In a world of shrinking budgets and rising rates of chronic disease, health information exchanges (HIEs) are an essential element of national and regional efforts to improve healthcare and contain costs. HIEs establish an interoperable framework for healthcare providers to share secure patient information across disparate electronic health record (EHR) platforms and other information systems.

Informatics Corporation of America (ICA) is a leader in the push to make HIEs a practical and powerful reality. ICA has deep clinical roots at Vanderbilt Medical Center, and its CareAlign* suite of software-as-a-service (SaaS) health IT tools and CareAlign Exchange* HIE combine ease of use with advanced capabilities for physicians, hospitals, health agencies, and other healthcare stakeholders.

CareAlign Exchange aggregates data from diverse EHRs within a medical community, converts the data to actionable information, and makes it securely available to authorized participants of the community. For example, when a person is admitted to the emergency room, doctors can access the patient’s most up-to-date medical history and information to help them develop a personalized treatment plan while avoiding duplicate tests and procedures. Using a growing set of analytics, CareAlign Exchange can integrate results in near-real time back into the contributing EHRs, presenting data and information via dashboards, alerts, and other mechanisms.

ICA’s focus on real-time transaction processing can help give all authorized members of the patient’s treatment team secure access to the latest clinical data, which can be critical in many fast-moving medical situations. In addition to facilitating more coordinated, collaborative care, ICA’s CareAlign suite can assist healthcare organizations in tasks ranging from tracking the spread of communicable diseases to qualifying for performance-based incentives.

“I have those Intel® AES-NI instructions in the Intel® chipset makes encryption less costly in terms of processing power. That’s the bottom line. When encryption affects your performance, and you can cut that down by a significant amount, that’s a big deal... If you’re a healthcare CIO or CTO and it can help you reduce the hardware costs for HIPAA compliance, that’s an even bigger deal.”

Tim Dunnington, Associate Vice President of Product Development, ICA
Scaling Beyond a Traditional Database

To empower its customers with information for timely decision making, the Exchange technology team focused on creating a flexible, reliable, and scalable analytics platform that could ingest large volumes of diverse data types and provide high performance for batch and interactive processing. Since healthcare providers face steep penalties if they fail to secure protected health information (PHI), the solution also required a robust security architecture that could keep pace with interactive performance requirements as deployments grew.

Scalability was critical, according to Tim Dunnington, associate vice president of product development at ICA. “If you look at 20 or 30 visits per doctor per day and start connecting several large practices that have dozens of doctors and hospitals that have hundreds of beds, even after one year, a relatively small HIE will have millions of medical records,” Dunnington says. “When our first customer was partially on-boarded, they already had 300,000 patients and 20 million records in the system. Some of those are Health Insurance Portability and Accountability Act of 1996 (HIPAA) audit records, but still, you can do the math and see where it’s heading.”

In addition to the sheer volume of data, ICA expects to handle a wider variety of data types as organizations incorporate semi-structured and unstructured data—from images to dictated and narrative notes—into their EHRs and HIEs. This growth in the variety and volume of data is compounded by the importance of providing responses in near-real time.

“Health providers need up-to-date information so they can make informed clinical decisions,” says Dunnington. “This means we’re going to be scaling not necessarily on how fast any one transaction or connection can be processed, but rather horizontally. We’re going to have many hundreds of systems simultaneously connecting to us, and they all have to have a consistent experience of a few seconds or less of processing time.”

These requirements led the development team to program scalability into every aspect of its solution, and to look beyond traditional database architectures. The team chose servers based on the Intel® Xeon® processor E5 family and paired them with MarkLogic, a distributed, enterprise-class, not-only-SQL (NoSQL) database. The Intel Xeon processor E5 family is designed to meet the performance, memory, and bandwidth needs of big data workloads.

To help ensure that the platform’s security implementation scales, ICA is using Intel® Advanced Encryption Standard New Instructions (Intel® AES-NI), a set of hardware instructions that select Intel Xeon and Intel® Core™ vPro™ processors use with software such as Microsoft BitLocker® to accelerate encryption performance.

At a Glance

Project
- Design a scalable, secure HIE architecture with value-added analytics for healthcare.

Accomplishments
- Developed an enterprise-ready HIE architecture that enhances security and can scale quickly and affordably to handle millions of patient records. Customers are using CareAlign Exchange to connect communities of healthcare providers, deliver more coordinated care, and manage population health.

Lessons Learned
- Match the database architecture to the application requirements and the volume, variety, and velocity of data. For an HIE, look for an enterprise-class solution that can handle documents, videos, images, handwritten notes, and other unstructured data.
- Build scalability across all solution elements, including security, computing performance, storage capacity, I/O bandwidth, and costs.
- Use Intel AES-NI with BitLocker or other security software to reduce the traditional performance and cost penalties for data encryption.
- Optimize interactive big data by choosing server processors with excellent CPU and I/O performance.
- If you’re deploying an HIE, get ready for big data. Build in performance and scalability and choose vendors who can help you go beyond basic data exchange.
Distributed Database, Scalable Infrastructure

As an enterprise NoSQL database, MarkLogic gives ICA and its users flexibility and scale to process varied data types in large volumes at near real-time speeds. MarkLogic is highly parallel, and designed to scale horizontally across industry-standard server platforms. This lets customers increase performance and capacity easily and affordably by adding servers as user communities expand and data volumes grow. MarkLogic runs native XML and supports auto-sharding, helping increase server and storage performance. Data is automatically replicated across nodes, improving data resiliency for healthcare environments.

ICA's leadership team also wanted to reduce entry barriers and enable organizations to easily establish and contribute to an HIE, so they liked the ability of the MarkLogic database to load information as is, regardless of size, volume, and complexity. "Our design allows us to utilize whatever data are contained in the medical records we receive," explains Dunnington. "Our customers get the benefit of making use of all the data, without the worries of translating different standards to a single format. We have the ability to take it all and make use of it all."

Adding further flexibility, MarkLogic can plug and play with the Intel® Distribution for Apache Hadoop* software, acting as a real-time database for Hadoop processing. "We can ingest data from the Hadoop Distributed File System* (HDFS*) into MarkLogic, and store MarkLogic files on HDFS," says Denis Sheahan, performance lead for MarkLogic. "We work quite well in a Hadoop environment, so our users can carry on analytics ranging from batch analytics to real-time analysis within one system."

As an enterprise NoSQL database, MarkLogic is well-suited to run on powerful Intel Xeon processors. ICA runs its three-tier environment on Intel Xeon processors, and while MarkLogic supports a range of server architectures, its technologists say Intel Xeon processor-based servers are their preferred platforms. "We are optimized for Intel multi-core hardware," Sheahan says. "We are very I/O bandwidth-hungry, so we want servers that have good I/O subsystems, good PCI-e* I/O subsystems, good storage I/O bandwidth, and a good amount of memory—128 MB if possible. The Intel® platforms give us all those things. We prefer storage in the box, although we also work fine with a storage area network or remote-mounted storage devices. The Intel® Solid-State Drives are great, and the more I/O bandwidth you have, the better."

For organizations choosing a distributed database, Steve Guttman, vice president of product management at MarkLogic, recommends starting from your analytic requirements and data types and then making sure the database is robust enough for enterprise computing at scale. “Think about all the things that allow you to run a mission-critical environment for big data,” Guttman says. “Then, make sure your database has the reliability and durability to keep your data protected and safeguarded and you’re not risking any data loss. That’s particularly important in healthcare.”

Cost-Effective, Hardware-Enhanced Security

Security was another crucial dimension of scalability. ICA designed a stateless implementation, reducing the risk of data theft but requiring that every service call go through security negotiations. ICA uses Intel AES-NI to accelerate full disk encryption and session encryption, helping ICA and its customers avoid traditional performance penalties and allowing encryption to scale affordably as the solution grows. Intel AES-NI is one of a variety of solutions that embed key security functionality in the hardware of select Intel processors and chipsets. Innovations such as Intel AES-NI enable more vulnerability-resistant platforms and, in ICA’s use of Intel AES-NI, help improve the experience for clinical end users.

"Every healthcare entity wants information as close to real time as possible in a very secure way, but many times those goals are in conflict. The big thing Intel enables us to do is to process a lot of data in a very secure way that is also very fast—which is a big win, because no physician wants to wait to get information."

John Tempesco, Chief Marketing Officer, ICA

Key Technologies

- Intel Xeon processor E5 family-based servers with Intel AES-NI
- Microsoft Windows Server* with BitLocker
- MarkLogic enterprise NoSQL database
- VMware vSphere® 5.0

Intel® AES-NI improves encryption performance and reduces costs
“Every healthcare entity wants information as close to real time as possible in a very secure way, but many times those goals are in conflict,” says John Tempesco, ICA’s chief marketing officer. “The big thing Intel enables us to do is to process a lot of data in a very secure way that is also very fast—which is a big win, because no physician wants to wait to get information.”

ICA’s leaders say Intel AES-NI not only reduces security costs but has transformative potential for healthcare. “Having those Intel AES-NI instructions in the Intel chipset makes encryption less costly in terms of processing power,” says Dunnington. “That’s the bottom line. When encryption affects your performance and you can cut that down by a significant amount, that’s a big deal. It’s one less server we have to buy in the cluster, and when we get really large, it could mean a number of servers we don’t have to buy.

The more we get software like Microsoft’s BitLocker and VMware’s vSphere® that just transparently take advantage of Intel AES-NI, the easier it becomes to deploy it and the more widespread it becomes. If you’re a healthcare CIO or CTO and it can help you reduce the hardware costs for HIPAA compliance, that’s an even bigger deal. If you’re smart about it, you’ll start using Intel AES-NI.”

Gaining Wisdom
While early Exchange users are working to establish their HIEs and contribute data, ICA’s visionaries are looking ahead to the analytics phase. “If you’re in a successful HIE community with hundreds of doctors contributing data and the doctor or care coordinator pulls down the records on a given patient, they might have hundreds of records,” Dunnington says. “How do you make sense of all that so the user gets relevant information quickly? That’s the big data challenge that every HIE is facing, and we are aggressively—very aggressively—pursuing that problem. We want targeted, useful information to hit their screen so that they see just what they need to treat their patient. It doesn’t mean the noise is gone, but it is significantly reduced so they can make use of this massive amount of data that they’re going to have access to. So it all comes back to the analytics.”

Tempesco sees this as the culmination of a four-phase evolution. “Healthcare has moved through the stages of creating data, sharing information, and turning it into knowledge,” he says. “Now, with analytics, we’re ready to create wisdom and get it back out to providers so they can use it to transform the practice of medicine.”

Find a solution that is right for your organization. Contact your Intel representative, visit Business Success Stories for IT Managers, or explore the Intel IT Center.