Video Streaming on the i.MX27 Multimedia Applications Processor

by: Freescale Semiconductor Inc.

This application note discusses the steps for performing digital video streaming on the i.MX27 multimedia applications processor. It also presents an overview about the usage of Gstreamer on the i.MX27 processor.

1 Introduction

Streaming digital video is gaining popularity in diverse markets, such as surveillance systems, social networking, and multimedia content servers. The i.MX27 applications processor is well-positioned for these diverse markets due to its combination of an ARM926EJ-S™ core running up to 400 MHz, an embedded Fast Ethernet Controller (FEC), and a CMOS sensor interface (CSI) that can integrate different types of sensor cameras, enhanced Multimedia Accelerator (eMMA), hardware H.264/MPEG4 decoder/encoder, security block, and many other peripherals.

Table Of Contents

1.1   i.MX27 Overview

The distinctive features of the i.MX27 device are as follows:

- Advanced, power-efficient implementation of the ARM926EJ-S core, operating at speeds up to 400 MHz
- enhanced Multimedia Accelerator Lite (eMMA)—MPEG-4 and H.264 hardware encode or decode up to D1 resolution at 30 fps or encode and decode up to VGA resolution at 24 fps.
- High-Speed USB On-The-Go controller, host, or client
- Smart Speed Crossbar Switch—Multi-layer AMBA-compliant bus allows any of the six bus masters to talk to any of the three slaves without interfering with the other bus master/slave transactions to provide system level parallelism.
- Security—Software and hardware combined security solution allows secure e-commerce, digital rights management (DRM), information encryption, secure boot, and secure software downloads.
- Smart Power Management—Includes frequency scaling, active well biasing, clock gating, and run, doze, and sleep modes
- LCD panels—Supports both smart and standard LCD panels
- Fast Ethernet—Supports 10/100 baseT Ethernet MAC

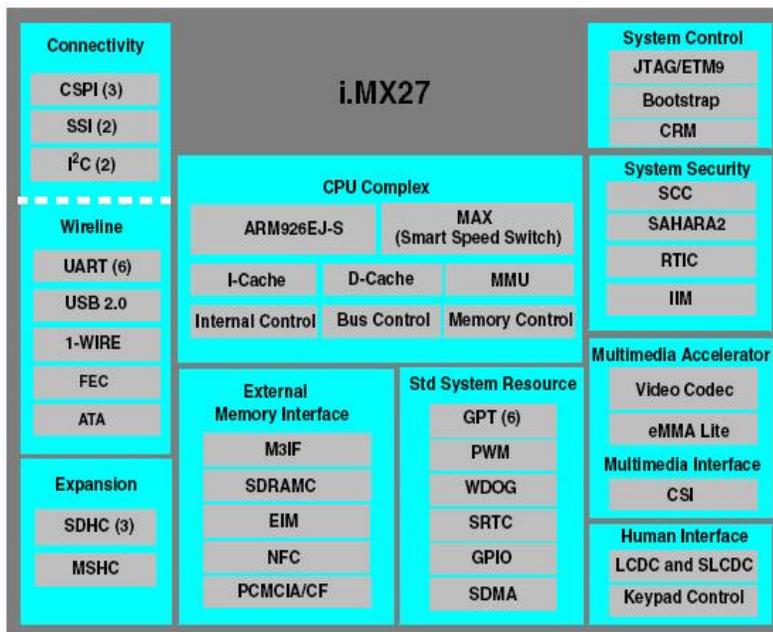Figure 1 shows the i.MX27 block diagram.

Figure 1. i.MX27 Block Diagram

1.2   Hardware Setup

The hardware setup described in this document uses the following equipment:

- i.MX27ADS board (with LCD and camera) with Redboot 200749 as the bootloader.

- Host PC running Linux (Fedora Core 9) with Gstreamer and VLC media player installed
- Serial Cable
- Ethernet Cable

2   Linux BSP Installation

For the i.MX27ADS BSP, there are two options for installing the Linux BSP:

- Installing from the i.MX27ADS Linux BSP iso image available at Freescale website:

  http://www.freescale.com/webapp/sps/site/overview.jsp?nodeId=02VS0l320822D0033202A7

- Installing a BSP from the Savannah LTIB CVS. Instructions for installing LTIB are available at http://www.bitshrine.org/

This application note uses the LTIB CVS approach.

Use the following steps to install the i.MX27ADS BSP from LTIB CVS.

1) Use the code provided in the Quick Install section at http://www.bitshrine.org/:

```
$ perl netinstall
$ cd /home/user/ltib
$ ./ltib
```

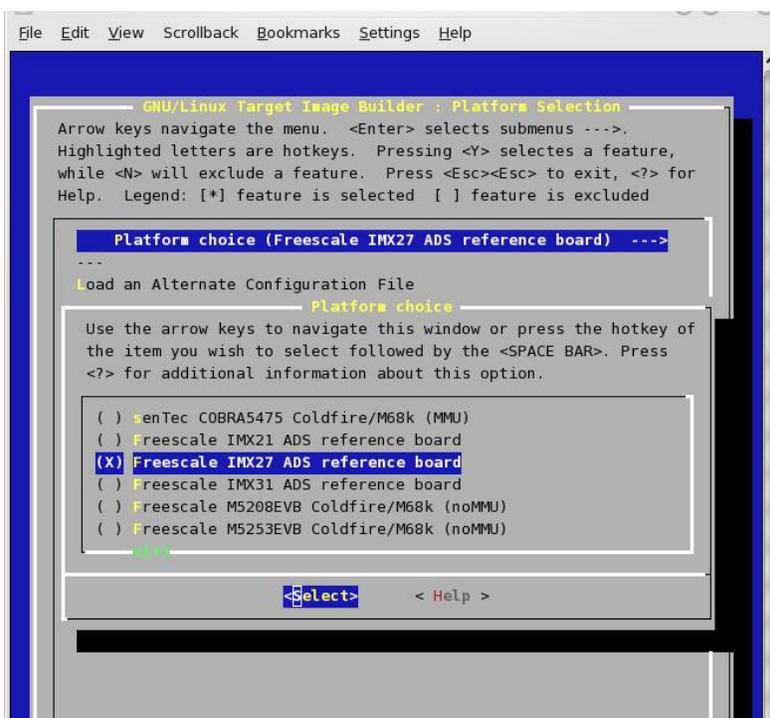After some minutes, the following window should appear:

Figure 2. i.MX27ADS Platform Selection

2) Select the i.MX27ADS platform, as shown in Figure 2.

3) Under Target System Configuration, choose:
```
Options --
Network setup – – – >
```

4) Select "[] get network parameters using dhcp" or fill in the network parameters if using a static IP address for the board.

NOTE

For simplicity, removal of the default Qtopia installation is recommended. Removal can be accomplished as shown below:
```
./ltib -c
Under ---  Package list - - - >
    Qtopia - - - >
        Qtopia version
                ( x ) Do not install Qtopia
```

5) Exit all menu windows, and return to the initial menu screen.

The default network controller on the BSP is the CS98000. To use the internal i.MX27 FEC, use the following steps.

1) Mark [*] Configure the kernel .

2) Save the configuration.

3) In the kernel menuconfig screen go to
```
Device Drivers - - - >
   Network Device Support - - - >
   Ethernet (10 or 100Mbit) - - - >
```

4) Mark <*> FEC ethernet controller and deselect < > CS98x0 support.

5) Exit all screens and LTIB will build the BSP automatically.

6) Copy the kernel (rootfs/boot/zImage) file into the /tftpboot directory.

7) Make sure Redboot is correctly setup for obtaining the kernel (zImage) through TFTP and mounting the root file system through NFS.

The i.MX27 FEC should be selected in Redboot as follows:

```
RedBoot> fc -l
Run script at boot: true
Boot script:
.. load -r -b 0x100000 /tftpboot/zImage
.. exec -b 0x100000 -l 0x200000 -c "noinitrd console=ttymxc0,115200
root=/dev/nf
s nfsroot=192.168.1.1:/tftpboot/ltib init=/linuxrc ip=dhcp"

Boot script timeout (1000ms resolution): 1
Use BOOTP for network configuration: true
Default server IP address: 192.168.1.1
Board specifics: 0
Console baud rate: 115200
Set eth0 network hardware address [MAC]: false
Set FEC network hardware address [MAC]: false
GDB connection port: 9000
Force console for special debug messages: false
Network debug at boot time: false
Default network device: mxc_fec
alias/bsp_ver: BSP_VER=rel3
```

8) To prevent i.MX27ADS LCD timeout, add the following lines into rootfs/etc/rc.d/rc.local:

```
if [ -c /dev/vc/0 ]; then
echo -e -n '\033[?25l' > /dev/vc/0
echo -e -n '\033[9]' > /dev/vc/0
fi
```

9) Boot Linux on the board and the i.MX27ADS Linux prompt, mx27#, should appear.

3   Installing i.MX27 Gstreamer Plugins

Freescale provides a Gstreamer VPU Codec Software Package to take advantage of the hardware-accelerated VPU engine on the i.MX27.

The Linux i.MX27 platform includes the following:

- Gstreamer plugin for H.264 BP decoder
- GStreamer plugin for H.264 BP encoder
- GStreamer plugin for MPEG-4 SP/H.263 P3 decoder
- GStreamer plugin for MPEG-4 SP/H.263 P3 encoder
- AVI demuxer that supports H.264 or MPEG-4 and MP3 streams
- MP4 demuxer that supports H.264 or MPEG-4 and AAC or MP3 streams
- MJPEG encoder
- PNG encoder

It is important to use the latest VPU library (2.2.4) and i.MX27 Gstreamer plugins that are available here:
http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=IMX27_CODECS&nodeId=02XPg Q82172973ZrDR&fpsp=1&tab=Design_Tools_Tab

Download and install the two packages in the following order:

1) MX27_VPU_FW_2.2.4_UPDATE_TO2.X_ONLY_LINUX
2) MX27_FULL_VPU_SW_LINUX_TO2.X_ONLY

3.1   Installation Tests

To verify that the Gstreamer packages and the i.MX27 specific plugins were correctly installed, use the following:

```
mx27# gst-launch --version
gst-launch-0.10 version 0.10.15
GStreamer 0.10.15
Unknown package origin
mx27# gst-inspect | grep mfw
```

This should show the following six plugins:

- mfw_vpudecoder: mfw_vpudecoder: Freescale: Hardware (VPU) Decoder
- mfw_vpuencoder: mfw_vpuencoder: Freescale: Hardware (VPU) Encoder
- mfw_v4lsrc: mfw_v4lsrc: Freescale Video Source plug-in
- mfw_v4lsink: mfw_v4lsink: v4l_sink
- mfw_avidemuxer: mfw_avidemuxer: FSL Avi Demuxer
- mfw_mp4demuxer: mfw_mp4demuxer: freescale-mp4 demuxer plugin mx27#

3.1.1   Gstreamer Introduction

Gstreamer features a very flexible framework for developing audio and video applications, and it is widely deployed in several processor architectures. Although it is not within the scope of this document to explain Gstreamer concepts, tutorials and a vast literature are available online.

For those interested in learning more about Gstreamer, http://gstreamer.freedesktop.org/data/doc/gstreamer/head/manual/html/index.html is a suggested starting point and https://lists.sourceforge.net/lists/listinfo/gstreamer-devel is a useful mailing list for Gstreamer developers.

3.1.2   Videotestsrc

A quick test to demonstrate Gstreamer functionality can be done on either a host PC or the i.MX27ADS.

On a host PC, enter:

```
$ gst-launch videotestsrc ! autovideosink
```
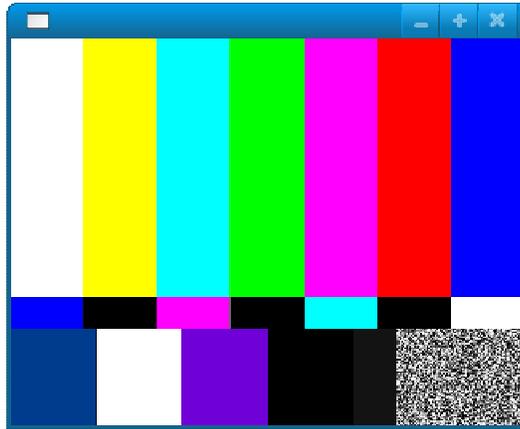
The PC screen should display the following video:

Figure 3. Video Test Pattern

On the i.MX27ADS, enter:

```
mx27# gst-launch videotestsrc ! video/x-raw-yuv,format=\(fourcc\)I420 !  mfw_v4lsink
```

The i.MX27ADS LCD should display the same pattern as shown in Figure 3.

3.1.3   Video Playback

Follow the steps below to set up video playback:

1) Download the MX27_TEST_STREAMS package from the following URL:
   http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=IMX27_CODECS&fpsp=1
   &tab=Design_Tools_Tab

2) Extract the package and copy the Kaleidoscope
   _mp4v_mp3_320x240_30fps_1200kbps_a_48khz_128kbps.mp4 file from the MPEG_VPU
   directory into the rootfs/home MX27 directory.

3) To play this media file, use the following code:

```
mx27# gst-launch filesrc
location=/home/Kaleidoscope_mp4v_mp3_320x240_30fps_1200kbps_a_48khz_128kbps.mp4 !
mfw_mp4demuxer ! mfw_vpudecoder codec-type=std_mpeg4 ! mfw_v4lsink
```

3.1.4   Camera Loopback

The default camera module driver in the i.MX27 BSP is the OV2640. A simple loopback test can be
performed as follows:

```
mx27# gst-launch mfw_v4lsrc ! mfw_v4lsink
```

This pipeline captures the camera image using the mfw_v4lsrc source element and displays it on the
LCD screen through the mfw_v4lsink sink plugin.

3.1.5 MP3 Playback

For MP3 playback, the following standard "mad" plugin can be used (not optimized):

```
mx27# gst-launch filesrc location=/home/something.mp3 ! mad ! alsasink
```

Connect a stereo headphone into the J19 jack to hear the music track.

4 Streaming Examples

This section discusses three examples for streaming images with the i.MX27 applications processor.

4.1 Streaming an H.264 Camera Stream from the i.MX27 to the Host PC

In this example, the image is captured by the OV2640 module, encoded into H264, sent through the Fast Ethernet Controller to the host (export), and received by Gstreamer.

- On the Host:

gst-launch-0.10 -v --gst-debug=2 udpsrc port=5000 caps="application/x-rtp, media=(string)video, clock-rate=(int)90000, encoding-name=(string)H264, payload=(int)96, ssrc=(guint)715953095, clock-base=(guint)2547213349, seqnum-base=(guint)28113" ! rtph264depay ! decodebin ! autovideosink

- On the i.MX27ADS:

mx27# export HOST=192.168.1.1   (change to the host PC IP address)

mx27# gst-launch-0.10 -v mfw_v4lsrc capture-width=320 capture-height=240 ! videoflip method=5 ! video/x-raw-yuv,framerate=30/1 ! mfw_vpuencoder codec-type=std_avc bitrate=100 width=320 height=240 ! rtph264pay ! udpsink host=$HOST port=5000

Figure 4.   Camera Stream Received on PC Running Gstreamer

4.2 Streaming an MPEG4 Camera Stream from the i.MX27 to the Host PC

In this example, the image is captured by the OV2640 module, encoded into MPEG4, sent through the Fast Ethernet Controller to the host (export), and received by the VLC media player.

- On the target:

mx27# gst-launch -v gstrtpbin name=rtpbin mfw_v4lsrc blocksize=38016 ! videoflip method=5 ! ffenc_mpeg4 rtp-payload-size=38016 ! rtpmp4vpay ! rtpbin.send_rtp_sink_2 rtpbin.send_rtp_src_2 ! udpsink port=5000 host=$HOST name=vrtpsink rtpbin.send_rtcp_src_2 ! udpsink port=5001 host=$HOST sync=false async=true name=vrtcpsink udpsrc port=5005 name=vrtpsrc ! rtpbin.recv_rtcp_sink_2

Note that the MPEG4 encoder used in this case was the ffenc_mpeg available from the gstreamer-ffmpeg package.

- On the host:

Create a text file, copy the content below, and rename it to mpeg4.sdp.

NOTE

The config field information can be taken from the output of the gst-launch command in the target ("caps" information).

Open the mpeg4.sdp using VLC media player and the remote image captured by the i.MX27ADS camera module should be visible, as shown in Figure 5.

Figure 5. Camera Stream Received on PC Running VLC

4.3   Streaming an MPEG4 file from the i.MX27 to the Host PC

In this example, an MPEG4 file is sent through the Fast Ethernet Controller to the host (export) and received by VLC media player.

- On the target:

mx27# gst-launch -v gstrtpbin name=rtpbin filesrc location=/home/Kaleidoscope_mp4v_mp3_320x240_30fps_1200kbps_a_48khz_128kbps.mp4 ! qtdemux ! rtpmp4vpay ! rtpbin.send_rtp_sink_2 rtpbin.send_rtp_src_2 ! udpsink port=5000 host=$HOST name=vrtpsink rtpbin.send_rtcp_src_2 ! udpsink port=5001 host=$HOST sync=false async=true name=vrtcpsink udpsrc port=5005 name=vrtpsrc ! rtpbin.recv_rtcp_sink_2

On the host:

Create a text file, copy the content below and rename it to Stream_File.sdp.

```
v=0
o=- 1223457093460663 1 IN IP4 127.0.0.1
s=RTSP Server
i=Codec00
t=0 0
a=tool:LIVE555 Streaming Media v2008.07.24
a=type broadcast
b=AS:21
a=control:*
a=source-filter: incl IN IP4 127.0.0.1
a=rtcp-unicast: reflection
m=video 5000 RTP/AVP 96
a=rtpmap:96 MP4V-ES/90000
a=framerate=30
a=fmtp:96 profile-level-id=1;
config=000001b001000001b5891300000100000012000c48d8800f50a041e1463000001b24
c61766335312e34392e30;
```

Open the Stream_File.sdp using the VLC media player. The remote media file sent by the i.MX27ADS should be visible, as shown in Figure 6.

Figure 6. Camera Stream Received on PC Running Gstreamer

5   References

Freescale documentation is available from the sources listed on the back page. The documentation

numbers for Freescale documents are included in parentheses for ease of ordering. Some documents may require a non-disclosure agreement. Please consult with your local FAE for assistance.

- *MCIMX27 Multimedia Applications Processor Reference Manual* (MCIMX27RM)
- Multimedia Linux Codecs SDK for i.MX27 ADS Release Notes - 10/29/2008

6 Support Information

For questions or suggestions regarding this application note, please contact your Freescale representative or Freescale's Technical Information Center (www.freescale.com/support).

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