will be shown as a UTC:

```
DM-37x# date
Thu Jan  6 01:33:06 UTC 2013
DM-37x#
```


Like almost everything in Linux, the time zone setting is just another file, but it contains much more information than just "GMT-6". For more information about what is contained in the files, please see the *man-pages website*.[1]

You can view the possible time zone values by looking in the */usr/share/zoneinfo* directory on the DM3730/AM3703 SOM (or on its root filesystem). The values are broken out in several ways, such as continent, country, and region. For example if the SOM's city is Chicago, you could select */usr/share/zoneinfo/America/Chicago* or */usr/share/zoneinfo/US/Central*. In fact, if you ran a diff on the two files, you would find they are identical.

To set the time zone, you'll need to create a symbolic link called */etc/localtime* to the file you chose. For example, to set the time zone to Central, you would execute the following command:

```
DM-37x# ln -s /usr/share/zoneinfo/US/Central /etc/localtime
DM-37x#
```

Now when you execute the *date* command, you'll see the time adjusted for the proper time zone:

```
DM-37x# date
Wed Jan  5 19:33:47 CST 2013
DM-37x#
```

4 Set Time Using Network Time Protocol

Network Time Protocol (NTP) is a network protocol that uses a statistical technique to synchronize the clocks of remotely located computers. The full explanation of its operation is quite complicated, but it is transparent to the user. For more information, please see the *Network Time Protocol* wiki article.[2]

This section will provide instructions and examples about how to synchronize the clock on the DM3730/AM3703 SOM to the host PC and also to other servers with much more accurate clocks.

4.1 Set Up NTP on Host PC

In order to synchronize the time on the DM3730/AM3703 SOM to a host PC, we must install an NTP server on the host PC. The steps below will install and configure the NTP server.

1. Install the NTP using Aptitude.

```
logic@logic-desktop:~$ sudo apt-get install ntp
[sudo] password for logic:
Reading package lists... Done
Building dependency tree
Reading state information... Done
Suggested packages:
  ntp-doc
The following NEW packages will be installed:
  ntp
0 upgraded, 1 newly installed, 0 to remove and 360 not upgraded.
```

[1] http://man7.org/linux/man-pages/man5/tzfile.5.html
[2] http://en.wikipedia.org/wiki/Network_Time_Protocol


```
Need to get 559kB of archives.
After this operation, 1,450kB of additional disk space will be used.
Get:1 http://us.archive.ubuntu.com/ubuntu/ lucid-updates/main ntp
1:4.2.4p8+dfsg-1ubuntu2.1 [559kB]
Fetched 559kB in 0s (1,261kB/s)
Selecting previously deselected package ntp.
(Reading database ... 134746 files and directories currently
installed.)
Unpacking ntp (from .../ntp_1%3a4.2.4p8+dfsg-1ubuntu2.1_amd64.deb) ...
Processing triggers for man-db ...
Processing triggers for ureadahead ...
ureadahead will be reprofiled on next reboot
Setting up ntp (1:4.2.4p8+dfsg-1ubuntu2.1) ...
 * Starting NTP server ntpd
[ OK ]

logic@logic-desktop:~$
```

2. Edit the *NTP* configuration file to update the servers it uses as time sources.
    a. As root (or sudo), use your preferred text editor to open the */etc/ntp.conf* file.
    b. On approximately line 16, change the following line from this:

```
…
server ntp.ubuntu.com
…
```

to this:

```
…
server 0.debian.pool.ntp.org iburst dynamic
server 1.debian.pool.ntp.org iburst dynamic
server 2.debian.pool.ntp.org iburst dynamic
server 3.debian.pool.ntp.org iburst dynamic
…
```

    c. Save and close the file.
3. Make the configuration change active by restarting the ntpd daemon.

```
logic@logic-desktop:~$ sudo /etc/init.d/ntp restart
 * Stopping NTP server ntpd
 * Starting NTP server ntpd
logic@logic-desktop:~$
```


4.2 Set Up NTP on DM3730/AM3703 SOM

To use NTP on the DM3730/AM3703 SOM, we must build and install a client that accesses an NTP server. An NTP client package is included with LTIB in the DM37x Linux BSP and can be installed with the steps below.

1. Switch to the home directory.

```
logic@logic-desktop:~$ cd
logic@logic-desktop:~$
```

2. Create a symbolic link to the LTIB directory. If you have already done this for previous documents, repeating this step won't hurt.

```
logic@logic-desktop:~$ ln -s
logic/Logic_BSPs/Linux_3.0/1022853_LogicPD_Linux_BSP_2.2-2/ ltib_3_0
logic@logic-desktop:~$
```

3. Switch to the *LTIB* directory.

```
logic@logic-desktop:~$ cd ltib_3_0
logic@logic-desktop:~/ltib_3_0$
```

4. Prep the *ntpclient* source.

```
logic@logic-desktop:~/ltib_3_0$ ./ltib -p ntpclient -m prep

Processing: ntpclient
======================
Build path taken because: build key set, no prebuilt rpm,
Testing network connectivity for gpp
...
+ STATUS=0
+ '[' 0 -ne 0 ']'
+ cd ntpclient
+ echo 'Patch #1 (ntpclient-2003_194-adjtimex.patch):'
Patch #1 (ntpclient-2003_194-adjtimex.patch):
+ patch -p1 -s
+ exit 0
Build time for ntpclient: 0 seconds

logic@logic-desktop:~/ltib_3_0$
```

5. Build the *ntpclient*.

```
logic@logic-desktop:~/ltib_3_0$ ./ltib -p ntpclient -m scbuild

Processing: ntpclient
======================
Build path taken because: directory build, build key set, no prebuilt
rpm,
```



```
rpmbuild --dbpath
/home/logic/logic/Logic_BSPs/Linux_3.0/1022853_LogicPD_Linux_BSP_2.2-
2/rootfs//var/lib/rpm --target arm --define
'_unpackaged_files_terminate_build 0' --define '_target_cpu arm' --
define '__strip strip' --define '_topdir
/home/logic/logic/Logic_BSPs/Linux_3.0/1022853_LogicPD_Linux_BSP_2.2-
2/rpm' --define '_prefix /usr' --define '_host_prefix /opt/ltib' --
define '_tmppath
/home/logic/logic/Logic_BSPs/Linux_3.0/1022853_LogicPD_Linux_BSP_2.2-
2/tmp' --define '_rpmdir
/home/logic/logic/Logic_BSPs/Linux_3.0/1022853_LogicPD_Linux_BSP_2.2-
2/rpm/RPMS'  --define '_mandir /usr/share/man' --define '_sysconfdir
/etc' --define '_localstatedir /var' -bc --short-circuit
/home/logic/logic/Logic_BSPs/Linux_3.0/1022853_LogicPD_Linux_BSP_2.2-
2/dist/lfs-5.1/ntpclient/ntpclient.spec
Building target platforms: arm
...
gcc   ntpclient.o phaselock.o   -o ntpclient
+ exit 0
Build time for ntpclient: 1 seconds

logic@logic-desktop:~/ltib_3_0$
```

6. Copy the *ntpclient* onto the DM3730/AM3703 SOM. The easiest way to do this is to use SCP.

    a. First, identify the SOM's IP address.

```
DM-37x# ifconfig
```

    b. Use that IP address as the destination address for the SCP transfer. In the example below, be sure to replace the **X.X.X.X.** placeholder with the correct IP address for your SOM.

```
logic@logic-desktop:~/ltib_3_0$ scp rpm/BUILD/ntpclient/ntpclient
root@X.X.X.X:.
root@10.0.0.105's password:
ntpclient
100%   20KB  19.6KB/s   00:00
logic@logic-desktop:~/ltib_3_0$
```

    NOTE: If you haven't connected to the destination machine with ssh before, you will be prompted to authenticate the MAC address of the destination. This is normal.

7. Test the client to ensure it runs properly.

```
DM-37x# ./ntpclient
Usage: ./ntpclient [-c count] [-d] [-g goodness] -h hostname [-i
interval]
      [-l] [-p port] [-r] [-s]
DM-37x#
```


4.3 Synchronize Time to Remote Servers

To begin, we will synchronize the time on the DM3730/AM3703 SOM to the host PC.

1. First, check the current time; the clock is horribly wrong.

```
DM-37x# date
Fri Jan  7 02:09:51 CST 2000
DM-37x#
```

2. On the SOM, enter the following command; be sure to replace **X.X.X.X.** with the IP address of the host PC.

```
DM-37x# ./ntpclient -s -h X.X.X.X.
36530 07841.178    5859.0      5.7  411169191469584.6      0.0        0
DM-37x# date
Wed Jan 16 23:50:37 CST 2013
DM-37x#
```

Looking at the output from the *date* command, we see the clock has been updated. Let's highlight the meaning of the values returned by the *ntpclient* command in the seven columns of output.

a. 36530: The number of days since 1900

b. 07841.178: The number of seconds since midnight

c. 5859.0: The elapsed time for the NTP transaction (microseconds)

d. 5.7: The internal server delay (microseconds)

e. 411169191469584.6: The clock difference between your computer and the NTP server (microseconds)

f. 0.0: The dispersion reported by server (microseconds)

g. 0: Your computer's adjtimex frequency (ppm * 65536)

The last two values are technical details related to the statistical algorithms used by NTP, which you can read about in this Doolittle wiki article[3] and on the Pool website.[4] The most pertinent detail is that there was a 411169191469584.6 microsecond error between the time on the DM3730/AM3703 SOM and the host PC that has now been fixed.

3. Now let's use a remote server that has a globally synchronized clock. We could go through the effort of looking up one of these servers and pestering it for the time, but there is a great project called Cron[5] that does this for us and makes sure no single server gets hit too hard.

   By using the address from the *NTPPool* project, you get a random time server that is geographically near you.

```
DM-37x# ./ntpclient -s -h pool.ntp.org
41289 00761.019   11475.0     22.8  510540.8  41595.5         0
DM-37x#
```

[3] http://doolittle.icarus.com/ntpclient/HOWTO
[4] http://www.pool.ntp.org/en/
[5] http://en.wikipedia.org/wiki/Cron

Here we see that even after we synchronized to our host PC, there was still a 510540.8 microsecond error in the clock that was fixed.

4.4 Maintain Synchronization

Going forward, the *ntpclient* command can be added to your boot script or to a Cron job to resynchronize your clock on a schedule your project requires. In this section, we will address how to set up a scheduled resynchronization of the clock. For this, we will need to activate the Cron scheduler, which is not turned on by default. If you already have Cron running on your system, you can skip to Step 3 below.

1. First, create the directory for the Cron scheduler tasks.

```
DM-37x# mkdir -p /var/spool/cron/crontabs
DM-37x#
```

2. Start the Cron scheduler.

```
DM-37x# /usr/sbin/crond
DM-37x#
```

NOTE: If you want to start the Cron daemon at boot time, add the line above to the */etc/rc.d/rc.local* file.

3. Create a script file for your clock synchronization task. Using your desired text editor, create the */root/timeSync.sh* file that contains the lines below.

```
#!/bin/bash
./ntpclient -s -h pool.ntp.org
touch /root/lastTimeSyncStamp
```

4. Create a Cron file entry for your script. The following command will automatically create/open a Cron file for you to edit using the VI editor. If you are not familiar with VI, you can learn about it and the basics of its interface in this VI Text Editor wiki article.[6]

   a. Open the file for editing.

```
DM-37x# crontab –e
```

   b. Once the file is open, add the line below.

```
0 */12 * * * /root/timeSync.sh
```

   This will run the clock synchronization script every 12 hours.

5. Verify the result.

   The last line of the clock synchronization script is *touch /root/lastTimeSyncStamp*. This means that every time the script runs, the time stamp of this file will be updated and you can check that to verify the synchronization task is being performed.

[6] http://heather.cs.ucdavis.edu/~matloff/UnixAndC/Editors/ViIntro.html

5 Set Time Using GPS

The time stamps in the GPS messages can be used to set the date and time on the DM3730/AM3703 SOM to within one second. In the DM37x Linux BSP version 2.4.2, the GPS demo application was updated with the ability to set the clock. The source code has also been supplied in the *DM3730-AM3703_SOM_Set_Maintain_Accurate_Time_Files* directory. It is only necessary to use these files if you are using a DM37x Linux BSP release prior to 2.4.2.

1. Check your BSP release version. If it is version 2.4.2 or later, you can skip to Step 4.
2. To apply the sample code files, move them into the following directories in the LTIB file structure:

   ```
   …/LPD-IP-package-pool/gpsdemo-1.1.tar.bz2
   …/LPD-IP-package-pool/gpsdemo-1.1.tar.bz2.md5
   …/dist/lfs-5.1/gpsdemo/gpsdemo.spec
   ```

3. Once the files are in place, follow the process in the *DM37x Linux BSP User Guide*[7] to build the GPS demo application.

   In this version of the GPS demo application, when a GPS fix is acquired, the time stamp from that fix is extracted and used to set the system time. The critical fact required to make use of the GPS timestamps is their format. The number is a 64-bit integer that contains the number of milliseconds since January 1, 1970. The example code provided makes use of the *timespec* struct, which is a standard data structure in the Linux environment. In order to set the time properly, all that is required is to prime that data structure with the millisecond count from the GPS time stamp and make the *clock_settime()* system call.

   This is the critical portion of the code:

```
struct timespec local_timeStamp;
GpsUtcTime GPS_timestamp;
…
local_timeStamp.tv_sec = (GPS_timestamp/ 1000);
local_timeStamp.tv_nsec = 0;
ret = clock_settime(CLOCK_REALTIME, &local_timeStamp);
```

4. To set the time with the GPS demo application, bring up the GPS hardware with the standard commands below.

```
DM-37x# modprobe gps_drv
[ 124.591705] (stk) :sysfs entries created
[ 124.596252] (stk) : debugfs entries created
DM-37x# /home/root/wl12xx/uim &
[1] 705
DM-37x# navd --android_log NAVD -p3 -nav\"-
c/system/etc/gps/config/pathconfigfile.txt\" &
[2] 706
cmd line navd --android_log NAVD -p3 -nav"-
c/system/etc/gps/config/pathconfigfile.txt"
MCP | initializing sighandler could not set new working dir: No such
file or directoryMCP | main |
starting...
Note: this task requires root priviledges
DM-37x#
```

[7] http://support.logicpd.com/downloads/1431/

5. Start the GPS demo with the -t option.

```
DM-37x# gpsdemo -t
================================================================================================================
GPS         Status
            ============================================================================================
            GPS is navigating
================================================================================================================
Location    Flags     Latitude    Longitude       Altitude      Speed        Accuracy    Timestamp
            ============================================================================================
             0         0.000000     0.000000        0.000000    0.000000     0.000000    0
================================================================================================================
Satellite   ID        SnR         Elevation       Azimuth
            ============================================================================================
             6        45.000000  -90.000000         0.000000
================================================================================================================
NMEA        Timestamp             String
            ============================================================================================
            0                     $GPGLL,,,,,,V,N*64
            0                     $GPRMC,,V,,,,,,,,,N*53
            0                     $GPGGA,,,,,,0,,,,,,,,*66
            0                     $GPVTG,,T,,M,,N,,K,N*2C
            0                     $GPGSA,M,1,,,,,,,,,,,,,*12
            0                     $GPGSV,1,1,00*79
            0                     $GPGSV,1,1,00*79
Waiting for GPS timestamp…
DM-37x#
```

You'll see the standard GPS demo application output with additional output stating that it is waiting for a valid GPS timestamp before proceeding. When the GPS position and exact time have been established, you'll see the final output with the correct time.

```
================================================================================================================
GPS         Status
            ============================================================================================
            GPS is navigating
================================================================================================================
Location    Flags     Latitude    Longitude       Altitude      Speed        Accuracy    Timestamp
            ============================================================================================
            29        44.984562   -93.270554        0.000000    0.137331    82.886253    1368478762000
================================================================================================================
Satellite   ID        SnR         Elevation       Azimuth
            ============================================================================================
            19        24.000000  -90.000000         0.000000
            16        33.000000  -90.000000         0.000000
             7        19.000000  -90.000000         0.000000
            28        30.000000  -90.000000         0.000000
             3        40.000000  -90.000000         0.000000
             6        41.000000  -90.000000         0.000000
            13        34.000000  -90.000000         0.000000
================================================================================================================
NMEA        Timestamp             String
            ============================================================================================
            1368500362000                     $GPGSV,1,1,00*79
            0                     $GPGSV,1,1,00*79
            0                     $GPGLL,4459.073759,N,09316.233666,W,205922.00,A,A*7F
            1368500362000
$GPRMC,205922.00,A,4459.073759,N,09316.233666,W,0.0,0.0,130513,0.8,W,A*3C
            1368500362000
$GPGGA,205922.00,4459.073759,N,09316.233666,W,1,04,3.3,131.4,M,-31.1,M,,*57
            1368500362000                     $GPVTG,,T,,M,0.0,N,0.0,K,A*23
            1368500362000                     $GPGSA,M,2,16,28,03,06,,,,,,,,,3.4,3.3,1.0*31
time: 2013-05-13 15:59:22.000000000
Clock updated.
```

6. A check of the system time will show this has been applied.

```
DM-37x# date
Mon May 13 15:59:25 CDT 2013
DM-37x#
```


NOTE: This program does not execute in a deterministic time frame. Its execution time is completely dependent on the local GPS signal quality of the target unit. If this sample code is used in a product, it should be run as a background task or separate thread.

NOTE: If the system time zone is not set correctly, the system time will seem to be incorrect. See Section 3 for instructions about how to properly set the time zone.

6 Summary

The techniques found in this document are a starting place for time management on your DM3730/AM3703 SOM. If your application requires more accurate timekeeping, please contact Logic PD[8] for assistance.

[8] http://support.logicpd.com/support/askaquestion.php

