2010

df8health

[WHITE PAPER: HEALTHFABRIC]

Solution for integrating heterogeneous systems and effectively using information technology as a key focal point for improving healthcare in terms of patient safety, quality outcomes, and economic efficiency.

df8health – HealthFabric

HL7 Standards

Since 1987, the HL7 organization has provided a framework (and related standards) for the exchange, integration, sharing, and retrieval of electronic health information. Version 2.x of the standards, which support clinical practice and the management, delivery, and evaluation of health services, are the most commonly used specification throughout the world.

It is a well-known fact that a majority of hospitals and healthcare provider organizations have implemented a "best of breed" environment, where heterogeneous computer systems are used for everything from billing records to patient registration.   HL7 specifies a number of flexible standards, guidelines, and methodologies by which various healthcare systems can communicate with each other. Such guidelines or data standards are a set of rules that allow information to be shared and processed in a uniform and consistent manner. These data standards allow healthcare organizations to easily share clinical information and help minimize the tendency for medical records to be geographically isolated and highly variable.

HL7 v2.x uses a textual, non-XML encoding syntax for its schema.   It enables the interoperability between electronic Patient Administration Systems (PAS), Electronic Practice Management (EPM) systems, Laboratory Information Systems (LIS), Dietary, Pharmacy and Billing systems as well as Electronic Medical Record (EMR) or Electronic Health Record (EHR) systems. Currently, HL7's v2.x messaging standard is supported by every major medical information systems vendor in the United States.

The Needs

The effective use of information technology is a key focal point for improving healthcare in terms of patient safety, quality outcomes, and economic efficiency.   HL7 v2.x provides a thorough framework for the exchange of data between computer systems. HL7 v2.x is widely spread among all major healthcare providers and institutions.

At the top level, HL7 uses trigger events to model real-world events of healthcare's complex data flows between systems. The definition of trigger event spans several different levels of data granularity and inter-relationships.   The basic structure includes: Event, Segment, Field, and Base Data types.   Each base data is further delineated into data type, repeating, optional/required and data length requirements as part of the specification.   This detailed data granularity provides a tremendous and concise roadmap and opportunity to represent the dynamic data structure of healthcare systems with proper information extraction and implementation.

We utilize HL7 v2.5 as our core concept for structural guidance and our methodology strictly adheres to its principles.   Our idea is to comply with the standard and provide a clear and simple platform solution to assist users with application implementations of HL7.   The solution encompasses HL7 message parsing, pure HL7 data type storage, .Net data access objects, and Silverlight data visualizations.

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df8health is an innovative provider of a healthcare information computing platform that helps organizations realize their Health Information Exchange (HIE) initiatives, increase quality of care, support CMS reporting, and improve overall operational efficiency.

Our approach to the complexity of HL7 v2.x is to provide a platform solution (HealthFabric) that tackles the issues from the ground up utilizing the HL7 v2.5 standard. The platform provides the tools ranging from the HL7 Structure Extractor, HL7 Message Parser, HL7 Message Inspector, HL7 database, High Level Concept Composer, HL7 Database Analyzer, and Virtual Health Record Composer.   Figure 1 depicts the conceptual architecture of the application layers introduced by HealthFabric.   Starting from the HL7 construct, the platform automatically generates code, both C# and SQL, representing the customer's needs into implementation libraries supporting the database, access objects and finally data visualizations.
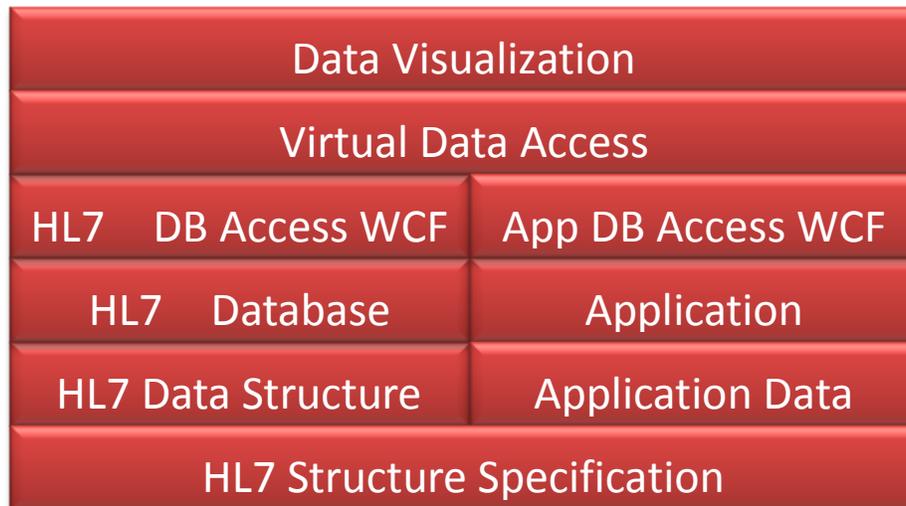
Data Visualization	
Virtual Data Access	
HL7 DB Access WCF	App DB Access WCF
HL7 Database	Application
HL7 Data Structure	Application Data
HL7 Structure Specification	

Figure 1. Conceptual Architecture of HealthFabric

HealthFabric^{tm}

HealthFabric is a suite of software subsystems enabling secure interoperability and common data access of regionally disparate clinical and financial information systems.   The system is specifically designed to be hosted in the Cloud as a "Platform as a Service" (PaaS) application or can be easily hosted within the customer's domain.   At its core is an Enterprise Data Fabric (EDF) that is a distributed, operational data platform from which Virtual Health Record (VHR) applications can be derived.   It receives HL7 messages from source applications (such as HIS, Lab, EMR) and uniquely stores them as pure HL7 data types.   It is a secure, highly efficient, compact and scalable SQLServer implementation of the HL7 v2.5 standard.   All HL7 messages and corresponding data types are processed and persisted directly into the database.   This creates an instant central data repository for all clinical and financial data that are continuously synchronized (Figure 2).

HealthFabric captures raw data from disparate sources and transforms those data into HL7 v2.5 data types.   These can be filtered and used proactively to make informed decisions.   In an HIE model, financial data as well as clinical data would fuel the analytics.   By integrating analytics, HIEs can transform existing electronic information into useful, actionable data to improve outcomes and provide physicians with precision tools to employ when caring for their patients.   Although analytics are not new to the health care industry, they have new meaning in the context of an HIE because the results are more complete when a multi-source, comprehensive data repository is used.

HealthFabric is based on a Service Oriented Architecture (SOA) and can be hosted in the local Information Technology (IT) infrastructure or in a private Cloud instance in Microsoft Azure.   Users of HealthFabric in the Cloud benefit by joining a growing community of customers who share infrastructure and IT costs, resulting in lower management overhead, little up-front investment and immediate access to the full range of applications.
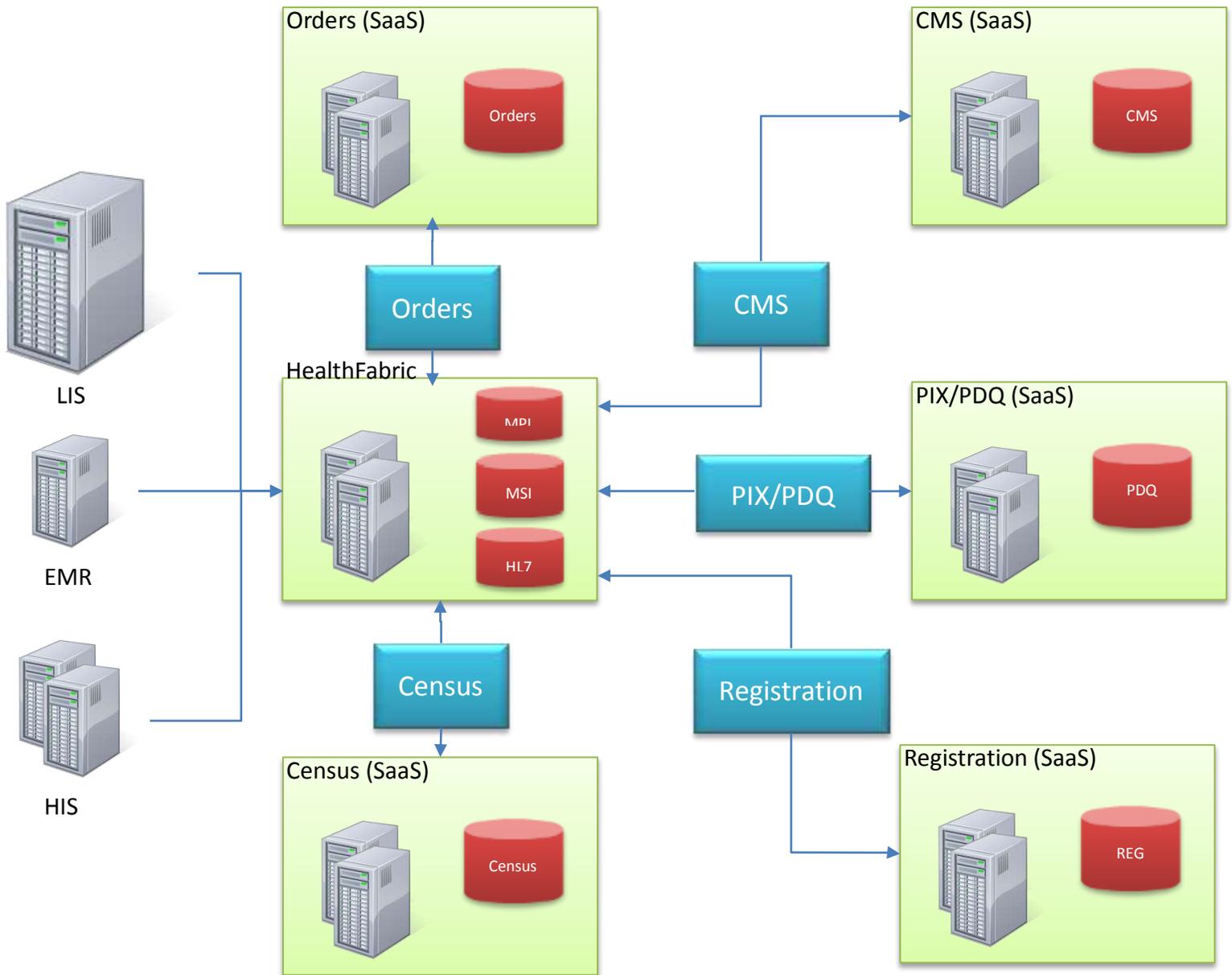

Figure 2.   Process and Data Flow of an Integrated Health System

HL7 Data Constructor

HealthFabric starts with the HL7 Data Constructor tool. This tool extracts the HL7 construct and generates the corresponding Class and SQL templates. Along with user-defined customization settings, the HL7 Data Constructor uses these templates to generate the database schema, access objects, WCF classes, and the XAML application (Figure 3).
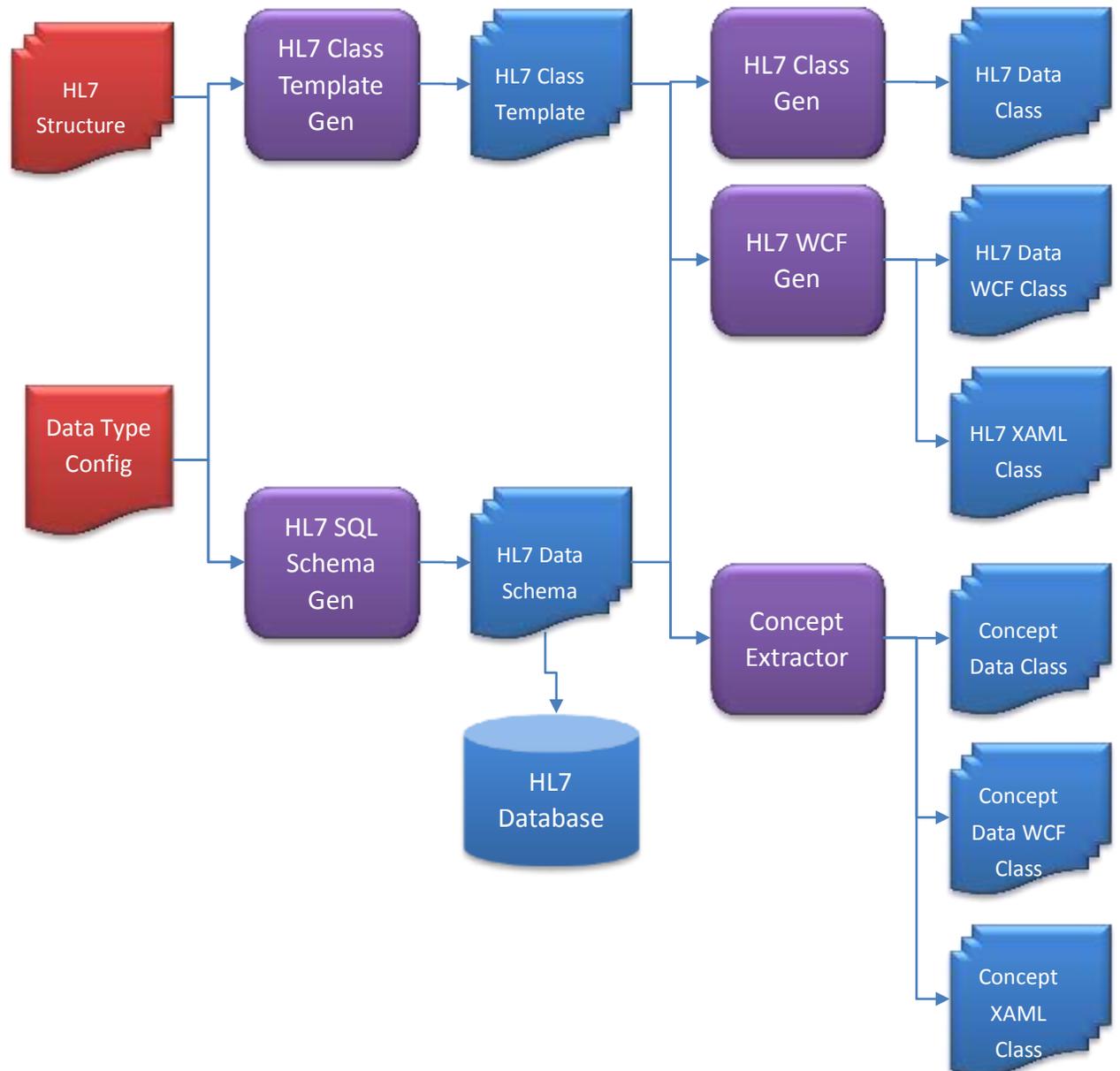

Figure 3. Process Flow of the High Level Concept Composer

HL7 Message Parser Library

HealthFabric provides an optimized and extendable HL7 message parser library with easy-to-use APIs.   This library can be embedded within interop-type applications.   In addition, a desktop Windows application, MyParser, is available as a reference implementation of the parser library.   This application inspects and edits the HL7 messages through a friendly graphical User Interface.   This tool also assists with integration efforts as the parsed field values are easily verified.
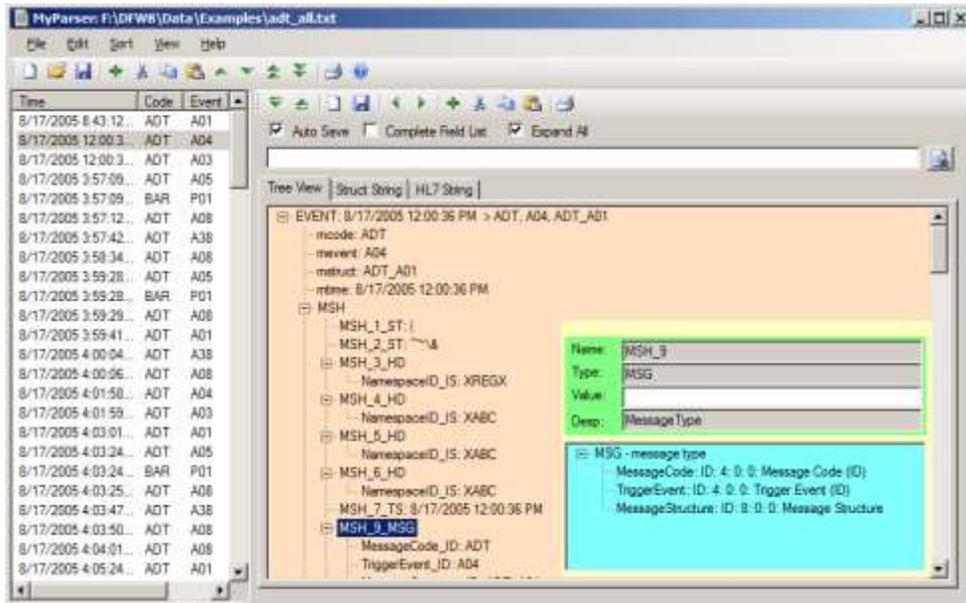

Figure 4. MyParser – HL7 Message Viewer and Editor

MyParser also provides a built-in help document in tree structure form representing the full HL7 specification from Events to the Data Type levels (Figure 5).
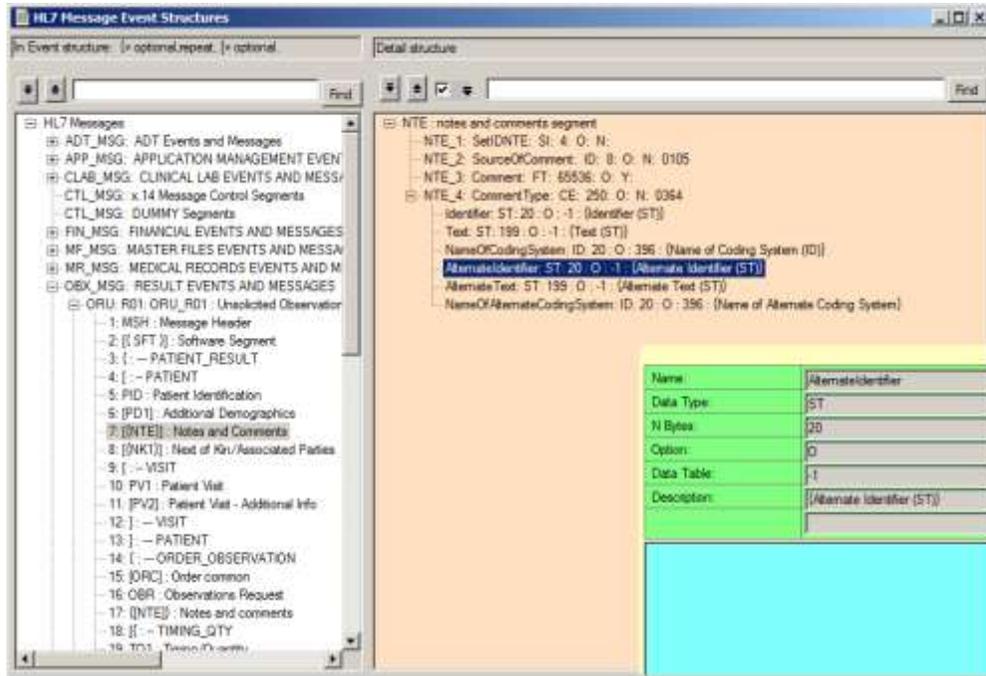
Figure 5. HL7 Tree Structure in MyParser

HL7 Database

The HL7 specification defines the data structure for Events, Segments, Components and Fields.   HealthFabric framework provides the tool set that automatically generates the database schema and its corresponding .Net classes and packages them together into namespaces.

The HL7 database schema represents all the HL7 data structures and provides the most compact, efficient and flexible central storage of the data.   This approach makes all the HL7 messages and their content actionable with standard database operations.   With this feature, all HL7 data are traceable and query-able to satisfy varied application requirements.

However, the HL7 structure tends to be complex making it difficult to easily use.   As a result, most source systems only value specific fields, leaving most other fields null or empty.   Ideally, it is desirable to customize the database and access objects to reflect only the actual data usage.   Fortunately, with the HealthFabric tools, High Level Concept Composer, and Virtual Health Record Composer, users are allowed to graphically establish their customized data sets and SQL and .Net codes are automatically generated for them.

High Level Concept Composer

The HL7 specification is a highly generalized and normalized concept structure.   Upon inspecting the HL7 structure closely, one will find that the definitions of entities are embedded within each message event.   It's often desirable (by application) to extract and package these entities into a class of its own.   For example, PID and PD1 describe Patients, IN1 for Insurance, and GT1 for Guarantor.   These entities are building blocks for establishing an application or partitioning a database for specific purposes or componentizing the database and application into modules for better management.

The High Level Concept Composer extracts the desired segments from the HL7 construct and generates the database schema, access object, WCF class, and XAML (Figure 6).

VirtualHealthRecord

The full set of HL7 and its derived subsets contain all the components and fields of the original form.   Their complexity often prohibits the view and access to the data easily. VirtualHealthRecord is a subsystem that works in conjunction with the HealthFabric infrastructure to create partitioned databases containing only data of interest.   These data sets can be used for real-time clinical decision support, care/case management and business intelligence/reporting.
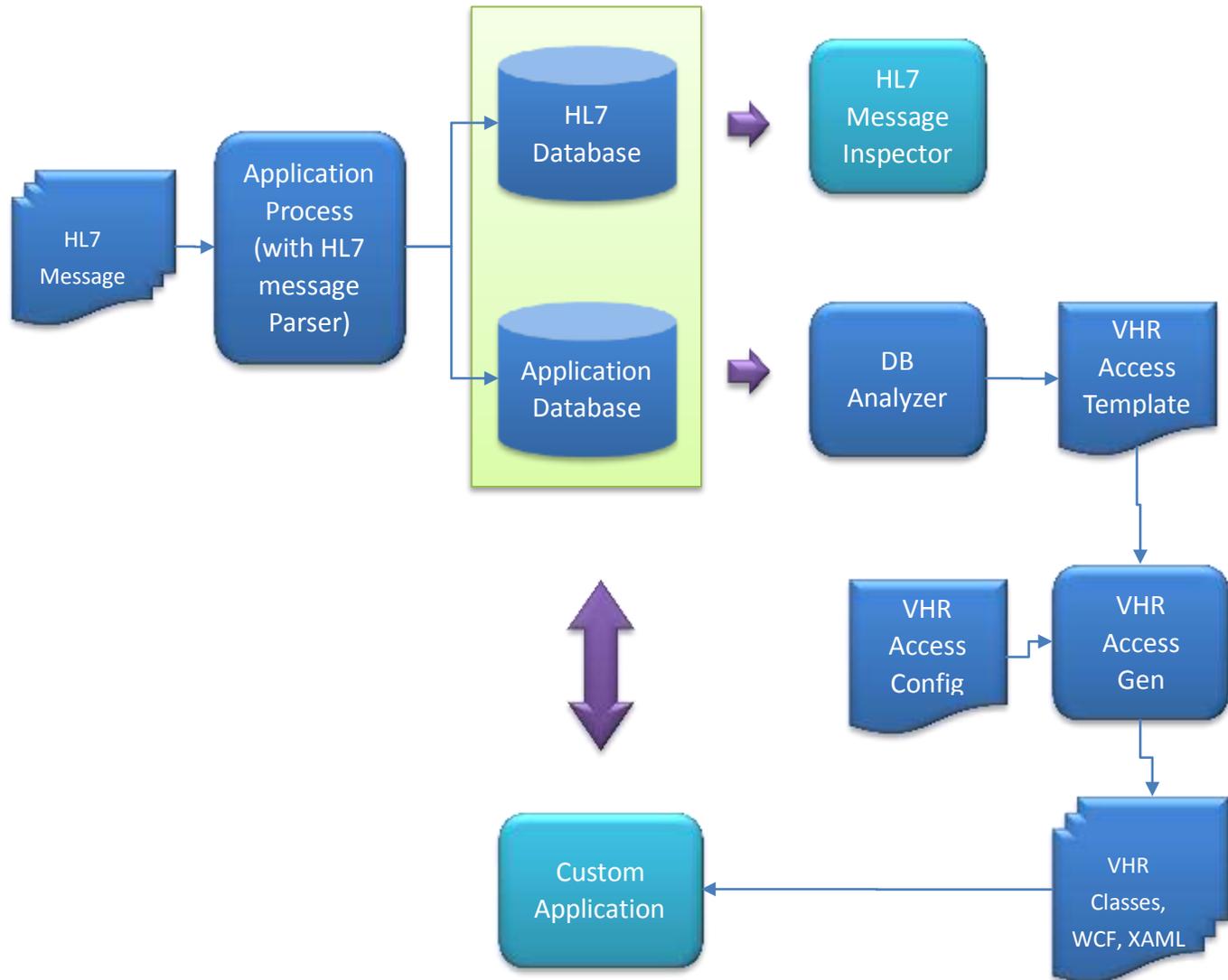
Figure 6. High Level Concept Composer Flow

Through the Database analyzer and Virtual Health Record Composer, the desired framework of DB schema, access data object, WCF class, and XAML UI is created and ready to use.
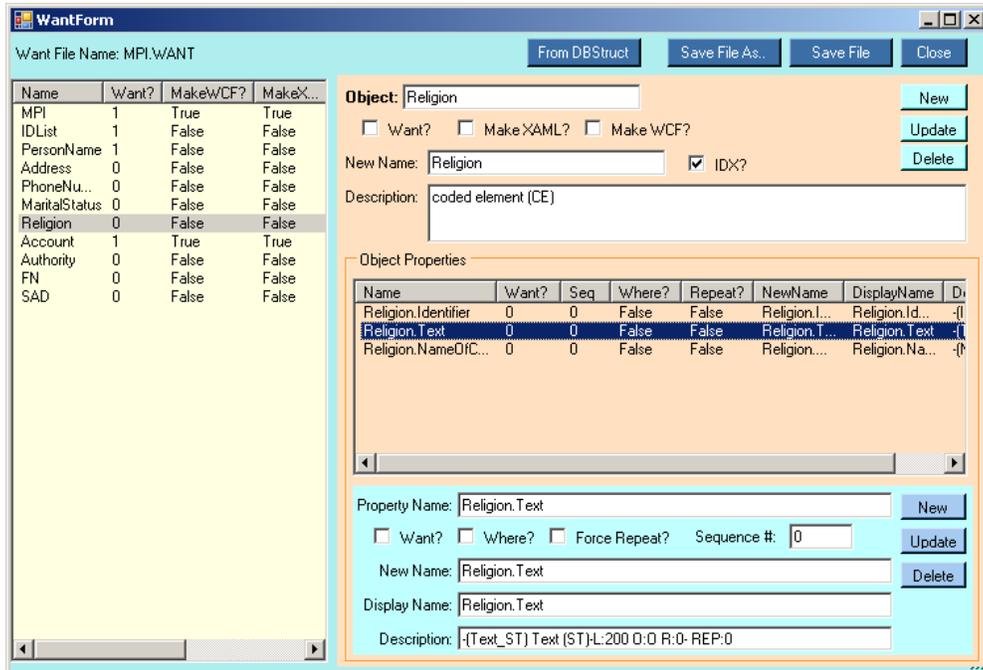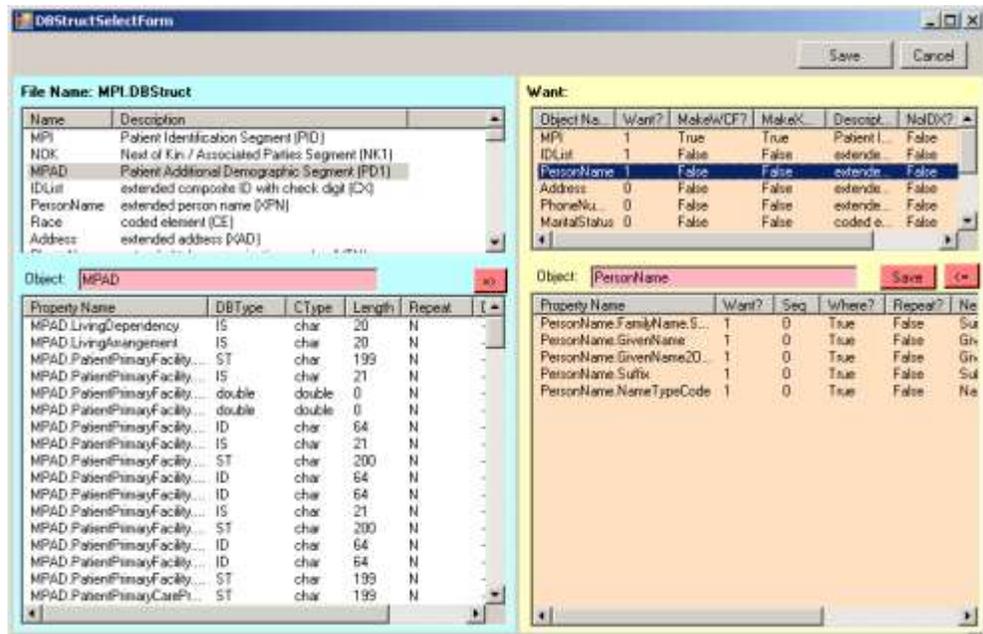
Figure 7. Configuration for VirtualHealthRecord

Figure 8. Setting of VirtualHealthRecord

Example Application

MDApplication is an example application uses the structure and libraries created by the HealthFabric platform.   Figures 9 and 10 are example screens of the application.   It's a Rich Internet Application (RIA) using Microsoft Silverlight.
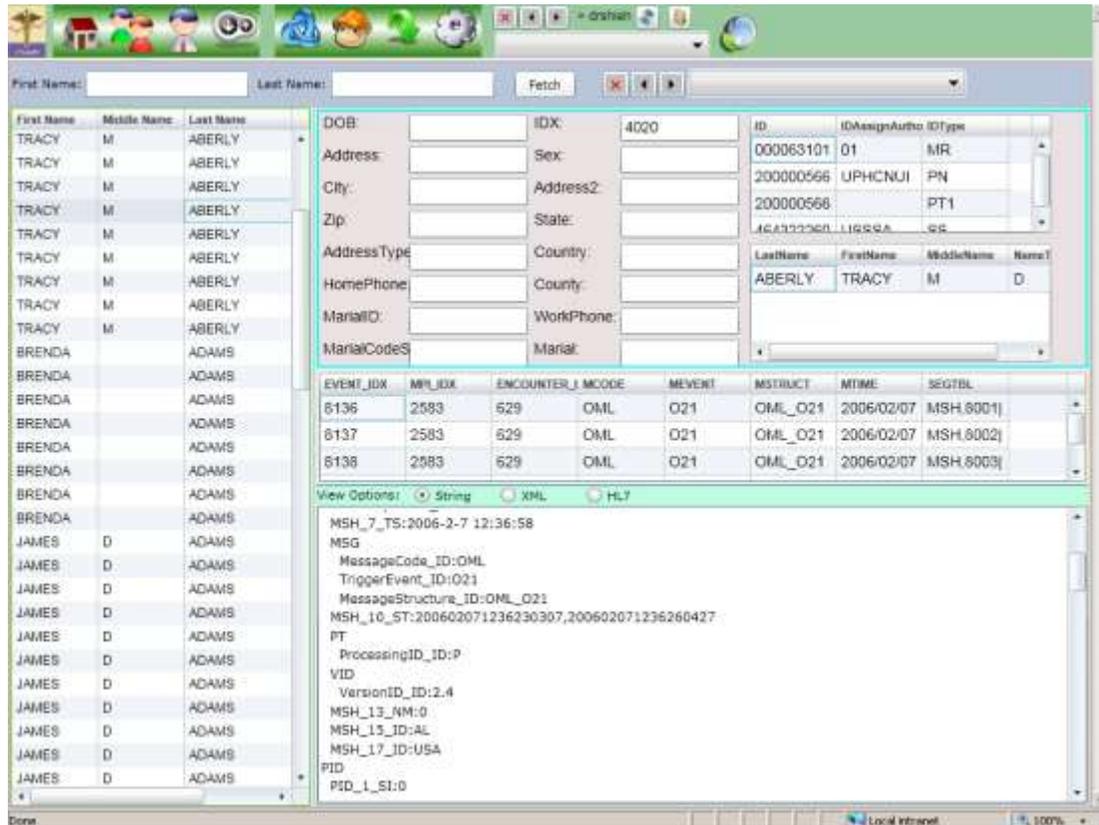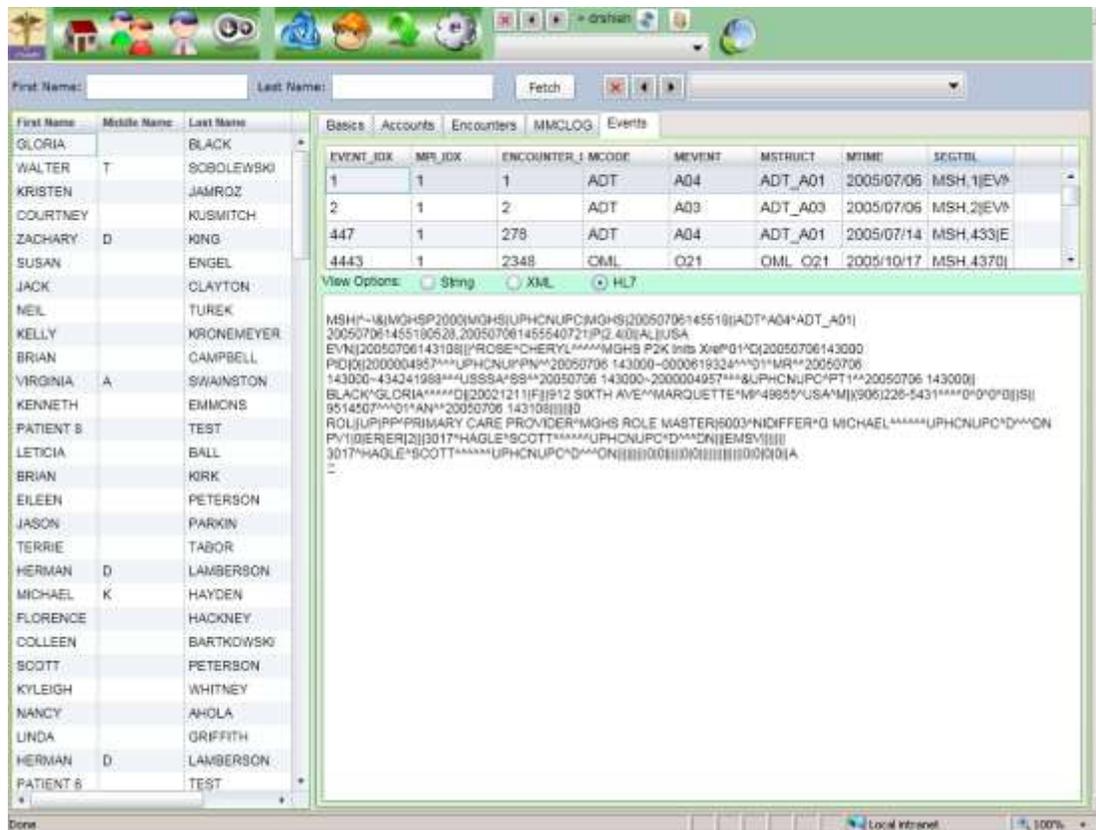

Figure 9.   ADT Screen of MDApplication

Figure 10. MPI Screen of MDApplication

Summary

df8health is an innovative provider of a healthcare information computing platform that helps organizations realize their Health Information Exchange (HIE) initiatives, increase quality of care, support CMS reporting, and improve overall operational efficiency. The HealthFabric suite of applications enable healthcare organizations to securely share medical and financial information, perform analytics and publish reports on longitudinal sets of data in real-time. The platform can be hosted locally within the health system or subscribed to Cloud services with the utmost stringent security policies.

Our goals of the HealthFabric platform include:

- aggregation of data across patient populations.
- integration of knowledge for decision support
- continuity of care over a patient's lifetime
- communication within episodes of care
- allow secure transmission of clinical information
- facilitate the adoption of electronic standards, standardized terminologies, electronic transactions and submissions
- reduce overall cost of existing information integration
- accessible to all

df8health provides the HealthFabric and VirutalHealthRecord framework to ease the complex problem of HL7 integration and data exchange.

HealthFabric and VirtualHealthRecord (VHR) provide unified access and management to all types of clinical and financial information. A templating feature of the VHR allows the selection of specific HL7 message types, segment types and/or data types from the HealthFabric database. This customization provides the flexibility to select only those data that are required for the specific VHR application.

Once the template has been created and applied, a solution set consisting of Microsoft's Silverlight XAML application and Windows Communication Foundation (WCF) services are automatically generated. This Web 2.0 application can be run as-is or can be further customized using .NET development tools to satisfy unique requirements. At runtime, the data from source systems received by HealthFabric are automatically propagated to the respective VHR application databases. This provides an overall huge advantage as each VHR application has real-time information for analysis, reporting and processing.
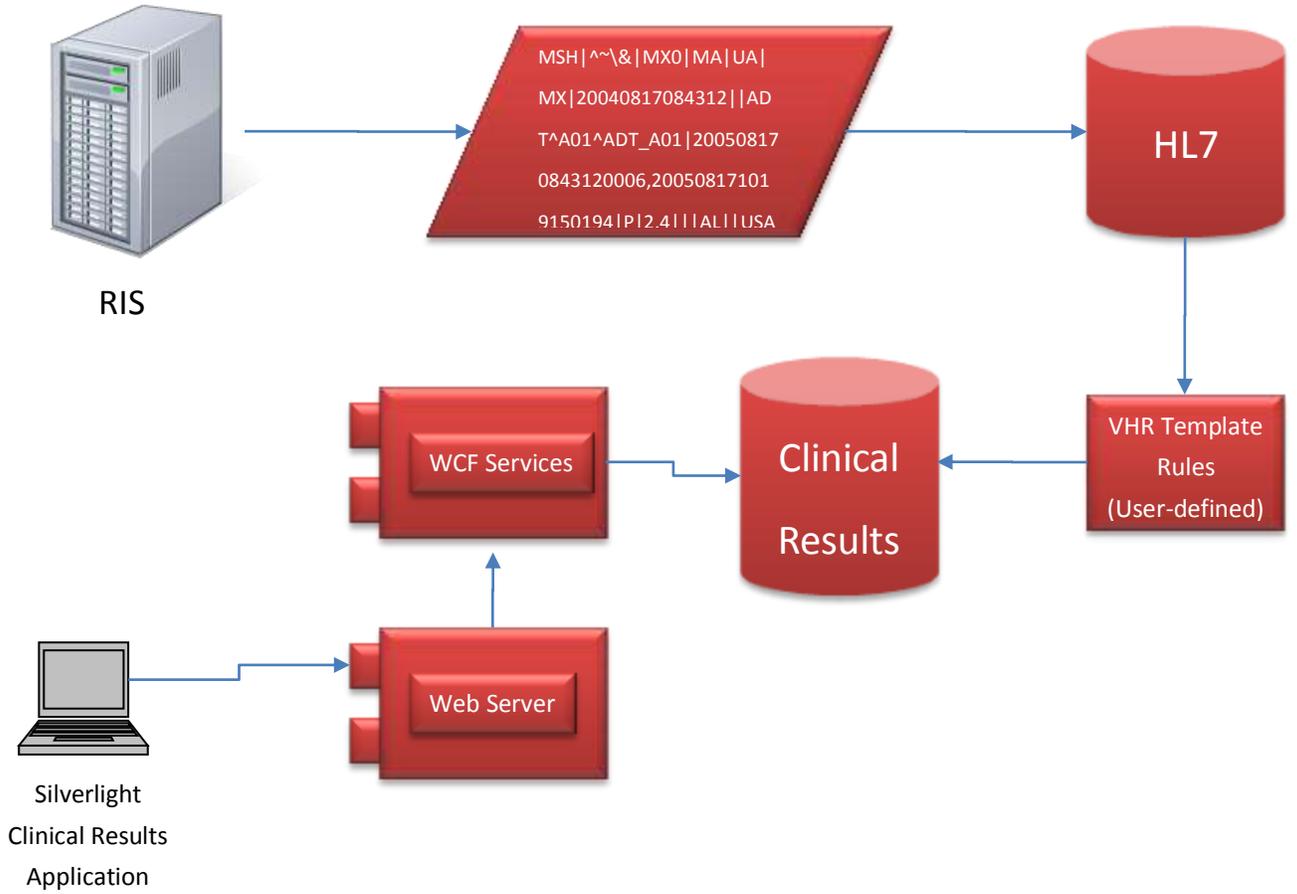
Figure 11. Conceptual View of a DF8Health Application