White Paper

Three Questions to Ask when Choosing a Processor for Multimedia, Display and IoT Applications

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Abstract

Rising end-user expectations now directly influence embedded designs. Designers must choose processors carefully, considering how their systems interface with human beings comfortable with a data-rich, multimedia world. The three primary considerations are: processing power, multimedia requirements and interfaces with other systems.

Applications Everywhere

Designers face new challenges when crafting any system that touches a human being. Users expect digital technology to interact in new ways.

Consumers and workers are so comfortable with technology in their lives, they bring new expectations to every device, every system or machine they use. Even traditional embedded designs are undergoing transformation with new connectivity through the Internet of Things (IoT) and Machine-to-Machine (M2M) communications. It is an exciting new era of interactivity and connected devices of all kinds, from wearables to digital signage and smart infrastructure that constantly monitor and produce data for analysis, control and automation. This means designers of virtually any kind of system have to raise their game and use a new mix of features. Freescale i.MX 6 series applications processors were designed for that world.

Consider automobiles.

Consumer expectations for vehicles include the traditional things like good gas mileage, comfortable seats and a proper number of cup holders. Today, the creative use of digital technologies differentiates one car from another as consumers shop for the best driving experience among competing vehicles. Consumers want large screens that display GPS information and all manner of control panels for various functions, as well as dynamic high-resolution displays in the back seats so kids can watch movies or play games. Vehicles are becoming mobile Internet gateways, entertainment systems, and rolling information hubs—pulling information into the vehicle from wireless networks or satellites and transmitting information to road infrastructure and other cars.

Consider healthcare.

Today, consumers have a wide range of health and fitness monitoring options. A wide range of devices collect, process and display that information to the consumer. Some of them record the information, publish it to the web or transmit it to doctors and nurses. Digital technology is also automating certain treatments for managing chronic conditions such as diabetes. Insulin pumps are combining the monitoring and injection functions into compact devices that can be worn on the body. By removing hassle, digital technology makes those patients healthier, raises their quality of life and creates a stream of data that physicians can use for fine-tuning treatments over time.

Consider consumer entertainment.

IPTV devices are available in a wide variety of forms, from set top boxes to consoles and other add-on devices. The television experience is evolving rapidly with new processing formats such as 3D that are just emerging. The very nature of programming is changing rapidly. Televisions are processing and displaying a variety of content from different sources including the Internet, game consoles, apps and cable or satellite.

Even industrial controls and the daily infrastructure of life are being upgraded with digital clusters and other displays that interact with users of all kinds. All of this interactivity has to happen on the consumer's terms. Consumers have no patience for technology that does not adapt to their preferences. Designers must delight those demanding consumers with scalable solutions that deliver a great experience at multiple price points.

Expectations are rising everywhere, from educational technology to healthcare and fitness to industrial control solutions. Consumers bring new expectations to many different experiences in life: interactive screens everywhere, eye-popping video, great sound, Internet access and permutations of all these things and more.

This white paper is geared toward exploring these expectations in real-world applications and asking key questions to satisfy them with the correct type of processor. Design examples will reflect what engineers are doing with i.MX 6 series processors around the globe. Designers have to mix and match new architectural features to meet these new requirements—always balancing cost, performance and energy efficiency.

It is an exciting time to be an embedded designer. Embedded designs provide the intersection point for many trends in industry and consumer technology. Designing a product today starts with assessing the processing needs of the system and its usage model. Freescale i.MX 6 series processors were architected to create new opportunities in a range of applications where the usage model and user expectations are evolving rapidly. Designers can take advantage of a scalable product line that offers a variety of options geared toward the new world of high user expectations.

The Key Questions

Many of these new usage models and expectations have common technical underpinnings, even if the end products look quite different. The i.MX 6 series processors offer a wide variety of configurations from single core to quad core with a selection of connectivity interfaces and multimedia options.

Determining which processor is right for a given design need not be a daunting process. The i.MX 6 series processors scale performance across a range of designs and user expectations. Where to begin? Answering three questions about design requirements makes the selection process much simpler.

Question #1: How much processing power do you need?

Processing power is the first question to address because the answer comprehends technical issues and the business strategy shaping the end product. Processing power also involves price issues and this price/performance dynamic is more complex than it might first appear. Failing to meet user expectations is costly. Processing power has direct implications for the responsiveness of a system and the sophistication of the underlying feature set it can offer. An under-powered design can disappoint customers and quickly damage a brand in a world where users routinely describe experiences on social media.

Processing power has implications for business models. Many product strategies involve scaling a base hardware design across multiple price points through software differentiation. The same hardware needs to be able to manage increasingly sophisticated software suites over time without a performance impact to realize the full-cost leverage from the design. One might think of a suite of personal healthcare devices that range from basic self-monitoring functions for the individual user to products that can monitor more functions and report results to caregivers. The underlying hardware can be the same design with software modules that unlock features. The underlying design must be robust enough to handle the most sophisticated software suite.

Likewise, many business models require that future considerations be considered in the initial design. Digital technology progresses quickly, yet today it is embedded in products with long useful lives. Car infotainment systems provide a good example. They are embedded in products with a useful life of several years. Codecs for sound quality and certain feature sets might leapfrog the initial technology two or three times during a car's lifecycle, yet no one expects consumers to trade in a car just because a new codec arrives. Future-proofing can add new touch points with a consumer after the initial purchase. Users can be satisfied through software upgrades pushed to embedded devices in the field several years after the initial purchase. That model only works if the hardware is robust enough to provide a great experience with the upgraded code. Capabilities that essentially do not yet exist must be comprehended in the initial design. Designing future considerations in the processor is the only way to ensure such a business model works in the long term and processor performance is the primary way to ensure the longevity of a product in the field.

These business decisions pair with more straightforward technical needs in choosing the number of cores for a design. How many data streams must be managed? How sophisticated is the user interface? Are voice processing or voice recognition involved? Voice is a performance-hungry feature, yet it is growing as a user convenience.

Some designs are essentially basic user interfaces providing an input/output front end on a larger system. The user expectation is little more than touching buttons or capturing keystrokes. A single-core solution works for that design in many cases.

User expectations start scaling very quickly, however. If web browsing is an integral part of the user experience, the design can quickly scale to a dual-core processor. Think of digital signage in a store. The user expectation is to check prices and inventory at that physical store and perhaps do some comparison shopping all on the same screen. Adding web browsing brings a new data stream into the design, one with its own protocol stack and graphical formats. Web pages increasingly have automatically updated content and standard video features that require processing. That load comes on top of running the user interface and querying local databases. The user expectation for responsiveness is set by their use of tablets, phones and PCs. If the wait for data is longer than the user expects, a sale can be lost. Devoting a second core to managing the web browsing function can speed the overall responsiveness of the system.

Inherently mobile devices require more services to maintain a quality user experience. GPS information is often shared dynamically while on the go along with cellular or WiFi overhead management. Managing those multiple services can tax a single core beyond its limits. Certain devices such as today's innovative healthcare devices or personal health and fitness devices process real-time information and often share information with online databases.

Quad core designs involve more data streams and layers of processing. Is there an embedded OS such as Linux or Android or another environment? Are voice processing or media streams involved? These might require dedicated cores.

Asymmetric Multicore Processing (AMP) is a growing trend, as more applications require different operating systems to run on different cores. Some software stacks run isolated within the system. This can be useful for real-time processing or security stacks that constantly run in the background. In industrial control applications, real time interrupts might be involved and a dedicated processor core could handle those interrupts so that other processes do not take a performance hit. Security is evolving as a huge issue as new device types enter mainstream usage. The potential for disruption and even serious injury is huge. Security will increasingly require a dedicated core in embedded designs of all kinds.

This intersection of cores, services, features and business models opens new playing fields for designs. Consider the features that could differentiate cars of the very near future. Collision-avoidance systems are poised to enter the mainstream. New features could detect drivers in danger of falling asleep or drivers that are incapacitated in some fashion. With more cores, these enhanced features could run on two cores with sophisticated threaded software while two cores are free to process more standard infotainment features.

Healthcare is developing rapidly. New monitoring devices allow patients to roam freely without being tethered to monitors. Purpose-built medical tablets put all information on a patient from electronic medical records and real-time monitors into one interface. New device types such as Orcam, a real-time visual sensor that provides real-world processing for visually challenged people, create new opportunities to empower people.

Processing power and the number of cores required is the first and most complex question to answer in modern embedded designs. The answer involves the scope of the technical design and the business model a given design can support. For the purposes of choosing an i.MX 6 series

processor, answering this question can narrow your choices from the five families to the one that matches your needs.

The i.MX 6 series processors are available in single, dual and quad core configurations. Processing cores are all based on the ARM® Cortex® A9 architecture. Together, the combinations of cores and cache sizes (32KB L1 cache per core, 256 KB to 1 MB L2 cache choices) create five families of processors that are pin[1] and software compatible:

- i.MX 6Quad: four cores for the ultimate in performance
- i.MX 6Dual: two high-performance cores
- i.MX 6DualLite: similar cores, smaller cache size
- i.MX 6Solo: single core
- i.MX 6SoloLite: single core, smaller cache

The questions from there begin tailoring that processing power to a specific design.

Question #2: What are the multimedia requirements in the design?

Systems that are primarily engaged in M2M communications in the IoT might not need a display because they are part of an autonomic nervous system that does not interface with humans in a factory or even in public infrastructure. Not every design requires a display, video processing or complex graphics. This simplifies the interface and connectivity choices to be made and in some designs has implications for the number of cores needed in the design.

Yet, these robust video and graphical features are now in demand on an increasing number of designs that interface even occasionally with human beings. Even some designs that traditionally could overlook displays now find differentiation in offering displays for user information and interactivity. For instance, digital instrument clusters are now popular in automotive designs and similar approaches are used in consumer kiosks and some home automation designs.

Once a display is introduced, designers must assess different levels of graphical needs (number of displays, physical size, display resolution, multi-layered UI, graphical effects) and interactivity (multi-touch driven display or primarily visual and non-interactive display) in the usage model as well as understand connectivity between the processor and the display (parallel RGB, serial LVDS or MIPI, HDMI connection, or low-power E-Ink display) and the memory bandwidth needed to drive the display.

The i.MX 6 series processors scale from 2D to 3D graphics quality, with one to four shaders to create effects. The 2D graphics are adequate for many applications, especially those that are primarily textual in nature. However, as 3D graphics become a larger part of the digital experience in the world in general, it is at least worth considering whether a design can benefit from 3D graphics. For instance, UI designs can prove to be more dynamic than seemingly sophisticated gaming consoles. UI content can be updated constantly with freshly processed images, text and data while gaming consoles often use already cached images. As 3D images become a greater requirement for even casual systems, multimedia processing requirements are increasing quickly. The i.MX 6

1. i.MX 6SoloLite is not pin compatible.

series offers a range of 2D and 3D graphics capabilities, from the triple-play graphics architecture at the high-end, to a scaled back 2D only implementation on the low end.

- i.MX 6Quad/6Dual: 2D and quad shader 3D GPU
- i.MX 6DualLite/6Solo: 2D and single shader 3D GPU
- i.MX 6SoloLite: 2D GPU

The introduction of a display into a design drives questions of whether video playback is necessary, in particular if an advanced UI is required. Again, the i.MX 6 series provides multiple options for video performance depending on the video requirements (number of streams, resolution, frame and bit rate). Video playback and streaming performance in particular is highly dependent on the display resolution and the ability of the system-on-chip to provide sufficient system bandwidth to provide high quality and low latency video playback and record. A faster and wider external memory bus is more likely to provide more total available memory bandwidth to meet the demands of high-end video processing performance.

- i.MX 6Quad/6Dual: 1080p60 video decode, 1080p30 video encode, 64-bit DDR at 533MHz
- i.MX 6DualLite: 1080p30 video decode, 1080p30 video encode, 64-bit DDR at 400MHz
- i.MX 6Solo: 1080p30 video decode, 1080p30 video encode, 32-bit DDR at 400MHz
- i.MX 6SoloLite: No video processing, 32-bit DDR at 400MHz

Display considerations raise the issue of connecting the processor to system resources such as the display itself as well as memory or storage subsystems. That is the third question that must be addressed when choosing a processor for your design.

Question #3: What connectivity and integration is needed with other solution elements?

Embedded processing now prevails in a wide range of system types and in a wide variety of environments. Different application segments have different standardized interfaces among system elements. In some cases, it is necessary to interface with external subsystems. The i.MX 6 series processors offer a range of interface options for tailoring their capability to different markets.

Displays require different interfaces in different segments and in different kinds of designs. Some designs even have multiple display requirements and the i.MX 6 series processors are designed for flexibility.

- i.MX 6Quad and 6Dual: four independent displays, supported display types include parallel RGB, dual LVDS, MIPI and HDMI
- i.MX 6DualLite and 6Solo: two independent displays, supported display types include parallel RGB, LVDS, MIPI, HDMI and E-Ink
- i.MX 6SoloLite: single display, supported display types include parallel RGB and E-Ink

An i.MX 6 series based design requires an external boot source, since this class of product is usually running a rich OS. However, i.MX 6 series provides multiple options for boot sources; cost-sensitive NAND Flash (not available on i.MX 6SoloLite), small footprint serial Flash, high reliability parallel NOR, to higher-performing, modularized and easy to integrate eMMC.

Now that most devices are connected to the network or cloud via some type of wireless connectivity, it is important to offer multiple wireless connectivity options, in particular options for 802.11 that let the designer trade-off between bandwidth and low power targets. All i.MX 6 series devices provide for connections to low-power USB 2.0 or SDIO based 802.11 solutions. If the designer needs access to higher throughput 802.11 solutions (for example 802.11ac) then a PCIe based interface is often required. PCIe is also used as a high-speed serial interface in many systems. External connectivity options tailor the i.MX 6 series processors to various markets and designs. Serial ATA (SATA) is often used in devices that require a large volume of attached storage, for example a network attached storage device or a high-end audio player. FLEXCan (Flexible Controller Area Network) is frequently used in automotive designs and other safety-critical segments such as boats, trucks and recreational vehicles. MIPI-CSI is a high-speed camera interface that is primarily used in camera enabled portable devices that are size and power constrained.

- i.MX 6Quad and 6Dual: SDIO, PCIe, SATA, FLEXCan, MLB, MIPI-CSI
- i.MX 6DualLite and 6Solo: SDIO, PCIe, FLEXCan, MLB, MIPI-CSI
- i.MX 6SoloLite: SDIO

The i.MX 6 series processors were designed to scale all these common capabilities across the range of applications that drive our digital world.

Tailoring Great Ideas to the Real World

The future is officially here. With the IoT, ubiquitous networks, high-resolution screens and data flowing everywhere, we can do things that seemed like science fiction several years ago. Today, every system is a “smart” system.

Users of all kinds are interfacing with technology at all times in their daily lives. Designers must adapt to rising expectations they bring to any system and those expectations impact the processor choices designers make. The i.MX 6 series processors make that adaptation as easy as answering three questions.

Freescale is opening doors to new ways of approaching embedded designs. The i.MX 6 series processors were conceived to power a range of designs in a world comfortable with digital technology. Designers must think beyond the basic functions of a system and consider how users experience that system. Designs must be tailored to users and use cases in new ways. Freescale’s diverse portfolio offers a range of choices for a new era.

For more information visit freescale.com/iMX6series

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