MicroTCA: Just what the doctor ordered

By John Groezinger and Paul Virgo

MicroTCA is predicted to make major inroads into the telecommunications arena, particularly for access applications. A major expectation, though, is that the technology will be adopted across several other major market segments, thereby fulfilling an economies-of-scale proposition that will benefit all applications and make MicroTCA a viable alternative to proprietary designs in cost-sensitive markets.

In this article, John and Paul look at one potential MicroTCA market, the medical and health care industry. Changing dynamics are making a market that has been somewhat successful for CompactPCI an ideal market for MicroTCA.

Background

Worldwide pharmaceutical spending is about $500 billion annually. Another $150 billion is spent on nutriceuticals (herbal and other quasi-medical remedies sold over-the-counter by specialty outlets and Internet sites). Chronic care accounts for 75 percent of all health care spending in the United States, approaching $1 trillion each year[1]. These costs are projected to increase significantly as baby boomers reach retirement age, and an increasingly obese nation experiences heart disease, diabetes, and other diseases associated with a sedentary lifestyle.

Diagnostic modality trends

Reducing capital investment in medical equipment is always welcome, and can be aided by building systems around open standard platforms that provide cost reduction through economies of scale and competitive pressures. However, the bigger challenge is to reduce operating expenses by increasing the efficiency with which services are offered. This translates to making equipment more portable, with higher compute density (MIPS per watt), increased scalability to support smaller served markets, greater flexibility, availability, and serviceability, and providing the broadband connectivity to support a decentralized distributed network of equipment that, to borrow terminology from the telecom industry, brings a wealth of services to the last mile, or last few miles anyway, of the patient location.

In the health care industry, the pendulum is swinging from low-margin/low-value diagnostics and high-margin/high-value drugs to the complete opposite. Leading drug companies have seen their companies devalued due to competition from generic drugmakers and failure to adequately contain costs. High-value/high-margin diagnostic modalities and advances in human genetics will usher in new treatment paradigms that utilize specialized drugs that are closely monitored and managed, improving outcomes and reducing costs.

MicroTCA can capitalize on high-value/high-margin diagnositic modalities. The paradigm shift is visible in GE Healthcare's vision to move from *Late Disease* care to *Early Health* by driving the industry to utilize comprehensive diagnostics and specific therapies before symptoms occur, resulting in higher clinical efficacy and efficiency. Likewise, Siemens Medical Solutions has said, "We are moving from treating illness to treating patients," which translates into demand creation for broadly based diagnostic modalities[2].

These and other health care industry leaders are pursuing the theory that costs for chronic care will decrease and patient health will improve if molecular imaging technologies detect diseases before symptoms occur. Molecular imaging can also be used to predict a drug's efficacy, help prevent Adverse Drug Reactions (ADRs), and determine safety margins for new drugs. Again, this will accelerate demand for high-end diagnostic modalities to levels never seen before.

Enter a new term, *theranostics*, which refers to tailoring generic therapeutic pharmaceuticals by utilizing diagnostic functional imaging techniques. Using scanning technology such as functional Magnetic Resonance Imaging scanners (fMRI), new drugs can be designed, therapy monitored, and patient care improved by working at the molecular level before symptoms appear. This trend will increase the need for new scanners of all types, including radiology technologies for diagnosis, as well as technologies for monitoring therapies. Pharmaceutical companies consider this *Disruptive Technology* vital for drug discovery and as a way to offset a significant portion of the typical $1-2 billion development cost per new drug[3].

Problems in the modalities

Leading-edge technology continues to create new applications (read reimbursable procedures) for advanced scanners such as Positron Emission Tomography/Computed Tomography (PET/CT) to diagnose epilepsy and dementia (for example, Alzheimer's disease). An aging global population along with the need to reduce chronic care costs of pharmaceuticals will drive increased demand for advanced scanners to more effectively, that is, economically, deploy health care at earlier stages of disease. As the cost of diagnostic equipment decreases, it becomes more practical to install equipment outside the hospital at clinics and laboratories, which operate under a much more stringent cost model. Performance, patient throughput, and relative expense make up the principal feature set driving secondary equipment acquisition. This growing market coupled with developing world medical expenditures drives a high-performance, compute-dense, and cost-effective base system model such as MicroTCA. Thus, the industry growth of 10-15 percent is likely to accelerate and drive the need for more embedded and integrated computing platforms such as µTCA. Figure 1 depicts a hospital network centric diagnostic imaging system for health care.

Slice wars

The slice wars continue with 64 MultiSlice CT (MSCT) scanners considered to be flagship products and 16 MSCT rapidly

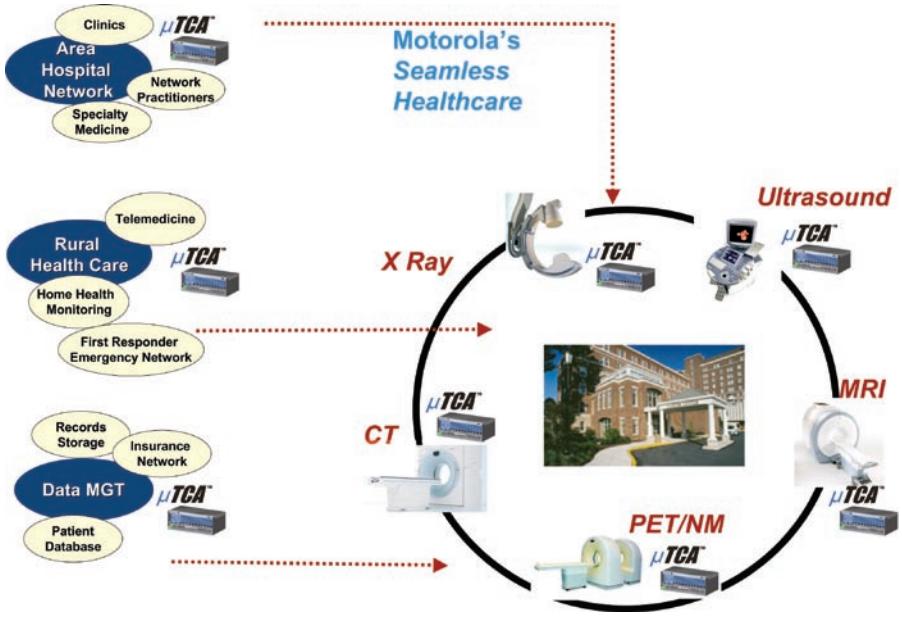

Figure 1

becoming outdated. The 64 slice scanners are enabling coronary CT Angiography (CTA), or CT Colonoscopy (CTC) applications. These procedures have higher diagnostic accuracy at reduced cost and increased patient comfort. As a consequence, 64 slice scanners will replace diagnostic coronary angiography and colonoscopy screening in the future. CTA is also proving to be a more effective ER triage tool than traditional Electrocardiogram (ECG) and enzyme markers techniques in determining whether chest pain is due to acute cardiac syndrome.

Dual Source CT, another leading-edge technology, provides increased speed and accuracy while addressing the concern regarding MSCT by reducing patient exposure to electromagnetic energy. CT systems are generating image data that is growing at an exponential rate, requiring higher scalability compute platforms such as MicroTCA. In addition, imaging applications such as CT and PET/NM are being combined to enhance multiple diagnostic throughputs at lower cost points. These *hybrid* devices – coupled with the implementation of 64 MSCT and Dual Source CT scanners – will drive a convergence of modular imaging functions into a common base platform. MicroTCA is the common thread that will allow these massive imaging and data intensive applications to attain the next level of integration in health care.

MicroTCA is embracing the requirements for higher power processors with 60 W per module available. Deploying modules with embedded processors results in the maximum processor per the physical volume the system occupies, thereby reducing the medial system footprint. Ten payload slots are available per system for processing, I/O, or third-party modules. The performance increase results in a huge reduction in recon and more time for patient procedures.

PET nuclear medicine

Through molecular imaging, PET/CT has been shown to provide early detection of brain disease, such as Alzheimer's, Parkinson's, and Lewy Body Disease (LBD). Statistics show that 10 percent of the North American population will suffer from some form of dementia between the ages of 78-84. This increases to 25 percent between the ages of 85 and 92[4]. By screening for these diseases, it is anticipated that care will be more cost effective and the disease less debilitating. This will drive demand for these high-end ($2 million and up) scanners. MicroTCA can help here, too.

Due to the *integrated* nature of PET/CT, OEMs are faced with integrating operator consoles running on Linux workstations (system #1), the CT image processing platform (system #2), and the positron detection platform (system #3) to create one cost-efficient modality. Typically, a high-speed, low-latency 100 Mb serial connection (other than Ethernet) between these systems is required, resulting in additional hardware and cost. MicroTCA delivers an embedded platform with Linux running on Intel architecture processors for console functionality. In the basic connection, two x2 PCI Express (PCIe) full duplex links will interconnect image processing cards at 1 GBps each. The extended connection can be used to obtain two more x2 PCIe links. Gigabit Ethernet (moving to 10 Gigabit Ethernet) interconnects everything in the same chassis, resulting in less equipment to manufacture, install, and service.

The Intelligent Chassis Management Bus (ICMB) in conjunction with software (such as Motorola Basic Blade Services software) allows intelligent reporting of system configuration and events to an internal system manager. This mechanism provides an orderly power up and health check of all processing functions. Clogged filters resulting in system downtime and increased costs can be prevented since elevated temperatures are reported before damage can occur. Front serviceability makes field upgrading modules easy. And the same manager will quickly re-inventory and reconfigure the platform when the customer purchases new diagnostic applications to field upgrade their existing equipment. All of this results in lower service cost for OEMs and higher uptime for end users.

New MRI applications

Applications including fMRI and high field (3Tesla) systems provide increased diagnostic accuracy for MR Angiography (MRA) as compared to Digital Subtraction Angiography without the use of ionizing radiation. In addition, multichannel and parallel sensing techniques, such as SENSE or SMASH, enable 10-second scan times for trauma applications. Therefore, additional techniques must be used to achieve reductions in scan times. All of this depends on embedded computing platforms, such as MicroTCA.

Building an MRI system that makes use of multiple channels and parallel sensing techniques typically requires integration of a wide variety of processing cards interconnected with a low-latency communication network. With MicroTCA,

the communication network is integral to the architecture. The MicroTCA specification allows for 16 communication ports each per 12 modules resulting in 192 ports for data transmission. These ports talk to a MicroTCA Carrier Hub (MCH) switch, which may be reconfigured as platforms are upgraded. This high-speed network can result in PCI Express links as fast as x16 8 GBps, which are nonblocking through the fabric switch.

And the platform is deployable with a wide variety of options, ranging from a low cost of entry solution with just a few slots to a multiple chassis solution. Consider the possibility of creating a remote image reconstruction console that is based on exactly the same MicroTCA technology as the MRI console, but located next to the radiologist. MicroTCA is small and scalable enough to be deployed for remote reading of images. Its size also allows it to be buried within the imaging device itself.

Ultrasound

Due to the rapid evolution in this market segment, many of the traditional ultrasound applications are being challenged or superseded by the advanced functional imaging technologies described earlier. While far from obsolete, ultrasound equipment providers will have to respond to this competitive pressure by focusing on markets that offer leaner margins, such as small practices, home health care, and developing world health care infrastructure, which require smaller, more portable systems and cost-optimized technologies. These are two of the essential value propositions of MicroTCA. Packaging such as PICO and the cube, coupled with performance and cost advantages, extend MicroTCA far beyond today's platforms with similar base technology.

Utilization of MicroTCA in very small form factors allows for the use of the same console technology that is being used in other modalities but with small, bolt-on firewall packaging. Even in small, cost-effective platforms, the platform has high processing power: The capability to integrate third-party cards and draw on the technology that is being created for other markets at cost-effective price points. Typical ultrasound modalities need graphics and sound processing, which will be available from the ecosystem that is being created by MicroTCA.

X ray

That old standby, the X ray, is also seeing changes that bring new life. Film-based systems are migrating to full digital detector systems, often incorporating features for computer aided diagnosis. These digital modalities require processing and consoles that provide the same look and feel of the other modalities found at health care providers. These include a wide variety of applications, such as vascular, fluoroscopy, and mammography.

Utilizing solutions (such as integrated consoles and image processing cards) already developed for other modalities enables a cost-effective platform development. MicroTCA application platforms provide upwards and downwards scalability while retaining a common communications infrastructure and Serial ATA storage technologies. The very fine level of granularity allows for insertion of new technologies and creates future cost reduction opportunities. This drives a much more flexible scaling model that is well suited to the ever increasing and dynamic nature of these diagnostic imaging modalities.

Health care physical for MicroTCA

MicroTCA has benefitted from the lessons learned from CompactPCI and AdvancedTCA in terms of building a modular/scalable, communications-centric, price/performance-sensitive architecture. Add to that value proposition the opportunity for commoditization through volumes more akin to enterprise applications, and we have a serious contender in the race to build a unified medical equipment platform strategy – a singular platform foundation for all modalities.

Until the advent of MicroTCA, a base platform has not been available to address all modalities. With the emergence of MicroTCA, medical OEMs can now start to realize their collective goals of applying a base foundation technology that addresses urgent health care economic issues while supporting the profound diagnostic advances required to revolutionize health care.

MicroTCA will enable the medical OEMs to provide theranostics and diagnostic preventative health care solutions for today, tomorrow, and beyond, ensuring it a healthy future and long life in medical diagnostics.

References

[1] Steve Burrill, Burrill & Co., Medical Alley Conference, October 5, 2005, Minneapolis

[2] Michael Reitermann, President, Molecular Imaging Division, RSNA 2005

[3] Steve Burrill, Burrill & Co., Medical Alley Conference, October 5, 2005, Minneapolis

[4] Heertum & Minoshima, MDs, RSNA 2005

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