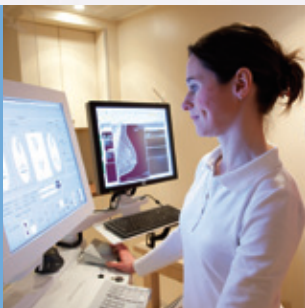## HOSPITALS IN TRANSFORMATION

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# HEALTHCARE IT SOLUTIONS ACCELERATE THE TRANSFORMATION OF HOSPITALS IN ASIA

Increased globalization is allowing the medical industry in Asia to quickly modernize, adopting the latest medical IT technology and significantly improving its healthcare environment. China, with one of the world's highest populations is certainly one of the focuses of this modernization. But, establishing a universal health care system among its 1.34 billion residents, with a rapidly increasing senior population of 178 million people, is an arduous task. Although there already are a huge number of medical facilities (954,389 health institutions including 21,979 hospitals), Chinese medical professionals face difficulties in meeting current demand. As a result, using IT technology to enhance medical efficiency and quality has become one of the most important issues in recent years. According to an IDC report, IT spending in 2011 for the Chinese medical industry was $2.32 billion US dollars, and this number is expected to reach $5.4 billion by 2016.

Recognizing the importance of digitization in health care systems, the Chinese government has proposed four new directives promoting IT development in its 12th Five Year Plan. This proposal includes a grassroots effort to build new and upgrade existing hospital information systems, boost digitization in large hospitals, broaden regional healthcare information platforms across the country, and start construction of a public health information system. Advantech is well-positioned to contribute to China's healthcare development initiative, bringing over 10 years of experience to market, with design capabilities for digital healthcare products that meet international medical safety standards and a combined advantage of local production with nationwide door-to-door service.

We hope you find the content of this edition to be engaging and informative. The cover story is about the transformation of the Asia-Pacific digital healthcare market. In the issue we feature a report from HIMSS Asia, a voice of authority dedicated to improving healthcare through analysis and application of information technology in clinical systems, increasing service levels in hospitals, and enhancing the overall quality of patient care. HIMSS Asia has established an eight-stage (Stages 0 to 7) electronic medical record adoption model (EMRAM) to measure the prevalence of information technology in hospitals. In the Asia-Pacific region, to date, ten hospitals have reached Stage 6 and one Stage 7 on the road to full digitization.

Also in this edition, we have invited Yiqiong Pan, Manager of System Support Department, GE Healthcare, Greater China, to talk about GE's "Healthymagination" plan which is designed to assist the medical information construction initiative in Greater China. We've also invited the Shimane University Hospital from Japan to share its experience in the improvement of medical safety. A special article has been written by Intel® to discuss the integration of Advantech's POC_Link software with Intel® Active Management Technology to provide an advanced mechanism for hospital medical equipment management. We close with a look at the future development of the medical keyboard. ■
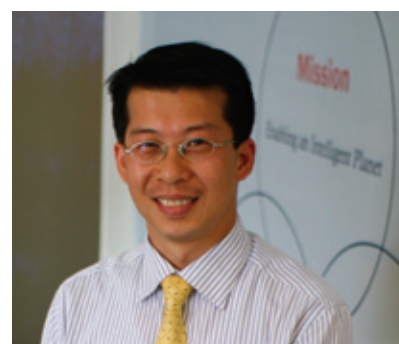
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GE HEALTHCARE'S STRATEGY IN CHINA

The Evolution of Healthcare Informatization

Yiqiong Pan, Manager of System Support Department, GE Healthcare, Greater China

Healthcare informatization includes the digitization, networking and informatization of healthcare services, which means managing information systems and associated data throughout hospital departments. Healthcare informatization was prioritized in China's 2011-2015 Five-Year Plan with the creation of the 3521 Project. The project sets a goal to construct a platform of healthcare information at national, provincial and prefecture city levels to improve the business application of public health, healthcare services, new rural cooperative healthcare systems, basic medicine systems and comprehensive management, as well as building health records and electronic medical records databases along with a special network. GE announced a brand new health initiative strategy in 2009 which will invest $3 billion dollars for healthcare innovation over a 6 year period, providing more people with better service at lower cost. GE also promised to invest $2 billion dollars to finance related programs, and another $1 billion dollars for relevant techniques and content, aiming at advancing information technology and healthcare in rural and impoverished areas. These investments will lay a solid foundation for GE's health initiative strategy, to reduce healthcare cost, improve healthcare quality, and increase healthcare opportunities for hundreds of millions of people around the world.

Accelerating Technology Development of Healthcare Information

GE's health initiative strategy will invest and develop at least 100 innovative techniques by 2015 in which it hopes to see a 15% decrease in healthcare costs and a 15% increase in access to new healthcare technologies and services. Healthcare informatization is a long-term process associated with healthcare reform. As a pioneer practitioner of healthcare informatization in China, GE Healthcare provides general solutions for healthcare information, including three core systems—a healthcare cooperation-based platform, a clinical application system and an integrated information platform. GE understands the issues in the Chinese market through its position of global leadership and its clinical experience.

Establishing regional healthcare centers is the focus of China's new healthcare reform. China's Ministry of Health has divided the country into seven regions of which each will support one to three national comprehensive healthcare centers and one to three national special healthcare centers. The comprehensive centers are the highest-ranked centers of the program while the regional centers will be set up at provincial, prefecture city and county levels. GE's regional healthcare collaboration platform consists of tele-medicine, regional SAAS PACS/RIS systems and healthcare information exchange platforms (HIE). The systems manage healthcare data for radiology, ultrasound, electrocardiogram, pathology, endoscopy, intensive care units and electronic medical records, allowing the safe and rapid sharing of high-quality healthcare information. The platform seamlessly integrates healthcare data, information, diagnosis, treatment procedures and applications for use by authorized staff in hospitals. This results in a decrease in repeated examinations and allows the sharing of healthcare resources among regions, enhancing hospital management and business operation efficiency. Additionally, regional SAAS PACS/RIS systems make PACS/RIS easily available to small healthcare institutions, allowing patients from remote areas to obtain high quality service from experts located in large hospitals via tele-medicine.

GE healthcare information systems enhance clinical applications and data using standardized digital formats. Among them, the electronic medical record (EMR) keeps track of all diagnosis, treatment and examination information, providing healthcare institutions with complete data, warnings and suggestions to support effective clinical decision-making. GE's surgical anesthesia information management system was designed to meet the needs of anesthesiology departments, improving working efficiency, decreasing risk, and reducing workforce requirements. Advantech's experience in digital healthcare augments GE's solutions with advanced research, design and manufacture of reliable platforms. GE's intensive care information system is oriented to the needs of the ICU department in hospitals, including critical care and surgical care units, helping improve diagnosis and treatment quality, provide early warnings, reduce personnel requirements and increase workflow efficiency. GE's CVIT (cardiovascular information technology) cardiac catheter information system helps patients with cardiovascular diseases, storing imagery and managing the entire clinical process. It consists of CV PACS and CVIS. The CV PACS system manages imaging equipment and meets DICOM standards including digital subtraction angiography in cardiac catheterization, echocardiography, intravascular ultrasound (IVUS), cardiovascular CT, cardiovascular MR, and nuclear medicine. It helps personnel make accurate diagnosis and analysis using powerful CA1000 advanced workstations for cardiovascular imaging. CVIS is to register and test patients with cardiovascular diseases, manage ECG reports, and record electrophysiological echocardiography information. It is also used for scheduling surgical appointments, tracking consumables, managing intra-operative events, editing intervention reports, as well as non-imaging data management, including inquiry and statistical analysis for teaching and research.

Hospital asset management is one of the biggest challenges faced today. GE's Asset Plus solution allows staff to obtain information about equipment at any point in time, optimizing assets, greatly improving operating efficiency and leading to an overall reduction in equipment maintenance costs. Mobile application solutions integrate GE applications with mobile hardware solutions such as Advantech's AMiS, mobile nursing cart, which is designed to seamlessly link to existing systems with real-time access of clinical data. This allows staff to be alerted to abnormal conditions in a timely manner and facilitates doctor consultations. GE's quality regulatory platform for mobile healthcare equipment keeps track of equipment based on the latest regulatory requirements released by China's Ministry of Health. GE Healthcare is a pioneer practitioner and global leader of healthcare informatization in China with broad clinical experience. It has a solid understanding of the market and will leverage its position in collaborate with Advantech to research new ways of lowering costs and providing better solutions. By offering the best solutions possible, GE Healthcare and Advantech will help China fulfill the goals of its healthcare informatization. ■

Special applications in clinical departments, virtual consultation centers, imaging platforms, data warehousing, BI intelligent decision-making analysis, clinical data models, hospital information integration, and clinical pathways

Medical data exchange, tele-education, regional medical imaging data center, tele-diagnosis

Healthcare service regulation, emergency operation, disease prevention and control, decision-making support

Hospital collaboration platform

Hospital intelligent solutions

Healthcare service regulatory platform

Informatization Solutions for GE Healthcare's Health Initiative

Family medical care solution

Medical community network

Mobile healthcare, individual healthcare consultant

Family rehabilitation, health consultation, tele care tracking

Medical digital application

Medical internet of things

Resident's health record

Management portal for resident health

Digital clinical department, electronic medical record, integration platform, management platform, etc.

Drug management, vaccine management

ELECTRONIC MEDICAL RECORDS ARE STREAMLINING HEALTHCARE

Mr. Steven Yeo, General Manager of HIMSS Analytics Asia Pacific

Patient medical records are transforming medical care as electronic medical records (EMR) are fast becoming the norm. There is good reason too; hospitals deploying digital technologies will save money, increase safety, reduce risk and provide more efficient care to patients. Incentive payments are being made available to healthcare providers in certain countries that are able to conform to the new technologies by replacing their paper-based medical records with digital equivalents in areas such as PACS, X-ray, administration, medication dispensing, and so on. In the United States, demonstration of a "meaningful use" of EMRs must be shown by 2015 for hospitals to be eligible for payments under the American Recovery and Reinvestment Act of 2009 (ARRA). In order to measure healthcare IT adoption in the acute care setting, the Healthcare Information Management Systems Society (HIMSS) Analytics has devised the EMR Adoption Model (EMRAM), an 8-step process that allows hospitals to track their progress and benchmark against others hospitals. Stage 0 is the starting point and Stage 7 is awarded for full implementation and operating in a paperless environment.

HIMSS, a not-for-profit organization started in 1961, draws experts in the healthcare IT together to disseminate best practices, public policy, and promote technologies that improve the quality, safety, access, and cost-effectiveness of patient care. HIMSS hosts a number of events and conferences in the United States, Europe, Asia Pacific, Middle East and even virtually to provide unparalleled opportunities for networking, learning and experiencing the latest healthcare information technologies.

A Yardstick to Measure Success

The EMR Adoption Model (EMRAM) developed by HIMSS Analytics is an excellent tool for hospitals to measure their progress in building a complete environment for electronic medical record system. The EMR Adoption ModelSM (EMRAM) identifies and scores hospitals using an 8 step scale that charts the path towards a fully digital integrated / paperless environment. Hospitals can track and benchmark their progress relative to the various stages on the model which aids in their strategic planning and healthcare IT investments.

Asia Pacific EMR Adoption ModelSM

Stage	Cumulative Capabilities	2012 Q2	2012 Q3
Stage 7	Complete EMR, CCD transactions to share data; Data warehousing; Data continuity with ED, ambulatory, OP	0.3%	0.2%
Stage 6	Physician documentation (structured templates), full CDSS (variance & compliance), closed loop medication administration	1.9%	2.2%
Stage 5	Full R-PACS	5.1%	4.3%
Stage 4	CPOE, Clinical Decision Support (clinical protocols)	1.9%	2.8%
Stage 3	Nursing/clinical documentation (flow sheets), CDSS (error checking), PACS available outside Radiology	0.0%	0.4%
Stage 2	CDR, Controlled Medical Vocabulary, CDS, may have Document Imaging; HIE capable	29.6%	27.6%
Stage 1	Ancillaries - Lab, Rad, Pharmacy - All Installed	2.2%	3.9%
Stage 0	All Three Ancillaries Not Installed	59.1%	58.6%
Data from HIMSS Analytics® Database ©2012 (Used with permission)		N = 372	N = 464

Digital Healthcare in Asia
China's Stage 6 Hospitals

The EMRAM data is valuable to healthcare planners and facilities worldwide. Hospitals that have achieved stage 6 or 7 in the model are well ahead of the game. Reaching level six is a great indicator of a hospital's commitment to improving safety, minimizing errors, and prioritizing IT implementation of digital healthcare solutions. These healthcare providers have established clear goals, shown measureable implementation plans and serve as examples for others in earlier stages of adoption planning.

In Asia Pacific, there are already a number of hospitals that have achieved Stage 6 in the EMRAM ranking. Three hospitals, located in different provinces in China (Shanxi, Liaoning and Shandong) have also made the grade; the largest one operates around 4,500 beds. Each of these hospitals has implemented solutions where all physician documentation, critical and clinical decision support, PACS, medication administration, nursing documentation, error checking, radiography, document imaging, ancillary support and other capabilities have been fully digitized.

Korea, Home of the First Stage 7 Hospital in Asia

The Seoul National University Bundang Hospital (SNUBH) can be proud of its achievements. It is the first hospital in Asia Pacific to reach Stage 7 recognition. It has achieved all the steps necessary towards reaching a paperless environment. At this level, the hospital enjoys a competitive and quality advantage, as they support real-time sharing, information exchange, and immediate access to patient data, improving process performance, quality of care and patient safety. SNUBH with annual revenues of $275 million, employs 515 physicians, 780 nurses, additional staff of 640, and sees 4,000 patients a day on an outpatient basis. With 8 specialty clinic centers and 23 clinical departments it is the first fully-digitalized hospital in Asia. The hospital has learned important lessons that are of value to other healthcare centers working toward adoption of a full EMR.

According to hospital management at SNUBH, the job of implementing digital healthcare systems is an ongoing process which requires a commitment to continuous improvement, collaboration, strong leadership and flexibility. EMR systems must be patient-centered and this focus should be kept in mind when planning IT platforms. There must be buy-in from hospital management to strategically support IT to realize a successful outcome. System development is best supported through collaboration and involvement of people of different backgrounds to gain the support of end-users and create a user-friendly platform people will actually use. Challenging workflows and efficiencies and building a quality assurance loop into the development cycle will help foster an atmosphere that supports continuous improvements. Finally, flexibility and a willingness to respond to user requests will improve satisfaction and adoption.

Check out a Hospital's EMR Rating before You Check In

Electronic medical records are revolutionizing medical treatment by putting critical decision support systems in the hands of skilled healthcare professionals, giving them the information they need to make timely decisions that save lives. From a patient standpoint, this is comforting news. HIMSS contributes to this transformation by creating a platform to more than 55,000 individual members and over 570 corporate members as well as conference participants around the world to network, discuss and share best practices in digital healthcare. The future of healthcare will only keep getting better with the intelligent application of technology, a patient centered focus and the dedication of skilled medical professionals. ◼

THE SOURCE IS AT YOUR FINGERTIPS

Bacteria-laden Keyboards are a Growing Threat

Clifton Broumand, The Big Cheese, Man & Machine, Inc.

Yours Might Be Breeding Right Now

It is widely understood that computer keyboards play a role in breeding bacteria, fostering the growth of Hospital Acquired Infections (HAIs), including methicillin-resistant staphylococcus aureus (MRSA) and other superbugs.

In fact, computer keyboards are among the five most bacteria-laden surfaces in any office. Left untreated, keyboard bacteria can grow by 30% daily. A study conducted by the Veterans Affairs Medical Center in Washington, DC isolated bacteria from 95% of its keyboards. The keyboards were found to harbor a host of pathogens, including stool organisms and fungi. At least one strain was vancomycin-resistant.

In the Operating Room Today, in Patient Rooms Tomorrow

In many hospitals, computer keyboards are already permanent fixtures throughout the clinical areas. In the OR, ER, ICU, and at nurses' stations, they are constantly in use and touched by the hands of multiple users—doctors, nurses, other medical staff—increasing the likelihood that they will transmit bacteria, blood and other contaminants.

Keyboard technology is moving fast. If current trends in the U.S. continue, computer keyboards will soon become standard equipment in patient rooms. Already on the market are workstations on wheels (WOWs) and wall-mounted units, increasing the number of places where a keyboard is used. When it comes to keyboard contaminants, the philosophy of "bringing technology to the patient" may bring a key source of infection to the patient instead.

As hospital computer usage multiplies, the keyboard's potential to do harm multiplies as well. Every keyboard is a potential carrier of bio-burden and other infectious contaminants.

Medical Records Go Digital

We are quickly reaching the point where all patient medical records, including X-rays, MRIs and CAT scan images, will be stored in digital form. Users, including physicians, nurses and staff, will retrieve, analyze, input and modify these records using a keyboard, mouse, touch pad, touch screen or other means. This will expand viral vulnerability to new generations of user interfaces. Medical organizations around the world are planning for the impact of this new wave of technology, approaching on the near horizon.

In the U.S., the urgency is even greater. Hospitals must comply with federal regulations that mandate electronic medical record-keeping as a condition for their continued receipt of government funds.

Keyboard Evolution

The low-cost keyboards shipped with computers were never intended for clinical environments. Starting in the 1990s, a small, specialized keyboard industry began to serve laboratories, hospitals and manufacturers. Users in these environments needed equipment that could be reliably disinfected.

First Generation

Specialty computer peripheral manufacturers addressed this market by developing keyboards that were water-resistant. Water-resistant keyboards can be rinsed in a sink without damage. However, only the surface of the keys and exterior of the keyboard housing can be disinfected.

Water-resistant or not, an open-style keyboard is still a potential reservoir for infection and contaminants. Disinfectants cannot effectively attack the bio-burden that collects underneath and between the keys or inside the recesses of a keyboard.

Blood and other contaminants get trapped in seams and under keycaps. Blood won't simply rinse out of a water-resistant keyboard, it binds like hardened egg residue. Rinsing alone won't help. Removing blood from inside a keyboard cannot be accomplished except by taking the keyboard apart for cleaning and disinfecting.

Second Generation

A few keyboard companies designed medical keyboards and mice from the ground up to meet the special needs in environments where infection control was imperative. The result of their labor was a fully sealed keyboard made from silicon rubber. Because there are no seams in its housing or between the keys, bio burden cannot accumulate on a sealed keyboard. Fully sealed keyboards can be immersed in soap and water, cleaned with 10% bleach solution, or wiped down with many hospital disinfectants.

Advanced Features

Medical keyboard technology and engineering have now matured. Refinements and extended capabilities are now offered for the second-generation platform. Customers are looking for keyboards that are:

Silent

Customers would like their medical keyboards to be silent. The click of keys can be disruptive and distracting in a patient room or surgical suite.

Illuminated

Individually illuminated keys reduce the degree of disturbance created when a nurse checks on a patient during the third shift. Gentle keyboard backlighting means that the room lights can remain off.

Lockable

A simple keyboard locking mechanism can save time and labor, even reduce capital investment. A keyboard lock prevents any commands or jumbled text from being entered while the keyboard is wiped down with

disinfectant. A locked keyboard and its USB cable do not need to be disturbed; there is no need to call people from the IT department. And there's no need to maintain an inventory of back-up keyboards for use while the primary keyboards are called out of service for disinfecting.

Convenient, with Out-of-the-way Storage

A magnetic attachment system makes the keyboard readily available and just as readily stowed securely out of the way. Dirty double-sided tape and Velcro™, which cannot be disinfected, are a thing of the past.

Hygienic White

A keyboard in white or another light color makes it easy to see blood, splatter and other contaminants that might not be visible on a keyboard of a darker color.

Tactile

Keyboard users are most productive when they are using a keyboard with a familiar touch and responsiveness.

Durable

A well-made keyboard should be durable, withstanding heavy use while remaining clean and fresh-looking.

Value Offering

Medical grade keyboards are critical to your infection control program. The proliferation of technology in the clinical areas of a hospital, and increasingly in patient rooms, calls for a shift in the way medical professionals think of electronic medical record devices like keyboards.

Keyboards designed for the medical environment are more expensive than those intended for consumers or businesses. They should be. It usually does cost more to equip a professional with the right tool for the job. A hospital-quality keyboard—made specifically for a medical environment to inhibit HAIs—represents a sound investment in responsible protection for the health and safety of patients and medical staff. ◾

INTELLIGENT HOSPITAL SYSTEM FOR HEMODIALYSIS

Increases Quality of Service for Chronic Treatment

Everybody wants to make visiting and staying in a hospital as pleasant as possible. Taking care of people with serious illnesses requires many different skills. Employing technology at the point-of-care brings many benefits to patients and caregivers.

Kidney disease and acute renal failure cause kidneys to lose their ability to filter and remove waste and extra fluid from the body. Hemodialysis is a process that uses a man-made semi-permeable membrane (dialyzer) to remove waste from the blood during treatment. Because treatments differ, hemodialysis can be applied temporarily during infection, or long term for cases of serious chronic malfunctioning. Patients undergo hemodialysis frequently, twice a week, hours at a time, or every day in some cases. Blood must be artificially cleaned, but in many clinics during treatment, medical professionals have no access to patient records and data input can be time consuming and laborious.

To address these issues, a medical software company called E.M.A. has developed a proven reliable compact touch panel computer to integrate with their dialysis software solution for La Timone, a famous children's hospital in France. Their goal was to develop:

- An all-in-one touch computer to integrate with their medical software
- The ability to link up with patient medical histories and labs
- An easy to clean and maintain product that conforms to quality medical specification and certifications
- Industrial grade build quality
- Data input at point-of-care in order to insure hyper-efficiency

E.M.A. (Engineering Medical Application) is a medical software company based in Aix-en-Provence, France with more than 20 years experience in the industry. They develop network and software solutions dedicated exclusively to the complete day-to-day management of a dialysis clinic. Their software optimizes the efficient use of each patient's medical record to improve quality and treatment—at point-of-care. E.M.A's solution can directly interface with hospital computer systems to exchange data and synchronize with medical labs for fast results. Caregivers can directly input data such as drug doses and application times which are stored in each patient dossier. This ease of access saves time and helps each medical professional provide their best care.

Professor Michel Tsimaratos MD, PhD of AP-HM Children's Hospital La Timone, Aix-Marseille University, France says, "E.M.A's Hemadialyse systems are used all the time in our Pediatric Nephrology unit. These devices are efficient in improving the quality of service provided to patients suffering from chronic renal failure. Physicians and nurses look forward to the next step that will allow paper free management of medical medical care." With E.M.A's Hemadialyse systems, center managers and medical practitioners can treat patients more efficiently as well as save time—letting staff concentrate on clinical work and administration.

Hemadialyse is a dialysis system product developed by E.M.A. that integrates Advantech's UTC-W101 fanless 10.1" wide touch computer based on the Intel® Atom™ Processor. The product, called Hemabox is based on a customized UTC-W101, upon which their software is installed. Hemabox retrieves each patient software medical record and dialysis monitoring data, and synchronizes and stores them securely with Hemadialyse which manages patient pathology records. One great advantage is that medical staff can view longer patient histories as all data is stored locally on the Hemabox system.

Some of main advantages of using UTC-W101 are: Medical-grade certification EN-60601, ISO 13485 and UL-60601 (essential for export to US and Canada), a 10.1" touchscreen, low power consumption thanks to the Intel architecture inside, elegant design and of course, reliability, based on 500 installations since November 2010. Hemabox is an innovative, all-in-one solution to meet the vast demand emerging from the medical market. Hot keys on the bezel provide instant function access, and the simple and elegant industrial design perfectly blends into medical environment. Another great benefit, highlighted by a survey done in Marseille Hospital, shows that every update done directly on the touchscreen saves 5 minutes per patient.

Jacques-Olivier Tchenio, General Director and co-owner of E.M.A. said, "When we started working with Advantech we had a few other suppliers, however we really appreciated the look and feel of their product, as well the quality of fabrication and easy maintenance. They were able to customize it for us and provide valuable after sales service, Advantech and E.M.A. now have a healthy and a long term professional relationship." ◼

MANAGEABILITY OF COMPUTERIZED MEDICAL EQUIPMENT

Intel® Active Management Technology Facilitates Remote Management

Hospitals today are being transformed into sophisticated medical facilities with computer-based medical equipment and intelligent, connected medical devices. Healthcare facilities are becoming digitized and networked, with a wide array of high-tech medical devices supplying data to a centralized electronic medical record (EMR).

Medical equipment such as diagnostic equipment, laboratory/analytical equipment, drug dispensing carts, computerized physiotherapy, patient infotainment terminals, multi-parameter patient monitoring, endoscopy and Computers-on-Wheels (CoWs) all leverage PC-based architectures and feed data into the EMR, which acts as both a permanent repository for health information and a system that can be accessed instantly by doctors to assist with clinical decisions.

As healthcare providers deploy more technology into hospital settings, remote management of these devices becomes critically important in helping to contain costs, reduce complexity and increase the quality of

healthcare. Intel® remote management technologies, already enabled in management tools in desktop PCs, servers and some tablet PCs, help deliver these benefits across the healthcare enterprise.

These technologies are part of Intel® vPro™ technology with Intel® Active Management Technology (Intel® AMT) and they enable Intel® chipsets to access and control an embedded system even if they are powered off (called out of band management) or in need of repair. This hardware-based feature expands and enhances the ability of healthcare IT to remotely monitor, maintain and repair such medical devices.

Intel AMT-enabled PC platforms improve overall device manageability. Intel works closely with healthcare providers and equipment manufacturers worldwide to effectively integrate these advances into the healthcare information environment. Multiple medical devices installed at different locations can be managed from a central location using standard communication protocols. Minimizing the need to send out repair

teams by diagnosing issues remotely reduces operational and maintenance costs, increasing device utilization by minimizing downtime. Intel AMT also supports a feature called KVM redirection over IP permitting the keyboard, video and mouse of an IT console to control and display the graphical user interface of a device in the field equipped with an Intel vPro technology-enabled platform with integrated Intel® Graphics Technology.

Intel® Active Management Technology: Discover, Heal and Protect

The Intel AMT value proposition for desktop PCs is often summarized as: "discover, heal, protect." Advanced manageability features allow IT staff to query, restore, upgrade, and protect devices remotely, even when they are powered off or experiencing software failures. Remote manageability capabilities are only available in Intel® Core™ vPro™ processors.

- Discover embedded devices, running software, operational status and whether failures can be dealt with remotely.
- Heal to quickly recover from failures. Many on-site trouble tickets are attributable issues that can be resolved through Intel AMT remote manageability.
- Protect with the convergence of manageability and security capabilities. Intel AMT has the ability to continuously check for the presence of security software agents, check for malicious packets, block ports used by suspicious software to disable access to the network, and isolate a system in case it is compromised.

Intel's embedded product line offers a wide range of solutions, such as Intel Core vPro processors, that support Intel AMT OOB solutions. Intel AMT is built into select Intel chipsets and employs a silicon resident management mechanism. This circuitry establishes a new communications channel, using an "out-of-band" link that operates independently of the "in-band" channel of the computing system and provides persistent connectivity. The Intel AMT out-of-band link employs a dedicated manageability engine (ME) that enables control over non-functioning systems. Other Intel AMT elements include a small amount of memory residing in the FLASH device and a firewall with filters supported in the Intel chipset. When the system is functioning properly, the Intel® processor communicates with the Intel® Management Engine (Intel® ME) using manageability service software it runs locally. In contrast, traditional remote management consoles use standard in-band networking, which utilizes the device's operating system, CPU and network drivers. When the network is the problem, or the end system fails after a power surge, or the operating system crashes, not much can be done by in-band remote access software as it has the drawback of relying on the continued operation of many equipment components.

POC-W211 Medical Point of Care Terminal

Advantech is a leader in providing a wide range of certified medical computing systems and services. The company has recently released the POC-W211 Point-of-Care terminal, a medical-grade device with a versatile array of options that fulfill a variety of medical usage cases. These systems and services are being employed in a diverse range of applications ranging from data acquisition to vital signs monitoring devices, Patient Data Management Systems (PDMS) and visualization (X-ray, endoscopy), and they play a critical role in the provision of medical care to patients. These devices are ideal in helping to bring EMR (Electronic Medical Records), PACS (Picture Archiving and Communication System) and CPOE (Computerized Physician Order Entry) to the point-of-care, they are UL60601-1/ EN60601-1 3rd edition compliant, and CE, CCC and FCC Class B-certified. The units are also IP65-certified for dust and water resistance, and easy to clean and maintain using disinfectant cleaners to help prevent bacterial contamination. The POC-W211 runs on the 2.2 GHz Intel® Core™ i7-2655LE processor and chipset, and it is capable of displaying crystal

clear images on its 21.5" wide-screen display. Additional performance can be obtained by enabling Intel® Turbo Boost Technology, which adjusts processor speed for more performance when you need it.

The POC-W211, housed in a slim 6.5 cm casing, weighs 7 kg, accommodates a 5-wire resistive touchscreen for ease of use, and supports many optional features, such as Bluetooth, RFID, WLAN and more. Fanless operation makes it an ideal computerized solution for image-intense medical applications in operating arenas, at bedside, nursing stations or other point-of-care locations within the medical facility.

POC-W211 and Intel® Active Management Technology (Intel® AMT)

As the sheer number and complexity of devices expands, the big challenge facing hospital IT staff is how to integrate, manage and secure these devices. Point-of-Care terminals are typically scattered in many different locations throughout a hospital. Advantech is now offering advanced management capabilities based on Intel AMT, one of the ingredients of Intel vPro technology available in the 2nd generation Intel® Core™ i5 and Intel® Core™ i7 processors, through its POC_Link software suite. The remote computer management software is based on client/server architecture (see Figure 1). It provides POC (Point-of-Care) devices with remote monitoring and management capabilities for critical managed items, including real-time battery capacity, system health, LCD, power and network status updates. POC_Link integrates Intel AMT technology and POC management functions to provide a single management console. It allows staff to manage, monitor, and maintain distributed POC terminals remotely irrespective of where they are located within the hospital. With POC_Link, hospital staff can administer devices more efficiently and provide higher Point-of-Care quality.

Figure 1. POC_link with Intel® AMT
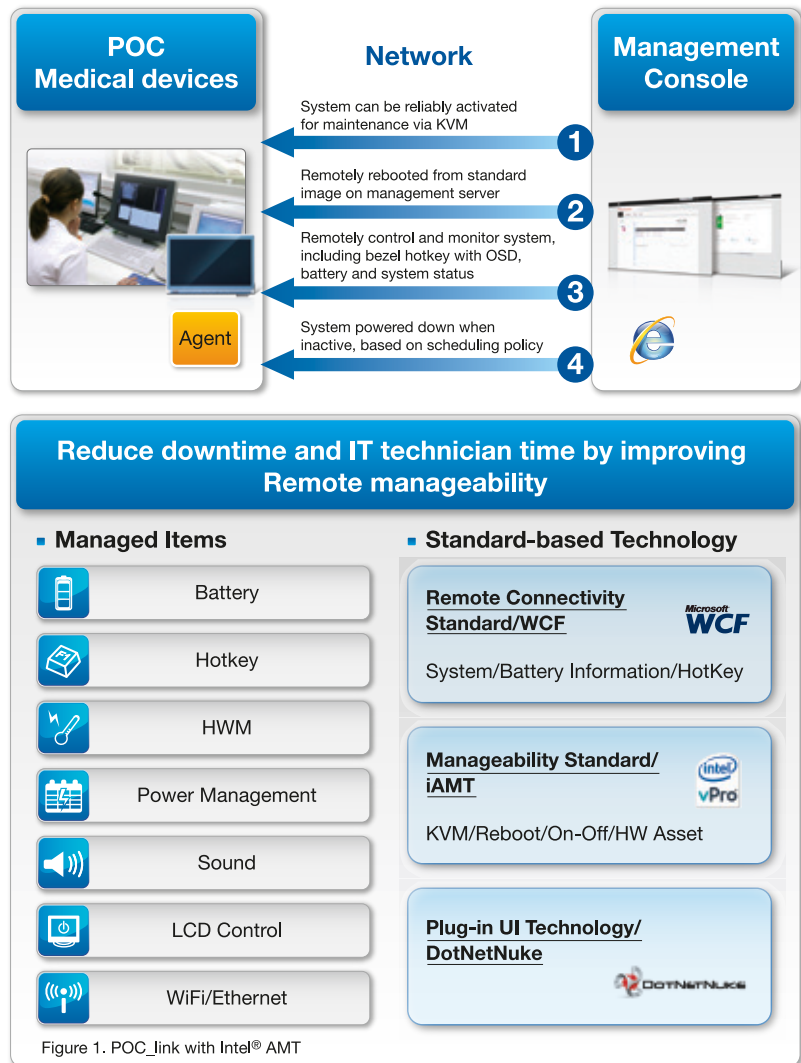
Main Features of POC_Link

POC_Link offers the following features:
- Web-based structure: modularized, OS-log-off data transfer, online service/update.
- Monitor system health: CPU temperature, voltage, battery capacity and remaining time, and network status.
- Discover system information: Hard disk drive (HDD) capacity, BIOS information and system information.
- Manage platform: LCD brightness, power management, volume and hot key control.
- Picture quality evaluation.
- Intel AMT 7.0 capable, which:
  • Enables IT to remotely troubleshoot and repair systems even when they don't boot. Using Intel AMT it is possible to remotely boot a device from a networked drive, called a golden disk, with known good software. IT staff can also remotely

change BIOS settings or reload a driver or OS, whether or not the system is running.
- Provides a reliable mechanism to turn systems on/off, if needed, to save power.
- Allows IT staff to quickly deploy security patches, remotely unlock encrypted drivers and manage data security settings.
- Gives IT staff complete control over a system with keyboard-video-mouse (KVM) remote control.
- Allows remote hardware and software asset tracking.
- Simplify management from a centralized console providing detailed information and allowing the ability to connect and configure remotely.

All in all, POC_Link helps an IT team simplify and streamline actions such as centralized deployment configurations, low-level virus detection and repair, improved uptime, automated power management, and hands-off software distribution and updates.

Simplifying the Manageability of Point-of-Care Devices

The manageability of intelligent distributed embedded systems used in "mission critical" applications is a critical requirement. Point-of-Care terminals are deployed throughout a hospital, such as the operating room (OR), intensive care unit (ICU) and laboratory. They are typically connected to the hospital information system (HIS) network and are essential in ensuring that all information gathered is made available in real-time to the attending healthcare practitioners. Point-of-Care terminals can be either wall-mounted or attached to a mobile cart (or onto an anesthesia device), making remote management even more important.

Advantech's POC_link helps customers maximize their return on investment using technology that provides greater flexibility and enhanced productivity. Apart from utilizing POC_Link, IT staff also has the option of developing their own manageability software. For these kinds of users, Advantech provides WMI and SUSI (Secure & Unified Smart Interface) manageability SDKs. Advantech's WMI and SUSI SDKs help reduce development time and cost, facilitating the needs of customers who want a real-time centralized monitoring and managing system. The SDKs provide a set of user-friendly, intelligent and integrated interfaces, speeding development, enhancing security and offering add-on value for Advantech platforms.

Advantech Digital Healthcare

Advantech is one of the leading suppliers of medical-certified computing systems and services for the medical market. The company has worked with all the prominent medical device OEMs and system integrators and their medical-grade computing systems are essential in helping hospitals provide real-time care in operating rooms, ICUs, exam rooms and wards. Advantech healthcare solutions allow healthcare practitioners to connect to hospital information systems (HIS) at the bedside to assist in patient consultations and treatment. They provide numerous medical systems technologies, such as:

- Point-of-Care Terminals
- Patient Infotainment Terminals
- Mini PCs and Box PCs
- Mobile Clinical Assistants
- Medical Tablets
- Single Board Computers
- Computer on Modules
- Diagnostic displays

Advantech's portfolio includes a diverse range of touchscreen-equipped POC terminals built specifically for the medical environment with a choice of configurations and screen sizes ranging from 10 to 22 inches diagonally.

For seamless integration, Advantech provides an application-ready platform software suite, which helps medical IT departments, application developers and system integrators achieve rapid application development, easy system deployment and smart system management.

For more information about Advantech healthcare solutions, visit www.advantech.com/healthcare. For more information about Intel® healthcare solutions, visit www.intel.com/go/medical. Conor Clancy is a Market Development Manager with Intel's Intelligent Systems Group focusing on the medical segment and can be contacted directly for assistance on medical-related designs: conor.a.clancy@intel.com. ■

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THE RENOVATED CENTRE HOSPITALIER ALPES LÈMAN IS TRÈS CHIC!

Hospitalier Alpes Lèman Undergoes a Facelift

Hospitalier Alpes Lèman Undergoes a Facelift

The Hospital Alpes Léman in Contamine sur Arve, France, serves as premier public hospital in the Geneva area. It was built in 1841 and has a 640 bed capacity. In 2012, hospital planners decided to give the hospital a much needed renovation. The hospital offers the public a complete range of medical and surgical options and the refresh to the facility was centered on digital healthcare. Blending technology with the expertise of the medical staff was a recipe designed to boost efficiency, comply with regulations and increase competence.

Patient-Centered Care Solutions

As hospital staff devised their plans to upgrade they followed a patient-centric approach. Applying technology to areas of the hospital where staff had more access to decision-making tools, where workflows were optimized and where patients reaped the benefits were the goals of the renovation. Hospital management identified key areas where systems were to be built. These include specialized areas such as surgery, endoscopy, recovery room, anesthesiology, as well as administrative systems for patient planning and care, regulatory checklists, prescription management, and room scheduling. The systems would connect hospital administration with operations and ancillary areas such as the hospital pharmacy and dispensaries through interconnected, real-time information systems.

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It All Begins at the Point-of-Care

Point-of-care terminals are the crucial endpoints of a hospital information system. From these terminals, surgeons make critical decisions, anesthesiologists monitor drug levels, administrators manage patients as they move through the system, from room to lab, to operating theater, to recovery and finally to check-out. Every step in the process is choreographed and having an efficient, robust and trusted point-of-care system in place ensures success.

Advantech POC-S197F Is Up to the Challenge

At the Hospital Alpes Léman, staff chose Advantech's POC-S197F Slim Point-of-Care terminals to address their needs. Patrice Sondag, a clinical worker in the hospital's surgical unit was impressed by the selection saying, "POC-S197F can be easily cleaned with the disinfectants used in the hospital, such as Surfa'safe or Surfanios. With its true flat panel, it permits easy and thorough cleaning." Ease of cleanliness and sanitation is certainly one key benefit that can reduce the spread of contaminants and bacteria in the hospital. But POC-S197F brings many other benefits to the hospital as well. It is fanless, allowing it to operate quietly in recovery rooms and areas where silence is required. It has a big 19" flat-panel, crucial for medical imaging applications. At the same time the terminal has a slim profile and it can be wall-mounted on standard VESA mounts with swing-arms allowing the terminals to be stowed. POC-S197F is practical and unobtrusive. The terminals also deploy ergonomic keyboards and mice suspended above worktables to maximize work area, a welcomed feature in nursing stations and administrative areas of the hospital. POC-S197F links all the pieces of hospital workflow together, streamlining them and improving efficiency and accuracy with real-time data access.

What the Renovation Brought to the Hospital

Following the renovation the hospital was able to analyze the project's success. One benefit realized was compliance with regulatory requirements. New legislation is mandating electronic medical records, and the digitization of the hospital's workflow has achieved this goal. Staff performance and productivity have been improved and workflow streamlined and made more efficient. This achieves another goal of the hospital; that of providing better care that is focused on the patient. Better data access reduces the risk of errors, and an easily cleaned device reduces the risk of contaminants. The hospital's decision management capabilities have been improved as well and this is a boon to staff morale.

The System in a Nutshell

Advantech's POC-S197F is a 19" TFT LCD display powered by an Intel® Core™2 Duo (low power) processor. The 1.2 GHz processor is the basis for a powerful system which supports 2 GB of DDR3 memory, and has a full set of I/O connectors (3 USB ports, 2 serial ports, and 2 LAN ports) to meet the hospital's requirements. WiFi and touch panel functions are also available to provide more flexibility, ease data entry, and allow the system to connect to other HIS platforms throughout the hospital. POC-S197F is fanless for quiet operation, saves space and has great ergonomics, and offers flexibility in connectivity and mounting choices. ◼

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INFOTAINMENT MAKES HOSPITAL STAYS ENJOYABLE

Imatis is Changing the Game in Digital Healthcare

Infotainment: A Fast Growing Market Segment

Today's infotainment devices provide multimedia entertainment and communication options to patients and give healthcare providers bedside access to hospital information systems (HIS). Real-time connectivity to back-end information systems has led to tools that allow better patient care and increased data accuracy. Patient entertainment has a positive effect on patient well-being and may even reduce hospital stays. The adoption of the latest digital healthcare technologies also serves as a differentiator in the market where hospitals are subject to the same pressure to compete as other businesses. Infotainment terminals are one nicety that attracts patients both for their entertainment and communication value, and for their clinical application.

Market Leaders Develop Premier Solutions

Imatis is a leading provider of innovative software solutions specifically designed for the healthcare industry—a game-changer in healthcare. Imatis' products focus on providing integrated solutions by connecting people, information, processes, and systems within a healthcare organization. Advantech is well-known for providing industrial-grade, medically-certified digital healthcare solutions, backed by local sales and support, a global manufacturing supply chain, and extensive R & D efforts. Company expertise and alliance with strategic partners like Intel® allow it to stay on top of the latest trends, requirements, and compliance issues in digital healthcare.

When 2+2 is Greater than Four

What do you get when you combine the talents of the best software solutions provider with that of the best hardware platform provider? The answer is: Innovation, Functionality, and Reliability Imatis, the global market leader for infotainment in the healthcare industry, has created Imatis Ludis, an integrated application system which runs on Advantech Patient Infotainment Terminals like the PIT-1502. Recently, they installed 300 of these terminals in St. Olav's University Hospital, in Trondheim, Norway, as part of a technology refresh. The Imatis Ludis software suite runs on PIT-series systems as well as Advantech's Hospital Infotainment (HIT) terminals and digital signage solutions (DSS).

Imatis provided key project management to St. Olav's, working closely with Advantech's global service team and its local support network, as well as coordinating efforts between the healthcare facility and third party installers as needed to deliver a complete solution tailored to the hospital's requirements.

Innovative Solution with Imatis Application Software, Powered by Advantech

Advantech Patient Infotainment terminals were used at St. Olav's. They are ITE and medically dual-certified, providing screen-to-receptacle solutions. Intel® architecture delivers performance with low power consumption and without generating heat. The Intel® processor is designed for high graphics performance, allowing applications to deliver outstanding graphic content. The bedside infotainment terminals are designed with VESA swing-arm mounts and integrated cable management making them easily cleanable and stowable when not in use. In parts of the hospital where aesthetics are important, Advantech's sleek-looking HIT-series terminals, with full-flat front panels and polished finish enclosures host the Imatis Ludus application portal. DSS-series displays complete the solution replacing whiteboards in nursing stations and helping staff manage patient charting on a big-board display. And all the systems are fully connected to back-end systems. The Imatis application portal allows staff the ability to query systems, locate patients and access EMRs from any point in the hospital. Peripherals such as handsets, RFID, Smartcard readers or magnetic stripe readers work seamlessly with the application portal, increasing efficiency, improving accuracy and ensuring safety while at the same time reducing or eliminating paper-based records.

What the Power of Intel® Inside Means to You as an Integrator

Intel®-based platforms allow Advantech to deliver products that support an open development environment. Interoperability allows our partners to develop solutions and deliver them to market quickly and cost-effectively. Open architecture gives our partners access to many third-party solutions already developed for Intel® architecture allowing new and unique usage models without having to reinvent functionality. Intel's compatibility across product generations mitigates

concern about hardware obsolescence and software rewrites: a single design effort will continue to operate in the future and can be scaled up as needed with technology refreshes. As one of Intel's five "Premier Partners" worldwide, Advantech has access to long-term embedded roadmaps, pin-to-pin level design information, and a broader range of embedded processor especially suited to medical environments.

Imatis is Helping Hospitals Transform Themselves

The Imatis Ludus application portal is an innovation in patient-centered, digital healthcare with a host of benefits: It increases hospital efficiency and safety, reduces risk and error, protects privacy with authenticated access, complies with EMR mandates, delivers medically-certified, industrial-grade computing systems, and creates a single point for information and entertainment at patient bedside. It is end-to-end integrated, from cable management, to terminal, to mounting hardware and is fully-supported by both Imatis and Advantech. And it differentiates and attracts patients and creates revenue streams within the hospital. Join the Imatis and Advantech in the Digital Healthcare revolution. Together, they are transforming hospitals and clinics worldwide. ▪

SIMSAFE MEDICAL INSTRUMENT MANAGEMENT AT JAPAN SHIMANE UNIVERSITY HOSPITAL

Improving Safety During Surgery

Why Medical Instrument Management is Important

Medical instrument management is a key safety issue at hospitals worldwide. Without proper controls in place, misplaced instruments can cause big trouble for healthcare providers. Accidents (like leaving instruments inside a patient during surgery) can be costly and potentially life threatening to the patient. Hospitals are looking for and designing management systems that prevent these mistakes from occurring, while at the same time not being so cumbersome as to interfere with the primary duties of surgeons and staff. These important safety issues have already led to legislation in Europe and the United States, and over time will likely become mandatory in medical care facilities worldwide.

Shimane University Hospital Teaches Surgeons Medical Best Practices

At the Shimane University Hospital in Yamato, Japan, medical instrument management is an important part of the hospital's curriculum. The hospital is a large, teaching hospital with a school of medicine, school of nursing, and a medical university. During surgical procedures, the hospital must keep track of its surgical instruments, counting everything from pins to scalpels. The hospital outlined a project to use advanced technology to build a system that would assist in instrument management. The goals were to prevent accidents, increase safety and efficiency, prevent infection and reduce work and medical instrument costs. The system will also capture a vast quantity of data which can bring value to its teaching programs through data mining.

SIMSAFE Application Provides the Solution on Advantech POC-C177 Terminals

The hospital selected Advantech's POC-C177 Point-of-Care terminals to form the cornerstone of its medical instrument management system. The terminals have 17" TFT-LCD displays, and an Intel® Atom™ processor with 1GB of SDRAM. They support a wide range of peripherals, 100 Mbps Ethernet, and touchscreen control, making them extremely flexible. The RFID controller and antenna are attached to a COM port, and the system uses Bluetooth to communicate with a PDA barcode/RFID reader. The system is attached to the hospital's existing infrastructure. Using SIMSAFE, an application designed specifically for instrument management, the hospital can record and store information read directly from RFID tags. This allows staff to keep tabs on where the instruments are located, and ensure there are no mistakes during surgical procedures. The new system tracks pre-op registration and post-op verification to make sure nothing is misplaced.

KRD Corporation's SIMSAFE System

SIMSAFE is the brainchild of KRD Corporation Ltd, a technical solution provider founded in Yamato, Japan in 1991. Their system works by using RFID tags to individually manage surgical instruments. Using SIMSAFE provides the hospital with the ability to trace instruments from start to finish of a procedure. Advantech's POC-C177, an easy-to-use multimedia computer, recognizes and records individual tag data from surgical instruments equipped with a SIMSAFE RFID tag using a reader and antenna. Installed on a mobile medical cart it allows the system to be moved in and out of the surgical environment without getting in the way.

Advantech's medical-grade products have a great reputation which was a key selling point in their selection in the program. Professor Ohira (Ophthalmology), in charge of the central materials department said, "We installed nineteen POC-C177 units in the central materials and surgical operations departments. The operability of the touch panel is excellent, the screen provides high visibility, and it is quiet as well. It is also easily cleaned and water resistant. It really has been the best choice."

Reduced Labor and Increased Safety

As a result of the new program, Shimane University Hospital has seen a reduction in labor, and has found a premier solution to preventing accidents and increasing safety with SIMSAFE's sure-fire management control, working at the "front-line" of medical treatment. The hospital's project has resulted in a reduction to one-third the previous time required for medical instrument management. Workflow and stock efficiency have been optimized. And an added benefit is that staff stress levels have also been reduced.

The installation, marking a milestone as the first of its kind in Japan, went exactly to plan. It can now be taught by Shimane University to up-and-coming medical professionals, and serves as an example of digital healthcare bringing increased safety and efficiency to patients and healthcare service providers. ■

NEW PRODUCT SOLUTIONS FOR THE INTELLIGENT HOSPITAL ON WORLD TOUR

Asia

Advantech showcased exciting computerized medical carts with different configurations during the HIMSS show, held September 17th-19th, 2012, in Singapore. These AMiS computerized medical carts feature hygiene-enhanced design, adopting cutting-edge technology. The different configurations are ideal for emergency departments, OR/ICUs, nursing stations and ambulatory care. Together with a manageable battery system, AMiS computerized medical carts are designed to provide clinicians and doctors with a comfortable, stress-free platform.
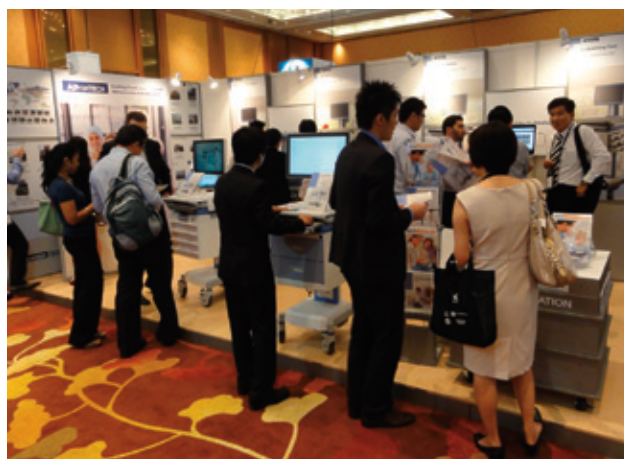
Europe

During the Medica exhibition from held November 14th – 17th, 2012, in Düsseldorf, Germany, Advantech Digital Healthcare showed medical-grade PCs for Critical Care and Patient Care. We launched a new member in the Point-of-Care family, the POC-W211 with IP54 protection. It is a completely sealed 21.5" full-HD LCD computer with Intel® Core™ i7 2.2 GHz processor. It is fanless and has isolated I/O ports and a third-edition EN60601-1/UL60601-1 certification. There is also an ultra-slim & cable-free 18" point-of-care terminal, which is only 5.8 kg and has a slim, 5.6 cm body. For Patient Infotainment Solutions we have a full line up of terminals available from 12 to 22 inches with features like Multitouch screen, RFID, Smart Card reader, WiFi and more. The are equipped with the latest standards such as Microsoft® Windows® 8. If customers prefer their own design, we also offer complete manufacturing services.

Experience our solutions & hospitality at one of our upcoming shows:

Middle East

We will be present at Arab Health in Dubai, UAE, January 28th – January 31st, 2013. You can find us in Hall Zabeel, booth CA35

USA

HIMSS 2013
March 3rd - 7th, 2013, Ernest N. Morial Convention Center, New Orleans. Our booth number is 5457.

FROST & SULLIVAN AWARD

Advantech Named "2012 Company of the Year" in the Medical-Grade PC Market

Frost & Sullivan is well-known for providing market research and analysis, growth strategy consulting and corporate training services. This year, the company presented its best in-class 2012 European Company of the Year award to Advantech for its best-in-class, medical-grade PC products.

Frost & Sullivan uses a stringent ten-step process for its selection of potential recipients, which includes analyzing an industry's challenges and opportunities, establishing weights and criteria for selection, determining best practices, and nominating a top-three candidate list. After candidate selection, performance is ranked on a scale of 1 to 10 for several key factors: growth strategy, growth implementation, product innovation, customer value, and market penetration. Companies must demonstrate excellence in growth and leadership qualities in customer value and market penetration.

Advantech's weighted rating was an impressive 9 out of 10 for its products and services in the medical market in Europe, outperforming competitors in the market in pricing strategies, channel optimization, and consistent delivery of high-performance, high-quality products over the last 5 years.

Even in light of tough economic conditions in Europe,

the Medical-grade PC market projects growth of 35%, and forecasts growth of 50% for the bedside terminal segment. There is also a trend in moving from mobile computers to tablets and MCAs in healthcare facilities as more medical-grade tablets enter the market.

Frost & Sullivan's analysis has identified key success factors to Advantech's approach to the market. Advantech products meet all European standards, including EN-60601 certification, and optimization is due in part to its in-house, ISO-13485-rated manufacturing facilities. In addition, Advantech provides local support, an online eStore, a global distribution network, and is diligent in responding to customer feedback.

These factors have served to differentiate and led to Advantech's strong market leadership position. Constant innovation has led Advantech to deliver a wide range of solutions for EMR, PACS, CPOE, POC, PDMS, and visualization applications. Other innovations include fully-sealed touchscreen interfaces, fanless designs, IP65/NEMA 4 and IPX1 ratings to prevent damage from dust and liquids, and high-performance computing and displays. Connectivity options ensure both wired and wireless connectivity to HIS infrastructures.

Patient safety and comfort is at the forefront of Advantech's medical-grade products, and people-based design makes them easy for clinical staff to use and operate. Advantech is an active market participant in Europe, staying in-tune with needs and changes in the local environment and as a result has become the market leader for medical computing systems in Europe. With a growth rate of about 20% in the market over the last five years, and in response to the criteria set by the Frost & Sullivan analysis, Advantech is proud to be named "2012 Company of the Year" and sees the award as affirmation of its diligent work in striving to deliver the best in-class products and services to the Medical-grade PC market. ■

Trusted Digital Healthcare Solutions to Count On

ADVANTECH

Enabling an Intelligent Planet

Excellence in Strategic Growth, and Customer Value

In the past decade, many medical institutions around the world have benefited from Advantech's Digital Heatlhcare solutions which ensure precise clinical decision-making and facilitate quality care. Advantech solutions effectively boost the quality and safety of healthcare and overall satisfaction of medical treatment. Even better, Advantech provides long-term support for its medical systems; they are highly reliable, easy to install, and seamlessy integrate into new and existing hospital information system infrastructures.

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