Use EMRs to Build an IoT-Enabled, AI-Powered Hospital

A shortage of clinicians, poor patient flow, and a general lack of communication limit the efficiency of today's hospitals. On the one hand, the lack of smooth patient flow is leading to overcrowded hospitals, delays in care delivery, and longer wait times.

On the other hand, the lack of planning and coordination among specialists, medical assistants, and nurse practitioners is causing an increase in the length of the average hospital stay. That's not only costly, it also results in fewer spots for inbound patients.

Then there is poor communication between patients and healthcare providers. A closer look reveals that inefficient communication among healthcare teams is a crucial factor behind poor patient flow and high readmission rates. The Ponemon Institute surveyed more than 400 healthcare providers and found that poor communication is costing the healthcare industry more than $11 billion annually.

Enter electronic medical records (EMRs), sometimes called electronic health records (EHRs). They embody a high-level mechanism for communicating general patient information among healthcare providers like general practitioners, specialists, and pharmacies (Figure 1).

Figure 1. EMRs provide medical staff with general patient information, but could integrate more dynamic, real-time data to transform the healthcare experience.

Enhancing EMRs for the Smart Hospital

While this is a good start towards increasing efficiency, EMRs could be far more effective if they were more detailed, more dynamic, and could be updated in real-time.

Today, EMRs provide a historical profile of patients. But with increased transparency, portability, and accessibility, doctors and nurses can use EMRs as real-time snapshots of a patient's status. This requires that EMRs integrate with the Internet of Medical Things (IoMT).

With the right IoT of security and communications infrastructure, patient location, vitals, and even MRIs or ultrasound images can be streamed wirelessly to mobile panel PCs or monitors used by nurses and doctors (Figure 2). In this connected hospital scenario, healthcare staff can use dynamic EMRs to access the information they need when they need it as patients move from intake to hospital rooms to operating rooms to recovery centers and eventually discharge (Figure 3). This can dramatically improve hospital efficiency.

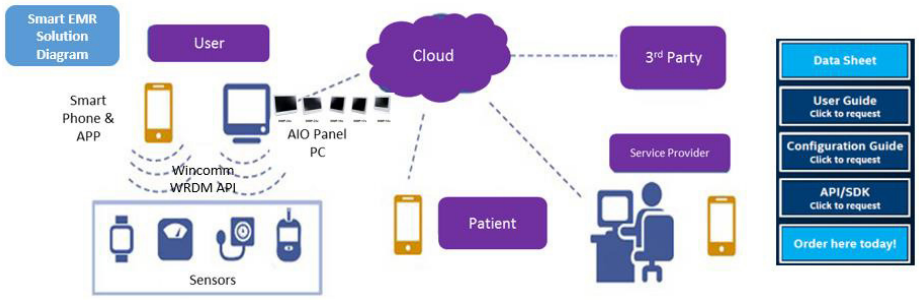

Figure 2. Smart hospital architectures allow data from sensors, lab systems, and other monitoring and measurement devices to be transmitted instantaneously over secure wireless networks.

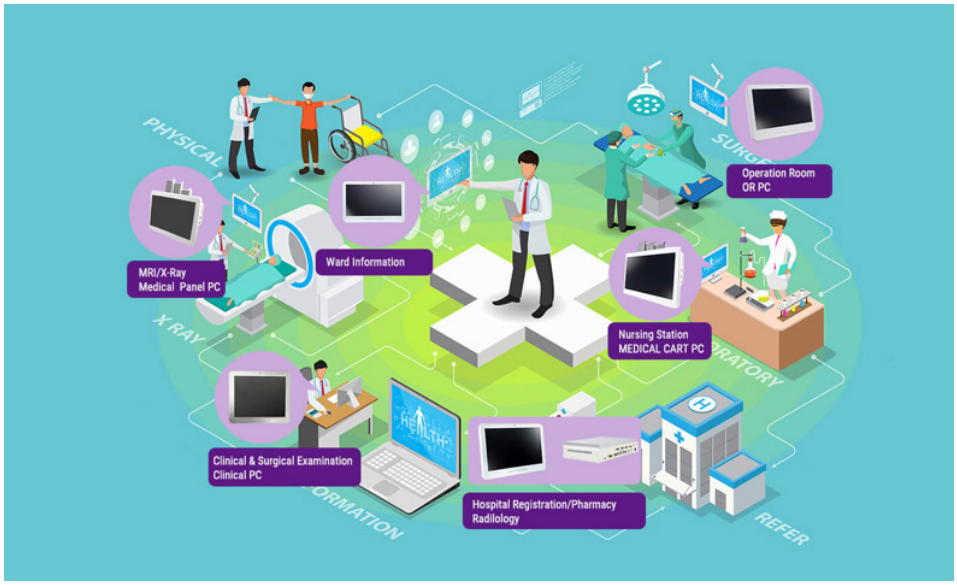

Figure 3. Dynamic electronic medical records (EMRs) can function as real-time documentation covering a patient's lab results, status, and other pertinent information about their stay.

The Advent of AI-enabled Medical Imaging

One significant challenge that must be overcome to realize smart hospital and IoMT deployments based on dynamic EMRs is medical imaging.

Medical imaging is the largest and fastest-growing data source in the healthcare industry, accounting for 90 percent of all healthcare data.

Still, more than 97 percent of it goes unanalyzed or unused. That's because the processing performance, network bandwidth, and sheer time required to scan, process, and analyze these complex renderings is far beyond the technical capabilities of most current healthcare devices.

However, artificial intelligence (AI) has emerged as an instrument that medical device technology providers are using to help smart hospitals overcome the challenges of medical imaging. Sophisticated AI algorithms can analyze imaging records instantaneously to identify cancerous tissue, bone deficiencies, and other physical abnormalities before they are rendered on full-HD screens inside patient rooms and operating rooms.

If connected to the IoMT, this information can also be added to EMRs that are streamed between hospital departments to save time, reduce costs, and improve the efficiency of care (Figure 4).

Figure 4. AI-enabled medical imaging can produce visual representations of patient conditions, which in turn can be added to dynamic electronic medical records.

But advanced, AI-powered imaging applications require a suite of enabling technologies. First and foremost, processors equipped with HD graphics features and hardware-accelerated video encoding/decoding are a must.

These capabilities are available on compute devices like 6th and 7th generation Intel Core processors, which are already being applied in a wide array of medical imaging applications such as ultrasounds, X-rays, MRIs, and CT scans (Figure 5). These scalable processors can efficiently perform deep-learning inferencing and thanks to a hybrid CPU-plus-GPU architecture that supports complex, memory-intensive medical imaging workloads.

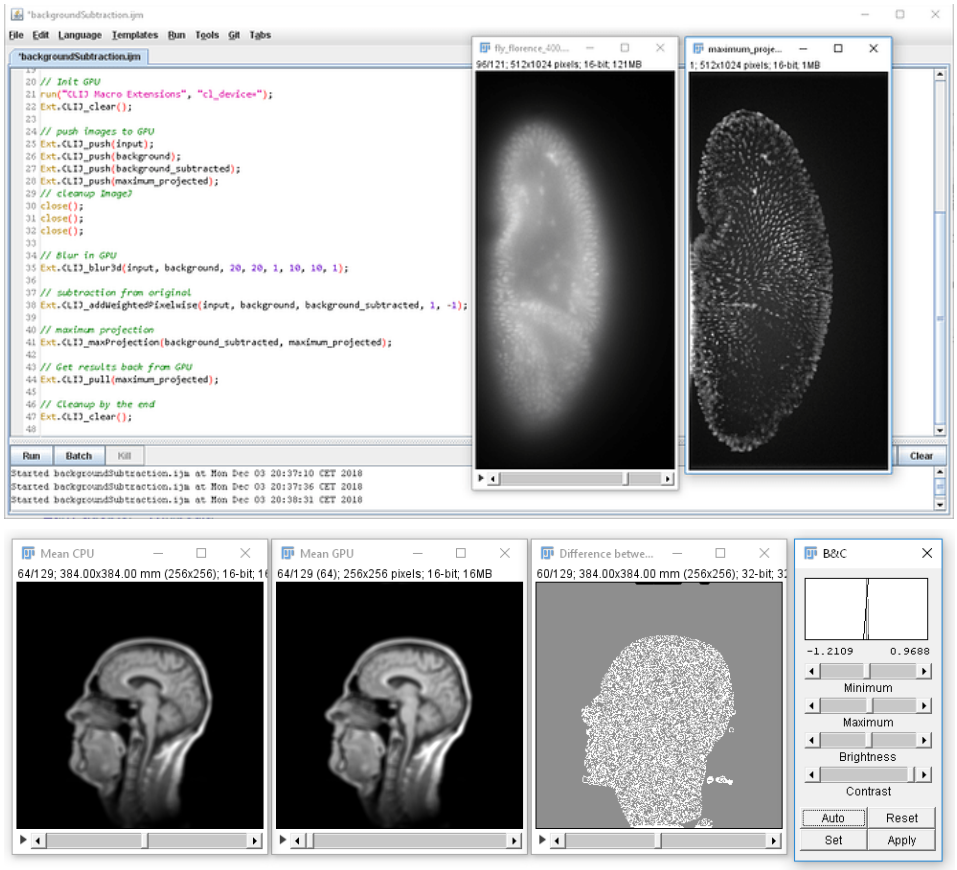

Figure 5. Integrated Intel® HD Graphics on 6th and 7th generation processors make them an optimum performance per watt (PPW) option for medical imaging applications.

Moreover, Intel Core processors are supported by the Intel OpenVINO toolkit, an AI software development framework (Figure 6). The OpenVINO toolkit allows developers to apply neural networks to a range of compute devices, including CPUs with integrated GPUs like 7th generation Intel Core processors. That dramatically improves inference performance by ensuring better processor core utilization.

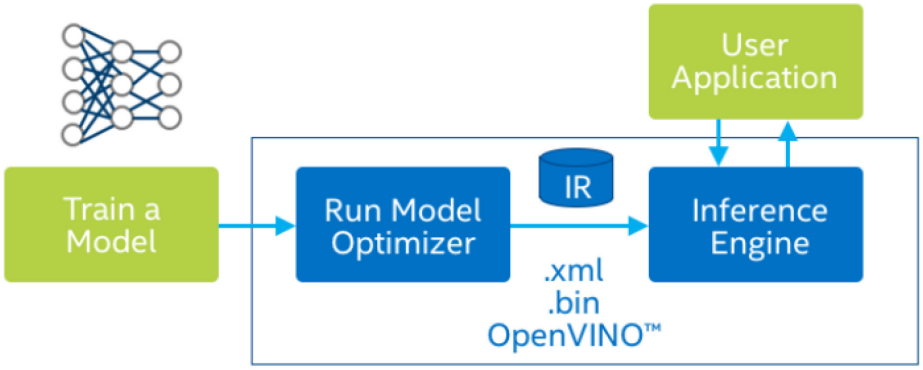

Figure 6. The OpenVINO toolkit complements Intel processors by facilitating the development of AI software for medical imaging.

In conjunction with the OpenVINO toolkit, medical-grade touch panel PCs facilitate convolutional neural network (CNN)-based deep learning inference on the network edge. They also provide an infrastructure platform for the quick, easy, and cost-effective deployment of EMR-driven IoMT hospitals.

The following section will provide a brief description of three medical-grade platforms that can serve as building blocks in the backbone of IoT-enabled smart hospitals.

Medical-grade Panel PCs Meet Industry Requirements, Deliver AIoT Performance

Wincomm is a leading manufacturer of medical touch panel PCs, embedded box PCs, and software products that empower IoMT facilities. And given recent advances processors and development tools, select Wincomm medical device platforms now support AI capabilities as well.

For instance, the company's WMP C, F, G and H series full-HD medical touch-panel PCs were designed from the ground up for deployment in smart hospital environments (Figure 7). The scalable TFT LCD displays range in size from 15" to 24", and offer resolutions of 1366 by 768 up to 4K2K UHD. They even provide optional support for the Digital Imaging and Communications in Medicine (DICOM) standard, which delivers high levels of luminance for clinical-grade examination in operating rooms or at a patient's bedside.

Figure 7. Wincomm C, F, G, and H series medical touch panel PCs are mobile full-HD displays available in a range of sizes.

On the performance front, each system leverages a 6th or 7th generation Intel® Core® i5 or i7 processor, with overall system power consumption as low as 45.5 W. In conjunction with support for the aforementioned Intel® OpenVINO toolkit, 32 GB of memory on all devices and either a 500 GB HDD, 64 GB SSD, or 128 GB SSD make provide more than enough compute horsepower and fast memory/storage for IoMT device data logging or precision medical AI imaging applications.

3D medical imaging-capable MXM graphics cards also takes medical imaging to the next level, and also allow for the integration of peripherals like webcams for live streaming of lab tests or surgical operations.

In terms of I/O, all C, F, G, and H series medical touch panel PCs come standard with DisplayPort, LAN, and USB 3.0 or 3.1 interfaces, with M.2 slots available on select models. These M.2 ports allow for the integration of various wireless modules that support WLAN, 802.11a/b/g/n, Bluetooth, or RFID connectivity that make WMP series platforms easy drop-in additions to any IoMT deployment.

This breadth of wired and wireless connectivity also allows dynamic, real-time EMRs tto be received and rendered directly onto the displays.

Clinical-grade by design

Given the performance and connectivity available on a single, mobile touch panel PC platform, WMP series devices integrate robust signal isolation mechanisms to block noise, reduce interference, and improve the quality of the signal transmission in hospital environments. This is especially critical as smart hospitals experience an increasing amount of electrical, electronic, and RF emissions.

Just as important for medical device OEMs and systems integrators, the C, F, G, and H series medical-grade touch panel PCs are packaged in an IP-65-rated, microbial-resistant anti-MISRA housing, complete with sealed front bezels and a fanless architecture (Figure 8). These features minimize the likely hood of secondary infections that may stem from the platforms, yielding a greater 99 percent reduction in the amount of germs on the devices.

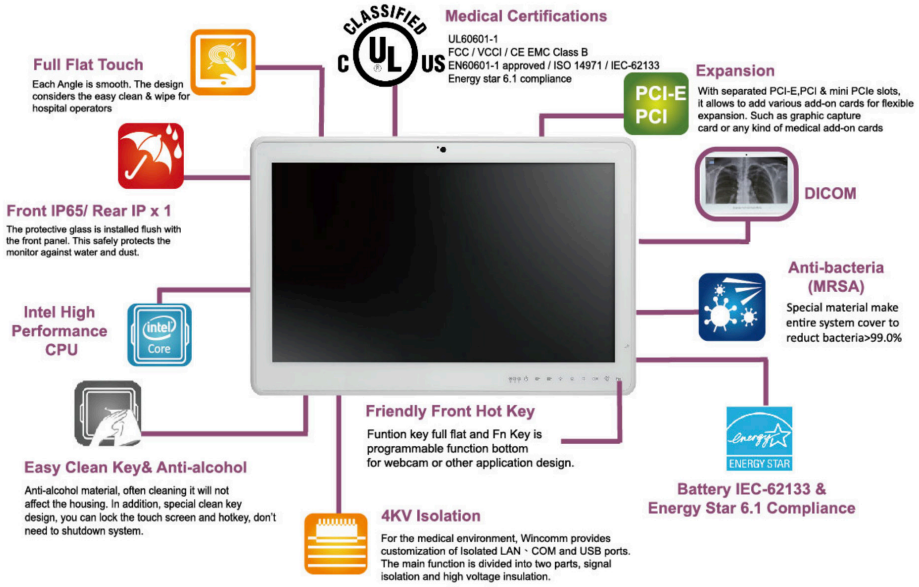

Figure 8. WMP series medical-grade touch panel PCs incorporate a range of design features that make them suitable for high-reliability, germ-resistant, 24/7 operation in smart hospital environments.

The systems also meet numerous industry standards and certifications to ease their deployment in stringent hospital environments, including:

- **IEC-60601-1 certification**, which ensures the safety and essential performance of medical electrical equipment
- **IEC-62133 certification** guarantees the safe operation of portable, Li-ion battery-based devices
- **ISO 14971 certification**, which covers risk management in medical devices including an inherently safe device design, protective measures during manufacturing, and information safety
- **FCC, CE, and VCCI certifications** that ensure proper wireless operation within acceptable RF emissions limits
- **Energy Star compliance**, ensuring efficient power consumption

These features help hospital operators, who manage facilities and equipment that must be operational 24/7, never experience downtime.

Sidebars 1-4 provide a closer look at the unique features of three WMP series medical touch panel PCs.

Sidebar 1 – WMP G Series

G series medical cart panel PCs are based on 7th generation Intel® Core® processors and designed to meet the mobility, connectivity, and processing requirements of healthcare IoT edge networks. Given the significant amount of compute performance, memory, 128 GB SSD, and expansive wireless connectivity options, G series PCs are perfectly suited as sensor hubs that can integrate data from nearby medical devices, perform AI-based image or streaming data analysis, and render EMRs for nearby healthcare professionals.

Figure 9. The integration of hot-swappable batteries makes the G series panel PCs highly suitable for mobile EMR applications.

But a unique feature of G series panel PCs is the presence of three hot-swappable Li-ion batters, which translates into a possible 24/7 runtime and non-stop operation (Figure 9). The hot-swappable battery design also makes them highly suitable for mobile EMR access, mobile surgery units, and patient record updating on nurse carts.

Meanwhile, the fanless design contributes to a quite medical environment that keeps patients rested and calm.

Sidebar 2 – WMP H Series

A sister product line to the G series panel PCs, H series medical imaging PCs also include three hot-swappable batteries that deliver 8-10 hours of power. To optimize the performance, power consumption, and thermal dissipation of its PGA socketed Kaby Lake processor, H series medical imaging devices are flashed with Wincomm's i-Control intelligent management software to ensure reliable, consistent operation regardless of where the devices are being used.

Figure 10. WMP H series medical imaging PCs come with high-end MXM graphics support and are flashed with Wincomm's i-Control Management Software that helps optimize the performance, power consumption, and thermal dissipation of the Kaby Lake host processor.

But as the name suggests, H series medical imaging PCs stand out for their graphical performance. The devices stock MXM graphics cards mentioned earlier, which, combined with the video encode/decode performance of 7th generation Core® processors, allows them to render high-resolution streaming video and images.

This of course makes the H series ideal for deployment on non-powered carts, where they can display patient vitals or detailed medical images as they transit from one hospital department to another or in emergency operating rooms where patient data is needed immediately.

Sidebar 3 – WMP F Series

Next, Wincomm's Intel® Skylake-based F series systems' Wi-Fi plus Bluetooth options to allow access to both hospital network backhaul over Wi-Fi links and direct interface with smaller ad hoc sensors or other edge devices using Bluetooth (Figure 11). Meanwhile, support for the Trusted Platform Module (TPM) 2.0 standard ensures the secure transmission of EMRs to hospital servers.

Figure 11. With 4K2K ultra-HD display options, Wincomm's F series medical touchpanel PCs also support broad connectivity, security, and remote management functionality.

Extending this secure connectivity, F series panel PCs also make use of the Intel vPro feature that enables remote access and control of medical devices even when they arer powered off or going through the maintenance or upgrades. This hardware-based feature means that medical appliance firmware and software can remain up to date without operational disruptions.

Last but not least, multiple display outputs in F series medical-grade PCs allow the system to connect to two external monitors and display up to three images or video feeds simultaneously – and all display outputs are capable of ultra HD 4K resolution.

End-to-End EMRs

Wincomm medical-grade panel PCs work hand-in-hand with the company's Wireless Remote Device Management (WRDM) client-to-server medical IoT software (Figure 13). This clinical-grade IT/OT platform enables medical device OEMs and integrators to orchestrate end-to-end data collection, analysis, storage, and management of dynamic, real-time EMR and IoMT systems in a fashion that is compliant with industry regulations like the Health Insurance Portability and Accountability Act (HIPAA).

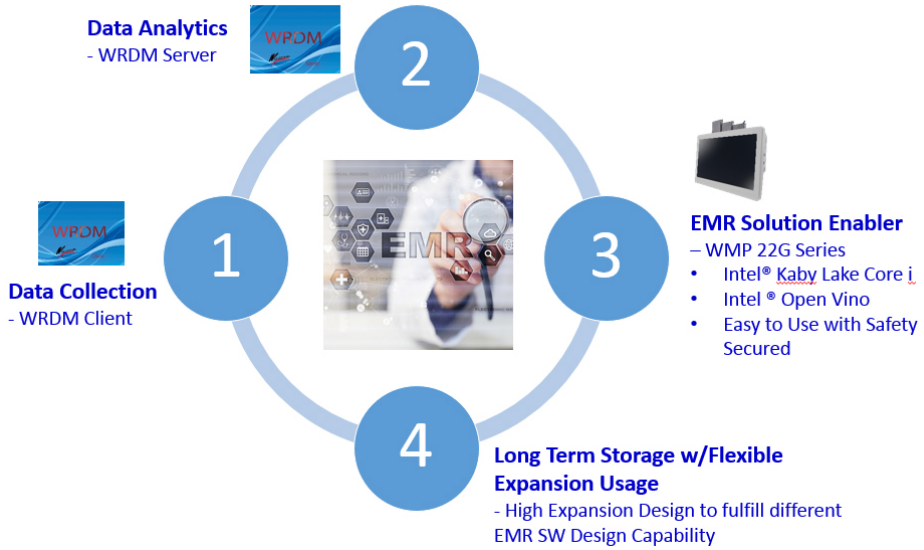

Figure 13. A view of the EMR value chain served by WRDM software on medical panel PCs.

This combination of WMP C, F, G, and H series panel PCs and WRDM software can also be used for AI training and inferencing in on-premise hospital servers in cases where local edge platforms are not capable of supporting the neural networks at the point of care. For instance, a C series panel PC could perform as data filtering and low-level analytics on data as it is acquired, then pass it back into more powerful AI infrastructure for inferencing.

This scenario could be used to support AI inferencing on edge devices, which would feed inferencing results back into hospital servers that actually train the original AI models. The result is a continuous feedback loop that improves the accuracy of neural networks over time in applications like medical imaging.

Sidebar 4 – WMP C Series

Finally, the C series of panel PCs for endoscopic systems comes with a USB 3.1 Gen 2 slot that doubles data transfer speeds to up to 10 Gbps compared to the preceding USB 3.0 slot (Figure 12). This pairs with the CPU and graphics capabilities of the onboard Skylake processors, PCIe [x16] expansion slot, and image capture card, which has led to multiple deployments of the C series in operating room endoscopic systems at European hospitals.

Figure 12. Wincomm's WMP C series touchpanel PCs have achieved a passmark score well above industry average, which helped propel them into deployment as part of endoscopic systems in the operating rooms of European hospitals.

The 15" to 24" panel PCs have achieved the industry passmark score of 7,421, the highest in its class and well above industry averages.

More effective, more efficient care

Imagine a smart hospital where MRIs or ultrasound images can be streamed wirelessly to mobile panel PCs or monitors used by nurses and doctors. And that these images or videos could be decoded and processed by AI algorithms in real-time to detect abnormalities and assist in diagnosis. Or, that neural network algorithms could be applied to live surgical video feeds to immediately identify cancerous tissues or other details of interest and render them on full-HD screens inside operating rooms. Furthermore, that this comprehensive data could be appended to EMRs for future treatment.

Thanks to building block smart EMR solutions for e-Healthcare, this type of precision care is possible today. Advanced medical-class panel PC solutions and device management software allow healthcare providers to seamlessly and securely drop these capabilities into hospital networks. These high-performance, mobile platforms integrate a wide range of wireless technologies, enabling them to serve as both endpoint sensors and gateway controllers for healthcare IoT deployments that make staff more productive and care more cost-effective.

This whitepaper has shown how Wincomm's medical-grade touch-panel can help overcome healthcare industry inefficiencies such as the shortage of clinicians, poorly-managed patient flow, lengthy hospital stays, high readmission rates, and poor communications.

These building blocks constitute a version of healthcare IoT that is based on connected nodes and smart medical software. The building blocks of the smart hospital are already here; they just need to be pieced together.

Wincomm is one of Taiwan's leading manufacturer of medical and industrial computers and related embedded computing products. Wincomm designs and develops all-in-one panel PCs, monitors, rugged box PCs, and embedded software products for a broad range of industries and applications. Wincomm also builds integrated Application-Ready Platforms to enable various IoT solution verticals, such as smart healthcare, smart factory, smart city, and smart transportation.

Founded in 1993, Wincomm is an ISO14001, ISO9001, and ISO13485 certified company. It is headquartered in Science-Base Industrial Park (SBIP), Hsinchu, Taiwan, with overseas sales offices in the USA and Japan.

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