

Role of an Enterprise Service Bus (ESB) in the Integration of Multiple Simulators

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Abstract. Key concepts in using an Enterprise Service Bus to support the integration of multiple simulators.

An ESB is the run time infrastructure that implements the Services Oriented Architecture pattern. ESBs are a proven reliable and high volume infrastructure foundation. They are used for the management of events as well as security policy enforcement and are ideally suited to triggering the recording of a collection of events for post engagement analysis.

IBM's Intelligent Operations Centre features an ESB that provides visualisation over the control of multiple simulations.

The paper covers three key concepts of the use of an ESB to support the integration of multiple simulators:

1. Exercise Control where the ESB can be the master timekeeper across simulations.
2. Translation Services where the ESB facilitates translation between standards and versions of standards.
3. Parallel Testing Concepts where the ESB is used to simplify introducing complex new simulation services

1. EXERCISE CONTROL

Simulation exercises are typically divorced from real time, with each simulator needing to be coordinated with "exercise time". Exercise control is a coordination application where the ESB can be the master timekeeper across simulations.

- Multiple named exercises in various stages of development at any one time
- A simulator 'instance' subscribes to the ESB for an exercise name and type
- The ESB sets the clock signal for each exercise that keeps all simulators in sync.

An example might be a named exercise such as *Talisman Indigo 2014* which itself may be in different stages of development and thus appear in three different states; *Dev | Test | Production*.

Simulation Control Concepts - the ESB can be the master time keeper for a simulation exercise. Thus all connected simulators can have their clocks synchronised according to the time pulse distributed by the ESB. A simulation exercise can be setup with its own name, state (dev, test, prod etc.) and timing. The ESB can keep these different simulation exercises completely separate. Thus a simulator would 'subscribe' to a particular scenario and be provided with its initial area of operations, geospatial data, timing etc.

2. TRANSLATION SERVICES

A primary use of an ESB in simulation is to facilitate the translation services between standards and versions of standards.

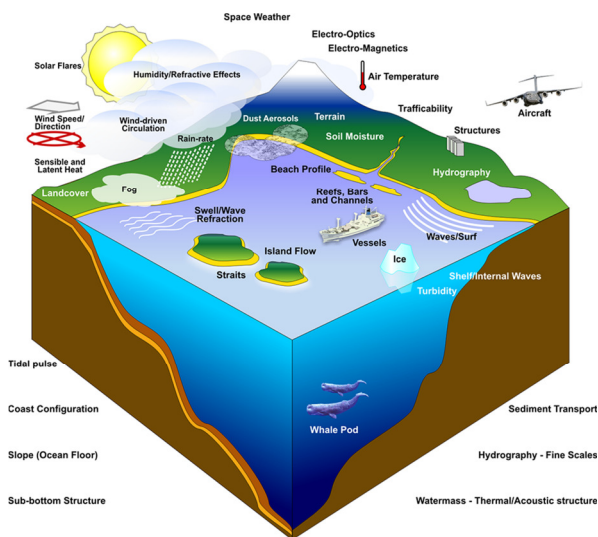


Figure 1 Environment Models

In Figure 1 above, the illustration shows the environments which are modeled for the simulators. Over time, multiple standards for Synthetic Environments have arisen, including:

- SEDRIS (sponsored by US DoD, now ISO 18023+)
 - Environmental Data Coding Specification (EDCS)

- CDB Common Database
- X3D Extensible 3D (replaces VRML)
- Open Flight
- Terrapage
- CTDB Compact Terrain Database
- Other Proprietary Formats ...

There are multiple standards for Synthetic Environments which makes it almost impossible to 'standardise' on particular formats and risk excluding otherwise viable simulators. One solution to this problem is to facilitate the translation of different standards as required.

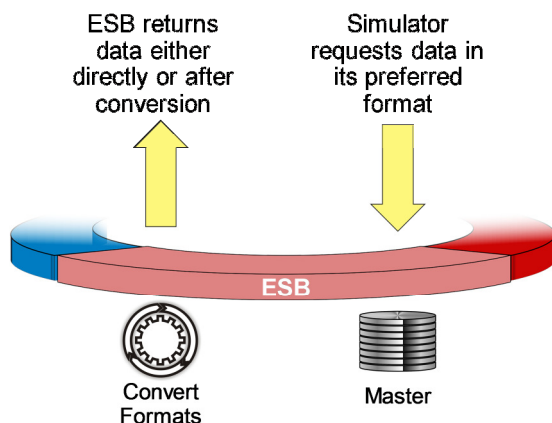


Figure 2 Design concepts for multiple disparate simulators.

An organisation can make its own decision about the standards for keeping various environmental and geospatial data.

Simulators can make a service request for data in their preferred format and as illustrated in Figure 2 above, the ESB can fulfil that request, either directly from the master data set or via a conversion routine to get the data for the "area of operations" into the right format.


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- Version 1 - 1992
 - Version 2 - IEEE 1278-1993
 - Version 3 - May 1993
 - Version 4 - March 1994
 - Version 5 - IEEE 1278.1-1995
 - Version 6 - IEEE 1278.1a-1998 (amendment to IEEE 1278.1-1995)
 - Version 7 - IEEE 1278.1-2012 (also called DIS 7)

Figure 3 DIS Application Protocols – examples of multiple versions of a standard.

Translation services can apply equally to different versions of the same standard, the ESB can provide the translation service from one version of a standard to the next, as illustrated by the 7 versions of Distributed

Interactive Simulation – Application Protocol, shown in Figure 3 (below, left).

HLA (High Level Architecture) was produced by the merger of the DIS protocol with the Aggregate Level Simulation Protocol (ALSP) designed by MITRE.

“HLA is defined as a set of services, provided by a C++ or Java API. There is no standardised on-the-wire protocol. Participants in a federation must use Run Time Infrastructure (RTI) libraries from the same provider and usually also of the same version in order for applications to interoperate¹.”

The ESB can provide that interoperability between different providers of RTI libraries to support participants in a federation of simulators.

In the Health domain, HL7 is one of the main interoperability protocols and is itself subject to different versions. The HL7 version 2 standard aims to support hospital workflows. It was originally created in 1989.

HL7 version 2 defines a series of electronic messages to support administrative, logistic and financial as well as clinical processes. Since 1987 the standard has been updated regularly, resulting in versions 2.1, 2.2, 2.3, 2.3.1, 2.4, 2.5, 2.5.1 and 2.6. The v2.x standards are backward compatible (e.g., a message based on version 2.3 will be understood by an application that supports version 2.6).

The HL7 version 3 standard aims to support all healthcare workflows. Development of version 3 started around 1995, resulting in an initial standard publication in 2005. The v3 standard, as opposed to version 2, is based on a formal methodology (the HDF) and object-oriented principles².

The ESB can facilitate the translation between simulators using various versions of HL7. This concentrates the translation services into one logical place on the SOA backbone and simplifies the simulator requirements; as conceptually illustrated in Figure 4 (below).

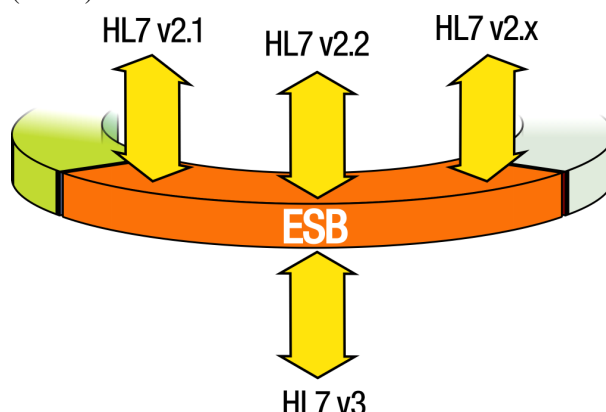


Figure 4 HL7 Translation Services

¹ [http://en.wikipedia.org/wiki/High_Level_Architecture_\(simulation\)](http://en.wikipedia.org/wiki/High_Level_Architecture_(simulation))

² http://www.hl7.org/implement/standards/product_brief.cfm?product_id=77

3. PARALLEL TESTING CONCEPTS

Components of a simulation can become so complex that they are not easily replaced by simple software upgrades. An example we might consider would be IVR (Interactive Voice Recognition). There is much tuning work to be done to make an IVR system perform at an acceptable level of recognition. There is no one configuration item to release in the upgrade but rather the combined result of complex testing and tuning. Parallel testing concepts to simplify introducing complex new simulation services are illustrated below.

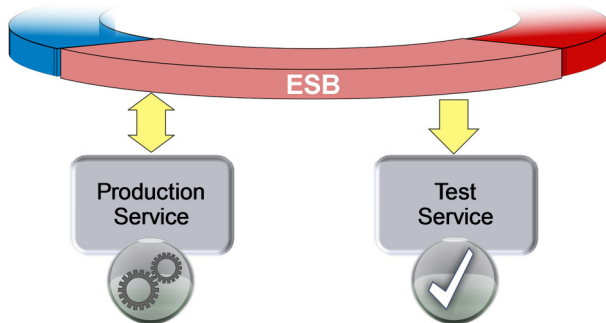


Figure 5 Parallel testing concepts

The Test Service receives the same input as the Production Service but does not affect the results – its performance is analysed until it can be promoted into production. Thus in the IVR example, a new service can be configured to see the same input and voice tracks as the production service. The output is analysed and the test service is reconfigured until such time as it provides acceptable results.

Promotion to production can reasonably be done when the test service obtains as good as or better results than the current production service.

4. BRINGING “LIVE” AND “VIRTUAL” TOGETHER

Consider the military scenario of a real jet flying over the area of operations and a simulated air defence missile launch.

From the Common Operating Picture (COP) we need the ‘track’ transferred across to introduce the jet into the simulator’s world view.

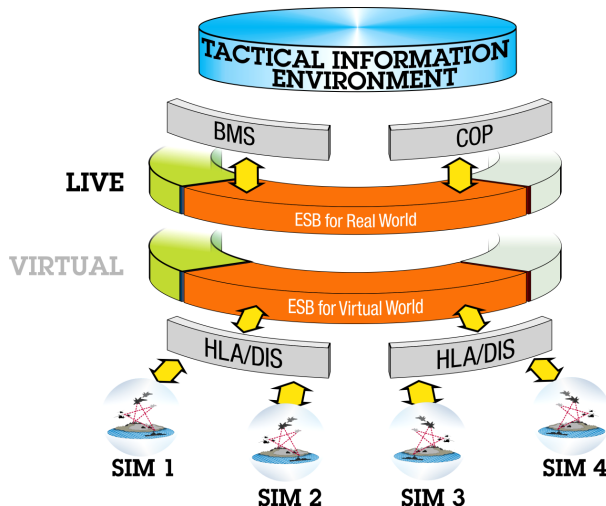


Figure 6 Live and Virtual

As illustrated in Figure 6 (below, left) the track from the real world can be introduced into a simulator’s world view to allow for ‘Live’ and ‘Virtual’ simulations.

5. IBM INTELLIGENT OPERATIONS CENTRE

Solution overview

ESB technology is at the heart of IBM’s Intelligent Operations Center³ — which is a key product within IBM’s Smarter Cities® Software Solutions product family.

The Intelligence Operations Center is designed to facilitate effective supervision and coordination of operations in the real world and simulations.

It can be installed on existing hardware (on premises) or deployed in the cloud. The solution uses the power of data generated by simulation systems by performing the following tasks:

- Collecting and managing the right data
- Integrating and analysing that data
- Facilitating easy and timely access to information
- Presenting related information in a coherent way

Benefits of the solution include the ability to:

- Adjust systems to achieve results that are based on the insights that are gained
- Optimise planned and unplanned operations by using a holistic reporting and monitoring approach
- Build convergence of domains in an organisation by facilitating communication and collaboration
- Improve quality of service and reduce expense by coordinating events

An operation can be divided into individual domains, which generally match with the organisation structure and the expertise of the people involved.

As the complexity of operations in a domain increases, a more customised solution is required. IBM Intelligent Operations Center has a number of different integration points where customisation can take place. These integration points and the infrastructure that is included give the flexibility to build a broad and powerful solution.

5.1 Features

IBM® Intelligent Operations Center provides measuring, monitoring and modeling facilities that can integrate underlying systems into one solution. This

improves the operational efficiency, scenario planning, and coordination of multiple simulators.

IBM Intelligent Operations Center is a GUI-based product that provides role-based access to data for an organisation and underlying domains. It has event management and integrated mapping capabilities. The solution can supply and track the appropriate procedures and activities in preparation for and response to events. It also has key performance indicator reporting (KPIs) and collaboration capabilities for improved effectiveness. These features provide users with the ability to integrate domains for improved cooperation and decision-making.

Event and data management

IBM Intelligent Operations Center provides an event reporting and data tracking mechanism to enable identification and understanding across underlying domains. It can manage predicted events, planned events, and current events as they evolve.

An integrated geographic information system (GIS) or location plan maps events visually. For example, managers can gauge the impact of events through interactive mapping and scenario analysis. Users can filter information about events that are based on date and time, location, and other categories that you define. Filtered information can be either highlighted on a map, or listed in a table. The information is easy to access when and where needed.

Response and activity management

IBM Intelligent Operations Center provides a system for storing appropriate procedures and activities that are associated with events involved in the preparation and setup of simulation scenarios. For example users can track the progress of procedures, and monitor or update the status of activities that are assigned to them.

Status monitoring

IBM Intelligent Operations Center provides a tool for creating and displaying KPIs. The KPIs can be updated as underlying data changes. This means the following tasks can be accomplished with minimal effort to monitor the progress of exercises in various stages of development:

- Summarise executive-level status for a single domain or across domains
- Highlight issues and identify problems
- Investigate further by drilling down into the KPI details

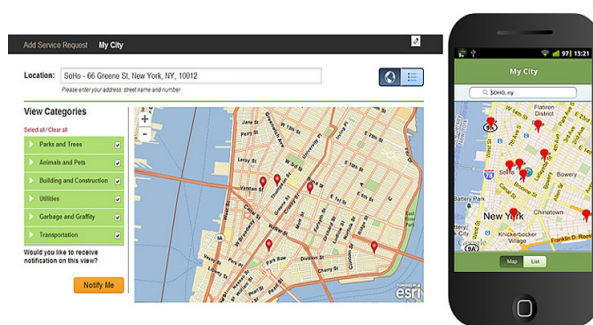


Figure 7 Dashboard Example

Instant notification and messaging

IBM Intelligent Operations Center provides a workspace that can maintain notifications for matters that need attention. This workspace can be used to monitor KPIs.

Viewing reports

The IBM® Intelligent Operations Center is designed for personnel who are involved with operational control in organisations and the management of simulation exercises: executives, supervisors, and operators.

Having access to meaningful data is only of use if the information can be presented in a meaningful and timely fashion. IBM Intelligent Operations Center gives you all the advantages of tailored summaries and graphical presentation where reports can be viewed graphs, tables, or pie charts. Users can filter the information that is displayed in the reports that are based on date and time, location, and other categories that can be used to collect and present the information that is most useful on an up-to-date and regular basis.

5.2 Components

At a high level, the structure of IBM® Intelligent Operations Center can be divided into major components, subsystems and services.

The following diagram⁴ shows a high-level view of the solution.

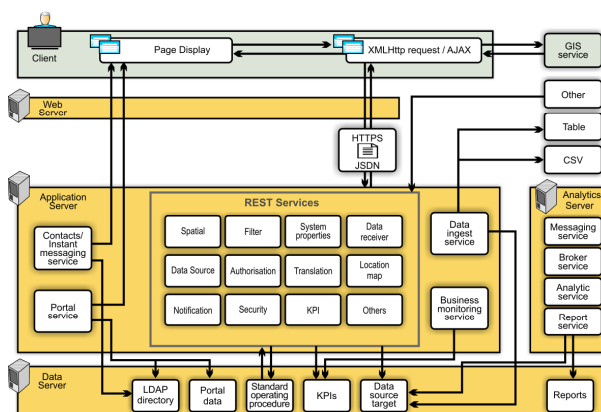


Figure 8 IOC Components

Client

IBM Intelligent Operations Center provides web-based, one-stop portals to event information, overall status and details. The user interface (UI) presents customised information in various preconfigured views in common formats. All information is displayed through easy-to-use dashboards.

Web server

The web server manages client requests to IBM Intelligent Operations Center.

Application server

The application server provides a set of services for accessing and visualising data that is managed by IBM Intelligent Operations Center. The data ingest service is used to import data from disparate external sources, such as databases and files. Because of the variety of data that can be supplied from these external sources, the data is normalised into a common format that can be used to calculate key performance indicators, trigger standard operating procedures and notifications, and provide spatial-temporal data.

The contacts and instant messaging service provides capabilities that enable effective, real-time communication. For example, in a simulation scenario, this can provide real-time communications between the exercise controllers and the individual operators of the various simulators.

The business monitoring service monitors incoming data records and uses the information that is contained in the data records to generate key performance indicators. In the user interface layer, that is provided by the Portal service, users can view key performance indicators, standard operating procedures, notifications, and reports. Users can also view spatial-temporal data on a geospatial map, or they can view specific details that represent a building or a stadium either on a location map, or in a list view.

The application server provides security services that ensure only authorised users and groups can access data.

Data server

The data server stores all the databases that are used in IBM Intelligent Operations Center.

Analytics server

The analytics server contains the following components that might be used by either custom solutions, or by other domain applications:

- **Messaging service and broker service**

The messaging service that is provided by WebSphere® MQ, and the broker service that is provided by WebSphere Message Broker, can be used to receive and transform data in formats that IBM Intelligent Operations Center does not support. When the data is transformed, it can be written either to a database table, or to a CSV file that IBM Intelligent Operations Center can process.

- **Analytic service**

The analytic service contains IBMSPSS® WebSphere Business Modeler and IBM ILOG® CPLEX® Optimisation Studio.

- **Report service**

You can use the report service that is provided by IBM Cognos® Report Studio to generate reports.

5.3 Event management

IBM® Intelligent Operations Center focuses on the integration and optimisation of information within and across multiple domains in a central operations hub, in real time and over long periods. Event data management enables IBM Intelligent Operations Center to assimilate data from multiple systems to constantly predict and react to significant events and trends.

Areas of practical application that would benefit from this capability include distribution of weather changes to multiple simulators and perhaps distribution of damage to buildings so that each simulator maintains the same 'world view'. Event messages are self-contained data items that contain basic but complete information to which recipients can respond. The IBM Intelligent Operations Center data receiver component pulls data items from CSV files and database tables. In addition, data items can be sent to IBM Intelligent Operations Center through a REST API.

Events come into IBM Intelligent Operations Center in different forms, which are based on the nature of the operations and domains in the central operations hub.

Examples of some forms of events are:

- Triggers
- Thresholds
- Complex events, and
- Manually generated events

Triggers are events that are generated by something that happens and usually requires an action to be taken by the recipient. The following list contains some examples of triggers:

- Sensors that reach threshold values
- Information technology systems that go down; e.g. a health monitoring service on individual simulators
- Intrusion detectors that are tripped
- Natural events that are picked up by sensors, such as earth tremors

IBM Intelligent Operations Center can receive information about such events from external systems and route it to the appropriate action. For example, the appropriate action might be to trigger a procedure, or to route the information to an integration point. In general, it is likely that lower-level indicators would be summarised and only passed to the IBM Intelligent Operations Center if they merited wider attention.

Threshold events help you determine when the measurements that are obtained from a sensor or other source have moved outside the normal range. Basic threshold events are comparisons that compare two or more measures and report a trend. More sophisticated threshold events can compare measures against a threshold that is created by historical information. The following events are examples of threshold events:

- Over and under temperature alarms
- High and low water levels
- Air quality and water purity that breaches environmental standards
- Excessive power consumption

IBM Intelligent Operations Center can manage such events in the form of key performance indicators (KPIs).

Complex events bring together information from multiple systems to determine whether a group of related events should be reported. The following events are examples of event that may be entered manually:

- Weather changes
- Changes to the terrain
- Damage inflicted on buildings

Complex event processing allows exceptions to be easily identified, occasionally to identify trends from unrelated data, and to predict future issues.

6. CONCLUSION

In summary, the IBM Intelligent Operations Centre solution provides a foundation for implementing both live and virtual simulations by allowing the coordination of multiple concurrent exercises in various stages of development, providing translation services between disparate simulators and simplifying the implementation of complex portions of code.