Case Study: Real-time Operations Intelligence for Distributed Global Manufacturing Operations

Edge Intelligence powers next-generation smart assembly and integrated global operations architecture

Customer
The Boeing Company, the global leader in aerospace and defense technology and manufacturing. Phantom Works Advanced Manufacturing Research and Development (AMR&D) Group.

Solution

System – OMNITROL™ Application Network Appliance and OMNITROL™ Edge Application Services Engine (EASE™) software;
Software - custom-developed OMNITROL Edgelets™ workflow and application services for Pedigree, Toolkit Locator, WIP visibility, ALE reporting and JBI-Open ESB integration.
Device Hardware - Alien ALR-9800, Symbol AR400 and XR400, barcode readers, Cricket Mote Sensors, Laser Projectors, indoor GPS (iGPS), Smart Hand tools.

Overview

Edge Intelligence enables 21st century real-time integrated network-centric manufacturing
Boeing is developing its integrated future factory powered by intelligent network-centric manufacturing to deliver a new level of operational performance. The Integrated Global Operations (IGO) is intended to provide real-time operational performance, ease integration of devices, systems and data across its distributed manufacturing and supply chain enabling smart assembly processes to power collaborative, real-time manufacturing of the future. Distributing intelligence to the shop-floor enables the Boeing system to stay ahead of the curve of the revolution in intelligent edge sensor networks.

Situation – The Need
Over the last 10 years, Boeing has experienced dramatic changes in the way it builds aircraft. Solid modeling, unitized structure, assembly automation and information systems have been the biggest contributors. The current focus is on lean manufacturing, common systems and ergonomics. To prepare for the next step function improvement in aircraft manufacturing, the Advanced Manufacturing Research & Development organization is exploring network-enabled manufacturing.

Network-enabled manufacturing provides enhanced visibility and vastly improved operational performance
Currently, there is a transition from centralized computing to distributed enterprise architectures. In progress for years, this trend will revolutionize manufacturing processes through the use of edge devices and edge device controllers. A new architecture is required to optimize a distributed manufacturing environment. Boeing and its suppliers require greater visibility into critical manufacturing and supply chain events. They also need a solution architecture that helps them collaboratively optimize and synchronize their partner production and supply-chain processes in a more intelligent, real-time manner.

Trends driving emergence of network-enabled manufacturing and smart assembly

- Real-time Integration of operations
- Sensors becoming ubiquitous
- Data barrage must be handled intelligently on the fly – on the shop floor
- RFID-enabled workflow edge application services
Solution

The project - cognitive factory rollout

As Boeing has transitioned to being a lead systems integrator, it has created an extensive network of internal and partner manufacturing operations. The cognitive factory includes a complex, global supply chain, numerous Boeing sites and interaction with multiple customers’ logistic locations. A network-enabled manufacturing approach will minimize infrastructure needs, ensure rapid deployment of productivity enhancements, and provide for unlimited incremental expansion through the newly-created lean supplier network.

Boeing Phantom Works Advanced Manufacturing Research & Development established a project to bring its network-enabled manufacturing vision to life. It required test beds to evaluate various aspects of the network-enabled manufacturing concept. It also required close coordination with industry leaders and universities to create the necessary technology advancements to realize its manufacturing transformation.

Rapid proof of concept of future factory project

The complete project took only three months of planning, training, design, implementation and preliminary testing. A cross-functional Boeing team from the Systems, Research, IT, and Manufacturing Operations departments was put together for this project. The project set out to explore Domain Specific Languages, process simulation, Radio Frequency Identification (RFID), Application Level Events (ALE), and Java Business Integration (JBI). The OMNITROL appliance was selected for this project as it uniquely demonstrates forward looking functionality.

Powerful out-of-the-box all-in-one web-based appliance solution

The OMNITROL application network appliance has all the functions to develop and deploy these innovative specialized edge applications and edge device control. The OMNITROL included RFID and Modbus drivers, a special purpose service creation language known as Service Description Language (SDL), a graphical simulation tool and a management console for edge service provisioning.

Other components of the configuration delivered by the OMNITROL included SDL based workflow and application services such as pedigree, toolkit locator, WIP visibility, ALE reporting and JBI-Open ESB integration. Device hardware included Alien ALR-9800, Symbol AR400 and XR400, barcode readers, and numerous control systems and sensors including Cricket Mote Sensors, Laser Projectors, indoor GPS (igPS), and Smart Hand tools.

EASE – develop, integrate, emulate, deploy

Core to the OMNITROL appliance is its integrated service development environment - EASE™, a peer-to-peer service delivery and execution framework comprising an easy-to-use Service Description Language (SDL), a visual service creation and emulation console. The EASE™ development environment is completely web-based to enable rapid, collaborative and remote application development, testing, deployment, and management.

“Whether being used by a team of one or 100, the OMNITROL’s workflow service creation environment provides an elegant and collaborative solution for rapid, broad-scale development and deployment efforts.”

Workflow process and applications – powered by Edgelets™

One of the aims of network-enabled manufacturing is to develop new production applications for hardware, tools, equipment and systems. OMNITROL’s SDL development tool enables rapid creation of intelligent distributed and federated real-time process engines, or edge application services called Edgelets™. These process engine-based edge application services expand the usability of documented processes and provide the interface to the model-based environment and manufacturing execution system. With a library of Edgelets to select from, a manufacturing engineer, industrial engineer or production foreman can select a best practice or establish a unique workflow application within hours.

EASE provides a rapid, simple, yet powerful means to create, test, deploy and manage edge workflows, applications and services. It’s a powerful services delivery framework that was specifically developed to simplify and rapidly develop business workflow solutions integrating intelligent edge devices. EASE provides a very powerful state-driven Service Description Language (SDL) that is an easy-to-understand English-like service definition and state modeling language. SDL enables OMNITROL developers to easily create, incrementally modify and deploy services. To fully enable edge intelligence, the OMNITROL supports an integrated real-time database. Services developed with EASE inherently include a high-integrity federated peer-to-peer real-time database for end-to-end service data management that is critical in delivering Always-On real-time performance.

Distributed model-based emulator environment

By adding virtual devices to model-based tools that enable process level modeling and simulation, and adding interfaces for manufacturing systems and equipment with the model-based environment, OMNITROL provides network-enabled manufacturing with seamless transition from engineering to production and suppliers.
From Possibilities to Realities

Network-enabled manufacturing pilot test suite and configuration
A pilot test was established to explore the effectiveness of the solution and make changes accordingly. The pilot test simulated a supplier network to demonstrate rapid deployment configuration using the OMNITROL. The project used the OMNITROL to integrate RFID readers and connect with a Java Business Integration bus.

Integration capabilities across global IT and operational systems
Further tests were performed to test the primary functions and configurations required of suppliers of tomorrow’s Integrated Global Operations, including back-end systems such as web services, JBI, the Boeing network and PLCs integration. Specifically, the team tested web service connectivity, Boeing network compatibility, Java application server, Modbus connectivity and JBI laser projector connectivity.

Testing deployment
The first tests were conducted on a private network and then moved to the Boeing network. This is a critical step in the evaluation of new technologies requiring successful execution across a plethora of test conditions. There are several reasons for this deployment process:

- network traffic tests the volume and type of traffic generated by edge devices before connecting them to the Boeing network;
- supplier simulation shows the kind of network environment that a supplier might have;
- rapid deployment enables the team to demonstrate a deployment configuration that can be immediately plugged into a supplier network.

Example shipping demonstration
The testing phase was followed by a shipping demonstration at the Building 245 shipping dock at the Boeing St. Louis facility. The readers included Alien ALR-9800, AR400, Symbol XR 400 and bar code readers. The tags used were Alien Squiggle. The service creation and deployment was based on the OMNITROL-1040 Appliance and Edge Application and Services Environment (EASE). Alien ALR9800 readers were installed at the loading dock door of Building 245. The antennas were positioned on either side of the loading dock, forming a portal. The portal was completed with a light sensor assembly for activation/deactivation of the portal.

Summary
Converged appliance delivers affordable solution to suppliers of all sizes
The OMNITROL appliance solution and deployment methodology provides the fastest and most cost-effective means to deploy next-generation architecture for distributed real-time operational performance for manufacturers and logistics firms of all sizes. All-in-one appliances provide business intelligence that evolves edge IT architecture by including the workflow service creation and deployment, device integration, event processing engine, wired and wireless network support on the shop-floor with enterprise back-end service and data integration.

Rapid service development and deployment
The most important performance data point in this project was the speed at which new services were created, tested, connected to the RFID equipment and integrated into a workflow. A new service would literally take a few hours to be created compared to weeks or months with other approaches.

Rapid learning and deployment of edge applications
Every step of deployment with the OMNITROL has been designed for ease of use to deliver a customer experience that’s truly unique in the marketplace. The OMNITROL’s full function capabilities support a web-based interface enabling Boeing’s team to have immediate access to the system’s many features for edge application development and integration. The team quickly learned the SDL workflow services language, device configuration and emulation and report generation with real-time alerts and notifications.

Leveraging our legacy
The OMNITROL project demonstrated leadership and the applicability of RFID using an innovative combination of cutting-edge software application and integrated hardware. The OMNITROL helped Boeing demonstrate the importance of RFID integration with existing manufacturing controller infrastructure including PLC’s, industrial machines, sensors, laser controls, bar code readers, etc.