Solution Brief

Intel® Product Technologies

In-Vehicle Infotainment

Reducing In-Vehicle Infotainment System Cost

Advanced Intel® product technologies lower development, product and service costs

Once considered novelties, In-Vehicle Infotainment (IVI) applications have become "must-have" options for many people living in a screen-to-screen world. Today's consumers expect vehicles to be equipped with features such as digital radio, Internet, DVD video and MP3 systems, and GPS navigation. The challenge for the automotive industry is how to address this opportunity seamlessly, quickly and cost-effectively.

Automobile manufacturers and suppliers understand that as the price for IVI system options comes down, customer demand will grow. In order to achieve lower price points, IVI equipment suppliers can leverage the latest computing technologies to reduce development, product and maintenance costs. Helping suppliers achieve these objectives, Intel® processors, chipsets and product technologies deliver many capabilities to provide key benefits, such as:

- **Reducing development cost** by simplifying software consolidation
- **Cutting product cost** by running all functions on a single processor

This solution brief discusses how technologies built into Intel® silicon components improve virtualization and multi-tasking capabilities, thereby enabling equipment suppliers to deliver more cost-effective IVI systems and drive higher sales volumes.

Reducing Development Cost with Virtualization

A significant challenge for IVI equipment suppliers is integrating and testing infotainment software applications that are sourced by various third-party vendors and in-house programmers. Traditionally, IVI systems run a single OS (e.g., real-time, general-purpose or homegrown), and applications written for a different OS must be ported, which can be time-consuming and resource-intensive. Alternatively, IVI equipment suppliers can choose to run multiple OSs and their associated applications in secure partitions using virtualization. This capability allows applications to run unmodified on their native OS, which avoids costly code rewrites and retesting. In addition, secure partitions help safeguard systems against unintended software interactions and outside breaches, thereby increasing platform stability and security.

Virtualization has been around for many years, most notably used in data centers where many applications are consolidated onto a single server. Complementing software-based virtualization solutions, Intel® Virtualization Technology (Intel® VT)[1] improves their performance and robustness and gives software developers greater control over operating systems and applications. This capability facilitates software consolidation, increases real-time performance and improves system stability, as shown in Table 1 and described in the next three sections.

Consolidate Software

IVI systems run a wide variety of applications, such as dashboard controls, cameras for blind-spot detection, audio and video players, and hands-free cell phones. Some of these applications run best on a fast, lightweight OS, whereas other applications benefit from a feature-rich OS like Microsoft Windows* CE. Virtualization enables developers to deploy multiple OSs on one board, which allows ported applications to run on their intended OS, maintain comparable performance and utilize their original development environment.

Increase Real-Time Performance

Many IVI applications have real-time requirements, such as video processing for cameras, communications stacks for phones and video streaming for music and movies. To avoid dropped video frames and voice cutouts, processors with virtualization technology can run these applications on a real-time OS (RTOS) while running other applications on a general-purpose OS (GPOS). Priority can be given to the real-time OS, increasing the speed and ensuring determinism of time-critical applications by giving them preemptive access to hardware resources.

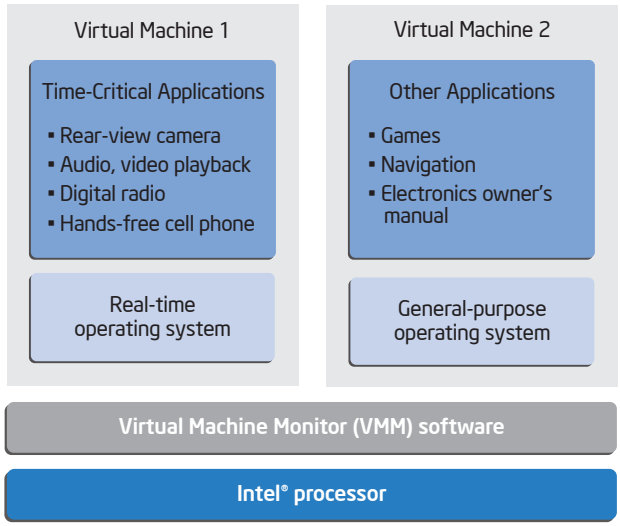

Figure 1. Virtualization Isolates Real-Time Code

Capabilities	Results
Run applications unmodified in secure partitions	Eases software migration and consolidation
Run RTOS on a dedicated processor core	Improves real-time determinism
Prevent unintended code interactions	Increases stability and reliability

Table 1. Intel® Virtualization Technology Capabilities and Benefits

Prevent Unintended Code Interactions

A major challenge facing IVI equipment suppliers is that during certification testing, they must ensure different applications don't interfere with each other. When applications run in secure partitions, labeled virtual machines in Figure 1, their memory space is protected by hardware features in Intel processors and Intel VT. This means software components running in virtual machines only have access to their own code and data regions, which protects their operating environments and provides separation that can improve reliability.

Avoid Rebooting the System

When an application running on an IVI system fails, the only solution may be a hardware reboot, which takes the system offline for a period of time. Using virtualization, developers can implement a software failover mechanism that restarts the software running in one partition without impacting the other partitions. For example, if a video streaming application running in a partition fails, it can be reloaded and restarted without interrupting applications running in other partitions.

It's also possible to deploy an automatic failover mechanism, where the system maintains duplicate copies of an application in two virtual machines and quickly transfers processing to the backup in the event of an application failure.

Cutting Product Cost with Multi-Tasking Processors

A major challenge for IVI developers is to design a system capable of handling diverse workloads while consuming minimal power and board real estate. This can be achieved by using a single processor with significant horsepower and multi-tasking capability, which boosts real-time performance. For example, the Intel® Atom™ processor with Intel® Hyper-Threading Technology (Intel® HT Technology)[2] can process two tasks (or software threads) concurrently, increasing performance by as much as 30 percent.[3]

Intel HT Technology provides separate data paths for two tasks, which means the processor maintains two execution states at the same time. As a result, the CPU will process another task if the task it's executing stalls (e.g., waiting for an I/O device), which eliminates wasteful idle time. The performance improvement derived from Intel HT Technology is illustrated in Figure 2, showing three multi-tasking examples. First, the tasks are executed sequentially, task 1 followed by task 2. Second, the tasks are assigned alternating time slots. These first two examples require about the same amount of time because they both incur significant delays when the CPU must wait for data. Third, Intel HT Technology executes both tasks concurrently, taking advantage of idle time to work on another task and thus reducing overall execution time. The key benefits of Intel HT Technology – performance, power and form factor – are described in Table 2.

Reducing the Cost of IVI Systems

Seeking to reduce IVI system cost in order to expand the market, equipment suppliers should explore the latest Intel product technologies that help to decrease development time, system cost and repair time. By adopting Intel processors and chipsets, IVI developers can benefit from the same established computing technology and ecosystem that already provides consumers with the digital lifestyle they currently enjoy. The "digital car" can be a seamless extension of the services and applications available in homes and offices and what consumers have grown to expect.

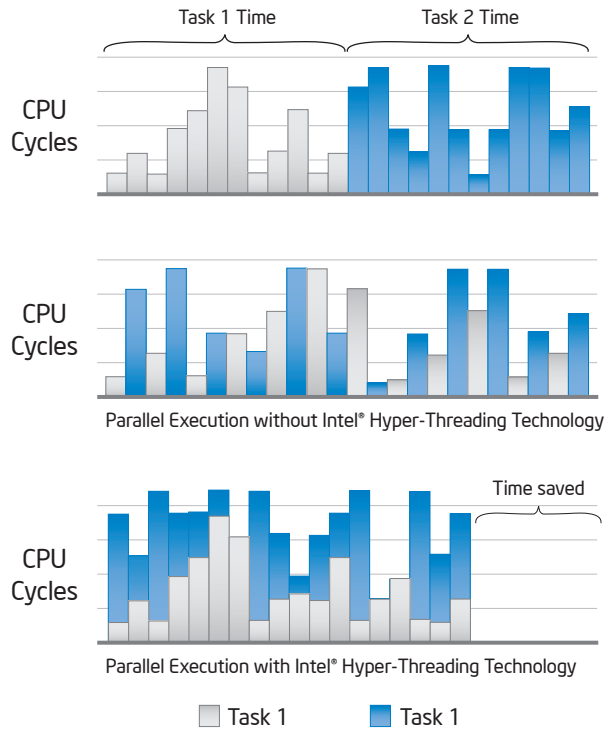

Figure 2. Three Multi-Tasking Examples

Benefits	Results
Two threads execute in parallel	Increases computing capacity by as much as 30 percent[3]
Power consumption remains the same	Provides a power-efficient performance boost
No additional hardware components	Doesn't increase form factor

Table 2. Intel® Hyper-Threading Technology Capabilities and Benefits

For more information on Intel® product technologies, visit www.intel.com/technology/advanced_comm.

To learn more about Intel's solutions for in-vehicle infotainment, please visit www.intel.com/go/infotainment.

[1] Intel® Virtualization Technology requires a computer system with an enabled Intel® processor, BIOS, virtual machine monitor (VMM) and, for some uses, certain platform software enabled for it. Functionality, performance or other benefits will vary depending on hardware and software configurations and may require a BIOS update. Software applications may not be compatible with all operating systems. Please check with your application vendor.

[2] Intel® Hyper-Threading Technology (Intel® HT Technology) requires a computer system with an Intel® processor supporting Intel HT Technology and an Intel HT Technology enabled chipset, BIOS, and operating system. Performance will vary depending on the specific hardware and software you use. See www.intel.com/products/ht/hyperthreading_more.htm for more information including details on which processors support Intel HT Technology.

[3] Performance tests and ratings are measured using specific computer systems and/or components and reflect the approximate performance of Intel® products as measured by those tests. Any difference in system hardware or software design or configuration may affect actual performance. Buyers should consult other sources of information to evaluate the performance of systems or components they are considering purchasing. For more information on performance tests and on the performance of Intel products, visit Intel Performance Benchmark Limitations: www.intel.com/performance/resources/benchmark_limitations.htm

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