Terminal Automation Revisited

Going beyond product receipt, product storage and product dispatch functions

ABB Value Paper Series

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In last few years, corporate systems requirements underwent revolutionary changes. Sparked by lean production, globalisation, and the Internet, corporations are increasingly elements in collabor-ative supply chains instead of freestanding, inward-looking, autonomous entities. Today, effective operation requires agile response to unanticipated changes. "Best of breed" application interfacing is not enough; systems must be vertically integrated from the data centre to real-time controller sensors. Concurrently, systems must be integrated across the supply chain to suppliers, distribution partners, and ultimately customers. Rapid response requires timely, accurate data, and timely, accurate data requires effective manageable integration.

Unfortunately, the infrastructure of most terminals today is a myriad web of systems, applications, databases, servers, networks, disks, protocols, user interfaces, and so on. Typically, these have evolved around "functional silos" and are built to meet the needs of these silos with very little cross-fertilization or engineering synergy. The result is multiple, heterogenous data sources scattered throughout the terminal — overlapping but totally incompatible. These existing systems and applications were based on "wooden" architectures — hard and inflexible. These were not designed with integration in mind and cannot provide access to information or the performance required to succeed in today's environment.

The situation is further complicated by the diversity of terminals across countries, industries, companies, and divisions, meaning that no two terminals have same functional requirements. Therefore a more a la carte approach to meeting terminal operations requirements was needed. Terminal automation software requirements are among the most diverse and granular of any application software market. Part of this is born of the real differences among terminals – partly the cultural differences among terminals, and partly imagined differences among terminals. The effect is that the exact same system rarely works well in two different terminals. Thus successful terminal automation applications must be highly configurable and easily tailored to meet unique terminal requirements.

Componentization

Traditionally, the automation industry has offered two approaches to terminal owners:

- An existing automation system is reworked and manually patched in an attempt to squeeze it inline with a terminal's requirements.
- The terminal's hardware and business procedures are changed to meet the specifications of an existing terminal automation system.

Neither of these approaches is cost effective or efficient. The former requires detailed product re-engineering, which is time consuming, expensive and results in a series of non-standard and untested code forks from the standard system that are difficult to manage and maintain. The second approach often results in prohibitively expensive hardware replacements, sub-optimal terminal operation due to mismatch between requirements and implementation and additional training.

Components based solutions assembly (CBSA) is the dynamic system architecture demanded by today's complex, global, interconnected electronic economy. CBSA systems feature flexible, adaptable solutions based on reusable and reconfigurable components. Thoroughly tested and standardized components are used to build up a complete solution, right from the device in the field to the enterprise's business system. CBSA provides improved agility through robust real-time integration and reconfiguration capability (components defined in the box at the end).

Integration

The challenge of meeting diverse terminal requirements has been addressed in much the same way as on the enterprise level — as a mix of heterogeneous applications sometimes called "best-of-breed." The interconnection challenge has also been addressed as it has on the enterprise level — as one of custom interfacing or integrating. Interfacing has typically meant the flat-file scheduled transfer of data between separate applications. This approach is satisfactory for loosely coupled applications and slowly changing data. However, it doesn't provide near real-time inquiry abilities, and it doesn't fit well into rapidly changing business environments. Interfacing is most commonly used to interconnect terminal systems with enterprise-level systems.

In contrast to interfacing, integration implies that two separate systems are interconnected so well that they function as one. Therefore, users can generate queries that require data from both systems; the queries are answered quickly with information drawn from both applications.

To be fully effective, terminal systems must be easily configured initially, readily reconfigured as requirements change, and centrally managed to avoid disintegration that results from independent subsystem maintenance.

The ABB Industrial^{IT} architecture treats every terminal device, barrel, and other plant elements as dynamic software objects. These objects are linked to the information required to engineer, operate, maintain, and optimize them. One of the goals of a consistent enterprise infrastructure is reduced engineering configuration from predefined objects containing all necessary information. Operators need to have access to updated, accurate, and current documentation. Maintenance personnel must have constant access to all alarm information, equipment data, and drawings from anywhere in the terminal.

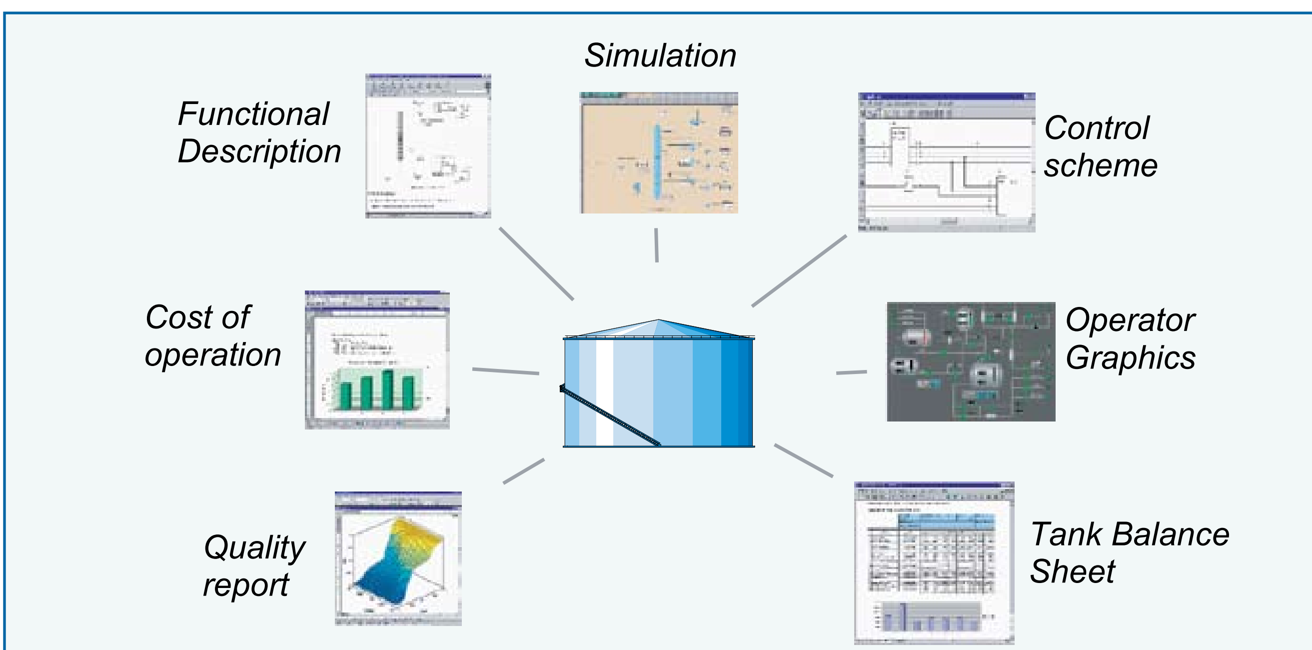
Plant-centric architecture

After years of debate over competing standards for communication protocols, automation providers are starting to understand that the real potential lies not in the “highway”, but in the objects that it connects. True plant-centric automation architecture must recognize each plant object (valve, pump, motor, meter) and its inherent characteristics (range, capacity, speed, meter-factor) as one. With this functional marriage accomplished, dynamic access to the object’s asset management characteristics (productivity, capacity, cost of ownership, ROI, etc.) follows logically.

Just the same, each definable unit of product (batch, barrel, bag, lot) might become an Industrial^{IT} object, accomplished by inherent characteristics including product specification, quality data, customer name, delivery date, etc. These product characteristics would become the “drivers” that issue the call to action of corresponding plant objects.

ABB’s approach to the plant-centric information architecture considers the myrid of enterprise objects (terminal devices, materials, products) as the building blocks that make up a total distribution scenario – or even a specific business-to-business transaction. Although various objects and their associated software may reside on multiple computers or networks, each object

Fig. 1: Different aspects of an object



carries with it an integral collection of characteristics, or aspects. A "system" is created by dynamically linking a series of distributed objects as software clients.

Beyond the obvious benefits of faster device installation and interaction, the object-oriented architecture opens powerful scenarios for both asset and business management: A click on the object icon offers up context-sensitive information from current configuration and diagnostic status to maintenance history and scheduling commitments. Linked dynamically to other plant management systems, the device contributes its local assessment to global decision support tools such as scheduling reports or quality comparisons.

Most important, the ABB "plug and produce" architecture sets stage for real-time interactions across the enterprise value chain – from e-business order input to product distribution. Drawing from vast library of dynamic enterprise objects, the Industrial^{IT} architect will deploy real-time repeatable automation scenarios to fit variety of business objective and not just automation. Just as one would browse the files in a PC directory, the users will browse among and configure multiple structures of enterprise assets – assigning each to the most productive and profitable task at hand.

Total solution

While a lot has been said and written around total solutions approach, not much has been seen in practice. Most terminal automation suppliers preach such sermons; however provide solutions that are limited to product receipt, product storage and product dispatch functions. All other areas of a typical terminal including safety systems, fire/gas detection and suppression, vapour recovery units, wastewater treatment plants, additive units, electrical systems and maintenance systems remain mostly neglected. This even has lead the customers to believe that a terminal automation system is just a software package that can be used to manage and control loading operations within a fuel distribution terminal or a depot. It is important to integrate all areas of a terminal to achieve optimisation of terminal operations. Information related to key performance indicators like energy consumption, average and peak bay utilization, average and peak truck waiting times, terminal throughput, statistics related to pump operations and vapours generated not only provide information for improving terminal operations but also help comply with environmental regulations.

Fieldbus

Despite the continued squabbling, infighting, and consternation that continues to plague the world of fieldbus and device networks, the installation of fieldbus-compatible control systems and devices in process plants is preceding at a solid pace. The Fieldbus Foundation (FF) claims to have over 1,800 FF-compatible systems either installed or on order worldwide, with over 40,000 devices installed. Similarly, Profibus claims to have an installed base of over 2 million devices worldwide. Even with all this collateral in the form of installations, products, and continued product development, why does fieldbus continue to be such a low-key topic in the terminals and distribution industries?

Part of the answer lies in the fact that most people believe fieldbus to be just a "way" of reducing wiring costs. Fieldbus benefits go beyond reduced wiring costs. These include:

- Reduced hardware costs
- Reduce process variability
- Increased product quality
- Increased capacity utilization
- Reduced maintenance
- Reduced commissioning/ engineering costs
- Reduced spare parts inventory
- Improved safety and regulatory compliance

Further, existing terminal automation systems are not compatible with today's fieldbus technologies with the result that the system suppliers do not advocate its use.

Today's automation market is increasingly gravitating towards performance-based automation contracts. With so few new terminals being built and capital spending continuing to contract, users are striving to squeeze more and more performance and productivity out of their existing systems and processes. Fieldbus remains a critical component in the performance enhancement equation. While the production and refining arms of the most large process industry giants are busy implementing fieldbus and reaping its benefits, the distribution business seems to be on the way to miss the bus!

Adoption of ISA-95

ANSI/ISA-95 consists of the following standards under the general title Enterprise-Control System Integration:

- Part 1: Models and terminology (published 2000)
- Part 2: Object models and attributes (published 2001)
- Part 3: Activity models of manufacturing operations management
- Part 4: Object models and attributes of manufacturing operations management
- Part 5: Business to manufacturing transactions

The goal of the standards is to reduce the risk, cost, and errors associated with implementing enterprise systems and manufacturing operations systems in such a way that they inter-operate and easily integrate. The standards may also be used to reduce the effort associated with implementing new product offerings.

Just as ISA-88 series of standards provided a model that energized the batch manufacturing industries, the ISA-95 standards should revitalize the integration of manufacturing systems with the rest of the supply chain. Both SAP and Microsoft have extended their support of the ISA-95 series of standards. (SAP and Microsoft press releases). IEC and ISO have a formed a joint working group (JWG 15) for the fast tracked internationalization of ISA-95. The IEC/ISO version of ISA-95 is being issued as multipart IEC/ISO 62264 series.

Part 3 presents models and terminology for defining the activities of manufacturing operations management. The models defined in Part 3 include the following:

- Production operations management
- Maintenance operations management
- Quality operations management
- Inventory operations management

Part 5 defines business-to-manufacturing transactions and manufacturing-to-business transactions that may be used in relation to the objects defined in the Part 1 and Part 2 standards. These transac-

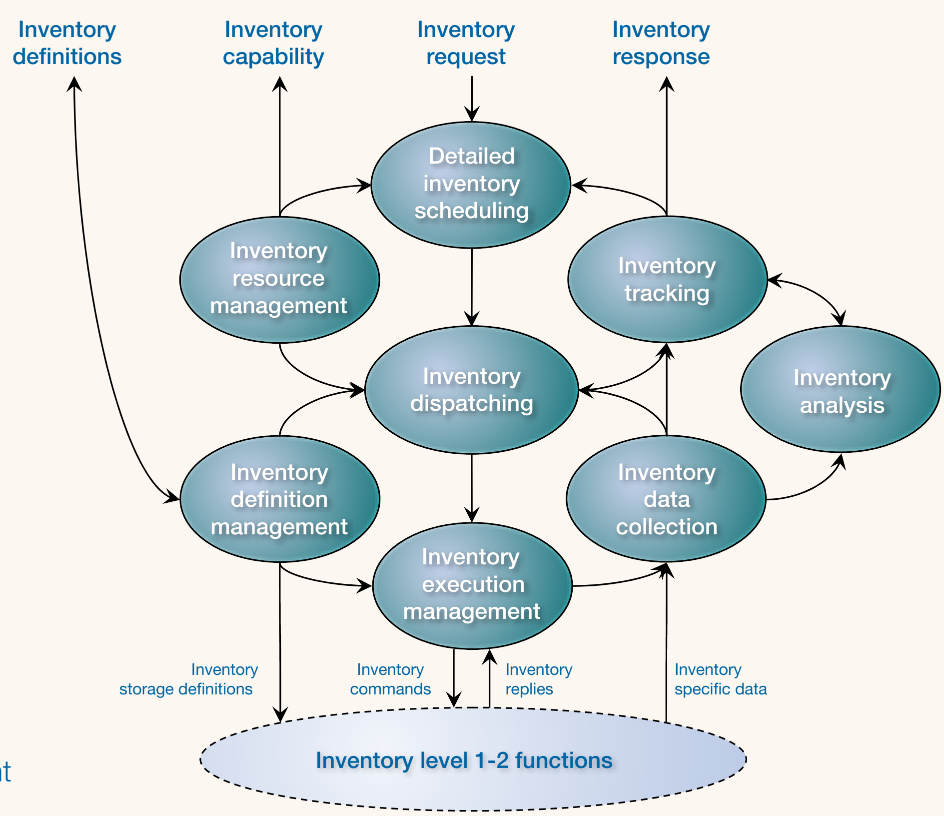


Fig. 2: Inventory Operations Management

tions, related to required and actual manufacturing activities, bind and organize manufacturing objects and activities. These transactions occur at all levels within the enterprise, but the focus of Part 5 is the interface between enterprise systems and manufacturing/control systems. Models are introduced which provide visual descriptions of the transactions, and explanations of their connection to business and production activities.

This Part 3 standard provides models and terminology for defining the activities of manufacturing operations management. The models and terminology defined in this standard:
- Emphasize good practices of manufacturing operations
- Can be used to improve existing manufacturing operations systems
- Can be applied regardless of the degree of automation

Some potential benefits produced when applying the standard may include:
- Reducing the time to reach full production levels for new products
- Enabling vendors to supply appropriate tools for manufacturing operations
- Enabling more uniform and consistent identification of manufacturing needs
- Reducing the cost of automating manufacturing processes
- Optimizing supply chains
- Improving efficiency in life-cycle engineering efforts

It is not the intent of this standard to:
- Suggest that there is only one way of implementing manufacturing operations
- Force users to abandon their current way of handling manufacturing operations
- Restrict development in the area of manufacturing operations
- Restrict use only to manufacturing industries

Components defined

For years the application rage has been Object-Oriented (OO) technology, but analysts have rarely made the distinction between OO programming and reusable objects in some other sense. More recently, discussions have shifted to using OO primarily to refer to programming done in languages like C++ and Java. Components denote reusable chunks of software design. In this sense, we can say that component-based development involves building systems by the combination, aggregation, and integration of pre-engineered and pre-tested chunks of design.

This is a nice academic-sounding definition, but it begs the real question: What are components? As is so often the case in the software business, there is no single, simple answer. Many technology approaches claim to be component-based and all (more or less) meet the requirements of the above components — the component-based development definition.

There are five key CBSA architecture characteristics listed below. All of the contending component-based development alternatives can be classified using these characteristics:

Object-Oriented	Encapsulation, Polymorphism Inheritance
Granularity	Fine-Grained Large-Grained
Reuse level	Source-Code Binaries Specifications
Component types	Technical components Business Components
Execution Site	Client Side Server Side

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