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A family of hardware/software processors to extend the multimedia capability of the core cellular system to support advanced applications

- **Nexperia Mobile Display Modules**

A fully integrated, easy pop-in solution embedding multimedia functionality inside the display while optimizing it for best front-of-screen performance

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# BASICS *of Design*

## MOBILE MULTIMEDIA

Don Tuite, Contributing Editor

## Meet *the* Design Challenges *by* Analyzing Tradeoffs *and* New Standards

**T**oday, mobile multimedia generally means **images and sound**. The basic design elements for mobile multimedia comprise an imaging chip and its encoding and compression circuitry, a display and its driving circuitry, possibly some storage, an interface to the rest of the system, and the logic needed to make all elements work together. 

At last the mobile industry is developing interconnect standards to extend opportunities beyond today's limited number of phone makers and vertically integrated electronics manufacturers. Standards will signal a new phase in the mobile business, making hardware architectures less proprietary and accelerating the de-verticalization in the industry. Moreover, standards will mean less risk to innovation. Once these hardware interfaces become stabilized, there will be more competition and greater product variety. Mobile multimedia need not be limited to cell phones even though they are the most volume-constrained of all mobile products (see figure, right).



Developing a new mobile multimedia design is necessarily untidy, as many equally important considerations all interact.

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## The most flexible way to turn a mobile phone into much more than a mobile phone.

**The Philips Nexperia Mobile Solutions make it real.** Pictures. Games. Music. People want mobile phones that do more than deliver voice and text. The Philips Nexperia range of semiconductors, software and complete systems offers you a variety of robust, low-power and cost-effective ways to bring multimedia to mobile handsets. It's proven, fully validated technology you can build with now.



- **Nexperia Cellular System Solutions**

A total solution approach enabling multimedia handsets to come to market quickly and at a price consumers can afford

- **Nexperia Cellular Multimedia Baseband**

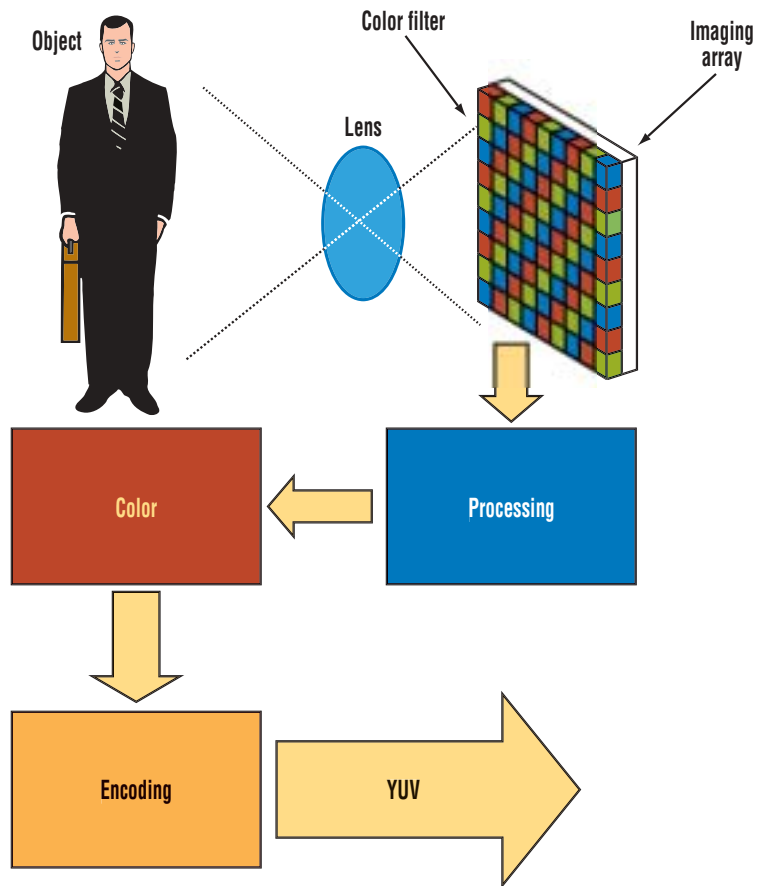
A fully integrated signal processor, based on an ARM9 core, that can run a variety of multimedia applications and is integrated in the Nexperia Cellular System Solutions

## A Look At The Imaging Subsystem

**T**o explore mobile multimedia design, consider how a camera subsystem might be integrated with existing cell-phone designs (see figure, right). Today, imagers and displays, along with associated hardware drivers and memory, are all available off-the-shelf. Memory is also available as IP ready for integration into an ASIC.

**B** Designing multimedia into a product such as a cell phone or other product poses a challenge. These elements must be combined and glued together into an optimized unit that can be added as simply as possible to existing base-band technology.

Particularly in the current environment of evolving standards, the design team must be up to the task. Camera modules are difficult to get running artifact-free; the smallest amount of power-supply noise is unacceptable; clocks must be stable, with low jitter; and the camera must match the display. Team leaders require prior experience to get all components working in harmony.



A basic imaging subsystem comprises optics, a CMOS color image sensor, and logic to convert the analog pixel levels clocked out of the sensor into a digitized YUV component signal. Commodity camera modules typically provide YUV output. (Pixel by pixel, Y is brightness and U and V are color phase-modulation components.)

## Design Constraints (Parlez-vous YUV?)

Using the mobile device's display as a viewfinder has implications for the amount of logic and memory in the design. The display in an old-fashioned cell phone is static. Used as a picture-phone viewfinder, however, it must be regularly updated, and the new product will require memory and processing power to accomplish this task. The minimum acceptable frame rate matters. If screen updates are too slow, if too much latency exists between the camera and the display,

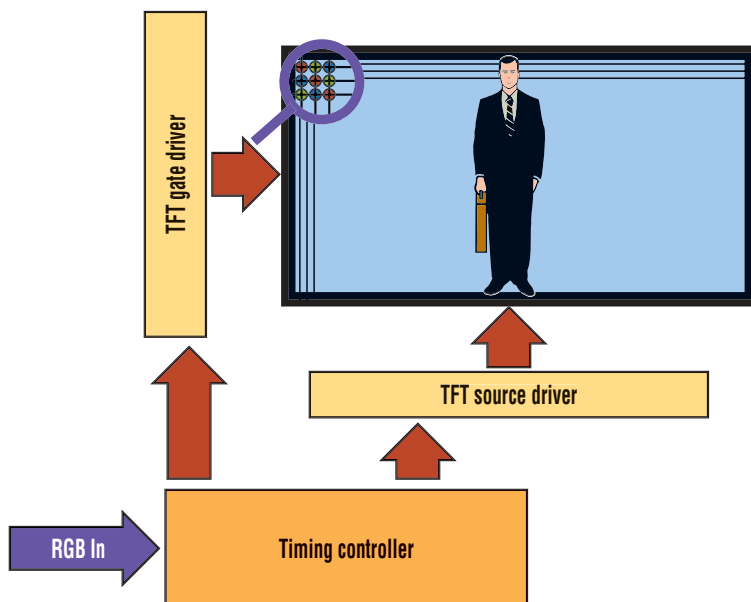
users perceive it as jitter. Market research reveals that ten to 15 frames per second is the minimum update rate acceptable to a target customer base.

Market data also shows that users want to archive and post-process their images and save them as JPEG compressed images with at least VGA resolution (640 by 480 pixels), even though the image resolution on the display in the portable device is scaled down from that.

Encoding and compression are needed, adding more memory and processing constraints.

There also are interface issues. That hoped-for set of standards may make life simpler for future product generations, but today's imagers and displays do not even speak the same language, so some logic must be committed to color-space conversion (*see figure, above*).

Power is another design consideration in mobile devices, particularly when multimedia functionality must be shared with cell-phone technology, which places a high value on availability and offers little opportunity for recharging. This is an opportunity to develop basic operating efficiencies, to concentrate on efficient ways of generating the many different voltages needed, and to implement as many power-management tricks as possible. The assembly should create the fewest possible system-level headaches in terms of product size and battery life. Moreover, the new phones must meet government licensing standards for electromagnetic susceptibility and interference.



A display module generally consists of the display itself, plus display-driver electronics. Generally, the driver components are mounted directly to the glass of the LCD display. Commodity displays expect RGB inputs. (Brightness levels for the red, green and blue elements of each display pixel.)

## Partitioning

**J**PEG compression and color-space conversion are compute-intensive. These operations probably can't be accomplished on the existing device's baseband processor because the baseband chip almost certainly already uses most of its computational capacity. Design partitioning starts here. How about integrating the image-processing functions with the display driver, or conversely, integrating a display driver into the imaging chip? This turns out to be a process-technology issue. Display drivers must provide high driving voltages, so they are typically built on more mature process technologies with larger feature sizes. But to make cell phones as small as customers seem to desire, it's best to provide as much of the logic as possible on the latest process technology. On the other hand, high-voltage functions and analog functions that would use up too much valuable silicon real estate on that bleeding-edge process are better implemented in a more mature process technology.



Memory requires further partitioning considerations. The product needs buffering for JPEG encoding, the display driver requires its own frame buffer, and graphics overlays for the image also add memory requirements. Where will memory reside and how shall it be implemented? Commodity display drivers integrate their own frame buffer memories. But drivers for costlier displays, with larger buffers, use off-chip memories. Memory partitioning significantly impacts power consumption and also image/video processing capabilities that enhance picture quality. The final partitioning tradeoff for a basic camera phone: integrate the buffer in a separate chip, leave it in the display driver, or maintain memory in both to maintain greater modularity? This decision gambles on the price of commodity drivers during the product's projected lifetime in the marketplace. Is it possible to sell enough of the new display drivers in a market saturated with commodity drivers to maintain a competitive price?



## Assembling The Pieces

**A**fter considering the components, design decisions turn to packaging and assembly. In mobile devices, the substrate for component assembly is critical. Cell phones have commonly had flexible circuit-board materials to accommodate the hinges in flip-phone designs. Flexible foils are also thinner in general than glass boards, and they enable pleating and folding circuits in three dimensions, allowing greater density in a smaller form factor. But flexible foil substrates can become too expensive for the application's target selling price, particularly if more than two metal layers are required.

In fact, routing complex circuits on two layers is a headache. Mobile ICs are typical-

ly packaged in thin ball-grid arrays, with around 100 balls or even more. Routing a BGA that complex on two layers without losing advantage of the package's small size is difficult. Four or more metal layers simplify layout, and the additional layers offer better prospects for power- and ground-plane EMI shielding.

The question is whether or not the product can bear the materials cost of a multilayer flexible substrate. It may ultimately prove more practical to use multilayer FRG, connected with flexible foil and headers, even if the end product turns out to be a little thicker than when using foil.

Another potential benefit of the FRG approach could come if there's a need for design change—a slightly different display with a different driver, perhaps. There's a reasonable chance of retaining the same circuit board layout while altering the interconnect to accommodate the new circuits.



## MIPI And The High-Speed Multipoint Link

In many handheld multimedia designs, parallel interconnect continues to be a major system problem. Consider that a parallel RGB-display bus requires 13 wires, and camera modules with parallel YUV outputs have fifteen. Now multiply all those bus interconnections by the number of potential imagers and displays in a clamshell-configuration multimedia product. The display portion already incorporates two displays and a speaker. Next add a camera looking out and another camera aimed toward the user. That's just too many parallel interfaces to fit in the hinge.

Additionally, parallel interfaces imply a wide footprint, cause electro-magnetic interference, and without standards pose an integration nightmare. From an electrical standpoint, a real need exists for high-speed interconnect to migrate from the cur-

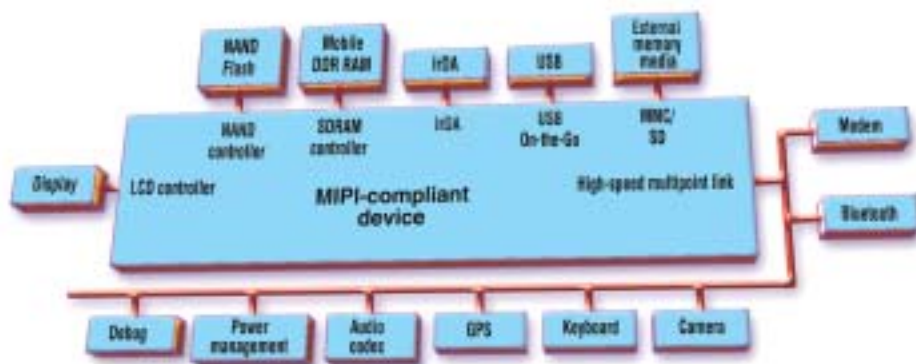
rent parallel approach to serial and from single-ended signaling to differential. Finally, from a manufacturing standpoint, fewer wires mean better yields and lower cost.

A short-term approach would be a custom serial interface with custom serializer/deserializer chips at each end. But no company would want to continually revisit that design effort for every new feature set with today's compressed life cycles.

For the longer term, the Mobile Industry Processor Interface (MIPI) Alliance's standards efforts offer hope (see figure, above). MIPI's statement of purpose says: "[The MIPI] Alliance is a collaboration of mobile industry leaders with the objective to define and promote open standards for interfaces to mobile application processors. Through these

open standards, the MIPI Alliance intends to speed deployment of new services to mobile users by establishing specifications for standard hardware and software interfaces to mobile application processors and encouraging the adoption of those standards throughout the industry value chain."

The MIPI High-Speed Multipoint Link Working Group



MIPI's working groups promise both standardized interfaces for subsystems and a backplane-like scalable-speed serial bus for most peripherals.

(HML) is tasked with developing, publishing, and maintaining a specification that will fulfill the needs of interconnecting multiple SoCs in a mobile environment. The working group will gather and consolidate system requirements from MIPI members, develop draft specification proposals for review, and subsequently publish a standard for a "High-Speed Multipoint Link."

HML goals include multimaster shared interfaces for SoCs, minimizing the number of pins required for communication, making bandwidth scalable, providing security, and keeping controller gate count, power requirements, latency, and signaling rates as low as possible.