ADS Helps AutoMARK* Develop Special-Needs Voter Assist Terminal on Intel® Processors

Table of Contents

Executive Summary

Any machine used in the balloting process must match a set of strict requirements. Failure to meet these specifications makes the machine unusable.

Among the requirements of the Help America Vote Act (HAVA) are mandates for accommodating disabled voters, including the mobility and vision impaired, who must be provided the same independent and private voting experience offered to the general population. Also, any U.S. voting precinct with five percent or more non-English speakers must offer ballots in the voter's native tongue, and languages with non-Latin alphabets can present challenges for the design of polling devices. State requirements mandate ballot font size, color, contrast, and the manner in which candidates and propositions are presented. Other mandates require that polling always continue, even during a power failure. Plus, there is an increasing need for a voter-verified paper trail that can be used for recounts.

While compliant polling devices must deliver all of this functionality, cost efficiency is also a major issue, since the purchasers are local and county governments with strict budgetary guidelines. The existence of a large installed base of existing equipment, much of it based on proven and generally acceptable paper ballots and optical readers, creates a barrier to the introduction of alternative devices because volunteers generally need to use any new equipment with little or no training. The variety and severity of the hurdles to adoption of new machines make the business risks very high.

The ES&S and AutoMARK® design satisfies these requirements. The AutoMARK Ballot Marking system allows all voters to produce the same ballot, which can then be verified before dropping into the ballot box. Typically, one or two of these devices will serve the special-needs voters of even a large district. The net effect is a traceable vote in compliance with HAVA and achieved at low cost.

The Business Challenge

ES&S, AutoMARK and Applied Data Systems (ADS) collaborated to supply a ballot marking system that would work with existing paper ballot systems. ES&S would distribute a complete solution and AutoMARK would design and supply the "Voter Assist Terminal" in collaboration with ADS, an associate member of the Intel® Communications Alliance. One or two such voter assist devices at the polling place would meet the requirement to provide physically impaired voters and those who need ballots in languages other than English the same privacy as the general population. Whether the voter has special needs or not, every voter would have an identical paper ballot to drop in the box for tabulation by high-speed optical scanning machines after polls close.

To meet these goals, the ballot-marking machine required many features. It had to display the ballot on a large LCD in virtually any language or alphabet. It needed high-contrast display options for visually impaired voters and audio options for blind voters. The mobility impaired needed a "puff tube" type interface rather than the traditional touch screen. The vision-impaired also needed a Braille keypad. Internal batteries would be required in the event of a power failure at a polling station. Finally, to further improve the voting experience, the ballot-marking equipment needed to be able to receive a full-sized or card-sized paper ballot in any position—up, down, forward, backward, left or right facing.

Solution Overview

The AutoMARK Voter Assist Terminal is a ballot-marking product that allows voters with special needs to mark a paper ballot independently and privately in compliance with the federal Help America Vote Act (HAVA). The AutoMARK design, developed with the help of ADS, is a stand-alone

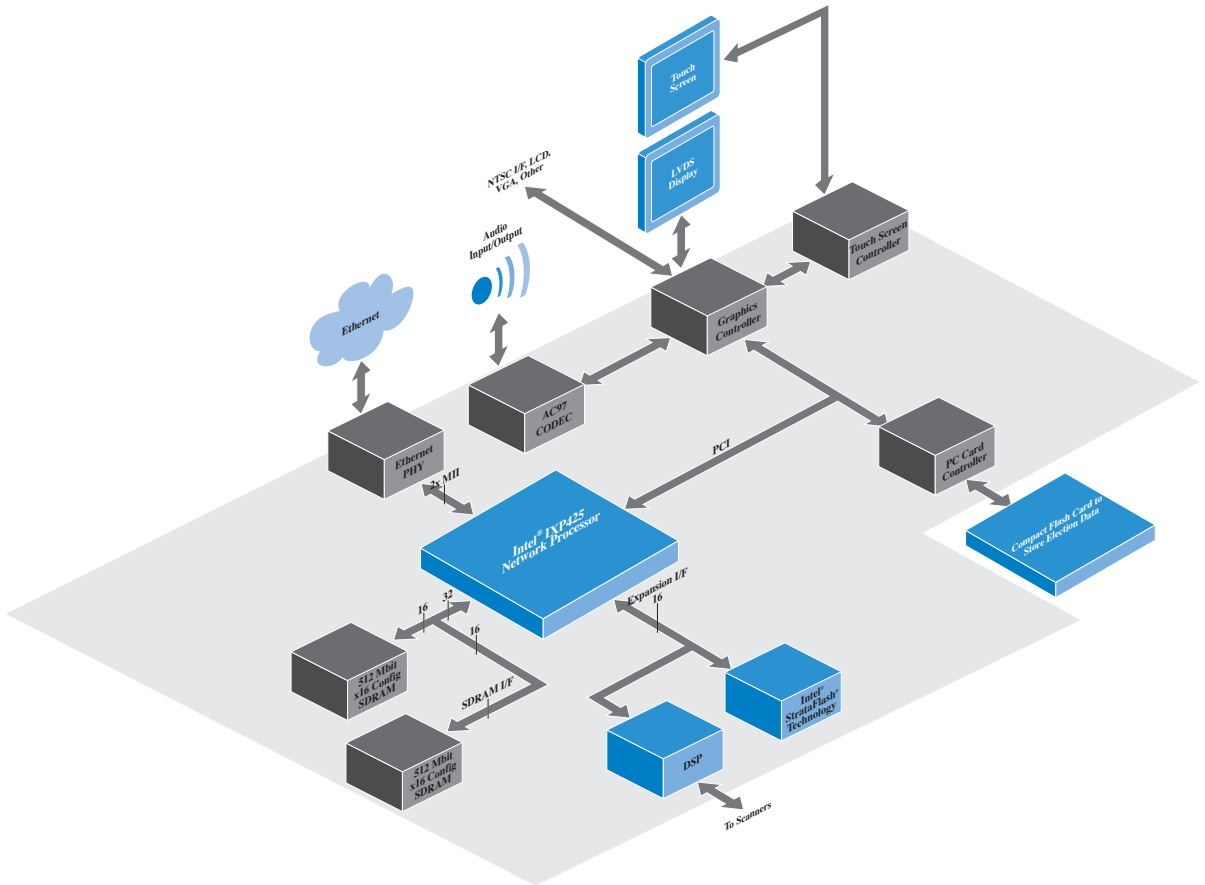

FIGURE 1. *Voter Assist Terminal Block Diagram*

device that relies on the power of the Intel® IXP425 network processor and takes advantage of many key features of the network processor to ensure regulatory compliance and cost efficiency. In one housing the AutoMARK Ballot Marking system contains a ballot reader, a printer, a multi-channel human interface system, and a powerful single-board computer designed by ADS as shown in Figure 1.

The computer extends the power of the Intel IXP425 network processor with both a graphics processor and a digital signal processing (DSP) subsystem. The graphics system supports the full international Unicode font library of Microsoft Windows® CE 5.0. Interaction is provided through an accurate five-wire touch-screen system. For visually impaired voters, the screen allows high-contrast white on black, and for blind voters an audio headset plug and Braille keypad provide interaction without visual cues.

The low-power design can continue operation using internal batteries in the event of a power failure. Low power reduces cost of usage. In addition, the low-power design assures continued functionality even in high temperatures, such as might occur when a power failure interrupts air conditioning at a polling place.

This Voter Assist Terminal runs the Microsoft Windows CE 5.0 embedded operating system on a single-board computer manufactured by ADS. The device is "designed to provide privacy and accessibility to voters who are blind, vision-impaired, or have a disability or condition that would make it difficult or impossible to mark a ballot in the usual way," according to ES&S, a leading supplier of polling equipment. In addition, the technology provides language assistance to voters who are more comfortable speaking a different language or who need help to better understand written instructions.

ADS recently introduced an Intel IXP425-based SBC, based on a 533 MHz Intel IXP425 network processor with Intel XScale® technology. The board includes a Silicon Motion SM501 graphics controller with 24-bit LVDS output that drives the system LCD screen, and an AC 97 audio codec supporting 16-bit stereo input and output. The board also has low power consumption, enabling it to continue running on batteries in the event of a power failure.

The main features of single-board computers include low power consumption and rich multimedia quality and performance. The SDRAM memory controller integrated into the Intel® IXP42X network processor product line supports a 32-bit data bus interface operating at 133 MHz, eight open pages, two external banks with memory configuration from 8 MB to 256 MB. The PCI capabilities include a PCI-to-Card Bus bridge that supports dual 16/32-bit PCMCIA/Card Bus slots, a miniPCI expansion slot, and a PCI port that supports various commercially available expansion cards. From the user interface perspective, the board includes a Silicon Motion SM501 graphics controller for 24-bit color output display (up to UGA) on CRT/TV monitors, and includes a 24-bit LVDS interface, a digital interface for video encoder (zoom video port), and a 4- or 5-wire resistive touch-screen interface. Other input/output ports include high-speed (480 MB) USB ports, dual 10/100 MB Ethernet MACs, a USB client controller, stereo audio and digital GPIO. Onboard synchronous flash memory can be up to 64 MB.

The ADS custom design takes advantage of many important features on the Intel IXP425 network processor, including the expansion bus interface, which is used for getting ballot data from the digital signal processor, and the high-performance PCI interface, which is used for the graphics controller and Card Bus. The product design also consumes little power, enabling the AutoMARK system to continue to run accurately on battery power if there is an electrical power failure. There is a comprehensive set of functions such as multimedia graphics, DSP hosting and HMI features. The system is also optimized for high-speed data communications, accelerated graphics and enhanced networking.

Finally, by incorporating additional hardware into the design, an SM501 graphics processor allows super video graphics array (SVGA) and larger displays at full 24-bit color depth through a low-voltage data signal (LVDS) interface. Stereo audio is supported with an AC97 Codec and the audio capability is a vital part of the product design.

Network Implementation, Technology and/or Architecture

The AutoMARK Ballot Marking system is a stand-alone device that relies on the power of the Intel IXP425 network processor operating at 533 MHz. ADS produces two or three new designs each month, with a majority based on the Intel XScale® technology. The emergence of the Intel IXP42X network processor means that a wider range of applications can be developed for situations where little power may be available.

The typical benefit of a low-power architecture is reduction of heat. This allows the system to be fully enclosed in a plastic or metal container without fans or cooling of any type. A fully loaded Intel IXP42X network processor-based system, with all of its peripheral hardware and drivers in place on the board can be designed within a power budget of a few watts.

An Intel IXP425 network processor-based system with approximately 4-watt power consumption may see its temperature rise less than 10 degrees Fahrenheit. Because the Intel IXP425 network processor is available for extended temperature ranges—to as high as 85 degrees Celsius (185 degrees Fahrenheit)—the Intel IXP425 network processor can be installed and perform in a sealed, uncooled cabinet in virtually any terrestrial environment. The benefit of the IXP425 network processor comes from the highly integrated design available through the 0.18-µm manufacturing semiconductor process technology. This process technology—along with numerous, dedicated-function peripheral interfaces and many features with the Intel XScale core—addresses the needs of many system applications and helps reduce system costs. The processors can be configured to meet many system application and implementation needs.

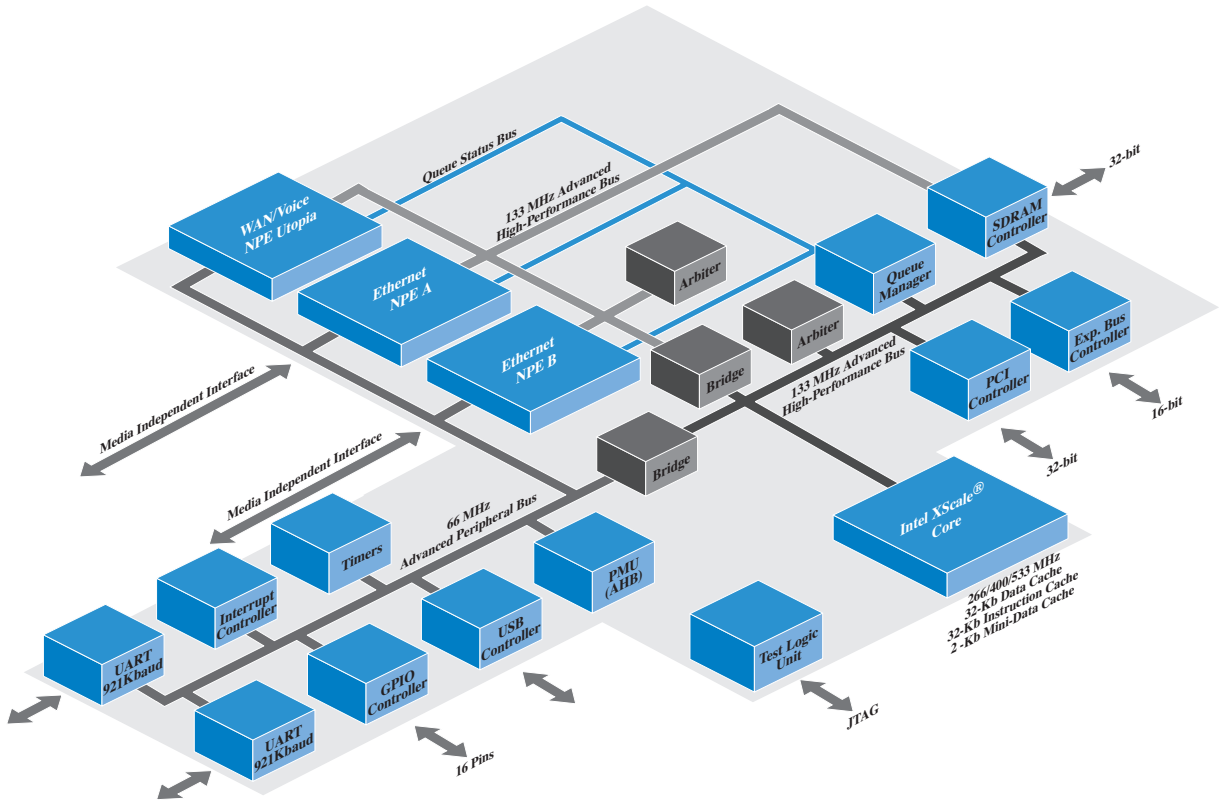

FIGURE 2. *Intel® IXP425 Network Processor*

Network Speed

The Intel IXP42X network processor has the expected configuration for interactive and other protected networks, and with dual Ethernet ports, it is ideally suited to the AutoMARK voting machine solution. The two 10/100baseT ports are each backed by a dedicated on-chip network processor so they can handle full Ethernet load with minimal impact on the CPU. The increased capability helps shrink automation controllers to a palm-sized board that has the equivalent processing power of a desktop PC with dual NIC cards. In another configuration, it could be used as a "dual-ported" thin client.

With an Intel IXP425 network processor, separate and independent network channels can be opened to separate back-end servers, each running a different level of protection software. A system can be devised to prevent any data from one network making its way to the other. This capability adds to the built-in Advanced Encryption Standard (AES) Cryptography module in the Intel IXP42X network processor, which can provide hardware-level security and speed as part of a protected client system. The Intel® IXP4XX processor family brings USB 2.0 and 32-bit Card Bus or PCI to fully embedded, generally low-power systems.

The computer extends the Intel IXP425 network processor power with a graphics processor and a digital signal processing (DSP) subsystem. The graphics system supports the full international Unicode font library of Microsoft Windows CE 5.0. Through an LVDS interface, the system drivers provide a bright, XGA display in portrait mode with full 24-bit color depth. For interaction, it supports an accurate five-wire touch-screen system. For visually impaired voters, the screen can move to a high-contrast mode of white on black, and for blind voters an audio headset plug and Braille keypad allow interaction without visual cues.

The on-board DSP supplies the extra processing power needed to scan the ballot and determine its orientation. The DSP code, specific for each election, is loaded by means of extensions to the Microsoft Windows CE operating system developed by ADS for the Intel IXP425 network processor. The 32-bit data path of the Intel IXP425 network processor makes this process speedy and seamless. The ADS designed computer board also includes a high-fidelity audio Codec and enough memory to support an audio version of the ballot. Finally, an Ethernet network interface is supported to allow loading of ballots during preparation for an election.

This entire system is a low-power design, able to operate on internal batteries in the event of a power failure at the polling place. The computer board includes regulation and smart charging circuits for the lithium ion battery so the charge and discharge process can be managed without attention from the poll workers. Alternative equivalently powerful PC-style processors, or a low-power version of a PC processor, would require larger and more costly batteries and charging circuits to provide the same "ride-through" power backup.

In addition, the low-power design means the device can be housed in a sealed case without vents or fans and still operate at high temperatures, such as might occur when a power failure interrupts the air conditioning at a polling place.

Conclusion

The AutoMARK Ballot Marking system is a stand-alone device built on the power of the Intel IXP425 network processor. This single processor enables the function for this single housing solution which contains a ballot reader, a printer, a multi-channel human interface system, and a powerful single-board computer.

The ADS custom design takes advantage of many important features of the Intel IXP425 network processor, including the expansion bus interface which is used for getting ballot data from the digital signal processor, and the high-performance PCI interface which is used for the graphics controller and Card Bus. The product design also consumes little power, which enables the AutoMARK system to continue to run accurately on battery power if there is an electrical power failure. The system offers a comprehensive set of functions such as multimedia graphics, DSP hosting and HMI features, and it is also optimized for high-speed data communications, accelerated graphics and enhanced networking.

The AutoMARK Ballot Marking system allows all voters to produce the same ballot, which can then be verified before inserting into the ballot box. Typically, one or two of these devices will serve the special-needs voters for even a large voting district. The result is a traceable vote in compliance with HAVA and achieved at low cost.

THE INTEL COMMUNICATIONS ALLIANCE

A Trusted Supply Line for Next-Generation Solutions

Applied Data Systems is associate member of the Intel Communications Alliance, a global community of communications and embedded developers and solutions providers committed to the development of modular, standards-based solutions using Intel technologies. With well over a hundred members worldwide, the alliance is delivering economies of scale to the communications industry, accelerating the development of optimized, multi-vendor solutions based on industry-standard technologies and Intel® communications building blocks.

Alliance members have a close, working relationship with Intel and have demonstrated the high levels of design expertise, research capabilities and manufacturing capacity required to deliver high value to customers in the communications and embedded markets. Combined with Intel's communications and silicon expertise and high-volume manufacturing capabilities, this broad community helps to ensure rapid innovation on a consistent architecture. It also helps to ensure the wide availability of interoperable solutions at every level of integration, so TEMs, carriers and service providers have a trusted supply line for deploying and supporting next-generation services.

ABOUT INTEL CORPORATION

By advancing silicon technologies and driving industry standards, Intel is leading the convergence of computing and communications to provide new ways for people to gain value from technology and transform their world. Intel is meeting the expanding need for innovative, cost-effective and standards-based building blocks in wired and wireless networking and communications infrastructure. Intel's strength in silicon design, integration and high-volume manufacturing delivers high-performance, low-power components at lower costs that provide the flexibility and faster time-to-market demanded by today's communications industry.

ABOUT APPLIED DATA SYSTEMS

Applied Data Systems (ADS), an associate member of the Intel Communications Alliance, designs and produces RISC-based embedded single board computers. These embedded "subsystems" are typically to-order and for applications as specialized and diverse as industrial automation, GPS, fleet management, medical monitoring and POS/kiosk. ADS's embedded systems are "application-ready," with all hardware, low-level software and drivers, and operating system fully integrated, complete to the API. ADS leverages world-class engineering and a deep library of hardware and software "technology building blocks" to provide customers with the precise embedded computer platform their applications require.

ABOUT AUTOMARK TECHNICAL SYSTEMS, LLC

AutoMARK Technical Services is a focused supplier of assistive technology and ballot marking systems for polling applications. They can be reached at 200 W. 22nd Street, Suite 220, Lombard, IL 60148, (630) 916-0030 Office (630) 916-0031 Fax.

For information about the Intel Communications Alliance, visit www.intel.com/go/ica.

For information about the Intel® IXP4XX Network Processor product line, visit www.intel.com/go/networkprocessors.

For information about Applied Data Systems, visit www.applieddata.net.

For information on AutoMARK, visit www.automarkts.com.

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