Summarization of Needs for Infrastructure, Tools and Next Generation Methodologies for Optimizing Business Processes in Health Care

By:

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1.0 ABOUT

This document summarizes the research conducted by Nitin Uchil in coordination with Tony Bromwell and the rest of the team at HIMS Solutions, Inc. to identify and assess infrastructure, tools and next generation metodologies to optimize business processes in Health Care. The need is to come up with an appropriate framework to create a Web-based Portal to integrate the activities of Coding with upstream (Registration, Patient Care, Discharge) and downstream (Claims Scrubbing, Billing) processes in the Clinical Management domain.

Shown below is a high level interaction diagram of the Health Care Ecosystem.
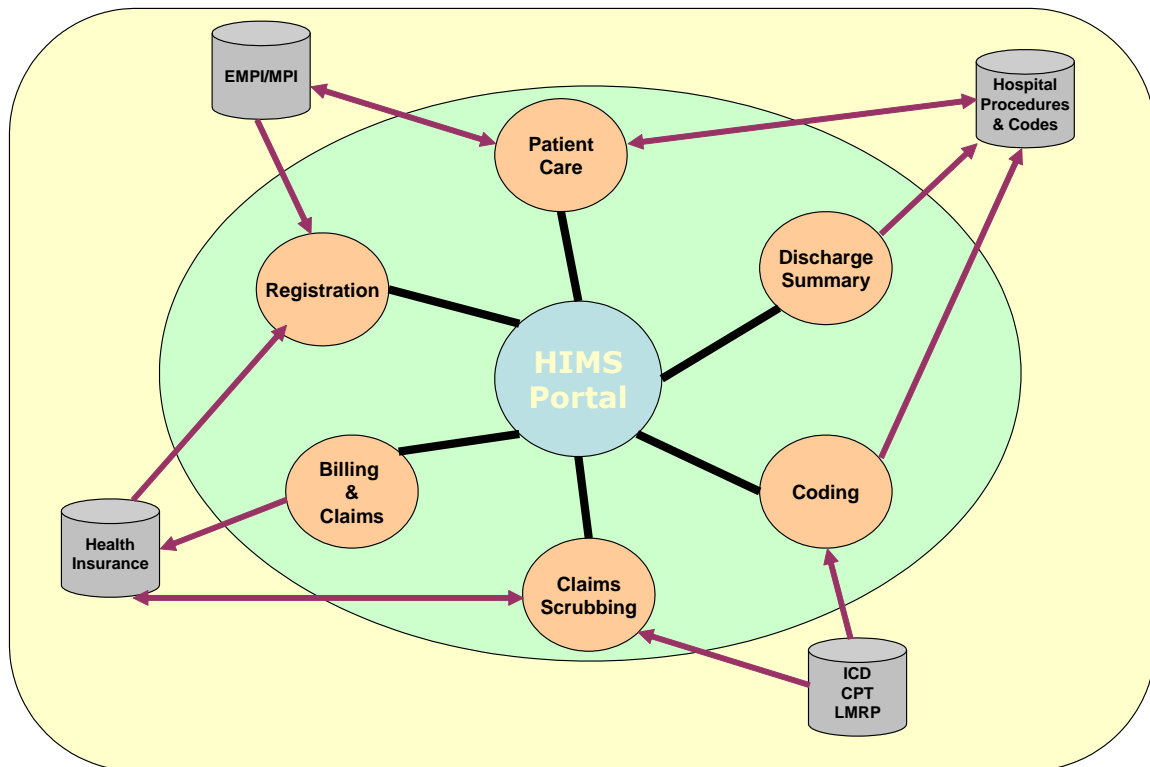
2.0 IDENTIFY AND ASSESS

A high level assessment of the Health Care domain was conducted in the first week of the consulting endevor to identify the requirements of HIMS Solutions, Inc. and to put it in perspective of available systems, infrastructure, consultants and prospective competition.

A glossary of terms related to Health Care was initially created to understand the domain andits acronyms.

Since the domain to intially effect the solution was in Medical Coding, a reveiew was conducted of existing Encoding software and here is a summary:

Company	Description
3M	**Coding Inpatient Solutions** • 3M™ Codefinder™ Software • 3M™ Clinical Analyzer Software • 3M™ DRGfinder™ Software • 3M™ Reimbursement Calculation Software • 3M™ Coding Reference Software • 3M™ Coding Reference Plus Software **Coding Outpatient Solutions** • 3M™ Codefinder Software • 3M™ Reimbursement Calculation Software • 3M™ HCPCS/CPTfinder Software • 3M™ APCfinder Software • 3M™ Coding Reference Software • 3M™ Coding Reference Plus Software
Ingenix	***Encoder Pro Professional*** is a comprehensive code lookup software that delivers a high degree of code detail and reference information on CPT®, HCPCS Level II and ICD-9-CM codes. • **Access LMRPs/LCDs and Medicare's Pub 100.** Check procedures for Medicare coverage instructions and medical necessity edits. • **Modifier Crosswalk.** Guides you to the correct modifiers when billing payers, and helps you associate modifiers with selected procedures and services. • **Powerful Ingenix CodeLogic™ search engine.** Search all three code sets simultaneously using lay terms, acronyms, abbreviations and even misspelled words. • **Color coded edits.** Reduce research time, improve coding accuracy and become more efficient by delivering cleaner claims the first time. • **Quarterly update service.** Rest assured you are always using accurate codes. Includes a year's worth of code updates as part of your subscription. • **Receive *Coders' Desk Reference* lay descriptions for thousands of CPT® codes.** Enhance your understanding of procedures with easy-to-understand descriptions. The top of the line, ***Encoder Pro Expert*** combines compliance editing and fee calculation with the powerful ability to search simultaneously across ICD-9-CM, CPT® and HCPCS codes and Medicare coding guidelines, delivering integrated search results, code details and lay descriptions - PLUS audit and report functionality. • **Exclusive — Compliance editor.** Check for coding accuracy and review your code selections for CCI unbundle edits, ICD-9-CM specificity, age, medical

	necessity, gender and more. • **Exclusive — Fee calculator by locality function.** Allows you to easily reference the Medicare reimbursement level for your area and others. • **Audit your E/M code selection with a detailed level-of-service review.** • **Powerful Ingenix CodeLogic™ search engine.** Search all three code sets simultaneously using lay terms, acronyms, abbreviations and even misspelled words. • **Color coded edits.** Reduce research time, improve coding accuracy and become more efficient by delivering cleaner claims the first time. • **Quarterly update service. Rest assured you are always using accurate codes** Includes a year's worth of code updates as part of your subscription. • **Receive *Coders' Desk Reference* lay descriptions for thousands of CPT® codes.** Enhance your understanding of procedures with easy-to-understand descriptions. ***EncoderPro.com Expert*** provides online access to powerful lookup of all regulatory code books and Medicare coding guidelines. Helps you improve coding accuracy and billing performance. This valuable online service benefits practices billing Medicare Part B and private payers. • **New!** Revised code edits screen displays a complete list of associated procedures as well as LMRP/LCD code relationships for all covered and non-covered procedures and NCDs. • **New!** Dynamic policy view allows you to read all of the guidelines and coverage instructions issued by your carrier in a print-friendly format. • **Review the adjusted Medicare reimbursement rate for your region.** Fee Calculator allows you to select your carrier and calculate the fee for the selected procedure. • **Verify accurate code selection.** Run your selected codes through the Compliance Editor, and confirm that your code selection unbundles properly, employs modifiers correctly and that it describes a complete diagnosis. • **Quickly review claims.** Quickly enter data into the Compliance Notepad to review your claims before submission or after denial. • **Understand which ICD-9-CM procedures define medical necessity and what the documentation guidelines are for successful claim submission.** Access LMRPs/LCDs and Medicare�s Pub 100 to check procedures for Medicare coverage instructions and medical necessity edits for Part B coverage. • **Verify selection of correct modifiers when billing payers.** Modifier crosswalk helps you select from all possible modifiers assigned to the selected procedure, based on hundreds of millions of claims scenarios. • **Understand coding relationships for bundled and mutually exclusive procedures.** Easily and quickly access a full year of CCI edits to check your code combinations. • **Quickly access content from more than 12 coding and billing specialty reference books in one powerful solution.** The Cross Coder relationships tool helps you crosswalk procedures to radiology, path/lab, medicine codes and more.
PMIC	Coding and compliance issues are becoming more complex every day. Providers and payers need access to complete, comprehensive and current coding and compliance information to do their jobs properly. **Flash Code™** makes coding fast, simple, accurate and painless! **Flash Code™ Platinum** is the ultimate electronic and compliance package for physician offices, clinics, hospitals and third party payers. The Platinum Edition includes a fully searchable CPT database, HCPCS database, and ICD-9-CM database. It is also packed with features such as CCI edits, LMRP text,

	RBRVS fees, custom fees, DME fees, lab fees, printable code lists, plus a new E/M coding matrix and National Drug Codes (NDC). **Flash Code™ Platinum** helps you increase reimbursement, reduce audit liability and maintain compliance with billing and coding regulations. **Flash Code™ Platinum has all of the features of the Basic Edition plus:** • LMRP text with ICD-9-CM to CPT and HCPCS links for ABN notification • CCI tables with over 125,000 edits for intelligent unbundling information • RBRVS fee information with geographic (GPCI) based fee calculations • Ability to create your own custom fee schedules • Instant prompts that help you determine which procedures have the highest payment • Laboratory and durable medical equipment (DME) fee calculations • Printable specialty code lists • E/M coding matrix • National Drug Codes (NDC) **CPT® Module** • Includes Tabular and Alphabetical indexes with over 7,000 AMA CPT codes • All Section Guidelines including Modifiers listed • Clinical vignettes associated with CPT codes • Allows for creation of ICD/CPT links by either CPT or ICD 9 code **HCPCS Module** • Includes Tabular index with over 2,300 HCPCS codes for supplies, injections and durable medical equipment • Includes the HCFA drug table for HCPCS **ICD-9-CM Module** • Includes Tabular and Alphabetical indexes with over 15,000+ ICD-9-CM codes • Search Tables for Neoplasms and Drugs and Chemicals
Quadramed	Quantim HIM Suite Quantim Compliance Monitor and manage your coding and billing practices with Quantim Inpatient Compliance and Quantim Outpatient Compliance. Quantim Compliance automates the selection process and assists the user in monitoring appropriate and accurate coding for both inpatient and outpatient encounters. It delivers a completely automated process to monitor and manage coding and billing processes across multiple facilities. Quantim Coding Improve coding productivity, efficiency and accuracy with Quantim Facility Coding and Quantim Physician Coding. Quantim Coding provides advanced search functionality, integrated references, and extensive edits. Coding accuracy is enhanced through a powerful simultaneous encoding and grouping system, designed to maximize productivity and minimize duplication. Quantim Abstracting Improve data quality with Quantim Abstracting, which captures, structures, and analyzes clinical and financial data, utilizing standard and customizable fields, rules and screen design. It provides an integrated solution that enables the user to access both the coding and compliance tools within a patient encounter, and provides timely and accurate data for your clinical and business decisions. Quantim Correspondence Management Safely and securely comply with HIPAA requirements with Quantim Correspondence Management. They provide complete functionality to facilitate your healthcare organization's compliance with the disclosure management aspect of the HIPAA privacy mandate. In addition, it provides the tools you need to automate the entire

release of information workflow process, including robust accounts receivable management.

Affinity HIS Solutions
Affinity Physician and Facility Coding improves your coding productivity, efficiency and accuracy. It provides advanced search functionality, integrated references, and extensive edits. Coding accuracy is enhanced through a powerful, simultaneous encoding and grouping system, designed to maximize productivity and minimize duplication.

Affinity Compliance
Monitor and manage your coding and billing practices. Affinity Compliance automates the selection process and assists the user in monitoring appropriate and accurate coding for both inpatient and outpatient encounters. It delivers a completely automated process to monitor and manage coding and billing practices.

Affinity Medical Records Abstract uses the power of the single Affinity database to facilitate efficient coding of the patient's medical treatments. With the ability to access coding and compliance tools, Affinity Medical Records Abstract makes important billing information readily available to the HIM professional to assist in making accurate coding decisions.

Complementing Affinity Medical Records Abstract is **Ambulatory Abstract**. Providing all of the same features, Ambulatory Abstract is a streamlined and efficient means to code charts for services provided in an outpatient or ambulatory setting
Affinity Medical Records Control

Affinity enables you to track and monitor patient's charts with **Affinity Medical Records Control**. It gives you powerful online tools to track the chart's location and monitor and report on its deficiencies. With Affinity Medical Records Control, you will be able to manage your incoming requests for correspondence and keep records of all outgoing replies, keeping you HIPAA compliant.

MPI Identity Management Solutions

QuadraMed SmartScan®
Assess your MPI data quality with QuadraMed SmartScan. QuadraMed SmartScan with embedded LinkSearch probabilistic record matching technology gives you a highly accurate, quantitative understanding of data quality problems within your MPI databases. Combining a comprehensive statistical evaluation of your MPI data with a supporting professional consultation to help you understand the specifics of the problem, QuadraMed provides the most complete data assessment available in the industry.

QuadraMed MPIspy®
Find patient identification errors as they occur with QuadraMed MPIspy Indexing Engine. QuadraMed MPIspy ensures that your organization remains continuously and immediately aware of any identification errors in real time, and it serves as a platform for enterprise-wide unique person indexing. Powered with industry leading technology, our advanced LinkSearch probabilistic record matching algorithm, and capability to simplify installation and setup, MPIspy is the most cost-effective means to build a foundation for accurate person identification across your enterprise.

QuadraMed SmartMerge®
Achieve fast, efficient resolution of patient identification errors with QuadraMed SmartMerge. No matter how complex the merge process or workflows, SmartMerge resolves patient identification errors effectively and efficiently. It features sophisticated,

workflow driven record management functionality, online user collaboration and reporting features, and powerful capabilities for seamlessly integrating with legacy information systems to put you in the drivers seat for a fast and effective clean-up of your MPI data.

QuadraMed SmartID®
Accurately identify patients with QuadraMed SmartID. The advanced SmartID person identification application not only enables accurate identification but eliminates the creation of new, preventable patient identification errors that occur from existing data quality problems and ongoing data entry errors. It integrates seamlessly with your legacy systems through its powerful integration technology, and leverages the MPIspy indexing engine for fast, accurate probabilistic searches across your enterprise.
QuadraMed Master Patient Index (MPI) Clean Up Services

Achieve a clean MPI database with the support of experienced MPI professionals with QuadraMed Master Patient Index Clean Up Services . Clean Up Services provide comprehensive support for your organization's efforts to resolve outstanding identity errors. It allows your organization to reach the goal of clean, effective MPI databases throughout your enterprise without costly missteps or resource limitations. Working with you, our credentialed HIM professionals provide a variety of specialized consulting. and project management services who employ a results-oriented approach and are tailored to your exact needs and resource constraints. QuadraMed offers unsurpassed performance and expertise in planning and managing your entire clean-up process from start to finish.

Affinity PreciseID
Achieve accurate patient identification while preventing new identification, errors with Affinity Precise ID. Precise ID accurately identifies your patients and eliminates the creation of new, preventable identification errors. Embedded directly within the Affinity Healthcare Information System, and leveraging the MPIspy indexing engine for fast, accurate probabilistic searches, PreciseID makes it easy maintain your Affinity MPI data accuracy. It empowers your users with the information they need to do their jobs effectively and accurately.

Affinity Community Master Population Index (CMPI)
Ensure consistent, accessible patient information across your enterprise with Affinity Community Master Population Index (CMPI). Affinity CMPI ensures that consistent patient information is available between multiple entities within your organization to improve productivity and delivers higher levels of patient satisfaction. It serves a central repository of patients and their encounters within a care delivery organization. CMPI allows facilities to share and exchange patient and financial information between the Affinity® HIS and other disparate systems — all with one single common enterprise identifier.

Other HIM solutions
If you have a question about the following QuadraMed HIM Products, please call QuadraMed Customer Support at 877-823-7263:
APC Analyzer
Cascade Master Encoder
Cascade Master System
IPFacts
MEDREC II
Millennium Chart Completion
Millennium Chart Location
Millennium Correspondence Management
nCoder+
OPFacts

	WinCODER+ WinCODER+ CS

Subsequently (2 weeks), companies having EHR implementations and infrastructure platforms were researched on based on capabilities, technology and usage. A lot of companies were reviewed in this space but ultimately the following were chosen for doing the competitive analysis:

- **HL7 Messaging Layer Integration – NeoTool and Interfaceware**
- **Core Components – Wellogic and Quovadx**
- **Natural Language Procesing and Context Recognition – Language and Computing, Health Language (partner with iSoft), Apelon and OntoReason**
- **Consulting Companies – AITechSoft, MiracleSoft and CareTech Solutions**
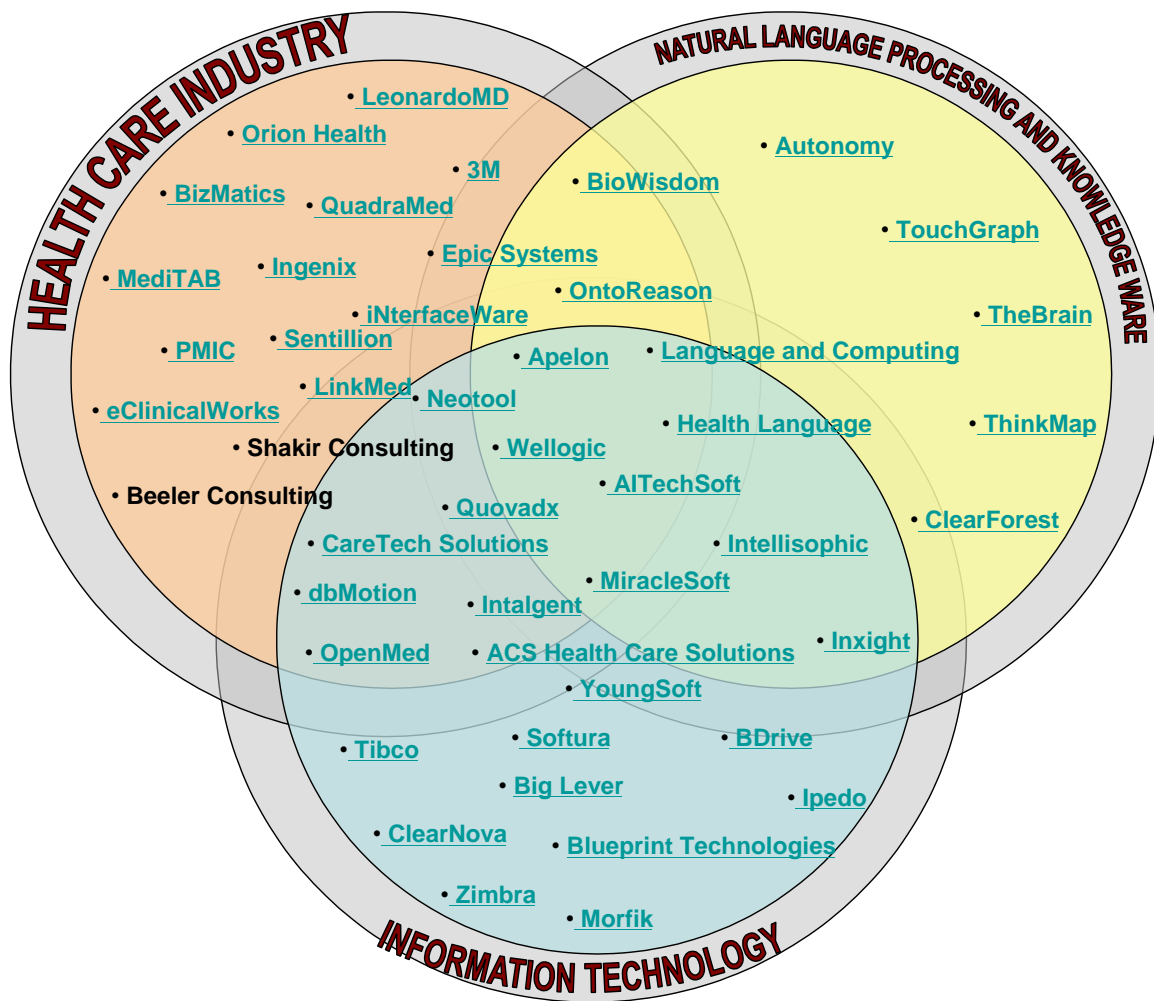
3.0 CLASSIFICATION OF NEEDS

Creating the next generation infrastructure for health care was envisaged to happen in 3 domains:

- **Development of the Business Infrastructure**: Here standards, protocols and necessities of the Health Care Domain were understood and accounted for.
- **Instilling intelligence into the application**: Here next generation companies that do work in taxonomies, ontology definitions and context pattern recognition were reviewed and their philosophies accounted for.
- **Information Technology Needs**: Service Oriented Architecture and the user interface depiction using AJAX and other Rich Internet Applications were reviewed for

HELATH CARE INDUSTRY

NATURAL LANGUAGE PROCESSING / KNOWLEDGE WARE

TECHNOLOGY
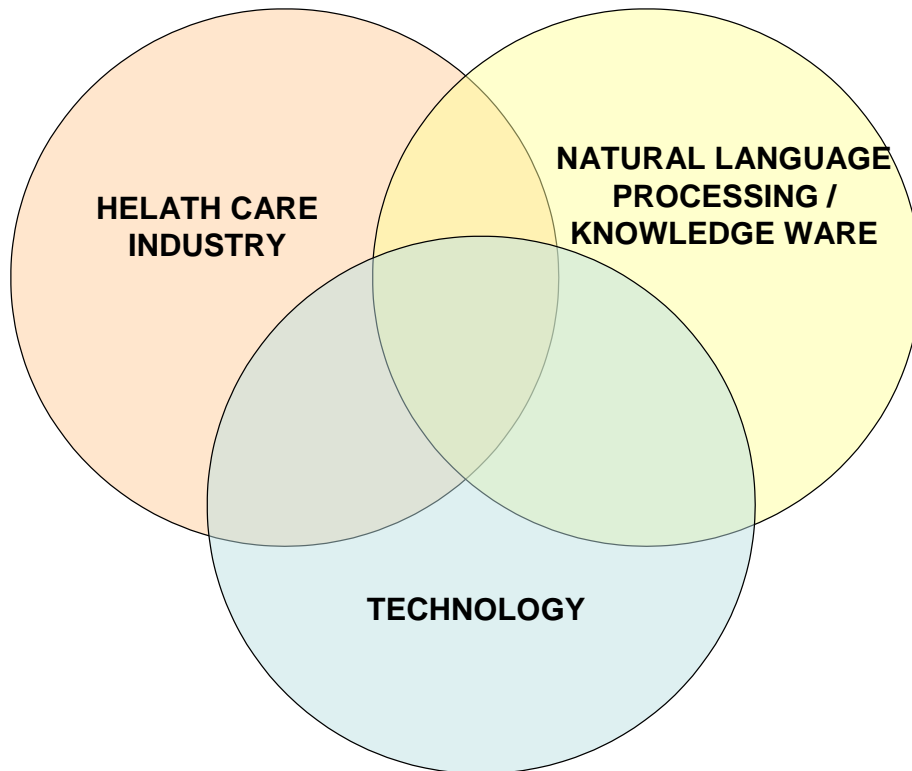
Based on the above structure the following is the representation of the companies that fit into the space.

HEALTH CARE INDUSTRY

NATURAL LANGUAGE PROCESSING AND KNOWLEDGE WARE

INFORMATION TECHNOLOGY

- LeonardoMD
- Orion Health
- 3M
- BizMatics
- QuadraMed
- Ingenix
- MediTAB
- iNterfaceWare
- PMIC
- Sentillion
- LinkMed
- eClinicalWorks
- Neotool
- Shakir Consulting
- Beeler Consulting
- Quovadx
- CareTech Solutions
- dbMotion
- Intalgent
- OpenMed
- Tibco

- Autonomy
- BioWisdom
- TouchGraph
- OntoReason
- TheBrain
- Apelon
- Language and Computing
- Health Language
- ThinkMap
- Wellogic
- AITechSoft
- ClearForest
- Intellisophic
- MiracleSoft
- ACS Health Care Solutions
- Inxight
- YoungSoft
- Softura
- BDrive
- Big Lever
- Ipedo
- ClearNova
- Blueprint Technologies
- Zimbra
- Morfik

Epic Systems

4.0 INFRASTRUCTURE DEFINITION

Effective enterprise software development

Developing enterprise-scale applications today requires an approach to software architecture that helps architects evolve their solutions in flexible ways. This approach should permit reuse of existing efforts in the context of new capabilities that implement business functionality in a timely fashion, even as the target infrastructure itself is evolving. Two important ideas are now considered central to addressing this challenge:

- **Service-Oriented Architectures (SOA)**. Enterprise solutions can be viewed as federations of services connected via well-specified contracts that define their service interfaces. The resulting system designs are frequently called Service Oriented Architectures (SOAs). Flexibility can be enhanced in a system's architecture by organizing a system as a collection of encapsulated services making calls on operations defined through their service interfaces. Many organizations now express their solutions in terms of services and their interconnections.

- **Software Product Lines**. Frequently, there is a great deal of commonality among the systems an organization develops and maintains. We see recurring approaches at every level of an enterprise software project, from having standard domain models that capture core business processes and domain concepts, to the way in which developers implement specific solutions to realize designs in code. Organizations gain a great deal of efficiency when patterns can be defined by skilled practitioners and propagated across the IT organization. This represents a move toward a software product-line view of development that promotes planned reuse of assets, along with an increasing level of automation, to realize solutions for large parts of the systems being developed. More generally, we can understand the application of well-defined patterns in a product-line view of development as a way to transform descriptions of a solution from one level of abstraction to a lower level of abstraction.

These two ideas have had significant influence on the thinking of the Object Management Group (OMG), a consortium of software organizations that develops and supports specifications to improve the practice of enterprise software development and deployment. (There will be more on the important role the OMG plays in the next section.) The OMG has created a conceptual framework that separates business-oriented decisions from platform decisions to allow greater flexibility when architecting and evolving these systems. This conceptual framework and the standards that help realize it is what the OMG calls "Model Driven Architecture (MDA)." Application architects use the MDA framework as a blueprint for expressing their enterprise architectures, and employ the open standards inherent in MDA as their "future proofing" against vendor lock-in and technology churn.

The OMG's MDA concept provides an open, vendor-neutral approach to system interoperability via OMG's established modeling standards: Unified Modeling Language (UML), Meta-Object Facility (MOF), XML Metadata Interchange (XMI), and Common Warehouse Meta-model (CWM). Descriptions of enterprise solutions can be built using

these modeling standards and transformed into a major open or proprietary platform, including CORBA, J2EE, .NET, and Web-based platforms.

Technical requirements

Health care business requirements are implemented based on the supporting technical requirements that deal with the necessary connectivity (to both existing and new systems), standards compliance, security, transactions, and performance. A key requirement is the support for connectivity to legacy systems, which can involve any and all of the following communications protocols:

- TCP/IP (network and transport layer)
- File transfer (FTP)
- Asynchronous (rs232/modem).

The Figure below shows a typical technical environment in which healthcare businesses must operate.
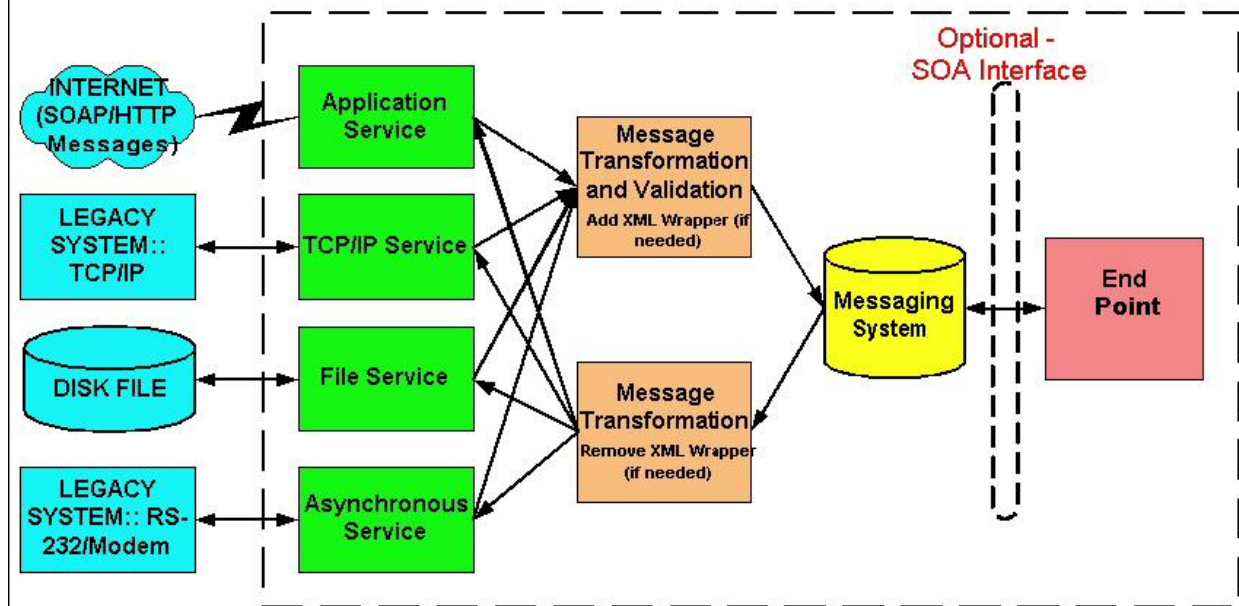
A healthcare architecture solution must address and support these healthcare-specific standard protocol requirements:

- HL7
- MLLP
- ANSI X12
- HIPAA.

Security and transaction requirements are becoming more critical due to the recently published HL7 V3x standard, which identifies a higher level of security and defines transaction semantics. Performance requirements are also addressed, affecting where components execute in the endto- end execution path. Some performance factors include:

- Message transformation
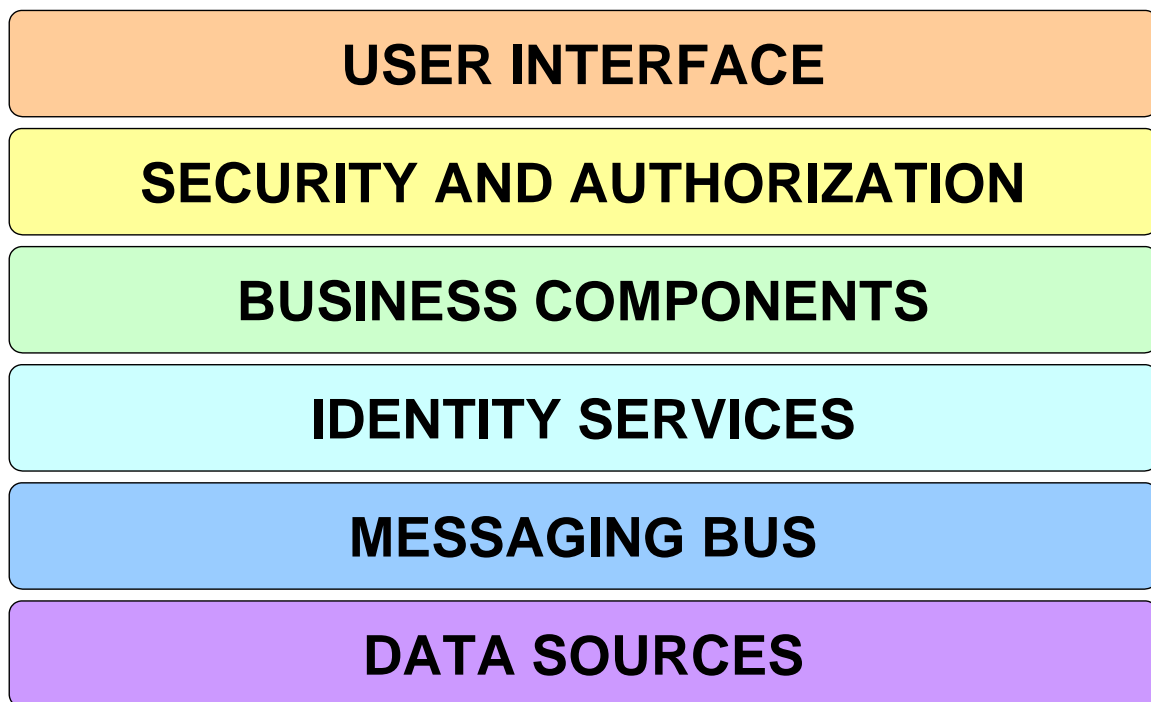- Message routing

- Messages per second
- Message size
- Distributed execution.

Most of the general logic flow is asynchronous, with some synchronous aspects predicated on various environments. The key steps in the logic flow include:
- Provide support for legacy system connection protocols.
- Connect and make a request of the legacy system.
- Convert the legacy protocol to MLLP.
- Transform the data into HL7 format.
- Package the data into an acceptable message structure.
- Route the message to the destination endpoint.
- Make use of the optional SOA interface.
- Process message at the endpoint.

A move to a more open environment would utilize the optional SOA interface using Web services.

High Level Application Stack

USER INTERFACE

SECURITY AND AUTHORIZATION

BUSINESS COMPONENTS

IDENTITY SERVICES

MESSAGING BUS

DATA SOURCES

Architecture Frameworks

The healthcare industry is evolving into a heterogeneous, distributed, and outsourced environment model. There is a regulatory push for more interoperability, auditing, and automation, leading healthcare-related companies to modify and integrate their existing environments to interact with a variety of business partners. Healthcare medical providers are expanding their services from the local and regional level to the national

level. To support this growth, many are utilizing third party software products to support their business. Additionally, some national healthcare countries, such as Great Britain, are taking an international approach to standardizing data format and protocols used in the processing of patient records and healthcare visits. Third party software vendors who develop healthcare-related applications must produce easy to use, flexible software products to support the move to the standards being developed, and to adapt to the unique needs and constraints imposed by the international community. Often, healthcare software vendors (HCVs) find it too expensive or impractical to develop the needed healthcare-specific software products and build the required underlying software infrastructure components -- and be standards-compliant. As a result, a HCV will focus on developing healthcare software products, but look to other business partners for the infrastructure and for the development and implementation of the standards-based protocols, data format, transactions, and security requirements.

Microsoft, SUN and IBM's technical whitepapers were reviewed as the basis for defining the framework for the application:
- Microsoft's DSL and Software Factory
- Sun's Open Rx Framework

Trends
The complexity of integrating internal systems and external business partners results in a growing challenge that must, out of necessity, be simplified into a manageable approach. Two long term approaches being taken by the industry are related to packaging and defining an enterprise service bus.
- **Packaging:** The first approach is to define industry-specific solutions that include software products, and customizable solutions that use templates (such as the WebSphere Business Integration for HIPAA Collaboration and Healthcare Collaboration solutions). Coupled with this is the need to have an authoritative group with expertise in these areas drive the solutions; hence the reason IBM created the Life Sciences Health Industry group, which specifically addresses the needs of the healthcare vertical market.
- **Develop an Enterprise Service Bus (ESB):** The second approach ties together software products with an intelligent infrastructure to support service-oriented integration. Essentially, this approach unifies SOA, messaging, message brokering and publish/subscribe functionality, and is based on industrystandards. Included is support for monitoring and management, plus a security domain based on federated identity management. This approach is being explored by IBM and other vendors.

Models
 Models to follow: NHIN & IHE

5.0 SOLUTION SCENARIOS

We can go about building the application based on 4 scenarios:

1. From Scratch

This would entail us buying the HL7 messaging layer from companies like Neotool or iNterfaceware and having a AITechSoft, MiracleSoft or CareTech Solutions build it for us.

Notes:

- AITechSoft has customized Inxight's products in its aiHealth product
- MiracleSoft has implemented a J2EE based JSF solution
- CareTech Solutions

2. Leveraging Existing Components

Here we would utilize core components from Wellogic or Quovadx Cloverleaf and theme our solution initially for coding and then encompassing all the other business processes.

Notes:

- Wellogic has a well defined platform for defining the Portal using the latest technologies
- Quovadx's Cloverleaf and Identity services

3. Upgrading an Encoding software

Alternatively, we could customize a Ingenix type encoder product to make it more code aware and then build the upstream and downstream modules.

Notes:

- Of all the encoders reviewed, Ingenix had the best desktop and web enabled solution for managing searches from ICDs, CPTs and DMRPs
- Companies mentioned in 1 or 2 could be used to build the infrastructure.

4. Customizing an EHR Software

Here we would put in the appropriate business rules into a Orion Health / 3M / Siemen / Epic / Eclipsys / Quadramed EHR system and make it more code aware. This would make us tied down to a particular large player in the industry.

All the above scenarios would utilize NLP based ontology software from companies like Language and Computing, Health Language or OntoReason. For the SRS therefore, this is the most important (and differentiator) portion of the entire infrastructure.

6.0 CONCLUSION

In today's knowledge-based economy, success depends on sharing relevant, timely, and complex information with employees, customers, and partners. Knowledge-based Internet solutions are the only way businesses will exist in the world of tomorrow: be it serving clients, transacting businesses, enabling employee communications, supply-chain management or manufacturing products.

Extending the enterprise, enhancing business relationships and sustaining a competitive edge, all depend upon a flexible, scalable, reliable e-Business strategy, backed by a sound infrastructure. Transforming the organization of a "bricks-and-mortar" business to fully take advantage of the dynamic Internet business economy is a challenging task - but one that is vital to any business longevity.

The changing healthcare business environment requires a process-based approach that integrates with business partners, technology that provides a flexible, dynamic environment, and a variable cost financial model in conjunction with a clear delivery model. To summarize, the healthcare industry is a prime candidate for a Service Oriented Architecture (SOA) solution, coupled with an on demand approach.

7.0 BIOGRAPHY

For the past 10 years, Nitin Uchil has been involved in creating web-based, data-driven and security-governed infrastructures for Knowledge Management, Process Optimization and Data Mining in the Automotive domain. Engineering Portals created by the company he founded (BDrive, Inc.) have optimized work flow in the upstream activity of Product Design and Development in PLM (Product Life Cycle Management).

In doing so he have created a web-based collaborative platform (Mantra) that orchestrates the development of the application build by managing its artifacts: plan, requirements, use-cases, code, test scripts etc. in a single environment. It also has design patterns for data mining, analytics and charting that can be embedded into frameworks using XML templates.

Of late, he has been trying to change focus to enable Health Care and the Life Sciences (moving from Power for Intelligent Collaborative Infrastructures to the Power to Be) to enable intelligent drug discovery, utilization of grid computing in genomics and process optimization in Health Care.

Prior to 1997, Nitin Uchil was involved in high-end Simulation – the creation of Computer Aided Engineering models for the automotive and aerospace domains, its analysis and post-processing of the results. He has worked with all the major automotive companies - Ford, GM, Jaguar, VW, BMW, Daimler Chrysler, aerospace companies - Northrop/Grumman, GE, Textron as a consultant or supplier. He also has expertise in coding software for dynamic representation (object manipulation, meshing and graphing) and high-end supercomputing.