Design anywhere, Build anywhere

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Abstract. This paper is a case study of a large UK Enterprise's inter-enterprise interoperability strategy and achievements. It covers the background years of IT development, the current interoperability requirement, the architecture of the solution, the benefits, experience and conclusions. The manufacturing background is covered with details of earlier attempts at integration of large IT systems, both proprietary and bespoke and how this has progressed to today's solution. The ultimate benefit being the 'design anywhere, build anywhere' for the enterprise.

1 Objective

To share experience of trying to solve Interoperability problems.

2 Background

The concept of ICT enabled collaborative working has been around for 40 to 50 years. The ways of collaborative working were usually framed in Memorandums of Understandings (MoUs) where IPR and investment is involved, but were actually made to work in practice by humans.
There have also been various levels of integration between various software systems, forming so called islands of automation:

DNC – Distributed or Direct Numerical Control 1980
In the beginning DNC stood for Direct Numerical Control. A computer provided machine instructions for a NC milling machine that were transmitted over telephone lines. Later the term DNC evolved to mean a system where a group of CNC machines are linked to a central computer. Or conversely a combination of computers are each linked to one or more CNC machines and the computers are linked together by way of a local area network. Distributed Numerical Control where by NC programs are sent (distributed) to the memory of a CNC machine. The program is then run from the CNC memory. Computerized Numerical Control (CNC) refers to ma-

chine tools that have a computer and memory to control their operation. Most all non manual machine tools sold today will be CNC. The ISO format is the most widely used data format for NC machines. The use of standards was supposed to promote interoperability but vendor interpretation generally failed to meet these expectations.

FMS – Flexible Manufacturing Systems 1985

A flexible manufacturing system (FMS) is an arrangement of machines.... interconnected by a transport system giving flexibility to a variety of manufacturing operations. The transporter carries work to the machines on pallets or other interface units so that work-machine registration is accurate, rapid and automatic. A central computer controls both machines and transport system... National Bureau of Standards [1]

The key idea in FMS is that the co-ordination of the flow of work is carried out by a central control computer. This computer performs functions such as:

- Scheduling jobs onto the machine tools
- Downloading part-programs (giving detailed instructions on how to produce a part) to the machines.
- Sending instructions to the automated vehicle system for transportation.

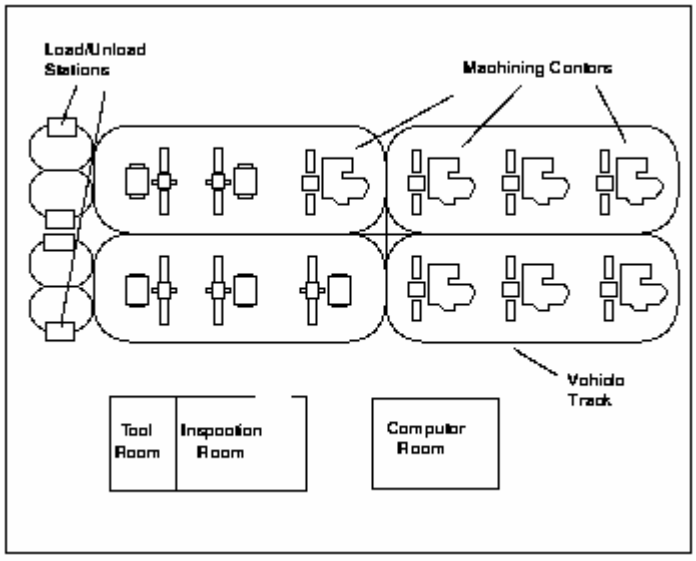

Figure 2 A Flexible Manufacturing System

The manufacturing environment was considered to be totally automated into a 'lights out' situation. This proved to be possible only in limited manufacturing applications though it still remains a goal to produce a fully integrated environment even across organisations.

[1] now National Institute of Standards and Technology

OBA – Overall Business Architecture 1983

The OBA took this philosophy to the factory level in the mid to late 1980s. It was a first generation Integrated Business System between design, planning, materials, manufacturing, procurement and invoicing applications systems. But the individual applications were locked together, difficult to maintain and inhibited business change and therefore affected the competitiveness of the business. Applications were built to aid a discipline and not to integrate with other disciplines' applications. The information was locked in the application. To integrate these applications, expensive point to point interfaces were developed.

There is a need for a more modular approach, where

- Data is seen as being separate from the application, which manipulates that data
- Information is a key company asset and should be treated differently from the application systems
- Data/information needs to be protected as it has a life expectancy
- Data standards are used – XML-xx standards need to be developed

like a platform following the schema produced by STEP for exchanging data across PDM's via a neutral data standard.
This approach was used for the next generation of integration for e-business and outsourced business.

A large UK enterprise's business depends upon the interface between Product Data Management (PDM) systems and Enterprise Resource Planning (ERP) systems to transfer Parts and Bills of Material (BOMs) to allow designed items to be purchased or manufactured.
For one Business Group, the multiple PDM systems were integrated with the multiple ERP systems using point-to-point interfaces, and a TIBCO-based interface existed between their previous PDM System, Sherpa, and ERP System at one site. For another Business Group, a similar interface existed between their Sherpa PDM and ERP Systems.

The large UK enterprise's first Business Group launched a programme to replace their existing PDM systems with a single common system based upon EDS' Metaphase, hosted on a single corporate server. There may be different site-specific data implementations dependent on the data transferred from their Sherpa systems.
The second Business Group similarly moved onto Metaphase, converting their data from Sherpa. This was totally separate implementation of Metaphase and is different from the Avionics implementation.

All the application software, both PDM and ERP, is the same but differences existed in the implementations of the ERP System to satisfy local business requirements.

3 Enterprise Integration

The first Business Group then required an interface between Metaphase and their ERP Systems. This interface is required to enable Product Structure data (i.e. single parts, single level BOM structures or multiple level BOMs) to be transferred from the single PDM database to any of the ERP databases identified, the choice of which ERP installation being made by the user. This to satisfy the concept of 'design anywhere, manufacture anywhere' and today some sites design but do not manufacture, so the data needs to be transferred to those sites who will undertake the manufacturing.
The second Business Group also required an interface between Metaphase and their ERP System but because their Metaphase implementation was different than the first Business Group's, there were different data translations to be performed.

4 Architecture

To meet this concept of transferring Metaphase Parts and BoMs to any ERP System, the interface needed to be designed and the data translations needed to be understood. Some sites have previously used a proprietary Message Broker and to also meet the needs of interfacing to an External Marketplace system from their ERP and other systems, a new corporate Message Broker was sought and acquired for this purpose, known as an Enterprise Application Infrastructure (eAI), supplied by webMethods.

Until recently, integration issues fell into several different camps with solutions provided by specific point products. However, the newer releases of Integration type platforms rise to the challenges, resulting from the broadening scope and depth of integration requirements by delivering a business-driven interoperability that fully encompasses data, packaged and customer applications, legacy systems, Web services, business partners, and human workflow. Recognising evolving and expanding requirements, these products integrate key elements into a comprehensive solution containing broad and deep support for all initiatives such as A2A, B2B, B2C, EAI, BPM, BPA, EDI and more. They deliver true end to end integration and interoperability between packaged and custom applications, mainframe system transactions, front- and back-office systems, Web services, and human workflow. Users can define disparate business processes that incorporate resources into comprehensive business processes that maintain a process context across the extended enterprise.

So the high level business process of the solution became

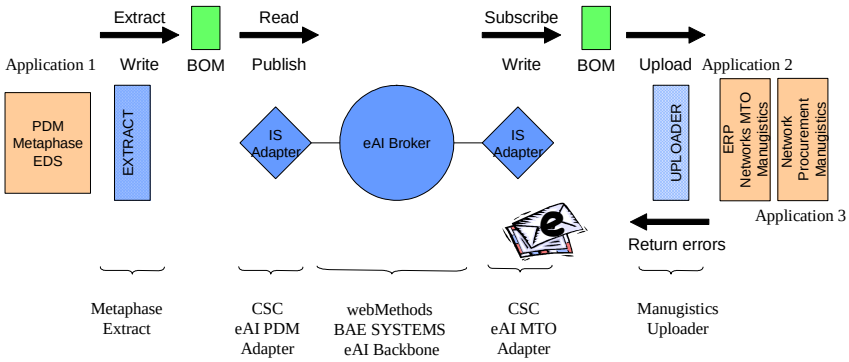

Fig. 1. Generic Business Process Model for the first Business Group's EDS Metaphase to ERP Interface

As can be seen there are three main components:

- The PDM (Metaphase), ERP (Networks MTO) and Network Procurement (if installed) systems (Application 1, 2 and 3 if installed). Network Procurement is not installed for all sites but the NWP capability exists within the interface and is dependent upon a user specified parameter to invoke it and NWP being installed.
- The software vendors (EDS (Metaphase extract), webMethods (eAI Broker and initial Adapters), CSC (eAI PDM & MTO Adapters), Manugistics (MTO Uploader)).
- The data to be transferred from Metaphase to MTO, dependent on whether Network Procurement is installed via a user configurable parameter (Bill of Material – BOM).

In addition, Fig. 1 also illustrates the generic steps and the direction of the data flow. The Extractor program selects and extracts through user screen interfaces and writes the data to be transported into a file. The eAI Adapter will read this file from the PDM environment and transport it to the MTO environment, dependent upon whether Network Procurement is installed, translating the data according to business rules defined by the Business Group. Once the file is in the MTO environment, the eAI MTO Adapter is then responsible for invoking the Uploader program via a script to load the BOM data into MTO, the data conversion and transfer being dependent on

whether Network Procurement is installed for a particular site. Codes are returned from the Uploader and translated by the eAI MTO Adapter into messages and returned, by email, in a message report file to the person initiating the transfer.

Note: The PDM Adapter, the MTO Adapter and the Uploader are common software across all interfaces but it is the choice of the user when to take these releases, so some sites have different releases installed. It is recommended that the latest release is tested, accepted for production release and installed, in line with business priorities.

Data integrity across this interface is paramount, so open source software could not be used as it is untested and unsupported. However, using software vendors' solutions doubled the cost and also increased the time delay by 100%.

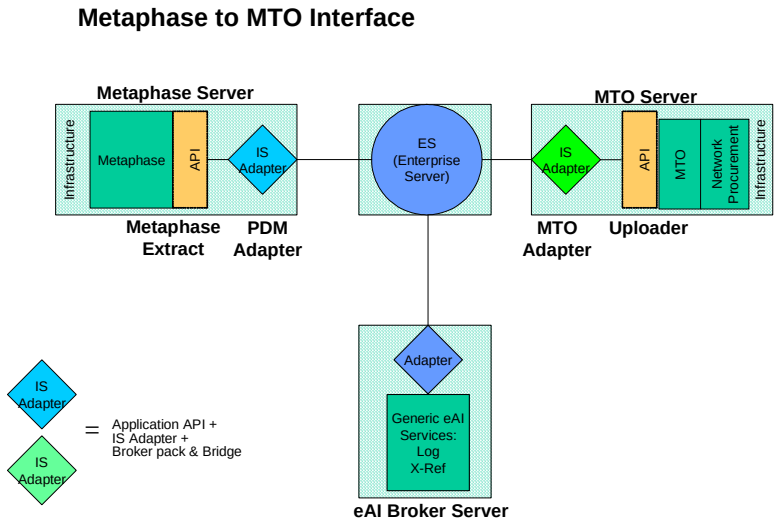

Fig. 2. Logical Application Architecture for the first Business Group's EDS Metaphase to ERP Interface

The second Business Group also required transferring Production Metaphase data to their Test ERP System, in addition to their Production ERP System. This was to satisfy a number of requirements, such as

- if during support and maintenance, there was a problem sending data across their Production interface, they could repeat the sending of the data but into their Test ERP System,
- for testing ERP System upgrades, without the need to fully replicating data into their Test Metaphase System, saving both time and cost.

This meant their business process and architecture is slightly different but this facility is now available for the first Business Group should they choose to install it.

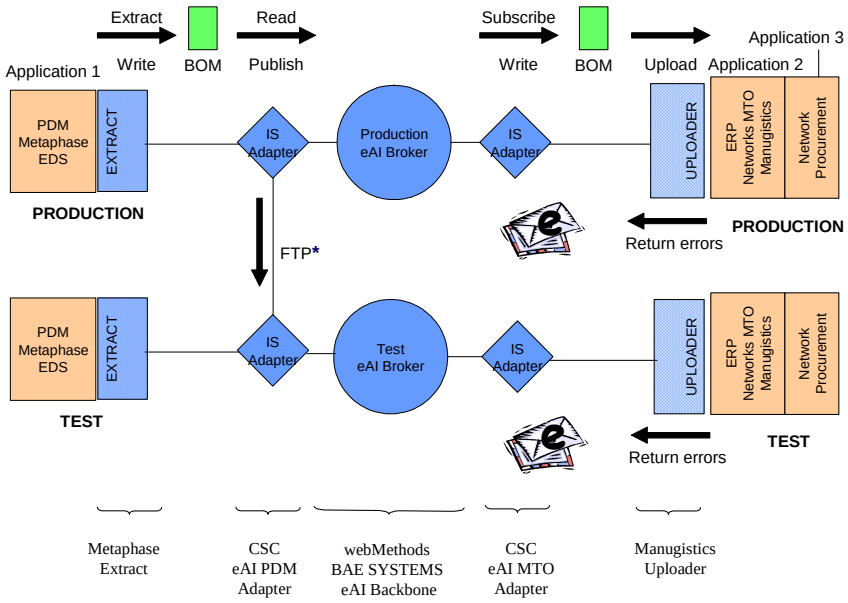

Fig. 3. Generic Business Process Model for the second Business Group's EDS Metaphase to ERP Interface

Network Procurement is not installed for the second Business Group but the NWP capability exists within the interface and is dependent upon a user specified parameter to invoke it and NWP being installed.

In addition, Figure 2 also illustrates the generic steps and the direction of the data flow. The Extractor program, through user screen interfaces, selects, extracts and writes the data to be transported into a file. The eAI PDM Adapter Build 3 will process this file from the PDM environment and transport it to the respective MTO environment, dependent upon whether the user has specified Production or Test and also whether Network Procurement is installed, translating the data according to business rules defined by the Business Group. Once the file is in the Production or Test MTO environment, the eAI MTO Adapter is then responsible for invoking the Uploader program via a script to load the BOM data into the specified MTO System, the data conversion and transfer being dependent on whether Network Procurement is installed for a particular site. Codes are returned from the Uploader and translated by the eAI MTO Adapter into messages and returned, by email, in a message report file, to the person initiating the transfer.

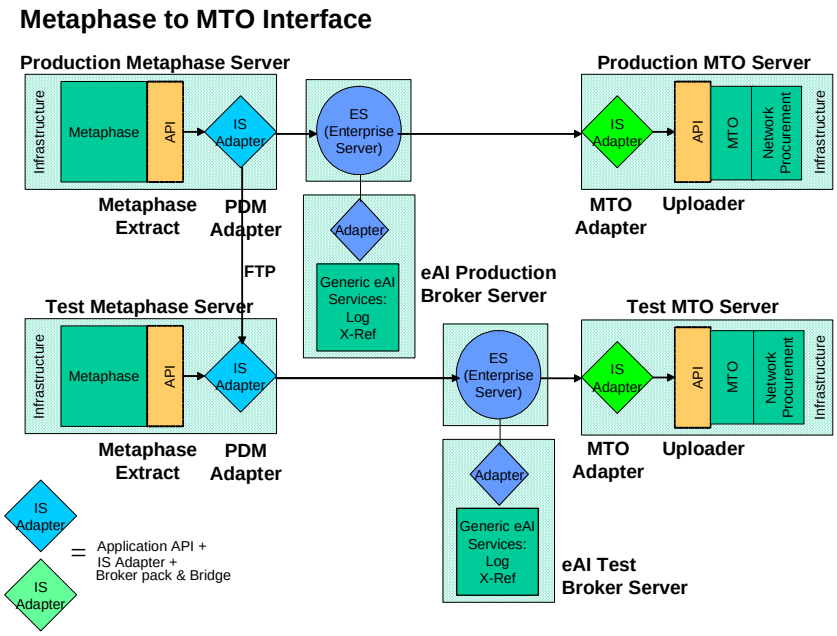

Fig. 4. Logical Application Infrastructure for the second Business Group's EDS Metaphase to ERP Interface

5 Benefits

The benefits of this approach are that there is a single software solution in place consisting of 4 main modules, utilising the EAI Infrastructure solution, with separate paths as required for each business.
The businesses cannot manage without this interface, as the recent migrations to the Production Metaphase System have shown, as they have been held for 'go live', pending the release of the metaphase to ERP Interface.
The software is easier to maintain and once facilities are developed for a site, then they are available for other sites to use as well.
The solution supports the concept of 'design anywhere, manufacture anywhere', reducing ordering times by 50% or even higher and reducing the number of internal buyers / procurement staff.

4 Experience

Experience with the Large UK enterprise has also shown that it is now possible to link:

- internal procurement systems i.e. SAP, BaaN, Networks MTO to the external Marketplace. EXOSTAR, i.e. to supplier catalogues and to order parts totally electronically.
- HR Systems to other HR Systems within and external to the company.

5 Conclusions

The eAI approach allows the modular (component) building of a system that has a degree of dynamic reconfigurability to meet business need of delivering capability to a contract need.
The cost needs to be addressed as do the analysis, modelling and, of course, the information Ontologies embedded in standards.