

Title: Display Prepared for Mobile TV  
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Mobile TV is a hot topic in mass media, the electronics market, the telecommunications industry, technology seminars of handset suppliers, and so on. The market wants this technology to come sooner. Meanwhile, the system is under development to support this application and fulfill our customer expectation. So, what is our customer expectation? It is simply to watch TV on a handset.

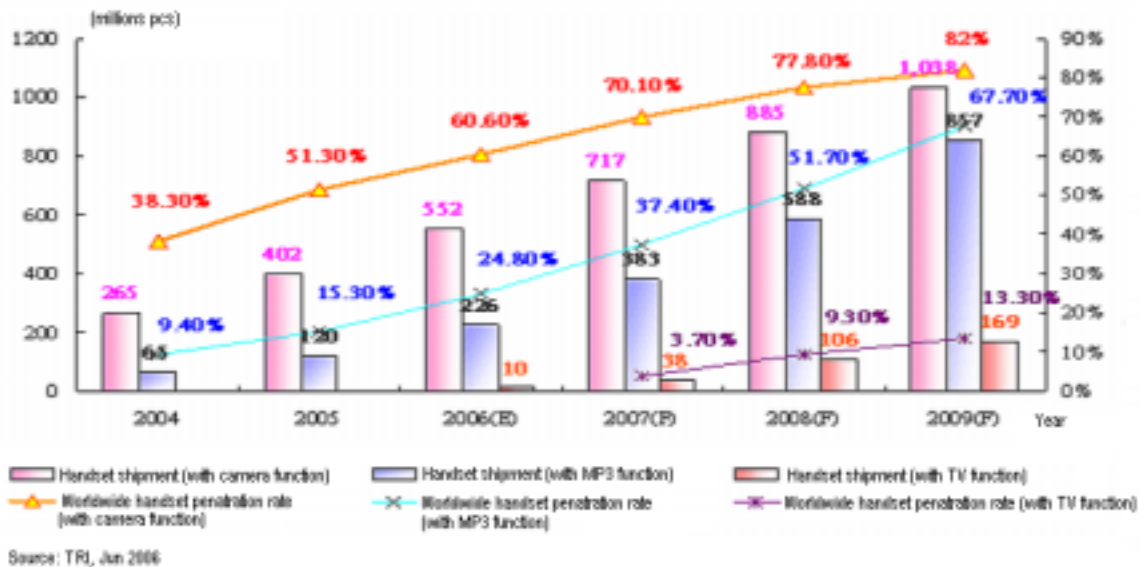


Figure 1: Worldwide mobile TV shipment forecast

We see a large potential market for mobile TV. It is one way for us to differentiate ourselves in the new era. People are eager to satisfy their desire for visual and voice technology. Meanwhile, there is major architecture required to run a mobile TV system.

Nowadays, mobile phones already have multimedia functions similar to a laptop — you can listen to music, take photos, play videos and games, and chat with friends anytime, anywhere (with network coverage). To provide mobile TV (the ability to receive television-like content through a mobile device), engineers require a lot of technical support from a network capacity, device hardware and software, and definitely the most important user interface - the display - for the massive content delivery.

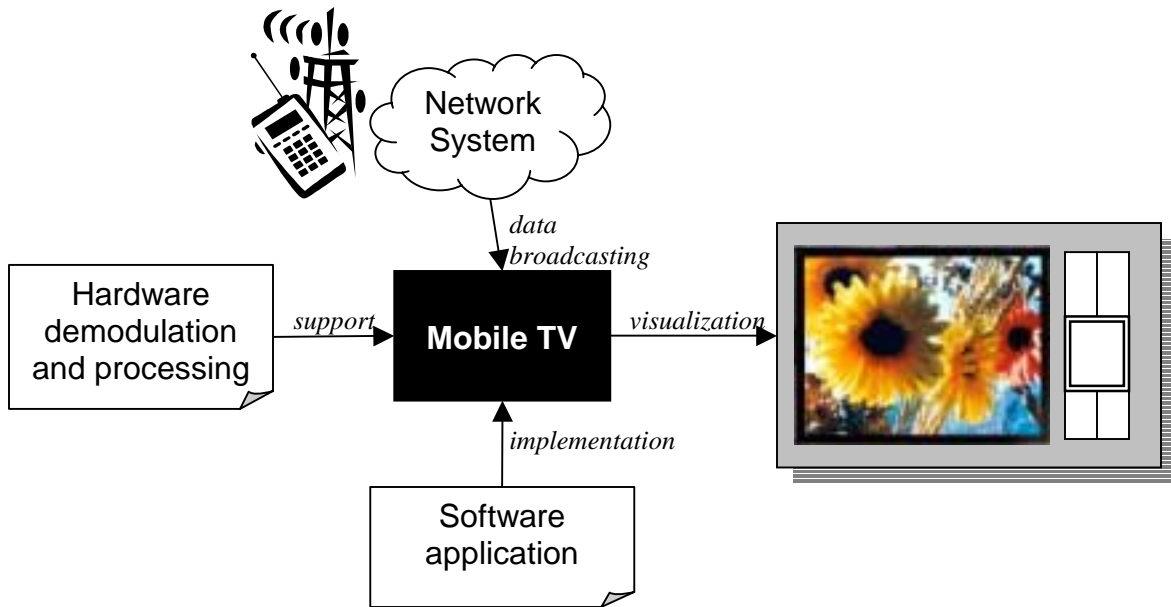


Figure 2: Configuration support for mobile TV

The implementation of mobile TV will rely on device support and network capacity. The configuration of a mobile phone will become more advanced and compact. However, the ultimate result should be what users can see on the display. The display is an essential element of mobile TV, so the display has to be enhanced in order to meet the requirements of watching TV on a mobile phone.

## Display requirements for mobile TV

### 1. Display performance

Table 1: Specification Comparison of Handset/TV-use Panels

Support	Specification	Panel spec	Remark
DVB-H	Nokia 7710	3.5", 640x320, 65k color	16:9 widescreen
	Nokia N92	2.8", 240x320, 16.7M color	
DMB	Samsung SPH-B4100	2.2", 240x320, 262k color	
	Samsung SPH-B2300	2.2", 240x320, 262k color	
	Samsung SCH-B100	2.2", 240x320, 262k color	
	Samsung SCH-B200	2.2", 240x320, 262k color	
	Samsung SCH-B250	2.2", 240x320, 262k color	
	LG-SB 130/KB 1300	2.2", 240x320, 262k color	
ISDB-T	Au W33SA	2.4", 240x320, 262k color	
	Au W41H	2.7", 240x400, 262k color	16:9 widescreen
	NTT DoCoMo P901iTV	2.5", 240x320, 262k color	Semitransparent TFT LCD

Source: FPDdisplay, Mar 2006

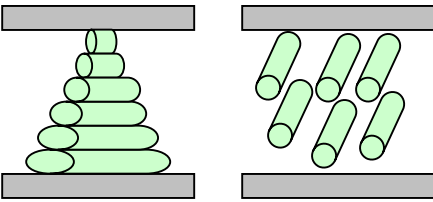
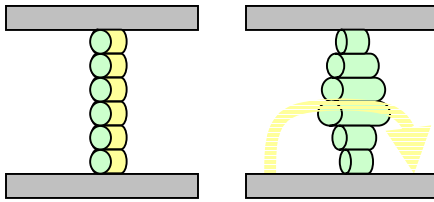
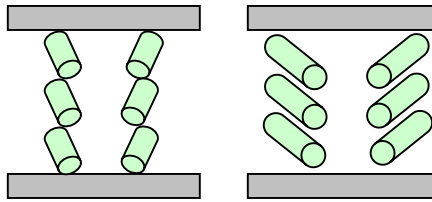
Some mobile-TV handsets showed that the display entry level would be the TFT-LCD with 2.2" or above, QVGA resolution or above, and at least 262k color. Considering the mobile-TV user, it is not difficult to determine the preferred requirements for the handset display.

a. Screen size and viewing angle

Imagine you have a 3G mobile phone and you are watching the World Cup 2010 on a train while you are traveling. It would be much more enjoyable if you could share and talk with your neighbors near your cube. At that moment, you would desire a big screen with a wider view. A display above 2.2", 2.6", 2.8" and 3.2" will be another trend for QVGA. A display that supports a wider viewing angle will be a benefit.

Traditional mobile display TFT LCD uses TN ( Twisted Nematic) LC (Liquid crystal) alignment. The viewing angle is typically at a 45-60 degree angle for the Left/Right/Upper/Lower sides. The LCD-TV panel adopts a different scheme of LC alignment method to allow a better viewing angle and contrast. Some panel makers use MVA (Multi-domains Vertical Alignment) or IPS (In Plane Switch), where both require higher driving voltage.

Table 2: Comparison between different LC modes (in mobile displays)

TN	IPS	MVA
 <p>OFF                  ON</p>	 <p>OFF                  ON</p>	 <p>OFF                  ON</p>
<p>Narrow viewing angle ~ +/-45°                      Low driving voltage, use ~4V                      LC (typical)</p>	<p>Wide view angle ~170°                      High driving voltage, use                      ~5.5V LC                      Slow LC response time                      Lower contrast ratio</p>	<p>Wide view angle ~160°                      High driving voltage, use                      ~5.5V LC                      Slow LC response time (better                      than IPS)</p>

From the above table, applying either the IPS or MVA scheme, requires higher driving voltage from the LCD driver for source output in order to provide sufficient voltage to move the LC to a certain angle. Therefore, choosing a suitable mobile driver IC to match the wide viewing angle display becomes a key factor.

## b. Display response time

Response time is an essential requirement for video display. It determines the image quality when displaying moving pictures. If the LCD has slow response time, the video image will cause blurring and shadows with quick movements or image changes. Typical mobile display response time is 25 milliseconds. It is enough for video signals of 25 to 30 frames per second. However, when LCD is applied with MVA or IPS for wide viewing angles, the response time suffers and ghosting or image sticking will occur. In this case, an LCD driver that can offer the over-drive scheme plays an important role in providing extra driving power to boost the LC twisting movement. Consequently, it will improve the response time and the video display performance.



Ghosting effect without over-drive scheme on slow response LCD



Sharp image with over-drive scheme on slow response LCD

## c. Color performance

We foresee advanced requirements for color performance in the future for mobile-TV display; 262k color is only the entry level. High-end mobile phones will go for 16 millions color display. Besides the number of display color will be increased, color saturation is another element that can improve the luminance and chrominance of the display. Higher color saturation will cover more of the color spectrum. General mobile display supports 50% to 60% NTSC, and for advanced quality, it will support 70% to 80% NTSC.

## d. Display resolution

Better resolution displays more precise images. Major high-end mobile phones support QVGA (240x320) resolution nowadays. In Japan's market, WQVGA (240x400) is popular, which is favorable for video. Some niche models may consider HVGA but the future trend will be VGA resolution because it will be the most compatible with monitor configurations and software applications such as video players. For

amorphous silicon TFT, there is a technology bottom neck for high pixel density. For higher resolution like HVGA or VGA, most LCDs are made by the LTPS (low temperature poly-silicon) TFT process because the LTPS process has smaller transistor and higher mobility for electronics. But the display driver architecture between amorphous silicon TFT and LTPS TFT are slightly different. An amorphous silicon TFT driver is mainly an all-in-one controller with full driving capability on source and gate output driving. While the LTPS TFT driver will provide data signals and gate signal timing only, it depends on the built-in gate driver on the panel.

## **2. Data transfer speed**

The data transmission rate will affect the display refresh and update functions. Because of higher resolution and video streaming data, high speed data transmission is required for a large information signal in a short period of time. A traditional CPU M68/i80 interface cannot fulfill the real time display. RGB interface was introduced for video signal data transferring but it will induce higher EMI via the connection from the baseband system to the display system. Many standards of high speed serial interface (HSSI) have been proposed from the industry. Solomon Systech also introduced mini-RGB serial interface to the market for some compact mobile phone designs. In addition, Solomon Systech was the first company who successfully implemented Mobile Industry Processor Interface [MIPI] on silicon. The purpose of HSSI and MIPI are to optimize the connection between baseband and display module interface, fasten the transmission rate, and lower the EMI.

Solomon Systech's latest QVGA ICs support wide-view angle panels with higher source driving power. The 262k color and 16 million color configurations are ready for different applications. There are all kinds of interface offered, such as CPU I/F, RGB I/F, mini-RGB I/F and MIPI interface, depending on the different mobile phone system designs. There is also LTPS TFT driver capability and there will be a series of driver controllers for different processes and resolutions of LTPS TFT LCDs. High driving power and over-drive scheme are also embedded in some of the high-end display solutions for mobile TV application.

## **3. Power consumption**

A display module, the major power consumer, includes a backlight unit and driver IC. The power of a backlight unit depends on how many LEDs it uses. A three LED backlight unit will use over 200mW. A QVGA TFT LCD will use approximately <20mW. Solomon Systech adapted the power

saving design in the latest driver ICs. The SSD1269 can achieve 3.6mA power consumption at 60Hz frame frequency in 2” QVGA amorphous TFT LCD. Additionally, in order to save power on the backlight unit, a proprietary dynamic backlight control algorithm has been developed in the SSD2208 for optimum backlight power savings with good display quality.

**Summary:**

Solomon Systech offers a series of TFT driver and interface solutions for future mobile handset display trends and is ready for the launch of mobile TV in the consumer market.

Solomon Systech TFT driver solution for mobile display:

Part Number	Display	Features
SSD1269	240RGBx320 a-TFT	262K color, ramless, RGB interface+SPI, Mini-RGB interface
SSD1299	240RGBx320 a-TFT	262K color, 172.8Kbytes GDDRAM, MCU interface
SSD2218	240RGBx320 a-TFT	16.7M Color, ramless, support MIPI or RGB I/F
SSD2208	240RGBx320 a-TFT	16.7M Color, 230.4Kbytes GDDRAM, support MIPI or MCU I/F
SSD2006	240 source output channels for LTPS display	3:1 MUX, 262K color, ramless, support RGB interface, SPI, Mini-RGB interface
SSD2116	320RGBx240 a-TFT	262K color, ramless, support RGB interface, SPI, Mini-RGB interface
SSD2118	320RGBx240 a-TFT	16M color, ramless, support RGB interface, CCIR, SPI

