Reconfigurable Vehicles Are Just Around the Corner

Automotive in-car applications are a fertile field for programmable logic devices. FPGAs and CPLDs offer designers the ability to evolve with new and emerging automotive standards and protocols, giving manufacturers faster time-to-market and longer time-in-market.

by Karen Parnell
European Marketing Manager
High Volume Products
karen.parnell@xilinx.com

When we envisage automotive electronics, we automatically consider electric windows, central locking systems, climate control, and electronic ignition systems, all of which require stringent qualification, temperature cycling, and certification. However, the emerging automotive electronics market has shifted from under the hood (or bonnet) to in-cabin multimedia applications. The inexorable trend toward mobile offices, onboard entertainment, and real time information on the move means the market is wide open for complex programmable logic devices (CPLDs) and field programmable gate arrays (FPGAs).

Historically, the lead time from a new vehicle conception to production has been about five to six years. Now, the shift is toward vehicle turnaround times as short as two years. This shift is forcing a phenomenal change in automotive design practices and techniques. Now, more than ever before, time to market is critical.

It's predicted that intelligent cars of the next decade will be able to perform the following functions:

- Provide a safe, informative, productive, and entertaining environment.
- Cruise intelligently by automatically keeping pace with the vehicle in front.
- Display their exact locations using satellite-based navigation.
- Summon emergency services to the precise location of a breakdown or accident with, or without, any driver action.
- Illuminate long distances in the dark with infrared and ultraviolet headlights.

Figure 1 shows some of the emerging "semiconductor rich" products that will become standard options available in vehicles over the next few years.

By utilizing the flexibility, time to market advantage, and after-sale reconfigurability of Xilinx devices and software, manufacturers can not only be first to market but remain best in class long after the sale.

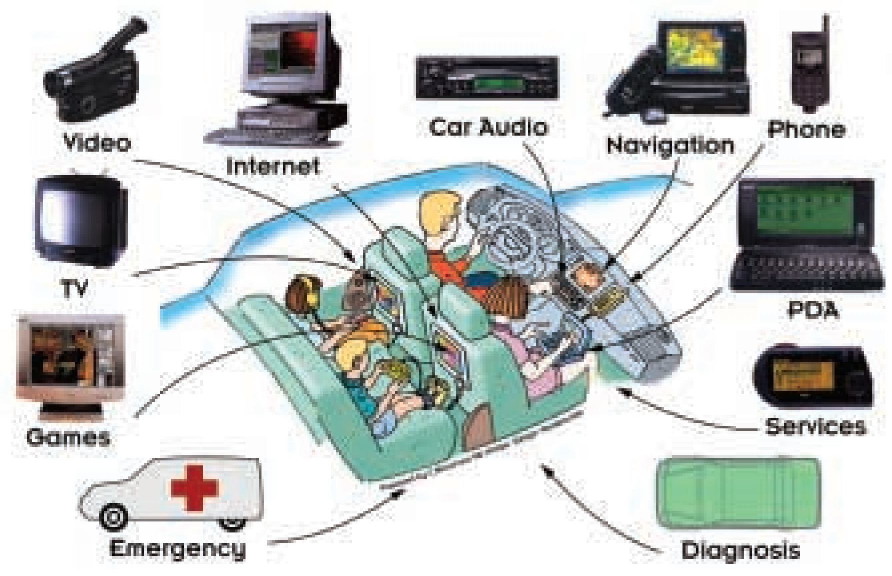

Figure 1 - Emerging in-car systems (source: Philips)

The Automotive Multimedia Platform Concept

As information and entertainment systems are added to automobiles, we're seeing the inevitable conflict of digital standards and protocols. A bewildering array of emerging standards and protocols are being tried and tested for use in the latest in-car systems, including: Bluetooth™, BlueCAN, MP3, Java™, AutoPC, AMIC (Automotive Multimedia Interface Consortium with JINI interface), WAP (Wireless Application Protocol), HTML, XML, MOST (Media Oriented System Transport), FireWire, CAN (Controller Area Network), TCP/IP, and more – but which one(s) will prevail?

Overcoming the Design Challenges

Designers of the new wave in-car multimedia systems must include traffic information systems, Internet/Web access, electronic game consoles, MPEG music download capability, digital radio reception, and mobile commerce services. These designers must also have the flexibility to provide all or just a few of these functions.

Other challenges faced by the designers are:

- Small physical space available to place devices in the dashboard or seat backs
- Low cost units that can fit into more than one model of car
- Aesthetically pleasing look and feel
- Ease of driver use
- Ability to upgrade the unit when automotive standards and protocols change.

Designers must also ensure that the in-car multimedia system can "talk" to other devices introduced into the cabin space. For example, if a mobile phone is brought into the car environment, it should be automatically detected and able to communicate with the car's communications network. This automatic connectivity could also include connection of PDAs, portable PCs, MP3 players, and other personal portable electronic equipment to provide a truly connected and functional in-car environment.

Some after-market, third-party manufacturers have provided short-term solutions to some of these problems by producing audio systems based around MP3 technology. When in the cabin, the MP3 player is seated in the car audio system, but when you leave the vehicle, you can take it with you as a portable MP3 player

The New Way of Designing

As in-car and consumer functions converge – and new automotive and consumer standards and protocols emerge – manufacturers are starting to prototype multimedia platforms that can provide as much, or as little functionality, as required. Such multimedia platforms can be best realized by designing with reconfigurable hardware. Ideally, the multimedia platform should be based around one human-machine interface that allows all functions to be accessed via a menu-driven touch screen.

Reconfigurable hardware can be programmed late in the production flow to provide custom functionality on a standard hardware platform – and can also be configured to accommodate the newest emerging in-car standards and protocols.

Figure 2 shows the automotive multimedia platform design approach. This concept allows hardware upgrades throughout the lifetime of the car. These upgrades can be implemented remotely by utilizing the wireless communications/Internet connectivity provided by the unit. Xilinx terms this remote hardware upgrading process Internet Reconfigurable Logic (IRL™) via the Xilinx Online program.

The Xilinx Online program is designed to enable, identify, and promote network upgradable systems, hence "future proofing" a system and avoiding product obsolescence. These systems can be upgraded, modified, or fixed long after they have been deployed in the field.

While many designers have been building upgradable devices based on Xilinx technology for years, the explosion of networked devices has dramatically increased consumer demand for these user-configurable, adaptable products. For example, an engineer can use the existing wireless communications/Internet infrastructure to reprogram an in-car multimedia system to include extra functionality, such as adding an MP3 player or upgrading the system to take advantage of the latest protocol or standard.

Multimedia System Design Flow Using FPGAs

The new way of developing in-car systems is to prototype using FPGAs in a generic development environment. The elements can then be developed quickly and easily without the need to fix specifications. This initial prototyping phase can be realized using Virtex®-II Platform FPGAs. At this early stage, the different standards, protocols, and functions can be tried, tested, and debugged utilizing the headroom that a large FPGA gives.

As the design firms up, the specifications are "chilled" or "frozen," and in engineering terms, the boards are "productionized." In other words, the desired standard, protocol, or function is chosen from the many tested. This move from prototype board to productionized printed circuit board

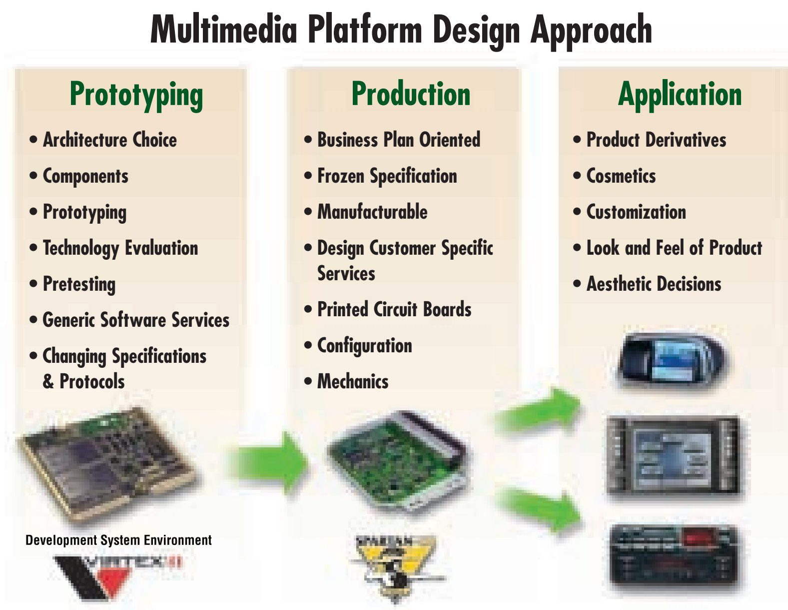

Figure 2 - Automotive multimedia platform design approach

(PCB) enables the design to be optimized and fitted into a smaller, low cost FPGA, such as a device from the Xilinx Spartan®-IIE family, while still leaving room for future system upgradability. Once in production, the FPGA can be used to aid total PCB testing using JTAG techniques. If necessary, designs can be 'tweaked' or enhanced at this stage.

The final stage is the look and feel or aesthetics of the product, which can be designed for each car manufacturer to fit into their specific dashboard (or fascia). All of the production multimedia units are built up around the standard FPGA-based platform. This standard platform can be programmed with its "personality" late in the production flow to accommodate last-minute design changes or end-user preferences.

Having a common platform cuts down on inventory and takes advantage of the cost savings associated with producing one platform for all units. The benefits of using this reconfigurable hardware-based multimedia platform approach are:

- Easier control of software and hardware development
- Re-use of components, be they software or hardware (design re-use)
- Increase in the time developers can spend on creating value as opposed to creating system interconnect structures
- Reduction of risk through clearer understanding of the basic components
- Choice of standard or protocol can be deferred and simply reconfigured later
- Increased productivity through the application of modern development tools
- Increased openness of the system, supporting the use of standards and integration of third-party components.

The Xilinx In-Car Multimedia Solution

We predict the heart of the reconfigurable multimedia platform will be a Xilinx programmable logic device. The common platform approach enables one PCB to be produced for all customers – with the only change being to the style, shape, and color of the unit front panel to satisfy the need for product differentiation.

Xilinx is the leading provider of complete and innovative programmable logic solutions. Our products help minimize risks for manufacturers of in-car electronic equipment by shortening the time required to develop products and take them to market – and keep them there long after the sale. You can design and verify your proprietary circuits in Xilinx CPLDs much faster than you possibly could by using traditional methods, such as manufacturing ASICs (application specific integrated circuits) and ASSPs (application specific standard parts).

Xilinx builds programmable integrated circuits, develops software, IP (intellectual property) cores, and other tools to provide complete solutions to our customers. We also provide world-class application support and design services to customers developing their own proprietary designs.

To "drive" the in-car digital convergence in the face of emerging standards and protocols, Xilinx recommends the Spartan-IIE FPGA family and the CoolRunner® and 9500XV CPLD families. The Xilinx CPLD families are qualified to meet automotive temperature range parameters. The Spartan-IIE FPGA family is based on the very popular Virtex family. Spartan-IIE extends the legacy of the Spartan series, with more gates, better performance, and enhanced features. The Spartan-IIE family offers digital delay locked loops, programmable I/Os, on-chip block memory, and densities up to 300,000 system gates. These features and densities, coupled with enhancements to software and an increased number of available IP cores, provide a reduced time-to-market and increased time-in-market at a much lower cost. Xilinx also has a range of IP cores such as memory controllers, system interfaces, DSP, communications, networking, and microprocessors.

Looking Down the Road

Consumers are demanding the comforts of home, the facilities of the office, and the state-of-the-art in information and safety systems in their cars.

This digital product convergence scenario requires that the latest interface standards and protocols interconnect and interoperate. These standards and protocols are still emerging – and may get more complicated before they are standardized.

So, should manufacturers make an educated guess as to what standard will prevail and produce at risk, or should they wait for the standards to be fixed and get left behind?

With Xilinx CPLDs you can win the time to market race at minimum risk by taking advantage of the capability to reconfigure your products to accommodate almost any standard or protocol – now and in the future. By using reconfigurable logic in production, the units can be reconfigured in-car to produce new hardware-based features, thus extending the life of the product.

Xilinx high-volume FPGA and CPLD devices provide you with cost-effective solutions that retain the traditional CPLD time to market advantage. Today, Xilinx programmable logic devices are employed by a large number of telematic and infotainment product manufacturers who recognize the added flexibility and time to market benefits achievable through the use of programmable logic solutions.

Conclusion

In the future, we expect programmable logic technology will play an even bigger role in automotive applications. This will come as a result of our ability to provide advanced features, such as Internet Reconfigurable Logic. By using IRL, you can build in upgradability and thus, reduce the risk of obsolescence.

For example, you could upgrade your car for the weekend by paying for the engine management system to be "race-tuned" to enhance the performance of your car. This would give you the ability to purchase a "racing car" for the weekend in your standard family vehicle. The engine management system would be reprogrammed via a wireless Internet connection to change the car's personality. At the end of the pre-paid time period, your vehicle would be reprogrammed back to its original settings. This is not just a dream about the future of the in-car environment but a realizable vision enabled by reconfigurable logic.

Car Driver Assistance and Active Safety

Car safety is one of the primary concerns in the automotive industry. Over the years, we have seen the addition of airbags, seat belt pre-tensioners, side impact beams, and other structural enhancements. We are now seeing the emergence of driver assistance systems to augment the more "physical" safety enhancements such as forward collision warning and night vision.

The latest driver assistance enhancement is based around a video-processing system located in the rear view mirror and dashboard of the vehicle. This system processes data from both inside and outside the car. It analyzes any perceived erratic vehicle movements, such as the car leaving the lane if the driver has fallen asleep, and automatically corrects and brings the car to a gentle stop. The system also analyzes outside light levels compared to road conditions, such as curves, and adjusts the headlamp luminosity and direction accordingly. This driver assistance system also measures distance to the car in front, and if an accident is imminent, it will ensure activation of the airbag and braking systems. The distance sensors can also aid when parking your vehicle. Xilinx FPGAs are ideal for implementing complex imaging and fast digital signal processing functions and are already being used in driver assistance systems.