Application Note
Intel® Atom™ Processor

An Energy-Efficient Platform for In-Vehicle Infotainment Solutions

Every component in the car affects fuel consumption. Weight obviously has an impact since heavier parts require more energy to move. Perhaps less obvious is the fact that electrical components use fuel too. Even daytime running lights – a seemingly modest safety feature – have been shown in various studies to increase fuel consumption by as much as three percent.

This is a concern for automakers who must balance the demand for fuel-efficient, "green" cars with customer preference for vehicles that are loaded with electronic features, such as infotainment systems. Even though these features consume extra fuel, they add to a car's value and can increase demand and profits.

The task then is to find ways to introduce strong computing performance and rich interactive applications in the car without significantly straining the power budget of the vehicle. Choosing hardware with very low total platform power consumption is important, because the greater the power consumption, the more fuel that will be needed to power the system.

But perhaps a more important consideration than power consumption is something called performance per watt (PPW). Consumers demand features that require strong computing performance, such as integrated navigation, video and graphics displays, voice recognition, and reliable Internet and device connectivity. And it takes a high performance computing system to deliver. It is important then for automakers to seek a hardware platform that offers the maximum PPW, which is a combination of low power consumption *and* high performance.

This application note describes the potential fuel-saving benefits of using a high performing/ultra-low power hardware platform. It also explains how hardware integration and silicon process technology enable Intel to dramatically reduce the power consumption of its processors – and therefore fuel usage in next generation cars.

Table 1 - Sample Platform Configurations

Platform Components	Sample Configuration #1	Sample Configuration #2
Processor/chipset/IOH/Automotive IO	3 watts	4.5 watts
A/V DSP with memory	included	2 watts
External Graphics (including memory)	included	13 watts
Total media processing power requirement	**3 watts**	**19.5 watts**
End-to-end power supply efficiency	75%	75%
Total power required for platform components at 14V	4	26
Fuel-to-electrical power ratio (% fuel consumption difference per 100km, assuming that 150 watts requires 3% of the fuel consumption of the average car)	0.08	0.52

Table 1 shows the power requirements for two sample in-vehicle infotainment platform configurations.

Configuration #1 is a highly integrated platform with video decoding, graphics, and memory controller on a single system-on-a-chip (SoC) solution. This solution can support dual-view and dual-independent displays so that the driver can use the navigation features while passengers concurrently stream Internet applications or watch videos in the rear seat. Total power consumption for this solution is 3 watts.

Configuration #2 is a conventional architecture platform with discrete chips that each require their own power and memory, including a host processor, DSP for audio and video and graphics card. It supports the same features as configuration #1, although it consumes 19.5 watts of power to do so.

Table 2 - Fuel Consumption Estimates

Kilometers/year	25,000
Fuel consumption in liter per 100km	6
Co2 in grams/kilometer	120
Fuel consumption in liters/year	1,500
Fuel savings between configuration #1 and #2 in liters/year (fuel consumption * difference in fuel-to-power ratio / 100)	6.6
Co2 savings between configuration #1 and #2 in grams/kilometer (Co2 in grams/kilometer * difference in fuel-to-power ration / 100)	0.53
Co2 savings over 10 year period in kg (Co2 savings * 25,000km/yr * 10 / 1000)	132

Table 2 illustrates the potential fuel and Co2 savings achieved by using platform configuration #1 versus platform configuration #2.

We assume that it takes approximately three percent of a vehicle's fuel consumption to generate an extra 150 watts of electrical power (see sidebar) for the infotainment system, resulting in a fuel-to-electrical power ratio of 0.08 and 0.52 for configurations #1 and #2 respectively. Using configuration #1 over #2 ultimately translates to a 132kg savings in Co2 over a 10 year period, as seen in Table 2. According to a variety of industry reports, the number of new light vehicle sales is expected to be close to 60 million in 2011. If just 2% of these new vehicles implemented a low-power platform configuration similar to #1, the Co2 savings could approach 158.4 million kg, or 174,000 tons.

The impact on our environment has the potential to be quite significant. Because you need about 67,000 acres of mature, healthy trees to remove that much Co2 from the air each year, choosing low power IVI is like planting trees. In fact, if two percent of the new cars sold in 2011 use a low power platform, you can think of it as if you had planted two trees for every one of them.[1]

Customer Requirements for IVI Systems

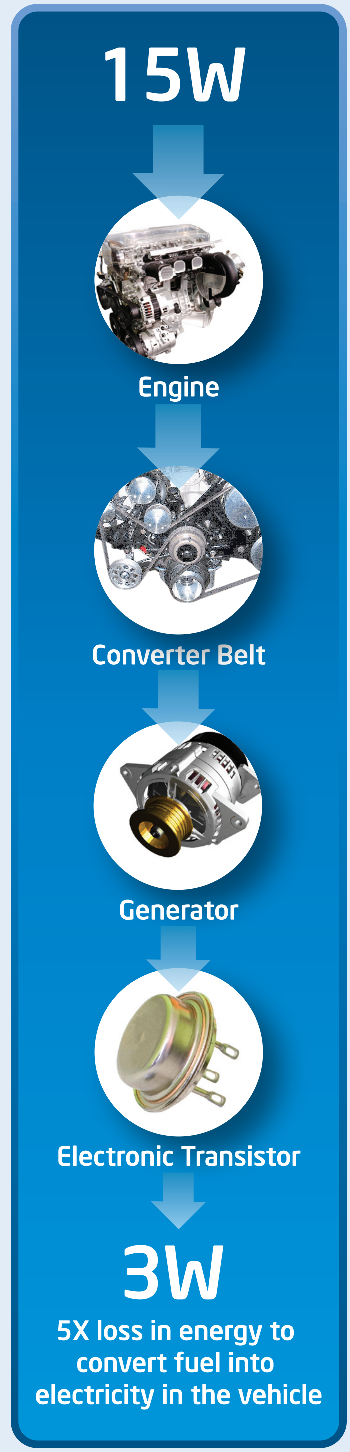
In-vehicle infotainment systems are quickly becoming must-have features in mid-to-high-end cars and trucks. Solutions today include a fairly basic package that provides navigation, video playback, and the ability to connect consumer electronic devices in the car. And consumers are hooked. They want to experience their digital lifestyle in the car, including all of the familiar ways they access personal connections, entertainment, business systems, etc.

Automakers will continue to expand on these demands by delivering future systems that offer a more extensive array of applications using multiple kinds of connectivity including USB, Bluetooth*, external/Internet (3G, Wi-Fi, WiMAX, GPS, etc.), and in-vehicle networks such as CAN*, FlexRay*, MOST* and Ethernet AVB as a multimedia backbone in the vehicle.

Customers too are requiring cars that are greener and more energy efficient. Although they may not comprehend the connection between infotainment systems and fuel consumption, automotive manufacturers can deliver these robust solutions in a more fuel-efficient manner using low-power computing platforms.

From Fuel to Power – a Pricey Conversion

The process of converting chemical energy (fuel) into electricity in the car is expensive and inefficient. This is because the process involves multiple steps where true energy is lost in the transfer. In the first step, chemical energy is converted to kinetic energy, a process that generates unusable heat. This kinetic energy is then transported over a belt driving the generator – and again energy is lost through transfer. As the generator converts the kinetic energy into electricity more power is lost. Then the electricity needs to be down regulated to the different voltages that are used by the electronics. Put simply, it takes 5 watts of chemical power for each watt of power needed to run the vehicle head unit.



[1] October 1, 2009, http://www.coloradotress.org/benefits.htm

Why Intel?

The Intel® Atom™ processor delivers the optimum combination of high performance, low power, and integrated graphics and video capabilities that are needed to power this next generation of in-vehicle infotainment solutions. The Intel Atom processor enables the automotive industry to develop products that incorporate connectivity, up-to-the-minute navigation/location information, radio, and rear-seat entertainment (gaming, DVD, streaming video, satellite TV) in a single integrated system.

Technologies that Reduce Power and Enhance Performance in the Intel® Atom™ Processor

- Intel's hafnium-based 45nm Hi-k metal gate silicon technology reduces power consumption, increases switching speed, and significantly increases transistor density over previous 65nm technology.
- Multiple micro-ops per instruction are combined into a single micro-op and executed in a single cycle, resulting in improved performance and power savings and higher scheduling efficiency.
- In-order execution core consumes less power than out-of-order execution.
- Intel® HyperThreading Technology[2] (available in designated SKUs) provides high performance-per-watt efficiency in an in-order pipeline, increasing system responsiveness in multi-tasking environments. One execution core is seen as two logical processors, and parallel threads are executed on a single core with shared resources.
- New C6 state (Deep Power-Down Technology) removes power from processor core and caches, resulting in less leakage than C4 state. This technology is transparent to the operating system and meets existing mobile C-state exit latencies.
- Split VTT rail removes power from ~90 percent of the I/O, reducing C6 state leakage and achieving a significantly lower idle power.
- CMOS drivers used on many of the FSB signals for lower I/O power consumption.
- Dynamic L2 cache sizing reduces leakage due to transistor sleep mode.
- SSE3 instruction set enables software to accelerate data processing in specific areas, such as complex arithmetic and video decoding.
- Enhanced Intel SpeedStep® technology reduces average system power consumption.

Conclusion

The in-vehicle infotainment system is a game-changer for the automotive industry and a way for automakers and after-market manufacturers to further differentiate their products from competitors. But interesting features aren't the only element to consider; platform performance and power consumption are critical to meeting the "green" standards demanded by consumers today.

Intel leads the silicon industry in the development of ultra-low power computing components, including the Intel Atom processor. Together we're working on the environmentally friendly solutions that are vital to a green future for us all.

[2] Hyper-Threading Technology (HT Technology) requires a computer system with an Intel processor supporting HT Technology, and an HT Technology-enabled chipset, BIOS, and operating system.

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