INTEROPERABILITY FRAMEWORK FOR CAD

Establishing Interoperability with Your Computer-Aided Dispatch System
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1. Introduction

This paper describes how Intergraph®’s Interoperability Framework for CAD, in conjunction with Microsoft® BizTalk® Server, provides a modern foundation for standards-based interoperability and advanced notifications in a Computer-Aided Dispatch (CAD) environment.

The Intergraph Interoperability Framework for CAD supports enterprise integration, information-sharing, and the implementation of customer-specific server-side business rules by interfacing Intergraph CAD (I/CAD) with Microsoft BizTalk Server. This product is a vital tool for establishing regional, interoperable security networks to safeguard communities. Using the latest technologies, Intergraph can simplify workflows and protect your investment for the future. The use of open and interoperable systems reduces the cost of ownership, while increasing operational efficiencies. These benefits result from sharing event, unit, and other critical information across multiple CAD systems and with other systems within the public safety enterprise.

1.1. Challenges

Creating interoperability within the public safety enterprise can be a challenging task. This is especially true when sharing data among multiple CAD systems that each have their own unique configuration and set of resources that they manage. A decade ago, the Association of Public Safety Communication Officers (APCO) started to address this issue by creating the first accepted standard for sharing CAD data. This standard was commonly referred to as the “APCO Project 36” standard. Intergraph’s response to the standard was InterCAD, a commercial off-the-shelf (COTS) product that codified the standard into software. Since the release of this standard, numerous tragic events have taken place in the U.S., which highlighted the need for a response doctrine to manage emergency situations. In the U.S., the response doctrine is described by National Incident Management System (NIMS) and the National Response Framework (NRF), and must be implemented whenever the scope of the incident expands beyond the capabilities or geography of single agency.

To support the sharing of critical information, the U.S. Department of Justice, in partnership with the Department of Homeland Security, created the National Information Exchange Model (NIEM.) NIEM is designed to develop, disseminate, and support enterprise-wide information exchange standards and processes that enable jurisdictions to share critical information in emergency situations, as well as support the day-to-day operations of agencies throughout the U.S. NIEM contains a number of Informational Exchange Package Documentation (IEPDs), which define the semantics and XML structure for data-sharing across various domains, including justice, public safety, emergency and disaster management, intelligence, and homeland security. You can find more information about NIEM at http://www.niem.gov.

1.2. The Paradigm of Coordinated Response

When establishing interoperability among differing CAD systems, one of the challenges that must be addressed is the management of “shared” resources. These resources are owned and primarily managed by one of the CAD systems, but may be dispatched to address incidents in another public safety agency’s territory, if that agency happens to be closer in proximity or needs additional resources. Intergraph’s approach to this type of situation has focused on a “coordinated response” paradigm, rather than “shared management.” Using this concept, each CAD system maintains ownership of its own resources and passes information to the other only with regard to how it responds to requests from the other. With this model, each agency creates and manages responses to requests for service/support from another agency. It is also responsible for informing the requesting agency of any action being taken, or change in status of those resources assigned to respond to the requesting agency’s support/service. Thus, each agency does not need to know or understand the response paradigms or policies of the other agency.
This approach also has the advantage of allowing each agency to continue to respond to requests for service using its own business rules for resource/incident management. In other words, Agency ‘A’ does not need to know exactly what recommendation or deployment policy Agency ‘B’ uses to fulfill its request for service; it must know only what action was taken, what resources are responding, and their status.

1.3. Virtual Agencies

When interoperability involves two or more CAD systems, the Intergraph I/CAD system(s) must have a view of the other CAD system’s agencies and units. This allows the local I/CAD system to validate the information it receives from the external system and present it to the local operator in a meaningful way. To accomplish this, Intergraph developed a virtual world in which an agency can define the view it needs in order to coordinate with the other CAD systems. In essence, the I/CAD system requires that a virtual version of the other CAD system’s agencies and units be defined and known within the I/CAD system. This allows information coming from the other CAD system to be accepted and properly applied within the I/CAD system.
2. Why Do We Need Interoperability?

There are two primary reasons why interoperability with a CAD system is important. These are:

1) A desire to leverage the intelligence of other systems within the public safety enterprise, and

2) Support for a coordinated response (when required) through the efficient sharing of critical information with other agencies.

2.1. Integration with Other Systems

Today, there are many different types of systems that provide workflows or contain information that is useful in the management of an emergency event. Each system plays a different role, but together can contribute to improving emergency response by providing this information in a timely and contextually correct manner.

Some of the systems that may be involved in sharing information with CAD are:

- Permitting systems that contain firearm registrations, hazardous material locations, or any other type of useful information for which a permit must be issued
- Resource optimization systems that help balance the deployment of resources to maintain adequate coverage and acceptable response times.
- Skills and roster management systems that track first responders’ skill sets
- Emergency Operations Center (EOC) applications

In the past, CAD systems had their own administrator, CAD network, and information technology (IT) staff, and were segmented and isolated because of the mission-critical nature of the system. CAD systems are now moving into the realm of mainstream enterprise systems and increasingly are falling under the purview of the agency’s IT department. This opens a range of opportunities for interoperability in terms of emergency management.

In addition to being one of the most affordable solutions on the market today, Microsoft was placed in the Leaders Quadrant by Gartner in its December, 2008 study “Magic Quadrant for Application Infrastructure for Back-End Application Integration Projects” based on its evaluation of BizTalk Server.

2.1.1 Directives and Standards

In early 2002, the Association of Public Safety Communications Officials (APCO) Project 36 subcommittee published an initial set of user requirements for the exchange of information among CAD systems. The purpose of this exchange was to enable the mutual management of shared resources among multiple agencies.

More recently, in the U.S., Homeland Security Presidential Directive 5 (HSPD-5) mandated a single, comprehensive approach to domestic incident management. This ensures that all levels of government across the nation can work efficiently and effectively together, sharing critical information in a timely manner.

Initiatives such as NIEM were designed to develop, disseminate, and support enterprisewide information-exchange standards and processes. This partnership between the U.S. Department of Justice and the Department of Homeland Security supports interoperability by setting guidelines and recommendations for all agencies. NIEM folded a number of existing standards into a compliant set of semantics that allows
various types of information to be exchanged among systems. Through the use of common semantics and well understood message schemas, public safety systems can now exchange a variety of types of information with other systems, such as records management systems (RMS), intelligent transportation systems (ITS), and other CAD systems. Intergraph understands the importance of supporting these types of standards-based exchange formats.

Outside the U.S., other countries are adopting NIEM or other standards. Intergraph understands the need to provide a mechanism that is flexible enough to adopt and implement those regional standards or customer-specific message schemas.

2.1.2 Loosely-Coupled Interfaces Reduce Costs

Intergraph’s partnerships with other companies allow us to leverage a wide range of technology offerings as part of our comprehensive solution. Intergraph’s Interoperability Framework for CAD leverages the use of middleware capabilities to efficiently handle tasks such as the communication methods, scaling, redundancy, and failover.

By building interfaces and the interoperability workflows on top of a middleware platform, they become “loosely coupled.” This loose coupling helps reduce or eliminate the impact of version upgrades because the interface is not directly connected to any of the systems. The key to ensuring smooth upgrades is to make sure the schemas of the message that are passed among the systems does not change. All of this together helps to provide forward compatibility for the interface.

As systems become more sophisticated, agencies expect more integrated and configurable workflows that support the needs of the dispatcher and response teams. Putting in place new capabilities, such as embedded business rules, allows configurable processes that automatically notify users of critical information and in some cases, and where appropriate, automatically take action. In past implementations, these specialized workflows were typically customized and embedded inside the core system and became available to the customer only when the next version of I/CAD was released. Using the Interoperability Framework for CAD, these specialized workflows can now be externalized from the core CAD system. This allows system enhancements to be performed independent of the CAD product version and release schedule.
3. How Is Interoperability Achieved?

When workflows are externalized and loosely coupled, the interfaces must be built in such a way that they can be implemented external to the CAD system, but still leverage the power and the capabilities of I/CAD. Intergraph’s Interoperability Framework for CAD leverages Microsoft BizTalk Server, an industry-proven enterprise integration platform to connect to and facilitate data flow between the various disparate systems.

3.1 Simplifying Business Rules and Workflows

Intergraph’s Interoperability Framework enables the creation of business rules to handle pre-defined situations. For example, when a dispatcher or officer in the field creates a new event, and the event involves a firearm, this can invoke a business rule that implements the standard operational procedure (SOP) associated with that type of incident. If the protocol is to automatically identify schools within a certain distance and notify them of the incident, the system could assist by presenting the dispatcher with contact information for the affected schools. A page could also be sent to the on-duty supervisor notifying them of the incident.

From a workflow perspective, this event comes in through the CAD system, whether from a mobile unit, or through the call taker. The CAD event listener runs in the background, looking for particular event details such as if the event involves a firearm. If this is the case, the business rule is invoked and the system searches to determine if any schools are located within a predetermined radius of the event location. In some cases, the organization may choose to implement (or already have) a service that implements the task of querying a spatial data source to locate schools. In an Interoperability Framework environment, Microsoft BizTalk Server facilitates the integration with these types of external data sources and/or services.

As a final step, a message is returned to the dispatcher containing a list of schools that are affected, along with contact information for those schools. The dispatcher can then use that information to notify the schools of the situation. In parallel to this, the system could also notify the on-duty supervisor by sending an e-mail or page. See Figure 1.
3.2 Why Use Microsoft BizTalk Server?

Microsoft BizTalk Server is a robust business process management server that provides a platform that can support the creation and hosting of customer-specific business rules, and interfaces to external systems – all outside of the core I/CAD system. Microsoft BizTalk Server provides a clear separation between the transport logic of how your data, your question, or your message gets from the CAD system into the BizTalk Server environment, and ultimately, to its destination. This separation between the transport and the business rules gives you flexibility in terms of how you communicate with other systems and provides a loose coupling of the interfaces and workflows that simplify system testing, upgrades, and cutovers.

Microsoft BizTalk Server can be configured as a highly available solution that can scale up and/or out as required. These capabilities provide a robust and high-performance platform with proven, real-time failover. As a result of the availability and scalability functionality that is part of the Microsoft BizTalk platform, any interfaces or business rules that run on top of the platform inherit this. If more computational power or system resources are required, there is no need to change interfaces, workflows, or business logic – just build out the BizTalk Server implementation. Microsoft’s BizTalk Server fits nicely inside the Intergraph technology stack, providing a consistent approach to implementation, operation, and maintenance. The development, deployment, debugging, and system management tools are also familiar, as they follow Microsoft standards. Keeping the middleware platform consistent with Intergraph’s technology direction ensures that you can incorporate future Intergraph innovations into the system.
3.2.1 How Does Microsoft BizTalk Server Streamline Communications?

The fact that Microsoft BizTalk Server is a business process management (BPM) server and enterprise integration platform allows an agency to automate and integrate business processes and connect disparate applications, within or across organizational boundaries. This enterprise integration component performs the tasks of communicating between systems, acting as an intelligent message broker.

Microsoft BizTalk facilitates communication through the use of "adaptors." Adaptors provide a flexible approach to dealing with different applications communications protocols. In essence, the adaptor abstracts the business rules and messages routes from the communication mechanism. In Microsoft BizTalk Server 2006 R2, adaptors are provided for HTTP, FTP, SMTP, POP3, File, SOAP, WCF, SQL Server, Oracle, MSMQT, WSE 2.0, SharePoint, JD Edwards, Tibco, PeopleSoft, Siebel, and others. In many cases, additional adaptors capable of providing connectivity to other types of systems are available at an added cost.

Microsoft BizTalk Server enables system connectivity through a “publish and subscribe” model. The pub/sub model, as it is commonly referred to, is an asynchronous messaging paradigm where senders (publishers) of the information do not have direct knowledge of the intended recipients. Receivers (subscribers) of the information express their interest in specific messages by means of a “subscription.” The subscription can include conditional statements that are evaluated against attributes of the message that have been exposed or “promoted." This decoupling of sender and recipient systems enables greater scalability and a more dynamic multi-point topology. Microsoft BizTalk server and the pub/sub model eliminate the need for hard-coded, application-specific, point-to-point interfaces in favor of a more flexible and adaptable loosely coupled multi-point interface.

The Intergraph Interoperability Framework for CAD brings this advancement to I/CAD. See Figure 2.

![Figure 2: Microsoft BizTalk Server provides a host of adapters that communicate with various types of systems, supporting various protocols.](image)

The diagram above depicts how messages flow into and out of the Microsoft BizTalk Server environment. The message originator (System A) can either be the Intergraph I/CAD system or a foreign system. The Receive Adapter receives the message from the originating system, which pushes it into the Microsoft BizTalk Server ‘Message Box.’ The message box is a specially tuned SQL server database used to store messages, dehydrated orchestrations, and message subscriptions. The Message Box database is completely separate from your I/CAD database and is used solely to support Microsoft BizTalk Server.

In the scenario above, if the communication transport mechanism changes with the target system (System B), you can easily update the interface to reflect the new communications method. For example, if the target system (System B) originally received its message through an XML “file drop,” but was updated to use a message queue such as MSMQ, this change in transport could be implemented as a minor configuration change, assuming the message structure (contract) remained unchanged. This is
easily accomplished as a result of the communication methods being separate from the interface workflow logic, which would be implemented as a BizTalk Orchestration.

3.2.2 Interface and Customer Business Rule Implementations

The workflow process that takes place when interfacing to a foreign system or when implementing a customer-specific business rule is created within the BizTalk Orchestration Designer. The Orchestration Designer allows for visual modeling of a workflow and supports logic control constructs such as loops, decision paths, parallel logic paths, error handling, transactions, compensation, and much more. Orchestrations are compiled into .NET assemblies and deployed to the BizTalk Server. Since orchestrations are compiled objects, changing them requires the involvement of a programmer. In many cases, it is necessary to change the behavior of an orchestration based on a set of parameters. These changes are straightforward and non-disruptive to the system. The Business Rules Engine (BRE) provides this capability and is suitable for use by a supervisor or other non-technical staff. The BRE allows for simple rules and parameters to be injected into the orchestration to change its behavior. For example, in the scenario described earlier, the business rule stated that all schools within a radius of five miles should be notified if an incident is reported that involves a firearm. The radius search distance could be parameterized in the BRE so that it could easily be changed. The rules engine could also be used to control who is notified when such events occur.

Orchestrations, like send ports, are subscribers to messages. This is the mechanism that an orchestration uses to express what types of messages it wants to process. When a message is published to the message box that matches an orchestration’s subscription, the orchestration becomes active and invokes its functionality. Once the orchestration has completed its work, a resulting message can be published to the message box. This new message can either invoke another orchestration, or can be routed to a foreign system through a send port subscription. In the earlier scenario, the orchestration listened for (through its subscription) events that involve a firearm. In this case, the event message would have had to “promote” (expose) a property within its message schema that indicated the presence of a firearm.

3.2.3 Visually Modeling Business Rules

Figures 3 through 6 illustrate the visual modeling of business rules.
Figure 3: The screen shot illustrates how an interface or customer business rule can be modeled visually using the BizTalk Orchestration Designer.
Productivity improvements

Microsoft BizTalk Server provides a number of tools that simplify and accelerate the process of creating BizTalk-hosted interfaces and business rules. BizTalk at its core makes extensive use of XML, and as a result, there is often the need to create XML schema definitions (XSD) that describe a message schema. To facilitate the creation of these schema definitions, BizTalk provides an XML Schema Designer tool.
The implementation of an interface or business rule often requires that data stored in one XML message be copied (in part or whole) into a message with a different schema. This new message schema may also need to be enriched with additional data from other sources. Moving data from one message instance to another with a different schema involves creating a transformation. The transformation process may include operations such as string concatenation, parsing, aggregation, format conversions, and the application of mathematical formulas. The enrichment process may include adding date/time stamps or creating new data as a result of a database query or executing a script. These transformations are created using the message mapping tool and the “Functoid” toolbox. Functoids are BizTalk’s mechanism for applying methods to data via a GUI drag-and-drop interface. A transformation is created by drawing lines between the attribute in the source message to destination attribute in the target message. Functoids can be inserted inline applying to the data the various forms of logic mentioned above.
Figure 6: This screen shot shows BizTalk’s message mapping tool and Functoid toolbox.
4. Components of Intergraph Interoperability Framework for CAD

The Intergraph Interoperability Framework for CAD is a single product containing two complementary components. Together, these two components provide a bi-directional interface to Microsoft BizTalk Server, as well as interoperability with your I/CAD system.

The first component is a set of integration services that together form the interface to Microsoft BizTalk Server. The services are:

**Listener Notification Service**

The listener notification service takes the I/CAD listener packet data that is sent using UDP, transforms it into an XML message, and sends it to the BizTalk server. Each listener packet type will have an associated XML schema definition (XSD) so the messages sent to BizTalk are strongly typed.

**CAD Command Service**

This service allows a BizTalk orchestration to submit commands to I/CAD in order to invoke certain functionality. The Command Service supports a number of commands, including those to create, update and close an event, send a message, change a unit's status, and more.

**CAD Data Service**

This service allows a BizTalk orchestration to query the I/CAD database for information the orchestration requires, but was not part of the original XML message sent from the listener notification service.

The second component, the “CAD Interoperability Module,” contains the Microsoft BizTalk orchestrations, maps and schemas needed to interoperate with I/CAD. This component provides multi-point InterCAD behavior on top of BizTalk Server.

In the traditional InterCAD environment, interfaces were point-to-point in nature and required the purchase of a separate InterCAD license for each. The Interoperability Framework for CAD scales much more easily and can service the needs of many multi-point interfaces without the need to purchase additional software licenses. Additional licenses for Microsoft BizTalk and the Interoperability Framework for CAD are required only when more computational resources are needed to meet the processing demand.
5. Interoperability in Action

Advanced Notifications

Intergraph’s Interoperability Framework for CAD and Microsoft BizTalk Server provide an ideal platform to support advanced notification capabilities. The platform allows the integration of notifications modules with other I/CAD services, such as the new timer service, to provide rich and robust notification functionality. Actions that occur within the I/CAD system can trigger a business rule that results in notifications being issued. These notifications can then be sent using a variety of methods, including e-mail, I/CAD “Send Message,” and more.

In order to promote officer safety, an advanced notification rule could be implemented that would automatically create a “health and welfare” timer whenever an officer creates a field event, such as a traffic stop. If the health and welfare timer were to expire before the officer closed the field event, the notification rule could be configured to issue a high-priority message to the dispatcher, who could issue a manual radio-based welfare check.

This example illustrates the Interoperability Framework’s ability to integrate with messages in I/CAD, leveraging services such as timers and background processes to assist dispatchers in doing their jobs more efficiently and effectively to protect the health and welfare of the first responder.

Third-party Interfaces

Intergraph’s partners provide complementary solutions that work alongside the I/CAD system. By incorporating the Interoperability Framework for CAD, our partners now have a mechanism that facilitates a more robust integration with I/CAD. Intergraph’s approved partners will be able to build new interfaces, which they can own, enhance, and maintain across I/CAD versions.

Simpler and More Efficient Customized Projects

Intergraph’s Professional Services teams will also use the Interoperability Framework for CAD to implement customer-specific interfaces in a more efficient manner and in a way that will simplify future system upgrades.
6. Supporting a Multi-Point Interface and Implementing Custom Business Rules

The Interoperability Framework is not an “end-user” product, and therefore doesn’t have a user interface to demonstrate. It is very powerful because of what it enables, not because of what it looks like.

Figure 7 depicts an actual implementation that was put together to demonstrate the power of this product.

![Figure 7: The implementation shown here involves multiple systems participating in information-sharing by using Microsoft BizTalk Server and the Interoperability Framework.](image)

The three systems involved in the implementation in Figure 7 include:

- **I/CAD** – Intergraph’s Computer-Aided Dispatch (CAD) system.
- **AcmeCAD** – A simple test system used to simulate another possible CAD system. This “CAD Simulator” is used to create events and change a units status.
- **Microsoft SharePoint® Server** – A system that would not have been considered a traditional public safety application, but is growing in popularity. The use of Microsoft SharePoint is being adopted by many different types of companies, including public safety agencies, to facilitate various forms of communication and collaboration.
With the previous generation of technologies, each interface has been point-to-point in nature. This is no longer the case with Interoperability Framework; interfaces can now be multi-point. In this example, three different systems are connected together.

To demonstrate the multi-point nature of the interface, an event is created in I/CAD, which resulted in AcmeCAD being notified of the event. See Figure 8.

![Figure 8: The system alerts I/Dispatcher of a new event created.](image)

The event details are also posted to a SharePoint list where they could be reviewed by a supervisor, chief, or any other approved person. See Figure 9.
The unit’s status is changed from enroute to arrived by AcmeCAD. I/CAD is automatically updated to reflect the change, and an entry was posted to the SharePoint to indicate that AcmeCAD changed the status on the dispatched unit.

In another example, a ‘Be On the Lookout’ (BOLO) message is created for a missing young girl. The Interoperability Framework has a rule that explicitly looks for BOLOs of this type. This rule creates an Amber Alert notification in SharePoint using both the raw NIEM format and the easily-readable report format. This demonstrates how critical information such as an Amber Alerts can be posted to a media advisory site, or made available for consumption by other systems, such as intelligent traffic message signs or lottery terminals.
7. The Future

The future looks bright for the Interoperability Framework for CAD. Shortly after the Framework was released as part of I/CAD 9.0, it was selected as one of the top new products of the year introduced at the Association of Public Safety Communications Officials (APCO) International annual conference in Las Vegas in August, 2009.

Intergraph understands that CAD systems must be integrated with other enterprise systems and must support data interoperability. The Interoperability Framework for CAD, in conjunction with Microsoft BizTalk Server, provides a middleware platform capable of addressing these needs today and far into the future.

Intergraph continues to be a proponent of open standards, and as such, is embracing standards such as those described by NIEM, APCO, and ANSI. Our goal is to provide our public safety customers with standards-based solutions that are reliable, performant, configurable, and capable of integrating with other enterprise systems.
The enclosed product information is shared for the sole purpose of providing an understanding of Intergraph’s current expected product direction, roadmap, or vision, and is subject to change at any time at Intergraph’s sole discretion.

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