



Technical paper

Infor Cloverleaf Integration Suite

Executive summary

Many hospitals struggle with managing the increasing amounts of information coming from multiple data sources. Not only can it be difficult for healthcare providers to get to all the information they need, they can easily suffer from data overload.

To provide the best care and avoid unnecessary and costly redundancies, healthcare providers must ensure that relevant information is available and easily accessible to the right people at the right time.

Today's sophisticated technologies make it increasingly important to integrate disparate systems in a meaningful way. These systems share data by sending each other messages of various formats over various protocols. To work together, these messages must bridge differing protocols for transmission and must often be transformed so that data arrives at a destination in a format compatible with the destination's system.

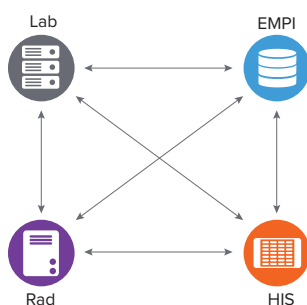
This paper examines a solution, Infor Cloverleaf® Integration Suite, which provides powerful and highly customizable integration capabilities to link hospital systems.



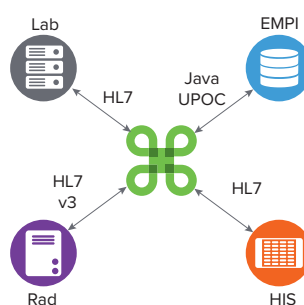
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Benefits of an integration platform



Point-to-point



Connected by Cloverleaf

Hospitals require connectivity between diverse systems. Although these systems need to share information, they often have different protocols for connectivity and different formats for recording the same data. It can be expensive and complex to maintain point-to-point connections among all these systems.

Infor® Cloverleaf Integration Suite supports many protocols for communication and is able to transform messages between many different industry-standard data formats. Cloverleaf acts as a common hub through which all systems communicate, eliminating the need for expensive point-to-point connections. The system supports standard variants of all formats, and allows users to create custom variants based on any of the standards.

Technical overview

Infor Cloverleaf Integration Engine lies at the heart of the Infor Cloverleaf Integration Suite. This market-leading, enterprise-caliber integration engine facilitates the movement of secure data through disparate systems within and outside your healthcare enterprise. It is a proven, reliable integration technology platform currently at use in thousands of facilities around the globe.

As the cornerstone of your interoperability strategy, Infor Cloverleaf Integration Engine can help you streamline processes to reduce administrative costs and save time—so you can focus on delivering quality care.

Additional components of the Infor Cloverleaf Integration Suite include:

- **Security Server**—Prevents unauthorized access with defined user IDs, passwords, and access control lists, facilitating HIPAA compliance, including the more stringent standards associated with ARRA.
- **Secure Courier**—Provides a lightweight, secure, bi-directional link between a hospital's Infor Cloverleaf installation and remote locations.

Cloverleaf-supported communications protocols

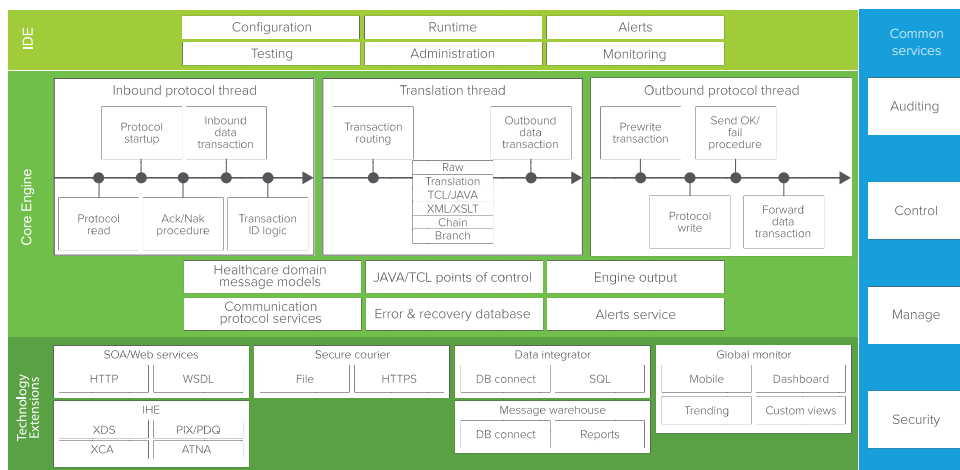
- Database (Oracle and SQL Server through JDBC)
- File
- Fileset FTP
- Fileset Local
- HTTP Client
- Java
- Link Async
- Prosper Async
- LU3
- LU 6.2 APPC
- LU 6.2 PPCF
- PDL Async
- PDL TCP/IP
- TCP/IP
- WebSphere MQ
- UPoC (User-written Tcl and Java scripts)
- Intelligent Broker

Cloverleaf-supported data formats

- HL7
- FRL
- VRL
- HRL
- EDIFACT
- HPRIM
- NCPDP
- X12
- XML

- **Secure Messenger**—Enables Secure Socket Layer (SSL) connections with other SSL-compliant application servers. SSL connections encrypt and/or decrypt data messages, while also providing the capability to authenticate the client or server. These types of connections may be configured in the Cloverleaf Integration Engine using TCP/IP, FTP, or HTTP protocols.
- **Message Warehouse**—Quickly and efficiently captures message information for analysis—without affecting message routing.
- **Global Monitor**—Provides a web-based interface that can access multiple Infor Cloverleaf environments from browsers and mobile devices.
- **High Availability**—Achieves the highest possible degree of availability for your Infor Cloverleaf environment, allowing you to accommodate planned and unplanned events while maintaining continuous uptime for your production sites and interfaces.
- **Web Services Adapter**— Allows you to easily build web services using out-of-the-box support for web service security, SOAP wrapper handling, RESTful web services, WSDL creation, and parsing.
- **Data Integrator**—Allows Infor Cloverleaf to integrate with industry leading databases such as Oracle, Microsoft SQL Server, and IBM DB2 through ODBC.
- **IHE Infrastructure Adapter**—Lets you integrate non-IHE enabled legacy applications into IHE frameworks.

Architecture



The Infor Cloverleaf Integration Engine can run on a variety of Windows and UNIX platforms. This engine receives messages from external systems through protocols such as TCP/IP, FTP, and Fileset, performs transformations on the messages, and sends the messages to their destination through the same set of supported protocols.

The Infor Cloverleaf Integration Engine records statistics to shared memory, where it can be accessed by a separate monitor daemon process. This daemon makes these statistics available to host server through TCP/IP and ultimately available to users running the Infor Cloverleaf IDE through a host server. The daemon also provides an alert mechanism, which can alert the user when user-defined trigger conditions occur.

The Infor Cloverleaf host server acts as a bridge between any number of Infor Cloverleaf IDEs (client GUIs) and the engine and monitor daemon. This allows an Infor Cloverleaf instance running on any platform to make itself accessible to users running the Infor Cloverleaf IDE on a Windows machine. The host server interacts with the Infor Cloverleaf IDE through Java RMI (remote method invocation) and accesses the Infor Cloverleaf Integration Engine through the local file system and monitor daemon through TCP/IP.

In addition to the Infor Cloverleaf IDE, Infor Cloverleaf Global Monitor is a web-based application tool that provides a way to monitor Infor Cloverleaf instances through any web browser, and support mobile devices running IOS and Android operating systems. Global Monitor accesses the host server through RMI and monitor daemon through TCP/IP, and contains a Tomcat custom servlet to interact with client browsers through http or https.

Advanced security can be configured through Infor Cloverleaf Security Server. Residing on a separate machine from any host servers accessing it, Infor Cloverleaf Security Server keeps access control lists (ACLs) on an embedded derby database. When a user attempts to perform a task, the host server will query Infor Cloverleaf Security Server through RMI to determine whether the user is allowed to perform the task.

When a remote location, such as a clinic, needs a secure link to a hospital's Infor Cloverleaf environment, Infor Cloverleaf Secure Courier provides a lightweight solution to send and receive messages. The Secure Courier server resides in the hospital, where it sends and receives messages to and from the Infor Cloverleaf Integration Engine directly through the local file system. It uses a Tomcat-based web service to exchange encrypted messages using https with Secure Courier clients in remote locations. Secure Courier clients can exchange data with external applications using file and TCP/IP protocols.

The power of Infor Cloverleaf can also be extended by interfacing it with web services through the Infor Cloverleaf Web Services Adapter, which allows Infor Cloverleaf to act as a web services client or server. The Web Services Adapter provides an API that allows Infor Cloverleaf to access web services through SOAP.

Core Components

- **Raima embedded databases**—All messages passing through Infor Cloverleaf are stored in queues between any actions that are undergone in the engine. These queues are backed by an embedded high-performance Raima network-model recovery database to ensure message continuity and integrity can be recovered in the event of an unexpected shutdown by simply repopulating the queues from the database. Messages that encounter errors are also stored in a similarly designed error database; from there they can be modified and re-sent to various points in the engine. A third embedded database acts as a cache for Infor Cloverleaf Message Warehouse, where messages are stored until they are flushed out to an external relational database.
- **Threading Module**—All inbound and outbound protocols, as well as translations (message transformations), are run in their own threads. These threads communicate and pass messages to one another through an interthread communications library. A single command thread handles external events and schedules the protocol and translation threads to run. To utilize parallel processing potential, the translation threads can be configured to run concurrently.

- **Data logging**—A Saved Message Archive Tool (SMAT) allows all messages coming into and going out of the Cloverleaf engine to be written to files. Message content and metadata are written to separate files, where they can be kept for historical purposes, viewed in the IDE, edited, and resent to any threads in the Infor Cloverleaf site.
- **Routing**—Routing is the way Infor Cloverleaf determines which messages go where. In practice, this is done by creating routes from inbound protocol threads to outbound protocol threads. A transaction ID based on the message's content is defined by the user, which is used to determine which routes a message takes. Translations can be configured to occur during these routes. An intersite routing tool is also provided so that Infor Cloverleaf sites on different hosts can route messages to one another directly using the interthread communications library.
- **Translations**—Infor Cloverleaf offers a number of built-in tools to transform messages through mathematical, logical, and iterative operations or lookup tables. The user can define how these tools are used in the IDE's translation configurator and save a particular translation into a translation file. These files can be tested in the testing tool to determine whether they work as designed before deploying in a production environment. When these tools alone are insufficient, the user can write scripts in TCL or Java to transform messages as they wish.
- **Scripting**—Embedded TCL interpreters and Java Virtual Machines (JVMs) allow users to run scripts that control message flow as well as transform message content at various points in the Infor Cloverleaf engine. The user can write these scripts in an external text editor and import them to Infor Cloverleaf, or use the built-in editor.
- **Database integration**—Infor Cloverleaf Data Integrator provides ODBC drivers that allow Cloverleaf to archive inbound and outbound messages to an external database. Support for reading and writing messages directly to and from Oracle and SQL Server databases by SQL statements and stored procedures through JDBC is supported in Infor Cloverleaf version 6.0.
- **Access control**—Infor Cloverleaf Security Server stores ACLs in an embedded derby database. Whenever a user attempts to carry out an action, the host server will query the ACLs through RMI to determine whether the user has permission to carry out that particular action. Users can be granted full read/write or read-only access to various areas.
- **Monitoring**—As the Infor Cloverleaf Integration Engine records statistics in shared memory, a separate monitor daemon process accesses shared memory to report these statistics to the user. The user can configure alerts to have the daemon send an email, pop up a window, or run a script when trigger conditions are met. These trigger conditions can be based on system statistics such as CPU and disk usage, or based on Infor Cloverleaf variables such as queue depth and protocol thread status. The monitor daemon communicates with the host server or directly with Infor Cloverleaf Global Monitor through TCP/IP.
- **Encryption**—Infor Cloverleaf Secure Courier uses AES 256-bit encryption and transports messages between the client and server using TLS v1 HTTPS.
- **Tomcat**—Tomcat serves as the web services container for both Infor Cloverleaf Secure Courier and the Infor Cloverleaf Web Services Adapter.

Key Features

- **UPoC**—Customers can customize Infor Cloverleaf at various access points, known as User Points of Control (UPoCs) by writing scripts in either TCL or Java. Scripts can be used to control both message content and flow. TCL scripts for commonly needed tasks such as HL7 ack/nak procedures are shipped with the product and can be modified by the user if desired. There is also an active community where customers often share their scripts with other customers who have similar needs.
- **Message archiving**—All message content passing into and out of Infor Cloverleaf can be archived to an external relational database of the user's choice, where the data can then be accessed for any purpose the user may need, such as calculating statistical information or keeping an audit log. Messages are first cached in an embedded Raima database, from which they are periodically written out to the external database by executing SQL statements through ODBC (JDBC in 6.0). This flushing of the cache is triggered by the monitor daemon.
- **Testing tools**—Infor Cloverleaf provides GUI and command-line testing tools that enable message translation configurations and data files to be tested without actually sending messages through the Infor Cloverleaf Integration Engine.
- **Generic Java driver**—The generic Java driver provides an API that enables users to create Java applications that directly access Infor Cloverleaf. Through this API, Java is treated as an Infor Cloverleaf protocol, and external Java applications can exchange messages directly with Infor Cloverleaf Java protocol threads.
- **Buildable Object Xchange (BOX) Migration Utility**—Provides the ability to create and package custom or standard interfaces for ease of deployment. Boxing reduces the need of creating interfaces from scratch and provides the ability to quickly share BOXed interfaces using migration wizards.

Conclusion

Take advantage of Infor Cloverleaf's unparalleled adaptability to simplify your healthcare infrastructure. Infor Cloverleaf provides full support for market standard protocols and message formats, as well as the ability to define your own variants, so any application can communicate with the rest of your healthcare ecosystem. The ability to write your own scripts means that you will be able to control message flow across these connections—no matter how complex the requirements. Whatever your needs are, the Infor Cloverleaf Integration Suite is ready to meet them.



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