

# From Legacy to Open Standards:

The Benefits of XML Messaging to  
the Air Transport Industry

**ARINC**

**SITA**

## TABLE OF CONTENTS

2	Executive Summary
4	Current Industry Situation
6	XML and Web Services Technologies
10	Standards Efforts
12	XML Benefits to the Aviation Industry
15	Industry-Level Adoption Strategy
18	Summary

# Executive Summary

The airline industry has a rich history when it comes to leveraging communications technology and is arguably one of the most connected industries in the world. Equally unique is the vast amount of business-to-business communications required to keep the airlines operating. The industry developed its own standards for business-to-business messaging decades ago, to automate operations and increase safety. Type B messaging in particular provides assured messaging industry-wide, and some of the most critical applications in the industry rely upon its unique features for data exchange. Type A transactional messaging as well currently uses industry-specific protocols and formats that are often implemented with legacy networks.

While Type B messaging has served the industry well, it is not extensible to meet the needs of more demanding newer applications with much more complex data. And while there are Type B approaches that leverage the benefits of IP networks, current implementations in the industry are still constrained to using either industry-unique standards (e.g. MATIP) or proprietary middleware solutions (MQ). Leveraging open standards such as XML for messaging and using the Web



Services communication framework have the potential to transform how business-class messaging is accomplished in the industry.

XML and Web Services stand to revolutionize how business-to-business communications are done between applications, just like the World Wide Web and HTML have revolutionized our ability to access and view data across the Internet. The XML standards have been around for nearly a decade and are used by most modern applications and data communications in many airline internal environments today. Used in

conjunction with SOAP, a messaging protocol built around XML, and Web Service extensions for security and message reliability, this open standard communication framework can eventually replace current approaches to Type B message, while providing a much more flexible platform for more sophisticated data structures and messaging in the future.

One of the primary benefits of XML, as well as XML-based SOAP and Web Services, is that they are open standards. The technology is platform and programming language independent, and has enormous support from the IT industry at large, both in terms of commitment to standards groups, and investment in products and programming tools. In addition to the significant benefits of being an open standard, the power of XML from a technology perspective is that it is a self-descriptive, structured formal language and therefore is machine interpretable. This enables an application to receive

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and act on XML-based messages with reduced integration effort, with little or no knowledge of the sending application. This loose coupling and self-specifying nature of XML-based messaging reduces the application development effort to integrate business applications, and decreases maintenance costs over time as changes are required.

The Air Transport Industry (ATI) will reap several specific benefits of the new technology as it is adopted over time as a future replacement for Type B messaging. Key benefits will most immediately accrue to new applications, and then to eventually to legacy applications as they migrate to newer platforms. In either of these cases, lower application development and maintenance costs for application interfaces will be realized for business-to-business communications. While in many industries this scope is confined to supply chain management, the scope of business-to-business communications is significant in the ATI due to interdependencies between many players for distribution and operations. The savings are likewise expected to be significant on an industry-wide scale. The increased agility that will be gained from quicker and more substantial integration between business partners is also expected to increase the scope and accelerate the value of partner integration.

Lower messaging and network costs are also anticipated as more peer-to-peer and Internet-based communications are enabled, as compared to current messaging approaches. Internal to airline IT environments, it is also expected that infrastructure dedicated to legacy message processing can be

reduced and eventually eliminated, lowering cost and complexity of the environment. Airlines will also increase the return on their existing investment in XML-based development tools used for internal interfaces when these begin to be leveraged for external interfaces. At this juncture it is difficult to ascribe a monetary estimate of savings to the industry, but considering the cost of messaging and network connectivity, and even a fraction of the budgets spent on IT and application development the savings to the industry could readily approach several million USD.

In order to achieve these benefits, first architectural and implementation standards are needed that specify how the technology is implemented to meet stringent messaging requirements of the industry and to insure interoperability. The ARINC-SITA Type X Work Group was created in September 2005 with the charter to deliver these specifications. Baseline releases of these specifications will be made in the third quarter of 2006. Subsequently, the Type X Work Group plans to execute one or more demonstration projects with subsequent refinement of the specification based on knowledge gained. Additional standards work will be needed on an on-going basis to specify XML schemas

down to the message level for the many different classes of messages that are currently delivered via Type B. The Type X Work Group has been engaged with the OTA, IATA XML Task Force to promote progress on this next wave of standards.

Once the technology is demonstrated, it is expected that early adoption will be driven by latent demand by players in the industry with newer applications, or new applications being deployed on the network. The next wave of adopters is likely to be driven by events, e.g. airlines and application providers that are migrating from a legacy environment to a newer application suite or platform. The urgency of the Type X Work Group to date has been motivated by these early adopters and fast followers. It is imperative that a modernized, more robust and flexible approach to business-to-business communications be available as these investments are made and airlines move from today's legacy environments. As momentum builds, it is the vision of the Type X Work Group that reduction in costs will grow throughout the industry, and once a critical mass of adoption occurs, agility and degree of collaboration enabled by the XML and Web Service technology will increase dramatically.

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# Current Industry Situation

## *A Brief History of Messaging in the Aviation Industry*

The Air Transport Industry (ATI) is arguably the most connected, communications-intensive industry in the world. The combination of mission criticality of communications driven by safety requirements, coupled with the real-time nature of network-based applications and operations creates a demanding environment for communications technology. At the same time, economic pressures drive the need for automation in every area possible. This has led to development of a highly effective and highly specialized set of communication standards in an industry that is ingrained in applications and data networks.

IATA standards for messaging between partners in the industry grew out of this need, and have evolved over the years to adopt new communication technologies as they have become available. Type B messaging is one of these standards which has evolved from teletype as the standard for reliable messaging. Mission-critical applications ranging from reservation systems to air-ground data communications have come to depend on its store-and-forward implementation. As a result, a

wide variety of specialized addressing, routing, and handling features found in IATA's Type B specifications are also coded into high-volume transactional applications and mission-critical operational applications that the airlines use to conduct their business.

Millions of Type B messages a day flow through industry-specific messaging switches operated by ARINC and SITA. Additional millions of messages flow over point-to-point implementations by airlines, global distribution systems (GDS), and other industry players that have invested in dedicated connections rather than use the ARINC or SITA community extranets. Type A messaging, including peer-to-peer oriented host-to-host communications and terminal-to-host communications, has also evolved over the years to support transactional business-to-business communications in the industry. These messages also flow over ARINC and SITA networks or involve point-to-point implementations.

The aviation industry's distinguished history in implementing communications also includes inventing communication protocols to support its industry-specific messaging

requirements. This was necessary as early implementations predated early networking protocols such as SNA and modern protocols based around the OSI model. IATA has managed this evolution through coordination of standards and standards bodies including the airlines to define messaging formats and communications protocols. Seven volumes of standards, the System Communications Reference manuals have been published by the Information Management Committee of IATA that have guided the industry through early implementations of airline-specific protocols such as ALC (P1024 B/C) and SLC (P1024 A), and UTS.

The standards have evolved to adopt newer network technologies such as X.25 and Internet Protocol (IP), including the definition of specifications for application message handling to provide for message assurance. With the error-free transmission provided by X.25, message assurance requirements at the application level were addressed with BATAP (Type B Application to Application Protocol) which required proprietary application development solutions within the host systems.



In the late 1990s, an open standard was developed to enable use of more modern communications protocols, using TCP/IP. Mapping Airline Traffic over IP (MATIP) is defined in RFC 2351, and provides a specification for airline-specific real-time messaging over IP. For Type B messaging, this implementation also requires BATAP to exist in the host systems.

Around that period, both ARINC and SITA began implementing IP-based Type B messaging solutions supported by IBM MQ Series middleware. This implementation leveraged the assured messaging capabilities of MQ rather than requiring BATAP, and to this day is considered a relatively convenient approach for some host systems. Both MATIP and MQ can be used as a protocol for transactional messaging as well, e.g. Type A messaging. These protocols have enabled much of the industry to move to modern IP-based networks, the de facto standard for data networking today, and have helped the airlines reap some of the benefits of IP-based applications and networks.

### *Motivation for Introducing XML-Based Messaging*

While IATA message standards together with current communication capabilities of MATIP with BATAP and MQ have enabled the industry to leverage IP technology, there are limitations that will need to be addressed for the industry to evolve to enable intelligent and collaborative business-to-business communications required of more advanced applications.

The first of these limitations is that Type B and Type A message types

are relatively limited in their size and format, and inflexible to change. Constraints are due to the relatively small number of data elements and available formats, and inflexibility comes from the fact that highly structured message formats are hard coded in end applications. These limitations are exacerbated by the collaboration required by global travel industry mandates such as Advanced Passenger Information Systems (APIS), and eTicketing. More modern messaging standards such as eXtensible Markup Language (XML) provide both extensibility and flexibility, which have made this technology the de facto standard for messaging and data handling in modern applications.

While MATIP and MQ have enabled more standard forms of IP-based networking and migration to IP-enabled applications, these approaches are in fact not open standards; MATIP is an industry-specific standard and MQ is a proprietary one. While use of MATIP and MQ is relatively ubiquitous, future evolution will never have the broad industry support that truly open standards enjoy. Today, Web Services are emerging as the leading set of open communication protocol standards for handling XML-based messaging that are being adopted across many industries.

Together, XML-based messaging and Web Services communications protocols are poised to revolutionize business-to-business communications within the Air Transport Industry (ATI). The rich data structures and adaptability of XML, together with the open standards based features of Web Services, will provide for more adaptable, cost-effective, and readily integrated applications, and enable

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more use of the Internet for communications. However, this cannot be accomplished without standards and implementation specifications that define how the technology is applied to achieve the highly reliable, secure, cost-effective, and aviation-grade communications that the industry requires.

ARINC and SITA have formed an industry work group to define the standards required for adoption of XML and Web Services. The next generation of messaging, referred to as Type X messaging, stands to bring significant benefits to the industry which are elaborated upon in this paper. In the sections that follow, the basics of the technology and required standards are defined, the high-level benefits are outlined, and an overall adoption strategy for the industry is presented.

# XML and Web Services Technologies

## XML Basics

The origins of eXtensible Markup Language (XML) are the same as Hyper Text Markup Language (HTML), that is, both evolved from Standardized General Markup Language (SGML) which was originally devised to provide a machine-independent language for documents geared toward printers. In the same tradition, HTML is a common language for display of data that was popularized by the World Wide Web (WWW). Just as HTML revolutionized our ability to access and display data from across the network, XML stands to revolutionize the way that applications and machines communicate across the network.

XML basically has two main functions<sup>1</sup>: a syntax for structured information, and a specification language which can define the message structure itself. XML as a syntax makes it possible to transport structured information. To this end, XML uses the mechanism of ‘tagging’, which means that each piece of information is embedded between a ‘starting tag’ and a ‘closing tag’. The role of these tags is twofold—they clarify the meaning of the piece of information and they indicate the start and end of the information.

At the same time, XML is a specification language, which means that it can be used to describe the exact struc-

ture of the message, i.e. the sequence of the fields in the message, the format of each of the fields, whether a field is optional or mandatory. The advantage of this specification language is that it is a so-called ‘formal’ language, meaning it can be understood by computers.

This specification is called an XML schema. An example of information represented in XML is shown in Figure 1, alongside its Type B representation. In the case of Type B message, note that there are two distinct aspects of the schema that must be specified: the Type B envelope information, and the XML schema associated with the message payload itself.

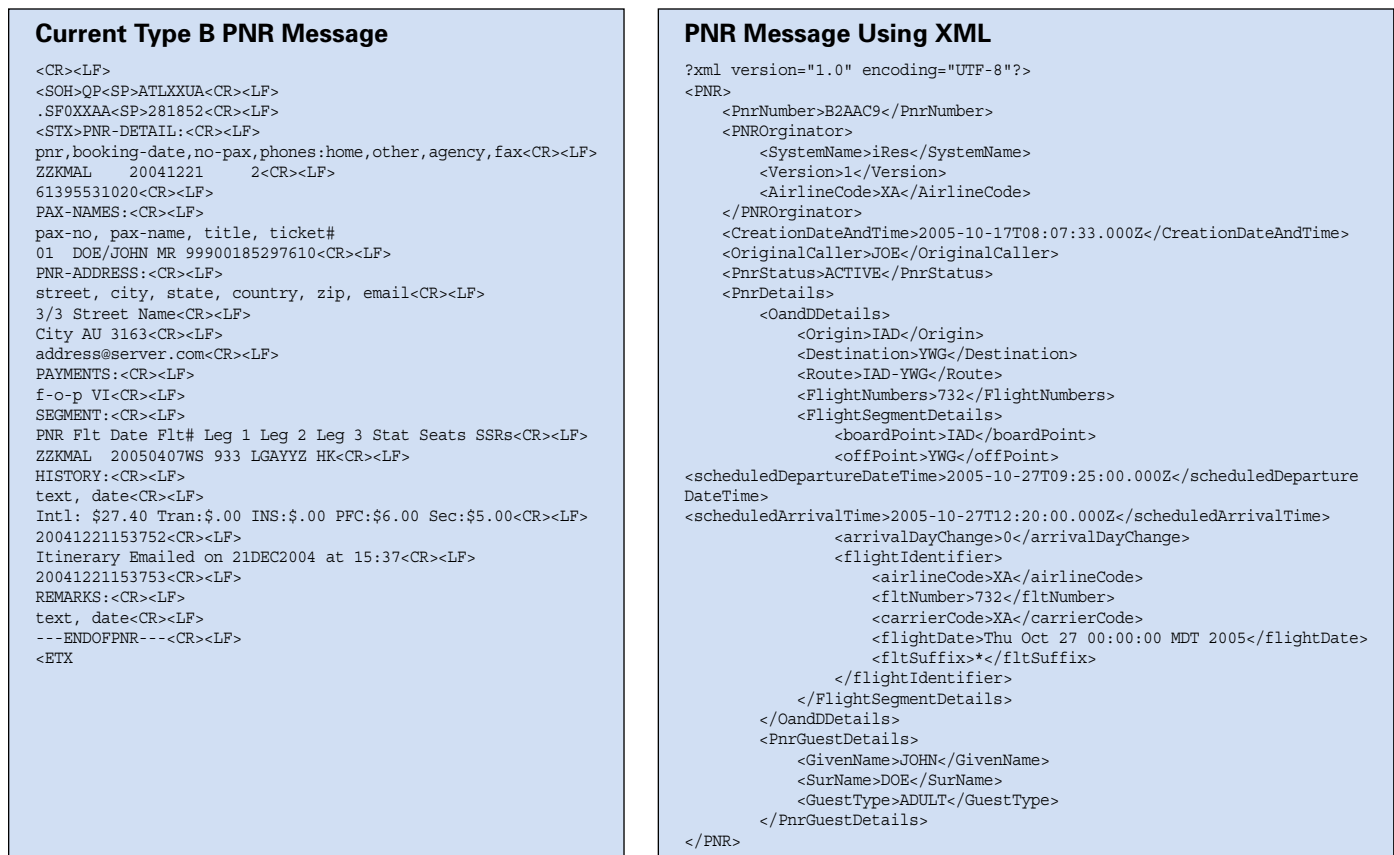


Figure 1. Example of Type B Message in XML Format

<sup>1</sup> XML description in part taken from “Simple XML – An Introduction for the SWIFT Community,” a white paper written for the financial services community in 2005, found at <http://www.swift.com/referenceinformation/>

To understand how powerful this concept is, consider the ACARS message<sup>2</sup> shown in Figure 2. In today's Type B messaging approach, the ACARS message is wrapped in a Type B envelope, and defined for sending and receiving applications down to the bit level. In that way, message processors deliver the message to its intended receiver which strips the envelope and delivers its payload to the receiving application. The receiving application must have hard coded, bit by bit, a built-in understanding of the data. Changes to the data structure cannot be made without costly and time-consuming modifications to the application that consumes the data. On the other hand, in an XML world computers can use a schema to interpret the message. A change in the schema can be dynamically adjusted to by the receiving applications.

### Communication Architecture Framework for XML Messaging

In order for the strengths of XML to be leveraged in the ATI, a communications framework is needed that includes defined transport layer, message layer, and application layer protocols for machine-to-machine communications. Ultimately, implementation standards are needed in all of these areas in order to facilitate bi-lateral communications between applications and to meet business-class messaging requirements that are currently met by existing forms of Type B communications.

HTTP over TCP/IP is the most common transport protocol for XML messages—the same transport protocol

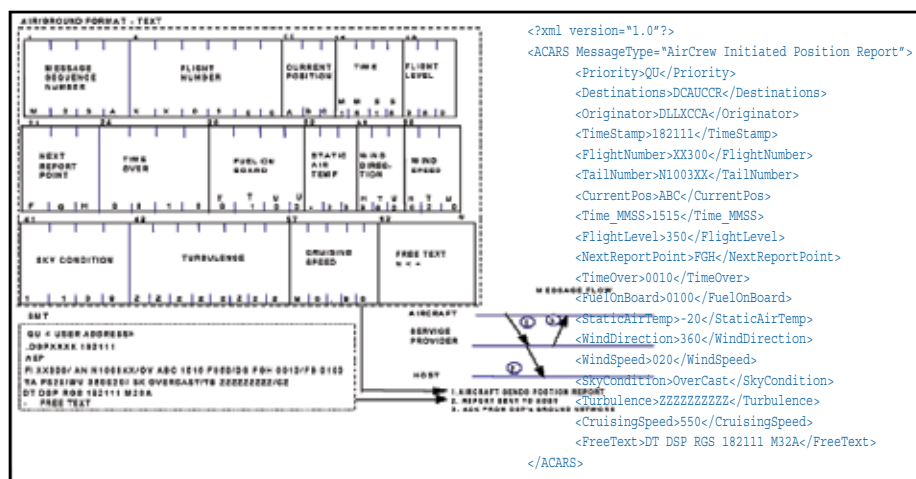


Figure 2. Message Body Example – ACARS Message

used by browsers to view data on the WWW. While HTTP is most prevalent, XML can be communicated over virtually any TCP/IP-based communications protocol, including SMTP, FTP, and MATIP.

Message layer and application layer communications are substantially more challenging to implement. Fortunately, the same requirements exist for business-to-business communications in all industries and powerful open standards have evolved to provide these capabilities. Simple Object Access Protocol (SOAP) is the most prevalent messaging layer standard for transport of XML messages. SOAP provides a simple and lightweight mechanism for exchanging structured and typed information between peers in a decentralized, distributed environment using XML<sup>3</sup>. SOAP is fundamentally an envelope for an XML message that enables exchanges between applications. A series of one-way SOAP exchanges between applications can create more complex interaction patterns by using features provided by an underlying protocol and/or application-specific information.

SOAP provides a framework by which application-specific information

can be conveyed in an extensible manner. SOAP provides a full description of the required actions taken by the receiving application, and includes information on fault handling. SOAP messages can also include attachments, creating a flexible mechanism for applications to exchange data. SOAP standards are developed by the World Wide Web Consortium (W3C) and can be found at <http://www.w3.org/>. Figure 3 shows the SOAP message structure alongside MATIP and MQ implementations.

The essential SOAP characteristics are:

- Simplicity
- Interoperability
- Loose coupling (i.e. implementation independence)
- Extensibility
- Flexibility in message size
- XML-centric implementation

The features of IATA messaging that are required by the existing installed base of applications have to be handled by any new form of messaging that is introduced, especially with regard to specialized message handling such as prioritization, message routing, and message protection. Security will also need to be addressed in the new

<sup>2</sup> Additional information on XML ACARS Messages can be found at <http://www.arinc.com/aec/projects/aoc/>

<sup>3</sup> <http://www.w3.org/2000/xml/Group/1/03/soap-xmlp-terms-01.html>

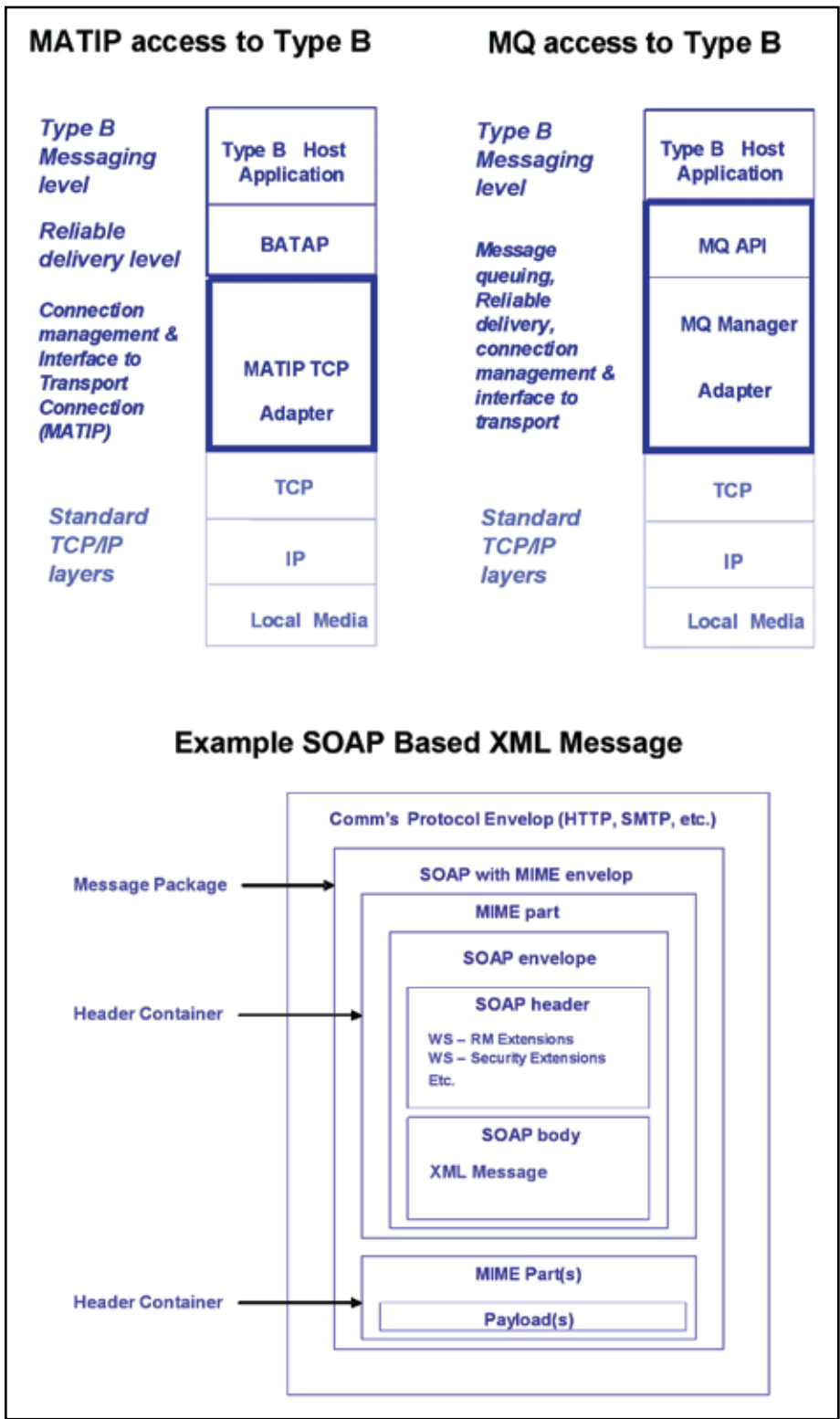


Figure 3. Communications Protocol Stack Examples, MATIP and MQ vs. XML with SOAP

paradigm of Internet-based communications. These features are handled today by private networks, along with different aspects of the Type B message format, industry-specific message processors, BATAP in the case of MATIP, or by MQ middleware features. For Internet-based XML messaging, these capabilities must be delivered by some other means. Some of these features can be handled through specification of specific tags and data elements in the XML schema of the message, or in the SOAP header or body. Additional capabilities are needed however that are beyond what these constructs can provide. These additional features are addressed by the Web Service communication framework and Type X specification.

A Web Service is a software component that is described via Web Service Description Language (WSDL) and is capable of being accessed via standard network protocols such as but not limited to SOAP over HTTP<sup>4</sup>. Entire business applications that are componentized in this way are said to have a Service Oriented Architecture (SOA). When an application is available to be called as a Web Service, it is accessed using a URL, just like a web page from a browser. Instructions for how to interact with the application are defined in the WSDL, which is machine readable. A body of standards governed by OASIS, referred to as Web Service extensions, or WS-\* provides a broad set of mechanisms for implementing Web Services. These capabilities can be leveraged to implement some of the features needed for robust business-to-business communications.

<sup>4</sup> <http://www.oasis-open.org/committees/wsia/glossary/wsia-draft-glossary-03.htm>

## *General Benefits of XML and Web Services Technologies*

In short, XML-based messaging technology offers many benefits as compared to current messaging approaches in the industry, and has the added advantage of being extensible to meet virtually any future business-to-business data communications need. With SOAP and other Web Services capabilities combined with XML and Type X specification, a communication framework is possible that is truly based on open standards while still meeting the strict and unique requirements of Type B messaging.

In order to understand the benefits and rationale for the industry to adopt this technology, it is useful to first look at some of the general benefits of adopting XML and a Web Service oriented communications architecture. Significant areas of benefits are summarized below.

**Platform and Programming Language Independence.** Like other Internet-based technologies such as TCP/IP, HTTP, and HTML virtually all modern system platforms and programming language can use the basic features of XML needed for business-to-business communications. This is essential for broad adoption and interoperability, and allows choice of the technology without locking IT departments into a specific vendor choice for servers and mainframes, or a specific development environment. That is not to say that standards are not required for interoperable communications, or that vendors have not developed proprietary extensions of the basic technology (see standards section of this document). Within these

bounds, business-to-business communications can occur with relative ease—even if .Net and J2EE environments are in use by the third parties for example, or even mainframes with open systems environments.

**Broad IT Industry Support.** Because XML-based technologies have emerged as the de facto approach to data representation for modern applications there is enormous support in the IT industry at large for the technology. This means a heavy investment in compatibility, broad participation in IT standards groups to move the standards forward, and investment in actual product capabilities that leverage the technology.

**Availability of Development Tools.** Because XML has massive support in the software industry, this has resulted in a wide selection of commercial off-the-shelf tools to process XML documents. These tools make it possible, for instance, to display XML documents on a screen, to validate the content of XML documents, or to extract the information from XML documents—known as ‘parsing’—and to quickly configure interfaces between disparate applications. The broad availability of XML tools enable the creation of XML-based applications with reduced programming efforts. This can dramatically reduce the cost and time of software development and maintenance.

**Prevalent Skill Base for Application Development.** The broad IT industry support, in turn, creates a situation where there is a broad skilled labor force that can make use of the technology. Just like Internet Protocol, once a critical mass of adoption occurs,

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a work force emerges that can leverage the technology. In contrast, MATIP and MQ will never enjoy such a prevalent knowledgeable work force. While both of these current approaches are a vast improvement over legacy technologies, neither will ever offer an IT industry-wide base of skilled workers.

**Lower Software Development Costs.** Because of the extensive tools available, the more automated nature of code development, the ability to reuse significant amounts of code, and the more generally available skills in the work force needed to work with XML, development costs and maintenance costs are reduced as compared to other environments. The lower costs make the prospect of developing more partner-to-partner integration more attainable, which in turn creates new opportunities for value chain

collaboration, automation of processes, and rapid introduction of new business models<sup>5</sup>.

**Lower Cost of Change.** Using an XML-based messaging approach and Web Services for application integration lowers software maintenance cost because it improves the adaptability of applications. Since message formats are not bit-wise hard coded into the application, changes in the message format and introduction of new data types and formats can take place without as much impact to the end applications. This is particularly true in a many-to-many communications environment such as exists for Type B messaging. On the one hand, the same development methodologies and tools that lower cost of development also lower the cost of changes to the application. On the other hand, changes in message format do not impact the application as significantly.

**Faster Time to Deployment.** The speed of change enabled by XML and Web Service technology creates additional business value that can increase the agility of an organization. This same agility multiplies when extrapolated across an entire industry. The speed of deployment consequently enables the benefits of the new application or integration effort to be realized more quickly, accelerating the business value received.

**Increases Value of Current and Future Investments.** The Delphi Group conducted a survey of more than 800 end users, software vendors, and service providers to understand business value expectations of the IT

industry in general related to open standards<sup>6</sup>. One of the most important sources of value cited for standards in general is that stable standards increase the value of existing and future investments—71% of developers and 65% of consumers of technology identified this as an important benefit. In the case of the airlines, investments are already being made in XML and Web Service technology for internal applications in most cases. This investment can be leveraged for business-to-business integration—consequently increasing the value of the investment already made.

Combined, the general benefits above enable deeper, more rapid integra-

tion of applications for business-to-business communications, while lowering the cost of development and change, and increasing the speed of change. Along with benefits come all the advantages of standardization that the aviation industry currently enjoys, but with the additional benefits of open standards, which increases by orders of magnitude the level of investment in the broader IT industry that is being funneled into the standards, both in support of standards groups like OASIS, and investment in products to be compliant with these standards. More specific expected benefits for the ATI are elaborated on in subsequent sections.

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## Standards Efforts

### *Overview of Relevant Standards Efforts*

As alluded to throughout this paper, a robust replacement for Type B messaging in the industry requires that standards be set at multiple levels. The main two areas of focus are standards associated with the communications framework (e.g. how Web Service extensions and SOAP are used as a communications interface), and standards associated with the XML message. The XML message standards must likewise address both the Type B message wrapper that interacts with elements of the communications framework, and the body of the Type B message, e.g. the content.

In order for the industry to fully transition to the new technology, all of these areas must ultimately be specified. While many of the benefits of XML



and Web Services technology stand on their own, the need to implement many point-to-point implementations with different approaches could easily offset the gains achieved with the technology. A single airline may have dozens and even in some cases hundreds of partners that require Type B message exchanges. Without defined approaches for Type X messaging that can be consistently

<sup>5</sup> Dwyer, Tom, "Business Benefits of Implementing SOA", Yankee Group, June 2005.

<sup>6</sup> Dephi Group, "The Value of Standards", June 2003

implemented without bi-lateral agreements, the new technology is not likely to take root.

## *Communications Framework Standards*

The Type X Work Group is primarily concerned with defining standards that represent both the communication framework and the XML message elements that functionally replace Type B wrapper constructs (e.g. the Type B envelope). The communications framework standards include which version of SOAP is used and how it is implemented, and also which Web Service standards are used, which additions are needed and how they are implemented. Web Service capabilities such as WS-Reliable Messaging, and WS-Security are under consideration. The Type X Work Group is not focusing on developing XML schemas for each and every class of Type B messaging that exists today. These aspects are the focus of multiple industry standards groups, and for that matter can be defined by an individual application provider for its users. Nonetheless, a complete plan for the industry is needed that includes how all of the standards will unfold.

In order to develop viable standards, a requirements document was published by the Type X Work Group to define all of the requirements that the new messaging technology must meet in order to achieve a level of backward compatibility with the current messaging environment, and to provide the level of reliable and secure messaging that applications in the industry depend upon. Next, a framework tradeoff was performed to provide a first-level

allocation of requirements to viable communications frameworks.

This groundwork resulted in the selection of SOAP 1.2 rather than full adoption of either of the two competing frameworks of Web Services and ebXML. This selection reflected observations that a) SOAP 1.2 was adopting more robust messaging features, b) that SOAP would be compatible with either ebXML or Web Service implementations, and c) that there is a macro trend toward convergence of ebXML and Web Services. Selection of these standards requires a firm knowledge of IT industry dynamics and the process and status of standards being worked by the World Wide Web Consortium (W3C) which specifies XML and SOAP related standards, and the Organization for the Advancement of Structured Information Standards (OASIS), which has both ebXML and Web Service standard ownership.

## *Promoting Interoperability*

In view of its global orientation, Type X can only gain from introducing uniform standards and guidelines. The selection of these requires research in uncovering the sometimes unclear relationships between the different standardization initiatives related to existing and emerging standards. Also, we have taken into account the practical considerations of these recommendations, while not necessarily restricting ourselves to a lowest common denominator focus of the Web Services stack. Our research indicates that most of the needed components to support the messaging usage scenarios are already implemented universally and uniformly.

At present, the work group has turned its attention to analyzing selective use of Web Service extensions to augment SOAP 1.2 to provide the full and robust set of features needed to meet all of the appropriate Type B requirements. In each case, to set industry-specific implementation standards, the Type X Work Group is both adopting current standards being set by other standards organizations, and specifying the missing complements and how those standards should be implemented very specifically to meet Type B requirements.

A strong liaison to industry standards groups has been developed to insure most advantageous selection of standards for the ATI that are gaining the most support and adoption in the vendor community.

In addition to general IT industry standards bodies, there are other industry groups that are working on standards related to XML messaging. The Open Travel Alliance (OTA), the IATA XML Task Force (XMLTF), and the ATA all have efforts that are doing relevant work to XML messaging. For the most part, the Type X Work Group is specifying standards that are complementary to these groups because the Type X Work Group is focused mostly on communications framework and architecture while these groups are primarily focused on developing XML schemas to specify message contents.

One exception is the Architecture Subcommittee workgroup within the OTA which is recommending changes and additions to previously released OTA SOAP and HTTP conceptual specification documents to further support asynchronous messaging.

Seeing an overlap with the Type X effort, the Type X Work Group has developed a strong working relationship to insure compatibility of the specifications that the two groups intend on releasing. In extending our collaboration to other work groups, we expect the resulting efforts to promote knowledge transfer and result in transactional interoperability with other travel industry verticals to include Hotel, Car, Cruise, and Tour operators.

### *XML Message Schema Development*

The development of XML schema that addresses the entirety of needs of applications in the industry is not within the scope of the Type X Work Group, but is already progressing on multiple fronts. The OTA to date has focused on defining messages related to travel agent booking on the distribution side of the

business, and has wide support in the industry from airlines, GDSs, and the travel agents. The IATA XML Task Force (XMLTF) to date has focused on messages related to passenger processing, and more recently in support of resolution 722, which specifies processing for automated tickets and corresponding boarding passes. The ATA has focused on the supply chain domain, and has developed XML equivalent schema to replace SPEC 2000 messages, which currently largely use Type B messaging.

As alluded to previously, many application and content providers have already specified XML-based formats related to their applications. In the future, one can expect that ARINC, SITA, the GDSs, GDS New Entrants, major aircraft manufactures (e.g. Boeing and Airbus), and network-based application providers in general will specify XML-based messaging formats to consumers of their applications.

It is interesting to note that some of the current content of Type B messages running over SITA and ARINC's networks contain XML data today.

The important conclusion from a standards perspective is that actual XML schema development will occur in many different areas and it is an application by application prospect. Since business applications tend to evolve to address specific domains of business requirements (e.g. distribution, operations, supply chain). To the extent that industry-based standards groups exist to address the data exchange requirements in these domains, such as in the case of OTA, IATA, and ATA, whole classes of applications will have focused XML schema development efforts. While these standards efforts will be critical for timely adoption of XML technology, Type X messaging standards will enable more immediate adoption from application providers at large.

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## XML Benefits to the Aviation Industry

In order to rationalize the case for adoption of XML-based messaging in the industry, it is important to understand how the more general benefits described in previous sections translate into specific business benefits for airlines, global distribution systems, and other consumers of Type B messaging. In fact, the benefits of adopting a new, open standard based, Internet-oriented set of messaging standards go far beyond just benefits to the systems and applications that consume and produce Type B messages. Type B messaging is targeted due to the large cost of current legacy messaging approaches.

However, the vision for use of the technology extends beyond Type B to Type A, and other partner-to-partner messaging that is currently done with point-to-point integration.

### *Reduced Software Development and Maintenance Costs*

The general benefits described in the preceding section apply to airlines and ATI participants in multiple ways. Most airlines are using XML and even Web Service technologies for internal application integration, and so are

already benefiting from reduced software costs within their enterprise. The focus of Type X messaging is in the business-to-business messaging interfaces very specifically, and so benefits would accrue to a portion of the development and maintenance costs.

To understand the magnitude of this problem, consider that it is not uncommon for a typical medium-sized airline to have Type A and Type B communications with dozens to hundreds of business partners. In the case of Type A, each of these interfaces must generally be developed and maintained

over time. In the case of Type B, multiple interfaces must often be maintained for multiple applications or to use different protocol level services. Therefore the benefits of reduced software development and maintenance costs can be estimated based on the fraction of the total software costs committed to interface development, and the subset of these costs dedicated to external interfaces. Even further, the lower development costs actually may make some projects feasible that were not previously feasible, capturing business benefits by introducing applications that could not have been developed otherwise.

True bottom line benefits in the area of software development and maintenance are not likely to accrue to existing legacy applications, but rather will apply to new application development or application migration. If an airline or GDS has internal XML-based Web Services that could be exposed directly, eliminating the Type B layer of processing, then these benefits can be realized readily even for existing applications. More often however, it is expected that there is not an ROI-driven business case for migrating applications to open platforms and application architectures based on integration benefits alone. The migration to this platform will instead be driven by other events.

One such event is migrating an application to a new platform, such as will be the case with the transition of TPF to zTPF for example. In this case, the transition cost can potentially be reduced, and maintenance costs going forward—especially related to the development of business-to-business interfaces—will be reduced. Another more common event is in the develop-

## *Using the same technology and tools for external interfaces development and internal application development maximizes return on existing investment.*

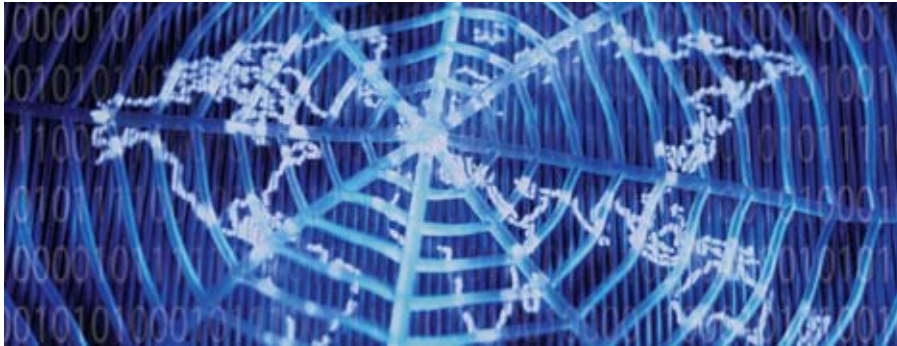
ment of new applications that provide functions that augment mainframe-based legacy applications. In a living enterprise like an airline literally hundreds of applications are in place to support the operations of the business. Business requirements cause the need for new applications to be introduced all the time. As subset of these applications are specifically geared around integration with business partners to automate operations—an area of great cost savings to the business. It is in this area that the industry will benefit from the Type X communications framework the most.

There are two very notable examples in the industry today where new requirements and specific events are causing the need for application development that is very specifically geared toward business-to-business communications. IATA's eTicketing initiative for one will require a richness and deepness of integration that is not available today—linking partner business processes in complex transactions. The new functionality requires new code development which benefits from lower development costs. Evolution of these business interfaces then benefits from lower maintenance cost and increased flexibility.

Another example that is current in the industry today is centered around new security requirements, where airlines are being asked by different nations to provide specific sets of data

to support national security efforts. Because each country has a different set of requirements for data, new application development is required. Because each country requires data, the application requires industry-wide exchange of data. Adoption of a common framework for XML-based messaging, in addition to providing extensibility in data type and formats needed to support these applications, will also lower development cost and increase flexibility to adapt to evolving changes in requirements. Several national governments are providing for XML-based data delivery in their requirements.

While it is difficult to pinpoint an estimate for quantitative benefits that can be attributed to Type X messaging standards, anecdotal experience conveyed in the aforementioned Delphi study suggests that 30% to 50% reduction in development costs can be realized using open standard based application architectures, and maintenance can be reduced by at least 20%. Other experiences cite reduction in total cost of ownership as high as 4 to 5 times. With these levels of benefits attributed to open standard based application architectures in general, the adoption of XML and Web Service technology as a fundamental component of modern applications is inevitable. This being the case, using the same technology for external interfaces and communications results in hard benefits from reuse of existing investments.



### *Reduction in Messaging Costs*

Type X messaging stands to enhance peer-to-peer communications by using open standards and enabling secure exchanges over the Internet. For some portion of current exchanges, cost savings are enabled by the use of this new communication pattern and standard.

While MATIP and MQ provide the capability for peer-to-peer Type B messaging over IP-based networks, and adoption has gained momentum over the last 8 years, bi-lateral agreements are still usually required to enable a point-to-point communication to take place with the appropriate compatibility.

With Type X messaging, reduction of the need for bi-lateral agreement and significant reduction of development at the host application will stimulate adoption and move more messaging to a peer-to-peer realm, resulting in a direct reduction in messaging costs currently paid to intermediaries. Over time, the savings to the industry could relatively easily approach millions of USD.

### *Increased Use of the Internet*

Because of lack of sufficient security features in the current messaging communication standards and lower

performance of Internet, private networks are intensively used for airline business critical communications. The Type X standard includes the use of digital signature and encryption to deliver the level of authentication, non-repudiation and confidentiality required for a large proportion of current business critical messages, enabling secure use of Internet for the related exchanges. On the other hand due to continuous Internet infrastructure improvements over the past years and improved services, it will be more feasible to use the Internet more intensively for business critical exchanges. This in turn delivers significant cost saving compared to private IP or legacy connections especially in geographic reach locations required in the aviation industry.

In contrast to the highly specialized industry-unique private networks, the Internet provides ubiquitous any-to-any connectivity at much lower cost. In fact, a managed connection to the Internet can cost up to 80% less than a private connection, depending on the location, access type, and quality of service. When the additional cost for legacy networking is taken into account, the savings are even greater. While use of the Internet has increased for some classes of applications, especially for example, a travel agent facing connectiv-

ity for GDSs, it has not gained as much acceptance for general airline networking needs. The primary reason is the lack of performance guarantees and SLAs for Internet-based communications, and the potential security threats and additional cost of insuring secure communications.

The availability of low-cost Internet-based networking will stimulate more use of the Internet for general connectivity needs for airline Wide Area Networks (WAN), but there are still deficiencies that must be overcome for the Internet to be suitable for Type B communications. With the adoption of Type X messaging, including the required standards for security and reliable messaging, more use of the Internet can occur for partner-to-partner communications.

While it is difficult to estimate the exact portion of networking that can be moved to the Internet specifically due to introduction of XML messaging, and more specifically the Type X communications framework, a relatively small fraction of the current industry spend would be needed for benefits to exceed several million USD.

### *Reduction in Legacy Systems*

As alluded to previously, many airlines have internal application architectures that are already built around XML-based data representation and messaging, and have to front end these applications with software and gateway platforms that interface to the existing Type B environment. There are savings to be realized in many of these cases by eliminating these gateway platforms altogether, or at least substantially reducing the volume of transactions that

they must process. In the case where whole systems can be eliminated, this produces real hard benefits. Factoring in TCO for the eliminated systems magnifies the benefits even further. Also, considering that many mainframe software pricing models are based on the MIPS of the computing base that they support, reduction in dependency on legacy mainframe platforms could produce tangible financial benefits for airlines that can offload a substantial amount of Type B processing to open systems.

### *Quicker Development of New Applications*

The benefits that can be accrued through more rapid deployment of new applications are hard to quantify, but intuitively easily understood. After all, business applications are being developed to produce some benefit, and so achieving the targeted benefit sooner in time increases the return on investment.

Consider the general case of a bi-lateral agreement between two airlines that brings some benefit to both businesses, such as increased revenue. Integration between the two organizations may be required at the application level in order for the business benefits to be realized. Or, perhaps the cost of supporting the relationship is higher, offsetting some of the revenue benefits, unless a deeper level of integration occurs. Another typical example is where business partner integration can introduce automation, lowering the cost of operations for both parties. Still another example is change driven by new requirements for compliance, where penalties in some real terms will be accrued if the airline is not compliant. In any of these cases, there is a quantifiable value associated with the

decreased time to deploy—the opportunity loss for the revenue or cost savings benefit yet to be realized.

An XML-based data exchange capability with the surrounding SOAP and Web Service communications protocols speed deployment of new capabilities due to many of the concepts mentioned in the previous section on general benefits. The self-describing, machine interpretable nature of the technology reduces the amount of coding by the developer. The robust development tools available help to automate some aspects of development, and especially

for applications that have adopted a service-oriented architecture, code reuse is increased. Combined, these capabilities enable rich and deep application integration with far less effort than middleware-based approaches, or less technically robust communication protocols. Equally as important, once there are well defined standards for Type X messaging, there will be less need for bi-lateral agreements between business partners to specify technical interfaces and business processes. This will have an enabling effect on business-to-business integration.

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## Industry-Level Adoption Strategy

There are significant activities required to enable adoption of Type X messaging broadly in the industry. The standards efforts in and of themselves represent one track of activities, as elaborated on in the previous section. Care must be taken to insure that all necessary components of the standards are well specified to insure interoperability. Attention must also be paid to insure that Type X standards leverage technology that has stabilized and has been deployed in vendor products that are prevalent in the infrastructure of the industry. Beyond the Type X standards activities, an overarching strategy is needed with a focus on implementation that will enable industry-wide adoption of the new form of messaging.

The highly integrated and networked nature of the applications using

Type B messaging creates significant natural obstacles to change. This is one reason that so much legacy technology has persisted in the industry today. Considering peer-to-peer communications, for a single airline to move entirely to the new technology, all of their trading partners must also move to the technology. Considering that a typical airline has dozens to hundreds of partners traded with, the prospect of all of these partners moving to the new technology is slim. This results in resistance to change. As noted in the previous discussion of benefits, driving forces behind transitioning to the new technology are far more likely to be new applications and other technology migration activities. The ROI for investing in new interfaces to replace existing ones is otherwise unlikely to be positive.

While ARINC and SITA and other potential new service providers are fully expected to develop new products that facilitate adoption, a deliberate roadmap is still needed for the industry to gain traction with the new technology. The roadmap needs to address activities like demonstration projects and reference implementations that are needed to prove and refine the standards, as well as to recognize industry level driving forces that can be harnessed to help drive adoption. A measured approach is outlined below which presumes three stages of adoption: Initial introduction, early adoption, and mass collaboration.

### *Introduction with Meaningful Demonstration Projects*

The first step in the adoption process is to execute meaningful execution projects with the purpose of proving the feasibility of implementing Type X standards in an operational environment. The objective is a set of projects that proceeds from prototype, to pilot, and ultimately sustained operational implementations. ARINC and SITA plan to work with the participants in the Type X Work Group to define and execute one or more such projects. The demonstration projects will involve at least one application provider and one airline, and will implement as significant a part of the Type X messaging specification as practical.

Aside from basic feasibility, the demonstration project(s) will provide feedback on the specifications with regard to level of effort to implement, compatibility of implementations between third parties, and general interoperability in a limited but



heterogeneous application and platform environment. The demonstration projects will be staged in a manner that provides a valuable knowledge base for migration strategy, produces some early benchmarks on performance, and establishes some initial positive confirmation of backward compatibility to existing Type B messaging. The feedback from these projects will be used to refine the Type X specification and begin to develop best practices for implementation.

### *Proactive Early Adoption*

Subsequent to demonstration projects a set of activities are expected to be undertaken on multiple fronts with the specific objective of reducing obstacles to adoption for early adopters. Ideally, a deliberate set of reference implementations and committed early adopters will be identified that reflect use cases that are prevalent in the industry. ARINC, SITA and members of the Type X Work Group, who may themselves be early adopters, will actively promote the use of the Type X standards and support early adopter implementation with interpretation of the specifications and recommendations as requested.

The Type X Work Group will actively engage other standards groups and

vendors to make relevant needs of the aviation industry known to the vendors, and vendor capabilities known to early adopters. In some cases, vendors may be actively engaged for the purpose of creating capabilities to facilitate Type X adoption. Additionally, it is expected that the Type X Work Group will support various industry groups that are creating schemas for XML-based messaging, again for the purpose of enabling adoption.

During this stage, two outcomes are expected. First, a set of documented reference implementations will emerge along with learned best practices. Second, gaps will be identified in the Type X specifications that will need to be addressed. The Type X Work Group will be focused on evolving the specification to improve ease of implementation as well. The result of this iteration should be a stable, mature specification and set of best practices that are ready for wider scale deployment.

### *Collaboration for Broader Adoption*

It is fully expected that at some stage of maturity the Type X specification will be transitioned to an appropriate aviation industry standards organization and the

majority of focus will be with multiple standards groups focused on developing schema for specific messaging domains. Adoption at this point will be driven by specific applications.

At this stage, collaboration and sharing of migration strategies, implementation best practices, and evolution of the Type X standards to adopt new features, will occur in existing and newly created industry-wide forums. In cooperation with IATA and other industry organizations, the Type X Work Group expects to transition into a mode of supporting the new owner of the standards, and assisting in the collaboration needed to continue to build momentum for adoption.

### *Summary of Likely Migration Scenario*

It is instructive to consider a likely progression of adoption through the industry in order to anticipate drivers for the transition. Specifically, what is the profile of industry Type B users that will most likely adopt Type X? What events or conditions are likely to stimulate airlines at large to adopt the technology? And, what driving forces in the industry will drive the need to adopt Type X? As has already been suggested, the likely adoption scenario is driven by where the benefits accrue the greatest. Early on, adoption will be driven by application providers and consumers that are best positioned to capture the benefits. Eventually, broader adoption will occur out of necessity.

Application providers are key to early adoption, since they can enable Type X messaging for large numbers of users, with a high potential data volume. In particular, application providers

that have a more modern application architecture will benefit from the adoption of standards, which can ultimately reduce the number of variants of interface technology that must be supported.

Among the user base of these application providers are a subset of early adopters using the applications. For whatever reason, these users have newer interfaces, newer platforms, or application architectures that are more readily adaptable to a Type X interface. Newer low-cost carriers and startup airlines are likely to have a compatible application infrastructure, for example. Airline alliances are also in a prime position to become early adopters of the standard, as they are more likely to have some process for adopting standards as a block, and have a heightened interest in application integration beyond normal bi-lateral business relationships.

The next set of adopters across the airline community, fast followers, are most likely to be airlines that incorporate the transition to XML messaging as part of a planned technology migration or strategic new application deployment. A large airline may have hundreds of business applications, and compatibility of their internal application architecture to more readily adopt Type X messaging depends on the extent to which XML and Web Services technology already form a part of the airline's enterprise strategy. While there may not be enough motivation to invest in transitioning legacy applications, these organizations are more likely to have the skills to adopt Type X messaging for new applications.

The wave of adoption that enables achieving critical mass across

the industry will likely be driven by one or more new industry-wide collaboration requirements. Collaboration that would most stimulate Type X adoption would include new data exchange requirements that both cause the need for new applications to be developed, and exceeding the capabilities of current messaging infrastructure. Applications such as eTicketing, eFreight, APIS, and so on, fit this category.

It is difficult to pinpoint when mass adoption has been achieved, but looking at MQ and MATIP as a reference point, adoption has been steady but relatively slow. In fact adoption of these IP technologies combined have just barely exceeded the 50% mark in the industry despite being available for more than five years. Type X messaging is expected to have an adoption that is somewhat accelerated relative to these earlier IP-based approaches, due to forces in the IT industry and vendor community at large, as well as internal to the airline enterprise environments. Still, the driving forces for more massive penetration will not be more powerful than the forces already driving the airlines toward more modern applications.

### *Obstacles to Adoption and Mitigation*

While XML technology holds great promise to transform the way communications are done in the ATC, there are some challenges that will need to be overcome. The biggest obstacle to migration to the new technology for business-to-business communications is the lack of standards and reference implementations. As stated above, ARINC and SITA and members of the Type X Work Group are committed to

removing these two obstacles, with a released specification and by conducting a demonstration project.

There are numerous technical and business challenges that will still need to be overcome, even with the existence of strong standards. Specifically:

- **Performance Issues**—XML is more processor intensive than current more simplified messaging approaches. As CPU power increases, this becomes less of an issue, but still the potential impact to high volume transactional applications of additional processing related to XML parsing and transformations are not likely to be acceptable. Technologies that offload some of this processing from the application host will likely be required.
- **Increased bandwidth**—The higher verbosity of XML and SOAP results in larger message sizes, driving the need for bandwidth up. Cost effective private network solutions and robust Internet-based connectivity options are recommended to insure that use of Type X messaging does not drive up the cost of bandwidth.
- **Legacy pricing models**—Due to the increased size of XML messages appropriate pricing models should be created to avoid penalizing early adopters. These potential issues must be addressed and managed as demonstration projects are implemented and early adopters start to take up the new technology.

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## Summary

This paper has defined the rationale for introducing XML and Web Service technology to the ATI, with a focus on the driving benefits of XML-based communications in general, and a specific look at how the benefits are expected to be realized in the highly networked airline community. The general benefits of XML as a technology have been elaborated on, including not just the open standard related benefits, but the specific power of the technology which has the potential to revolutionize business-to-business communications. Specifically in the ATI, these benefits will manifest themselves as an overall lower cost for communications that is expected to be significant.

A context for standards development going forward has also been delineated. The scope of the Type X Work Group is providing an important bridge between the general standards for XML, SOAP, and Web Service extensions and how these standards need to be implemented in our industry in order to meet the stringent requirements of Type B messaging while enabling interoperability to speed adoption. The Type X Work Group effort is complementary to the OTA and IATA XML Task Force, and it is essential for successful adoption that these and other standards groups continue to develop XML schemas to enable whole classes of applications to move to the new paradigm.

As critical communications infrastructure providers in the industry, ARINC and SITA formed the Type X Work Group based on demand from airlines and application providers based mostly on economic drivers. The urgency of the Type X Work Group to date has been motivated by early adopters that are already poised to take advantage of XML communications technology for new applications, and fast followers that are moving from legacy application infrastructure and have opportunities to depart from legacy messaging approaches along with this transition.

ARINC and SITA also recognize other transformations in our industry that are driving the need for change. New applications that increase collaboration are developing rapidly, for improved safety, security, passenger experience, and efficiency of operations. It is imperative that a modernized, more robust and flexible approach to business-to-business communications be available as investments are made in new applications and airlines move from today's legacy environments. As momentum builds, it is the vision of the Type X Work Group that reduction in costs will grow throughout the industry, and once a critical mass of adoption occurs, agility and degree of collaboration enabled by the XML and Web Service technology will increase dramatically. ■

## **ABOUT ARINC**

ARINC Incorporated is the world leader in transportation communications and systems engineering. The company develops and operates communications and information processing systems and provides systems engineering and integration solutions to five key industries: airports, aviation, defense, government, and surface transportation. Founded to provide reliable and efficient radio communications for the airlines, ARINC is headquartered in Annapolis, Maryland, and operates key regional offices in London and Singapore, with over 3,200 employees worldwide. ARINC is ISO 9001:2000 certified.

## **ABOUT SITA**

SITA is the world's leading service provider of IT business solutions and communications services to the air transport industry. SITA manages complex communication solutions for its air transport, government and GDS customers over the world's most extensive communication network, complemented by consultancy in the design, deployment and integration of communication services. Its extensive range of airline and airport applications and services includes airport operations and integrated baggage services, common-use and desktop services, flight operations and air-to-ground communications and end-to-end airline distribution and fares services.

SITA covers 220 countries and territories and the head office is in Geneva, Switzerland. SITA had aggregated revenues of US\$ 1.554 billion in 2005 (€1.295 billion).

