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white paper

Architecture Matters: A Services-Oriented Architecture for Unisys AirCore LOYALTY

Realizing business agility through a modern system architecture

expertise

Loyalty Marketing: Architecture Matters

For over a decade, Unisys Global Transportation has offered the Customer Loyalty Solution. While robust and successful, the limits of its architecture are becoming apparent.

Unisys designers of a modern, Service-Oriented Architecture need only to look to the Airline Core Systems Solutions (AirCore) passenger services solution for a model.

The commercial drivers for reengineering the Customer Loyalty Solution to the future AirCore LOYALTY system are compelling. Meanwhile, the AirCore architecture exemplifies solid support for six “must haves” that are crucial to a Loyalty Marketing solution.

When fully deployed, AirCore LOYALTY will provide the various types of agility that should be the ultimate commercial goal of this system, and indeed any system.

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Architecture Matters

Unisys Loyalty Background

Unisys Global Transportation has offered its Customer Loyalty Solution (CLS) to airlines for over a decade. CLS is at the heart of the Loyalty marketing business function at such major carriers as Cathay Pacific Airways, Northwest Airlines, Vietnam Airlines and Air Berlin, among others.

Unisys has had a long and successful history of providing its air transport clients with leading edge solutions. In accord with this strategy, Unisys plans to re-architect CLS in order to achieve the benefits of a modern, Service-Oriented Architecture (SOA).

This white paper examines the commercial drivers for the planned migration to a new architecture, using Unisys AirCore as the exemplar for its design. The nature of new CLS services is discussed in both technical and business terms. The paper goes on to discuss six requirements of high interest for a Loyalty solution and how they can be realized via the new architecture.

Finally, the author briefly discusses six types of added agility provided by this type of solution.

Business Imperatives for the Unisys Loyalty Program

Historically, Unisys CLS has been an important part of Global Transportation's solutions portfolio for the airline industry. As a proven frequent flyer system for airlines just launching or expanding their initial frequent flyer program (FFP), the solution has proven to be invaluable.

Commercially, the appeal of CLS as a Loyalty program spans the spectrum of airline loyalty experience, program design, business strategy and regional concentration. As a full-service IT solutions provider for airlines globally, this range of appeal is both important and gratifying to Unisys.

If initial releases of CLS appealed to the classic airline FFP marketplace, the current release of CLS already includes important extensions that reflect the next level of Loyalty solution requirements. These features include true multi-language integration and support, member self-service features enabled via a Web browser, real-time promotion generation and initiation and multi-program capabilities.

Nevertheless, there are real benefits to be realized by re-architecting the system to an SOA. At a high level, we see benefits in technical, functional, commercial and strategic areas, including:

- The promise of efficiencies in creating new functionality or modifying existing functionality
- Platform independence, since the execution environment is independent of the functionality, which is contained in and described by web services
- Division of responsibility: technical staff can concentrate on technologies while business staff can concentrate on business services and processes
- Deployment on a modern technology base increases the number of available trained resources and lowers total cost and risk
- Faster implementation and easier systems integration to external (local) systems and databases

Moving to an SOA will help Unisys expand the reach of the new solution beyond its traditional airline market to include retail and banking segments.

Our AirCore development experience is invaluable. Designers will not be defining the architecture from a blank sheet of paper, but re-architecting our proven CLS solution to integrate with a proven SOA solution, AirCore.

What Is a Service-Oriented Architecture?

SOA Is a Design Approach

A Service-Oriented Architecture relies on loose coupling (that is, independence) among the various software agents at work. This has been made possible by the development of web services technologies, the most widely adopted distributed computing standard in the IT industry's history.[1]

[1] Some information courtesy of Understanding SOA with Web services, Newcomer, Eric and Lomow, Greg. Addison-Wesley, 2005.

An SOA is an architectural style that guides every aspect of creating and using business services throughout their lifecycle (from conception through retirement).

An SOA is a way to define and provision an IT infrastructure to allow different applications to exchange data and participate in business processes, regardless of the operating systems or programming languages underlying those applications.

Services Make It Work

Services are relatively large, basically unassociated units of functionality. We can think of them having two components: the functional code component and the service description component. The code describes what it will do when executed; the service describes where, when and how it will execute.

The service description carries the processing details:

- The network address for the service
- The operations it supports
- Its requirements for reliability and security
- The ways it can be transacted
- A schema for the data contained in the message

By separating the code (functionality) from the processing details, services can be implemented, modified or recombined very easily. During an implementation, they are simply mapped to the list of executable agents for that particular implementation.

Services reside in the Services Library. Since one can compose reusable services from the library into larger services quickly and easily, this provides the added agility needed to respond to business and operational changes. One can also aggregate web services to encapsulate multiple other web services.

Indeed, some vendors are now selling generic services (such as “validate credit card”) that can be bought and added to a library.[2] In this way, SOA enterprises can achieve cost synergies in code creation and support.

Common business operations, such as “get customer” or “place an order,” are separated from variations in the underlying software platform.

[2] In the near future, many SOA enterprises will have a significant component of reusable web services in their Service Library that they have not in fact created.

These service characteristics mean that IT investments can be planned around the realization of operational business needs, versus the features of any individual product or software technology that has been chosen.

AirCore Architecture

The launch of AirCore reflects Unisys multi-year investment to re-architect its widely implemented USAS (Unisys Standard Airline System) for passenger services, including reservations, departure control, load planning and other modules. Unisys architects have already resolved performance, security, and availability issues which are now a part of the new AirCore architecture.

AirCore comprises a set of integrated components, each with a formal interface layer. And each AirCore component is implemented as a subsystem.

The subsystems can be thought of as being arranged hierarchically. Thus lowest level components such as SHARED (shared system utilities) and AGREEMENTS (database of commercial agreements), support mid-level components such as FLIGHTS (scheduled capacities) and SPACE (flight inventories). These in turn support highest level functionality captured in components such as BOOKING (booking transactions).

AirCore uses a web browser-based user interface that is implemented as Java Server Pages and Java helper classes.

The AirCore architecture separates the various functional roles into discrete layers in order to achieve a loose coupling that helps in realizing the hoped-for benefits.

Adhering to a layered software architecture means one can:

- Achieve functionality within the proper layer, not in code embedded within applications, improving performance, support, flexibility
- Abstract a layer of services for members, partners, users, etc.
- Quickly introduce new presentation channels
- Distribute layers on different tiers onto multiple servers and application platforms
- Achieve scalability requirements

- Integrate external systems and components.

This approach allowed Unisys to design with a "no limits" approach. Unless deliberately parameterized, there are essentially no limits to many aspects of the solution, including:

- Storage size
- Record size
- Maximum number of flight segments
- Booking window size

Seperation of Software Layers

Architectural Features Important to the Loyalty Solution

Unisys architects have identified six operating characteristics that are crucial for a loyalty solution. We can investigate how well they are achieved by the SOA design.

Loose Coupling: Interface, Technology and Process Coupling

AirCore fulfills the requirements of a service-oriented architecture.

All functionality in AirCore is provided by services. Public services are designed and implemented to be location transparent. The remote interface provides the contract for each service. Loose coupling is accomplished by using data transfer objects among layers and service consumers and providers.

The AirCore business process layer consists of two layers of services: coarse-grained workflow services and fine-grained service Application Programming Interfaces (API). The workflow services assemble lower level service APIs to form complex business transactions (across multiple subsystems or within one subsystem). Each service in the Service API layer performs a small specific task. This is where business objects collaborate, business rules are applied and the persistence state is changed. Infrastructure services such as logging, persistence and messaging also exist.

Data stores include most Relational Database Management Systems (RDBMS) and non-relational data sources such as object databases, flat files and XML data. When interfacing to an external component system, the persistence of the external data is assumed to be the responsibility of this external system.

It is these characteristics that help achieve the goal of loose coupling. Now we can have hardware and location independence, and we can implement and recombine services as needed for future requirements.

Open Standards Solution

Business managers have been demanding Open Systems for years; with a well-designed SOA architecture, this is finally achievable.

The Unisys AirCore architecture supports open standards in both design and toolsets. This is only fitting, since Unisys is an active member of standards-setting bodies both within the Transportation industry and within the Information Technology environment. Some examples:

Object Management Group (OMG)

Originally established to create and promote specifications for the Common Object Request Broker (CORBA), the OMG promulgates specifications that define Web Services Description Language (WSDL) and mappings to C++ and CORBA to WSDL mappings. Unisys is a founding member of OMG, perhaps its largest contributor and most active participant, and sits on the OMG Board.

International Air Transport Association (IATA)

Unisys is a long-time member of IATA, and, as a leading vendor of Passenger Services Systems, has dedicated staff to ensure that all products adhere to IATA standard specifications. This standardization of transport and travel terminology, master data, and processing requirements is built into the AirCore functional modules, making LOYALTY a prime benefactor.

OpenTravel Alliance (OTA)

The OTA is a trade group coalition that defines requirements for interconnectivity of systems among various participants in travel and transport sectors. The chief emphasis is on achieving communications interoperability. Unisys is an

OTA member company and reviews all OTA framework specifications as issued.

J2EE

Our services platform is based on open, standards-based tools and components. Chief among these is the Java 2 Platform, Enterprise Edition, or J2EE. Web server, servlet engine, session beans, entity beans, message-driven beans, JDBC, JMS, JNDI, and many other APIs and services are provided, and designed on specifications for open systems. J2EE implementations are available from most of the major IT vendors. There is a very large and active J2EE user community.

Support for Multiple Interfaces and Presentation Channels

The SOA Interface Layer includes components to handle interaction between channel-specific presentation components and process components. Each Interface Layer implementation can be specific to a presentation channel—for instance, one can physically implement different design patterns across different presentation channels.

Based on the inherent separation of web services (functionality) from its execution agent (technology), we see that our SOA handles all types of user interfaces:

JSP	XML/XSL	WAP
PDA	iDTV	rich GUI fat clients

These interfaces support the handling of externally-generated triggers and events to the architecture, a common feature within a robust loyalty solution.

Just as important, new presentation channels and their business requirements for data presentation, supported functionality and workflows to be invoked can be decided by business managers and implemented quickly within the technical architecture by technologists.

Design for Multiple Invocation Styles

The architecture design makes it possible for a service provider to be reused in many different scenarios and invocation styles, including:

- Asynchronous queuing
- Request/response
- Request/callback
- Request/polling
- Batch processing
- Event-driven, publish/subscribe.

This flexibility of invocation is vital to a loyalty solution, especially when considering the demanding back office requirements of loyalty.

Consider batch processing: it would be difficult to identify another application with more “connections” than a loyalty solution. Loyalty’s in-bound and out-bound batch requirements are substantial and somewhat intricate. They are also of vital importance, as they are often the source of billing information and, ultimately, revenue realization.

The AirCore solution contains a robust engine for batch processing, within the AirCore SHARED component. The SHARED Batch Framework is a subsystem for batch process management. It supports manual and automatic event triggering, as well as all aspects of job staging and scheduling.

High Security, with Flexible Controls

Loyalty applications have been compared, not without justification, to a banking application. Access to membership data, transactions that affect account balances, and policy-sensitive functions and crediting require almost the same level of security in loyalty as is needed by banks.

Using an industry-standard Java API for Authentication & Authorization Service (JAAS), security applies to authentication (governing application access, and managed within the Interface Layer) and authorization (governing access to functionality, managed primarily within the Process Control Layer). Field-level controls are supported: a user in a given role can display fields others cannot see, while another user may be able to update some fields that others can only display.

Most practitioners state security requirements within a flexible Roles & Rights framework. Our SOA achieves this, because the Process Control Layer manages access to the Open Lightweight Directory Access Protocol (OpenLDAP).

In this way our architectural design decouples security from the application, so that a variety of implementations could be enabled[3] , with varying security policies and providers. The use of OpenLDAP and JAAS are technology implementations in our solution that enable the security function.

This interaction between the Interface and Process Control Layers[4] support multiple logon modules. For example, when an employee logs onto the system, functionality can be invoked to validate them in the Roles & Rights data repository, but also in an external Employee Master File.

If the employee's status is not recognized by the Employee Master File, the system invokes a response, such as:

- Allow logon at a default lower Roles and Rights authorization; send an alert to a manager
- Disallow logon with or without an informative response message.

Support for Implementation of Local Code

The invocation of services is done through use of the service contract approach, together with service-level security. This makes it possible to provide services (simple or combined services) that can be invoked only by a single entity. This can be true in the case of an independent system used by a single company or in a multi-host environment. Either case permits creation of custom services or local code that is restricted in its invocation and use to a particular calling entity.

In this way, one can think of a multi-host environment as having switches that permit the various users to invoke custom code for their business requirements.

System Flexibility and Performance

Six Ways To Realize Agility

Nothing in business is as consistent as change. Certainly the loyalty business function illustrates this truth. Loyalty solutions must be adaptable in ways that produce real commercial and operational agility for the business. Our SOA architecture provides this agility[5] in six identified ways:

1. Agility in terms of finding the right service. As new business needs are defined, it is vital to locate and implement appropriate services quickly. Web services can be located quickly and efficiently, whether provided by IT, another user department a partner, or a 3rd party vendor.
2. Agility in terms of changing service providers. Our architecture prevents vendor "lock-in" and thereby promotes cost efficiencies.
3. Agility in terms of quickly assembling services into applications. An agile business can respond to new business opportunities and threats quickly. Services designed with abstract interfaces that are not tied to a single business process are ideal for assembling quickly into new applications. Web services standards such as WS-BPEL provide facilities for composing services quickly and easily.

[3] For example, Oracle, MSSQL, and Windows Security.
[4] For example, it is the Interface Layer that actually tracks a user's state and their Roles & Rights. Thus the Process Control Layer is said to be "stateless."

[5] This taxonomy of agility is provided by Newcomer, Eric and Lomow, Greg. Understanding SOA with Web Services. Addison-Wesley, 2005.

4. Agility in terms of supporting new service requesters and new delivery channels. Loyalty is a prime example of growing a business by offering existing services to new customers, often served by new or alternate delivery channels. Loosely-coupled, platform-independent services can be quickly adapted to support new channels.
5. Agility in terms of dynamic capacity adjustments to meet variable business demands. Dynamic provisioning of services is enabled automatically, since services (representing discrete business functions) are dynamically discovered and are location-independent. Thus it flexes as processing needs vary over time.
6. Agility in terms of using existing services to support new and unforeseen business requirements. Services in our design are not tied to a single business process; they can be easily recombined and adapted to meet a new business need.

What About Performance?

Reliable, efficient system performance is crucial for a Loyalty marketing system. Looking at recent performance data for AirCore, one finds some real encouragement.[6]

In an extended performance test performed in July 2007, Unisys ran a fully configured the AirCore Passenger Reservations system non-stop for five days. The system files and settings represented a prototypical airline of 100 million annual passengers in size.

The system's database before the test comprised 18.1 million booking sales records (do not think of PNRs!). During the performance test we executed 4.9 million more booking transactions of various types, bringing the total to 23 million booking records. This is an increase of 27% within five days. We averaged 57 booking EOT transactions per second.

Throughout the test, we ran full daily and periodic system maintenance programs.

There were no outages and no degradation of performance. We conducted an extended series of performance measurements, ranging from simple to complex transactions. Five of the test results, comparing actuals to target results, are shown in Figure 1.

The test results helped to confirm our optimism about the system architecture's resiliency and efficiency.

Naturally this is encouraging for the AirCore Loyalty program, since we will be relying on the same architecture for our future system.

AirCore Performance Test Results

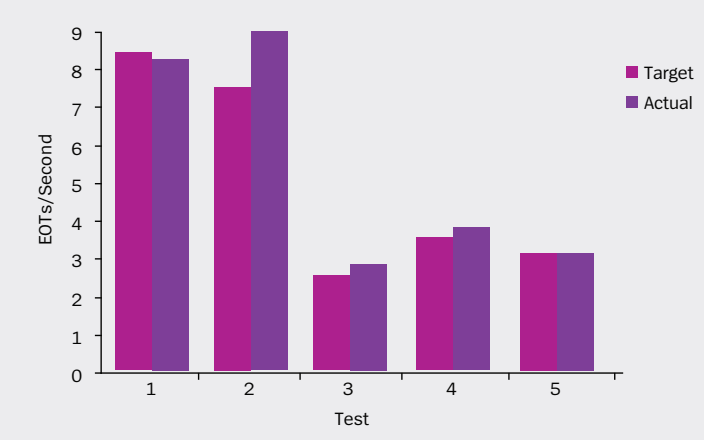

Figure 1. Comparing Actuals to Target Results in Five Tests

[6] This is particularly gratifying, since several key high-performance technologies were not on the market at the time Unisys actually began the AirCore conversion investment.

Conclusion

Loyalty marketing systems are designated as mission critical by many Loyalty providers. Hence the architectural design of a particular system must fully support their required business demands.

As Unisys makes plans to migrate the current Unisys Customer Loyalty Solution to a modern architecture, one finds that AirCore offers an attractive model for Loyalty. Its SOA provides support for six key loyalty requirements. Its flexibility within a secure, high-performance environment is ideal for a Loyalty marketing solution.

Once completed, the development effort should result in a Loyalty solution that truly delivers the various types of business nimbleness and flexibility that are envisioned.

About Unisys

Unisys is a worldwide information technology services and solutions company. We provide consulting, systems integration, outsourcing and infrastructure services, combined with powerful enterprise server technology. We specialize in helping clients use information to create efficient, secure business operations that allow them to achieve their business goals. Our consultants and industry experts work with clients to understand their business challenges and create greater visibility into critical linkages throughout their operations. For more information, visit www.unisys.com .

About the Author

TERRY L. ELLIOTT has over 25 years experience as a managing consultant, systems architect, and financial analyst. He specializes in helping organizations plan for, implement, integrate, and ultimately profit from advanced systems technologies.

His experience includes marketing and business development, revenue management technologies and practices, risk management, financial planning and forecasting, and change management. He often uses a Business Architecture Modeling framework to visually depict the current and future business processes targeted by the introduction of new technology. This helps build understanding and consensus by all parties on the business results that can be achieved—and on the changes that may need to take place.

Within the Unisys Transportation Practice, Terry has consulted on Web commerce initiatives for large airports and for international airlines. He recently led two teams in this regard, one for the largest airport in the world, one for the fastest-growing airline in the world. He has taken a thought leadership position on the emergence of low-cost carriers, and spoken to industry conferences in this regard.

Outside of Unisys, Terry helps start-up companies and existing small businesses asa Counselor with SCORE, a non-profit organization affiliated with the US Small Business Administration.

Areas of Expertise

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Old Dominion University, (Norfolk, Virginia): Political Science, specialty in Asian Studies
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Printed in U S America 03/08

BL100115-100