SmartPlant® Enterprise for Owner Operators

Leveraging the engineering design basis across the plant life cycle

A White Paper

Process, Power & Marine, a division of Intergraph

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Improved Plant Operations and Project Execution with SmartPlant® Enterprise for Owner Operators

ABSTRACT

Owner operators can benefit greatly from interoperability between the dynamic engineering design basis and other information systems in the context of critical work processes across the plant life cycle. SmartPlant Enterprise for Owner Operators provides preconfigured work processes and out-of-the-box integrations with operations systems to provide major improvements in working efficiency and information consistency across the owner operator system landscape.

1. Executive Summary

Overview

The purpose of this white paper is to review owner operator challenges throughout the life cycle of a plant asset and the role that SmartPlant Enterprise for Owner Operators from Intergraph Process, Power & Marine can play in meeting these challenges. This paper discusses some of the key work processes related to greenfield/brownfield project execution, handover to operations, and plant operations and maintenance. The solutions offered, associated benefits, as well as quantifiable return on investment are discussed. The Intergraph approach to SmartPlant Enterprise for Owner Operators implementation is presented and the technologies exploited are briefly explained.

Introduction

Over the years, many owner operators have chosen Intergraph's industry-leading SmartPlant Enterprise integrated suite of tools to manage their dynamic engineering design basis. Building on this success and leveraging the power of new service-oriented technologies, Intergraph introduces SmartPlant Enterprise for Owner Operators (SPO). SPO offers preconfigured, best-practice work processes covering the complete plant life cycle and interoperability with maintenance, reliability, and other operations systems, and a common, role-based Web portal designed for owner operators.

Business Drivers

Owner operators in the capital-intensive process, power, and marine industries are facing greater challenges to ensure their profitability and long-term viability than ever before.

Owners are expanding existing facilities and building new capacity at record levels to meet growing demands in the global market. This has to be achieved safely with finite resources; within demanding schedules to minimize time-to-market/maximize time-in-market; and within stringent capital expenditure (CAPEX) budgets.

Operations are also under unprecedented pressure to achieve safe, sustainable production at lowest possible costs (OPEX) while demand for product and competitive pressures has never been higher.

At the same time, regulatory authorities' demands for compliance are increasing. The owner operator's "virtual plant," in-plant documentation, and IT systems must be consistent with the current physical state of the plant in operation. Also, a demonstrable management of change process is needed with full traceability and a complete audit trail of plant changes.

Retention of plant knowledge in the face of an aging workforce is an additional unavoidable factor that owner operators increasingly have to face given current demographic trends.

We understand there are differences among the various industry segments, such as:

- **Pharmaceutical industry** – Short patent windows drive a need to go into production sooner

- **Chemical industry** – Certain products may be in high demand but with considerably less margin if there is an overproduction

- **Power industry** – Reliability of power supply must be ensured and load shedding must be avoided

Intergraph not only understands these business developments, but pioneers the course of engineering technology solutions. Intergraph has been providing powerful, comprehensive, and proven solutions to build and operate plants for decades. Our aspiration is to partner with owners so they may become the best in their businesses.

2. Overview

Sid Snitkin, vice president and general manager of ARC Advisory Group, in his white paper "Improve the Functional and Financial Performance of Your Plant Through Better Plant Asset Information Management," discuses the importance of information management and interoperability[1] between participants in work processes in achieving maximum profitability for the owner operator.

Snitkin identifies that, "Achieving high (plant) performance requires a different model of Asset Lifecycle Management, and an information management infrastructure that enables effective Interoperability among all stakeholders." He proposes a DOMinO model (Design, Operate, and Maintain for Owner Operators) in which interoperability needs between groups (both the internal and external Design, Operate and Maintain (DOM) teams) and the importance of a common Web portal are highlighted.
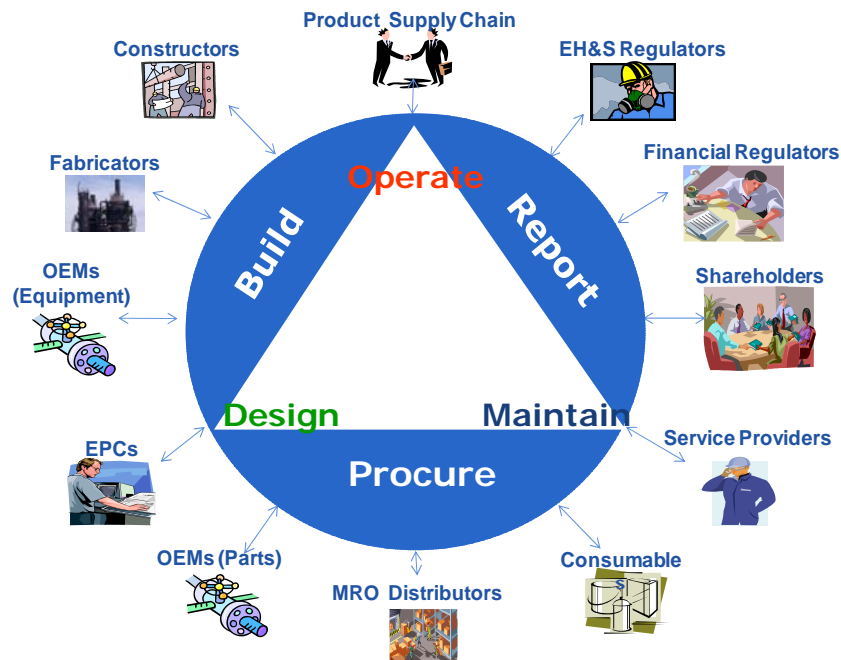
ARC's DOMinO Model and the External DOM Team

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[1] Interoperability can be defined as the ability to manage and communicate electronic product and project data between collaborating firms and within an individual company's design, construction, maintenance, and business process systems.

Sid Snitkin cites Intergraph's SPO as an illustrative example of an initiative that is in line with the DOMinO model by the provision of interoperability between the highly dynamic engineering design basis and other operations systems, providing a common, role-based Web portal and providing interfaces for the integration of business processes across the project value chain.

To meet these challenges, facility owners have a mandate to improve work processes and affiliated costs to retain a competitive edge and increase market share and their margin.

These challenges find resolution not by the traditional CAD path, but an exponentially more efficient process – a data-centric approach that turns engineering data into a valuable strategic asset that is as valuable as the physical plant itself.

The SmartPlant Enterprise for Owner Operators solution forms the engineering and design basis for the plant and the gateway to communicate with other operation-critical systems, such as DCS, ERP, reliability, and safety.

Data and data interrelationships are the key to the plant's asset configuration and management. This new technological approach offers a much more effective way to create, modify, and access plant information to support operational tasks. The owner can begin to lower costs significantly at commissioning and handover with the delivery of datasets in an accurate, well organized, non-redundant format.

Plant operation revolves around continuous safety and reliability. SmartPlant Enterprise life cycle products assist in planning maintenance, risk-based inspections (RBIs), and scheduled plant shutdowns – minimizing shutdown time, maximizing productivity, optimizing product quality, facilitating training of new operations personnel, and ensuring the safety of personnel and the entire facility. Intergraph products also help to predict instrument failure, as well as unscheduled shutdown risks, through a reliability analysis interface.

The importance of the plant data lies in the information asset that it represents rather than in the data itself. It is an integral part of every phase of the plant life cycle, from the bid proposal and conceptual design to maintenance and decommissioning. At some point in time, *every person* involved in the operation of a plant must access plant data to perform their tasks. Therefore, it is critical that data is continually kept up-to-date, accurately reflecting the as-built plant at all times.

Given that no single company can answer all the needs of the plant owner, Intergraph has adopted a partnership approach that combines Intergraph's engineering and operating software with complementary software from other superior industry vendors for a holistic, truly effective solution for the life of the plant. The alliance serves as an integrated operational solution, based on Intergraph's architectural model called SmartPlant Enterprise, which integrates both within the SmartPlant Enterprise suite and with partner applications.

SPO is based on Intergraph's SmartPlant Enterprise suite of industry-leading information management and design tool applications. SPO provides out-of-the-box, preconfigured key owner operator work processes, integrations with other leading third-party owner operator systems for maintenance, reliability, DCS, etc. and a common Web portal. In addition, data exchange mechanisms with contractors and suppliers will be provided to facilitate project execution throughout the project value chain.
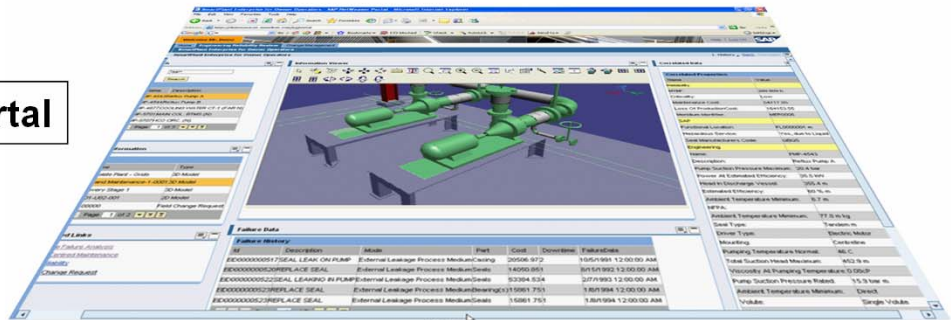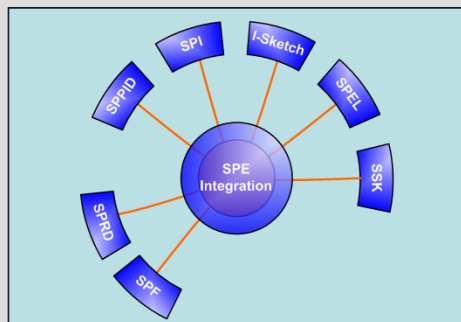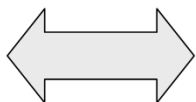
SPO is comprised of three solutions as shown in the figure below. Each SPO solution is comprised of business packages that provide out-of-the-box preconfigured work processes and integrations with third-party systems.

SPO Core Solution – Managing work processes that are relevant to the entire plant life cycle such as Plant Breakdown Structure and tag management, document management and data loading/QC. SPO Core includes a site license for SmartPlant Foundation, SmartPlant Reference Data, SmartPlant Isometrics (previously I-Sketch) and SmartSketch. Other integrated SmartPlant design tools such as SmartPlant Instrumentation, SmartPlant Electrical, and SmartPlant P&ID are licensed separately and can be included as required.

SPO Operating Plant Solution – Managing key work processes that are relevant to the operations and maintenance part of the plant life cycle, including Management of Change, Maintenance and Engineering Web portal, data staging for QC/verification, transformation, and loading to operations systems.

SPO Project Execution Solution – Managing key work processes for greenfield/ brownfield project execution, including Management of Change in Projects, Interface Management, Non-Conformance/Waiver Management, and Management of Technical Queries.
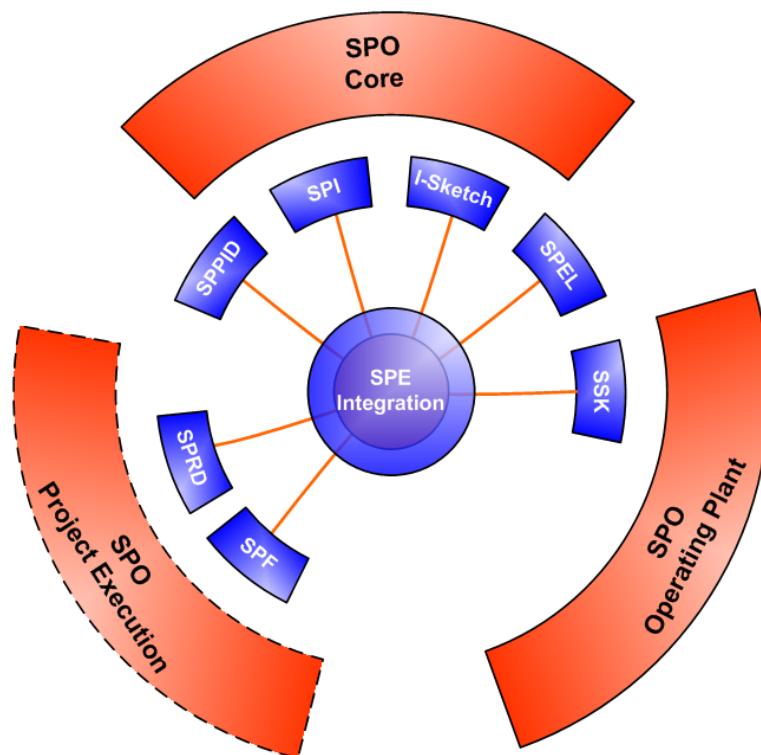
SPO solutions and business packages are being released in phases. In 2007 the SPO Core and SPO Operating Plant solutions were released. During 2008 the SPO Project Execution solution is due to be released.

The preconfigured SPO work processes are intended to be a 50 to 80 percent fit for any customer and may be rapidly adjusted to meet a specific customer's needs. This is further discussed in the Implementation section of this document.

3. Work Processes

The delivery of work processes is at the heart of SPO. In order for Intergraph to define these work processes, a highly structured methodology has been developed. All SPO work processes are defined at three levels of detail.

- **Level 1** – An owner operator workflow is described, independent of the tools used to execute the process. The focus is to define the roles involved and the high-level steps involved.

- **Level 2** – The Level 1 work process is mapped to the applications involved in the work process at a high level.

- **Level 3** – The Level 2 work process is mapped to the detailed actions performed, including details of transactions undertaken in applications. Where appropriate, links are provided to annotated screenshots or AVIs that explain each step in the process in detail.
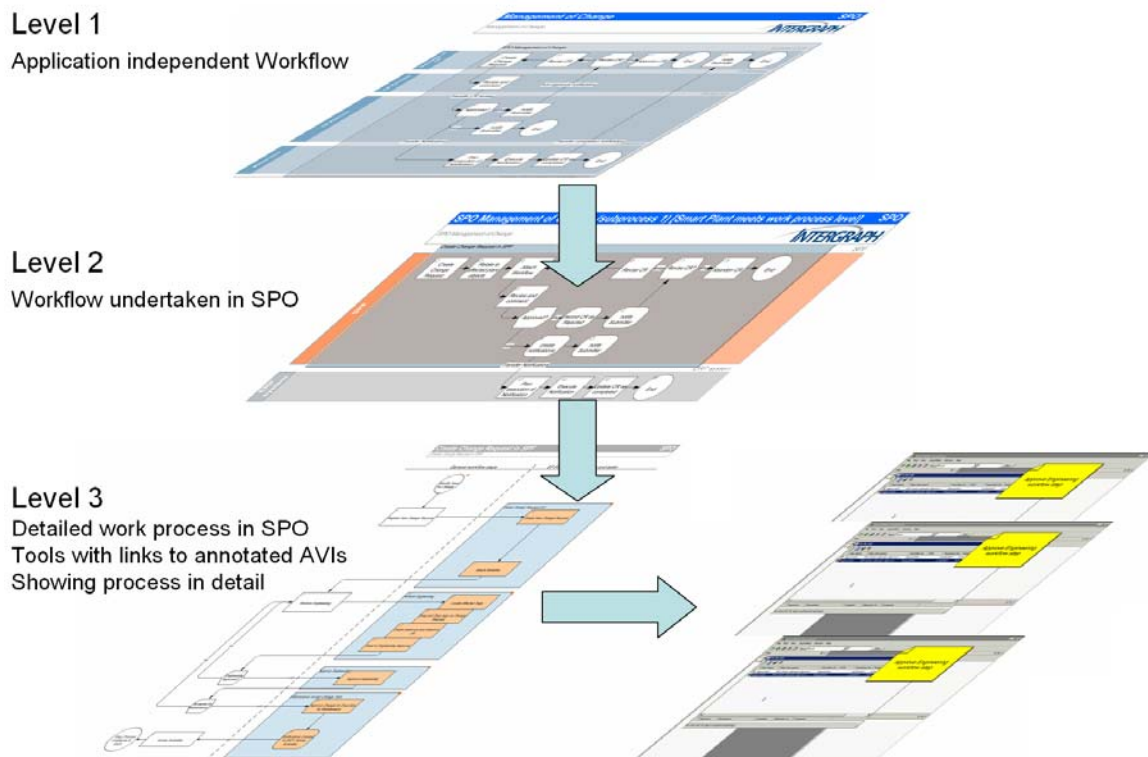
These workflow diagrams provide both a model and basis for the consistent development of the work processes being delivered in SPO, but they are delivered to customers published as a Web-based help system. The published diagrams provide an intuitive guide to the user showing the work process provided in SPO. Simple hyperlink drill-downs to increasing level of detail and annotated AVIs represent how work process steps will be executed. This provides a simpler, more interactive form of user assistance than lengthy function/feature-based help documentation.

4. Solutions and Business Packages

Complete Life-cycle

Conceptual Design → Detail Design → Procurement → Construction → Completion Start-up → **Operations**

Solution: SPO Project Execution

- Management of Change (Projects)
- Interface Management
- Risk Management
- Non-conformities/Waivers
- Fabrication Records Management
- Technical Queries
- Completion/Start-up

Solution: SPO Operating Facility

- Brownfield data capture
- Brownfield/Greenfield data validation, transformation and loading
- Plant Information Browser
- Management of Change (Operations)
- Engineering assistant for Maintenance
- Engineering assistant for Reliability
- Engineering assistant for Safety
- DCS Change Management
- Intelligent Manuals
- Plant Optimization Assistant

Solution: SPO Core

- PBS and Tag Management
- Document Management
- Plant Data Loading & QC
- On Plant Engineering & Design
- Vendor Data Capture
- Inspections & Audits Assistant
- Conceptual Engineering

SPO Core Solution

The SPO Core Solution includes business packages covering key work processes that are relevant throughout the plant life cycle. This solution provides a common information integration hub for SPO and is a prerequisite for the other SPO solutions.

The following business packages are currently available:

On-Plant Engineering and Design

Maintaining the dynamic design basis in line with plant design modifications during the plant life cycle is a critical, demanding activity.

A bundle of well proven Intergraph SmartPlant Enterprise tools will be offered on a plant site basis to support maintenance of the engineering design basis and to perform small on-site projects. These tools include SmartPlant Foundation, SmartPlant Reference Data, SmartPlant Isometrics (previously known as I-Sketch™), and SmartSketch®. Other SmartPlant design tools such as SmartPlant Instrumentation, SmartPlant Electrical, SmartPlant P&ID, and SmartPlant Layout are licensed separately and can be included as required.

SmartPlant Foundation performs the role of both an integration hub between the design tools and third-party applications and as a highly flexible repository for core data and workflow engine.

Plant Breakdown Structure and Tag Management

Establishing the plant breakdown structure[2] is a fundamental activity required to manage the design basis of any plant. The consistent and accurate allocation of tag numbers in accordance with the plant engineering numbering system and capture and maintenance of design properties in the tag index and datasheets is also an essential activity during all phases of the plant life cycle.

This business package will facilitate the bulk load of the plant breakdown structure (system, area, fire area, discipline, etc.) from Microsoft® Excel®.

The business package will also support the centralized allocation of tag numbers in SmartPlant Foundation in accordance with a pre-defined Engineering Numbering System, maintenance of tag data, datasheets, and the publishing of tag details to SmartPlant Enterprise design tools.

Engineering Document Management

Effective and consistent management of documents with auditable traceability is essential for operations to demonstrate regulatory compliance and to manage the vast numbers of documents that describe a complex process facility.

This business package comprises a comprehensive set of work processes for document management, including the central allocation of document numbers, capture of document metadata, file archiving, distribution/review, subscription, check-in/check-out, and online approval and transmittal of documentation internally and externally. Full revision history and linking of documents to the plant breakdown structure, tags, referenced documents, contracts, disciplines, etc. is supported to facilitate flexible retrieval.

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[2] A plant breakdown is the systematic sub-division of a plant from multiple perspectives, e.g. by Area, System, Discipline, Fire Area, etc.

Where an existing corporate enterprise document repository is deployed in an organization such as SAP DMS or Documentum, it is planned to offer the facility to integrate with these systems. Once the document revision has been created, reviewed, and approved in SPO, the final approved engineering document revision data and files will be transferred to the enterprise document repository. These documents will still be seamlessly available in SPO.

Plant Data Loading and Quality Control

Ensuring the quality of design information received from EPC contractors and suppliers is essential to avoid costly remedial work during operations. Even small errors in syntax or cross-referencing can cause significant extra work or erroneous decisions with major cost implications.

This business package includes Excel templates to facilitate the control and loading of data to SPO.

Conceptual Engineering

The commercial and technical evaluation of alternative plant layouts is an essential part of the conceptual engineering process.

The Conceptual Engineering business package uses SmartPlant Layout (based on SmartPlant 3D) for the conceptual layout of plants. Different plant layout concepts can be quickly generated for new plants or extensions to existing plants and compared. The results of any layout can be exported to estimating tools to facilitate cost comparison.

Future releases of the SPO Core solution are planned to include the following business packages.

Vendor Data Capture

The timely acquisition of vendor data from package suppliers is an essential activity to avoid delays in design engineering on both greenfield and brownfield projects. Traditionally the work required to expedite, receive, register, and distribute vendor data in projects has been considerable. The time-consuming nature of the activity has contributed significantly to project delays.

This business package will support the direct capture of data from vendors during capital projects, modifications, or routine equipment replacement during operations. Vendors will be able to submit tag indexes, datasheets, cross-references, and documentation to the owner operator directly over the Internet. Once the package-responsible engineer has completed the review of data or documentation, the engineer can retrieve markup comments and acceptance codes. Incoming data and documentation can be sent on standard distributions via the workflow engine in SmartPlant Foundation, ensuring rapid, auditable, and consistent handling.

Inspections and Audit Assistant

Audits and inspections are integral processes for both project execution and plant operations. Effective definition, auditable execution, and archiving of these inspections are essential to demonstrate project compliance with regulatory requirements and corporate best practices and to ensure ongoing plant operational efficiency, safety, and regulatory compliance.

This business package will facilitate the planning and capture of the results of inspections and audits during development projects and operations. Inspections and audits can be related to plant breakdown structure and organizational units to facilitate traceability. Findings can be categorized by priority and remedial actions planned and followed up. Audit and inspection plans can be archived to facilitate consistency and reuse.

SPO Operating Plant Solution

The SPO Operating Plant Solution provides business packages supporting common, critical work processes for the operating plant.

The following business packages are currently available:

Plant Information Browser

The Plant Information Browser business package will provide seamless access to plant design data, maintenance data (from ERP systems), reliability data (Meridium), DCS data, etc. via a common, intuitive, role-based Web portal. Data will be available via drill-down of the plant structure, structured queries, or from 2D/3D graphical navigation of the plant. The current version provides access to engineering data and data in SAP EAM. Later releases will expand the scope of data to other operations and EAM systems.

The SPO portal recognizes the roles that a user fulfills related to a specific plant and provides a portal designed to assist the user in undertaking his/her work tasks. The maintenance planner will be able to access data in the maintenance system, reliability system, and engineering design tools seamlessly and interrogate the system by Functional Location or Equipment Number. A plant engineer will be able to use a tag number to seamlessly access design data, maintenance data from the ERP system, data from the DCS system, and reliability data.

The portal will assist plant maintenance and engineering personnel in many work processes, for example:

- Assisting in the replacement of equipment – As plants age, equipment is replaced by similar equipment, which is in turn replaced by similar equipment until, over time, the original design basis for the optimized plant systems can become "lost" which could cause unnecessary, costly plant inefficiencies and unplanned outages. This browser will help maintenance personnel find the original design criteria that apply for the equipment to be replaced.

- Structured query of the engineering design basis – Data is provided to assist inspection planning and execution.

Management of Change (Operations)

Maintaining the accuracy of essential plant engineering, maintenance, and operations information is crucial to safe, efficient plant operations. Traceability of plant changes and auditability of the management of change process is essential to demonstrate compliance with regulatory requirements.

The Management of Change business package is designed to provide rigorous management of change (MOC) of engineering information with full traceability and audit trail.

The synchronization of data between the engineering design basis and maintenance is currently available for SAP. In later releases there are plans to extend this functionality to other leading maintenance systems.

Where tags are created, updated, or terminated in the design basis, this will trigger an automated update of the corresponding functional location in the plant maintenance system. Similarly, where equipment is installed or replaced against a functional location in the plant maintenance system, this will trigger an update of corresponding data in SmartPlant Foundation where links between tag, functional location, and equipment are held.

The MOC process handled includes the process of review, authorization, design, and approval of changes by engineering in the engineering design basis and the process of notifying maintenance to perform changes by creation of notification records in the plant maintenance system.

The impact assessment of engineering change is also covered by the business package. During the planning of engineering change, plant engineering must anticipate the MOC implications of planned plant change. The Web portal will assist the engineer in assessing the plant items affected. The linking of affected plant items to changes also facilitates the assessment of change impacts with other ongoing or pending changes.

Future releases of the SPO Operating Plant solution are planned to include the following business packages.

Brownfield Data Capture

Plant walk-down and as-built data validation is a costly, time-consuming process. The Brownfield Data Capture business package will support using handheld automation tools to compare as-built data and documentation vs. field conditions, mark up field changes, sketch undocumented equipment, and compare and collect actual equipment data vs. as-built information. After field work is complete, the application automates interaction with the engineering data warehouse to note discrepancies between actual and as-built information and facilitate the creation of appropriate engineering change requests for the controlled update of as-built information.

Brownfield/Greenfield Data Validation, Transformation, and Loading

This business package will supplement the basic Loading and QC business package in the SPO Core Solution.

Tools will be provided to facilitate the bulk loading and verification of plant data. It is envisioned that alternative loading mechanisms will be offered based both on bulk data loading and Web services. Incoming data will be held in a staging area for validation, transformation, and completion prior to loading to operations systems. Verification will be performed in accordance with a set of defined rules, including checks on syntax, degree of completion, referential integrity, specified engineering rules, etc. Records of tests performed and results can be archived and returned to the contractor/supplier for remedial action for data to be resubmitted.

Tools will be provided for the optional clean-up and completion of data prior to release from the staging area, for example, the completion of data with BOM details, tag hierarchies, or links to the corporate material master ready for export to update the as-built design basis and the plant ERP system.

Tools will be provided to aid the controlled release and loading of data by sub-system, area, or equipment type. A data comparison tool will be available to facilitate manual evaluation of changes about to be made in the released/as-built design basis environment. Data loading utilities to facilitate the population of SAP will be offered.
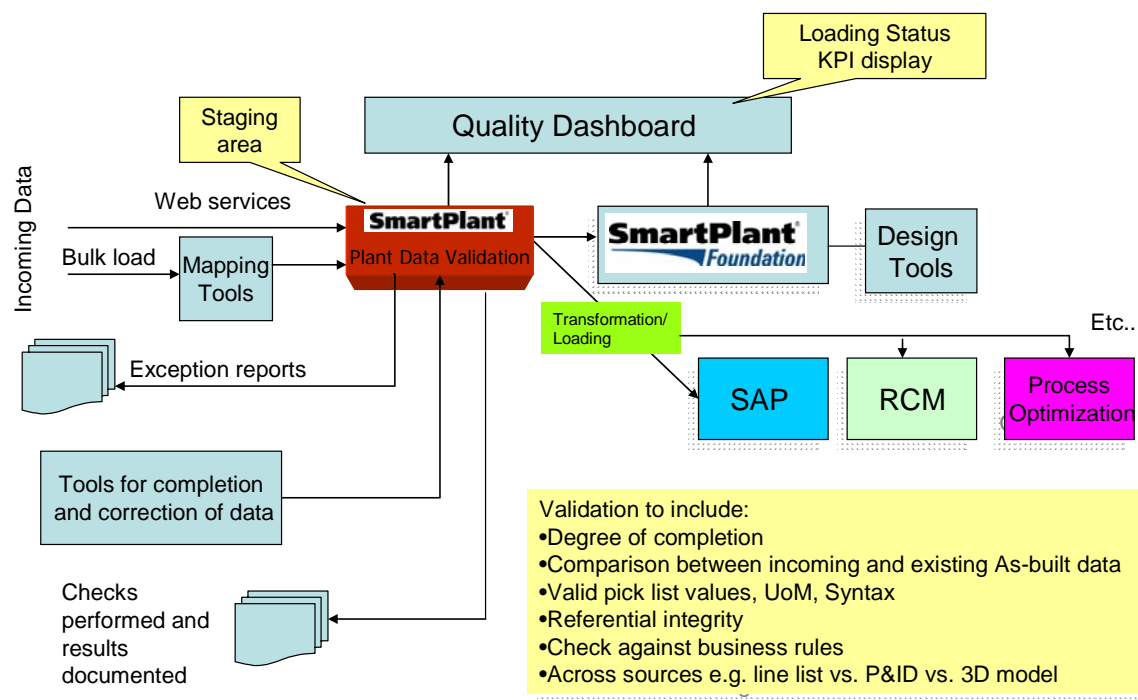
The Engineering Assistant for Maintenance business package supports several key work processes for the maintenance engineer, including:

Work Clearance

A robust, fail-safe methodology for assuring equipment shutdown and isolation is essential for safe plant inspection, maintenance, and overhaul. This work process will assist the maintenance engineer to identify how equipment should be isolated mechanically or electrically to create an approved procedure for tag lock-out. The approved procedure may be stored for reuse. Where SAP Plant Maintenance is being used, execution of the procedure will be integrated with the Work Clearance management utilities in SAP.

Work Package Configuration Management

The analysis, planning and documentation of complex plant work packages is a demanding task, requiring significant effort from a variety of the most experienced plant staff.

The Work Package Configuration Management Assistant application will facilitate this process, providing NetWeaver portal-based capabilities to query and analyze plant engineering data to define the optimum maintenance, repair, and overhaul processes. The system will then enable the compilation and annotation of work instructions describing the desired sequence of activities, including appropriate as-built or as-designed project data from the engineering data warehouse.

When the work package development is complete, the application will archive the approved work package correlated with the current as-built plant configuration. This important capability enables safe reuse of the work package in future activities by determining if subsequent plant changes have affected any systems or components involved in the archived work package.

When the SmartPlant Enterprise for Owner Operators environment is integrated with SAP Plant Maintenance, the Work Package Configuration Management Assistant application will support SAP Work Order Management utilities.

Location-based Maintenance Optimization

Task team coordination and conflict avoidance is a major challenge when scheduling multiple maintenance and project activities during a plant shutdown. Planners require a detailed knowledge of physical plant layout in order to avoid safety problems or space conflicts or determine the need to erect scaffolding or other means to access equipment.

The Location-based Maintenance Optimization application will address this challenge by providing a visualization of planned project locations and time sequences using a graphical 3D model of the physical plant. The application, available through an intuitive Web portal, displays color-coded 3D volumes depicting the spatial location of planned activities in sequences including ingress/egress requirements, based upon the schedule and duration of the activity.

When the SmartPlant Enterprise for Owner Operators environment is integrated with SAP Plant Maintenance and Project Scheduler, the Location-based Maintenance Optimization application will visually depict changes to activity schedules made in the SAP applications.

Accurate plant engineering design data in concert with detailed plant performance metrics is a prerequisite to be able to perform accurate reliability analysis.

This business package will provide Web portal-based screens, enabling reliability analysts to easily identify the systems and equipment of interest and initiate the information extraction, transformation, and loading process to support reliability analysis. The solution is based on exporting data to Meridium's RCA, RCM, and RCFA tools.

The synchronization of information between the engineering design basis, reliability, and maintenance systems has major synergy benefits to critical processes during operations as shown in the diagram below. However, the synergy between these systems is not limited to the operations phase. Exploiting proven designs and live asset performance and reliability data can offer major benefits during the design and procurement phases of greenfield and brownfield development projects.
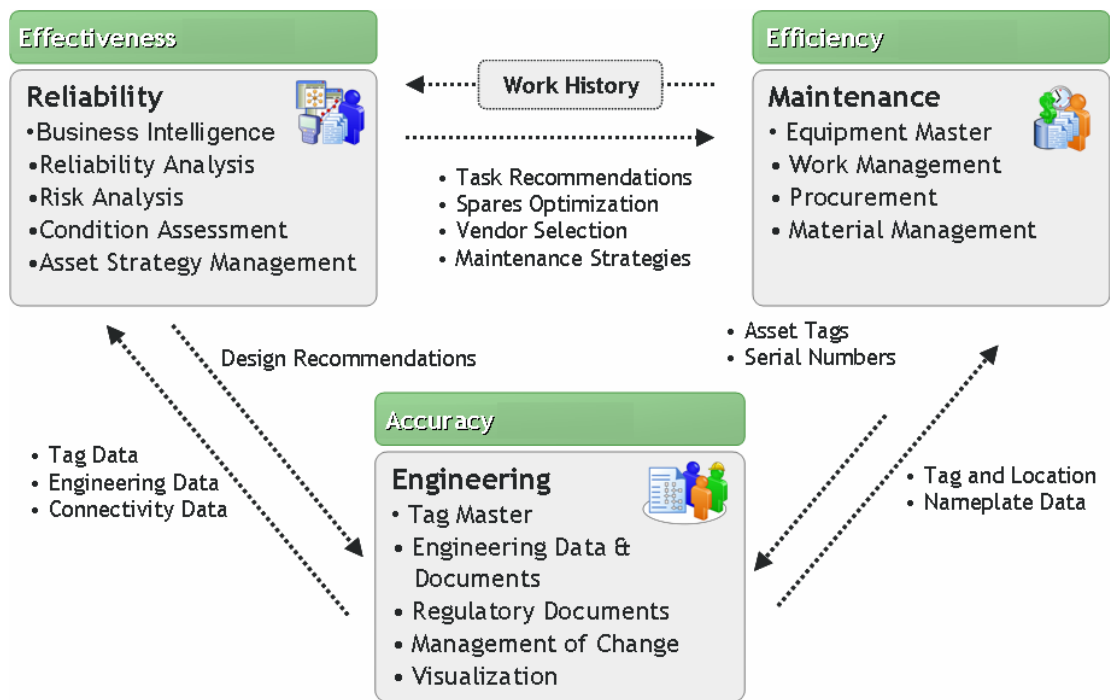
Engineering Assistant for Safety

The efforts of plant process safety teams in performing HAZOP analyses are critical elements in ensuring plant safety. The effectiveness of these teams is heavily dependent upon their ability to access the safety knowledge of their most experienced engineers, operations staff, and safety experts.

The HAZOP Analysis application will enable companies to capture their accumulated safety knowledge in a rules-based knowledge repository. And, by largely automating hazard identification, the application can cut the time and cost of HAZOP studies in half.

HAZOP analysis, accessible through a portal-based interface, will utilize intelligent P&ID diagrams from the engineering data warehouse to automatically trace hazard and operability issues. The HAZOP team then uses the application interactively, considering each node, deviation, and fault-consequence pair, assessing risk, evaluating safeguards, and assigning actions.

The results of the HAZOP studies are archived and correlated with the current as-built plant configuration. This capability enables rapid updating of HAZOP reports as plant changes occur.

DCS Change Management

Management of change to the plant DCS can have an enormous impact on plant performance. While plant operations personnel own the responsibility for establishing and tuning control system ranges and set-points, several other organizations depend on current, accurate knowledge of these values to perform their jobs.

This business package will facilitate consistent management and auditable traceability of change to the plant DCS through predefined workflows, including changes in range and set-point settings and changes to DCS configuration. The Web portal will provide intuitive utilities to assist plant operations personnel to create a field change notification to document changes made to control system ranges and set-points.

Intelligent Plant Manuals

The accuracy and ready availability of plant operating manuals and procedures is an essential component of plant safety. Because plant configurations change as a result of revamp projects or maintenance modifications, plant operating manuals and procedures must reflect those changes to maintain accuracy.

The Intelligent Plant Manuals application will ensure this continued accuracy by extending the strategy of enterprise plant configuration management to include management of plant operating manuals and procedures.

Digital plant manuals will be created by reusing existing plant data and documentation as far as possible and will be accessed via an intuitive Web portal.

Features will be included to reduce the burden of maintaining manuals and ensuring data shown is current. This will include intelligent chapters that are "self-maintaining," being able to locate documents that belong to it based on predefined search criteria, and the possibility of creating manuals in which data in the body of manuals is automatically updated with changes in the engineering design basis, such as ranges and set-points.

Manual owners will be able to subscribe to be automatically alerted to changes in the design basis that may affect the manual.

Monitoring the process performance of a plant and early detection and warning of abnormal conditions offer a great benefit to plant operations to avoid unplanned outages and reduce costs through improving process performance and regularity.

The SPO Plant Optimization Assistant business package will provide an integration with the FALCONEER toolset within the Web portal which audits manufacturing process performance in real-time and advises on any "abnormal" conditions that are detected. These advisories could be related to instrumentation, process equipment, process conditions, or Key Performance Indicators (KPIs). This real-time auditing and advice helps the plant improve product quality and process reliability and uptime while reducing raw material, energy, and other operational costs.

SPO Project Execution Solution

The SPO Project Execution Solution (first release planned in 2008) provides business packages supporting key, critical work processes for greenfield and brownfield projects. Collaboration across the project value chain will be facilitated by providing open, secure data exchange mechanisms allowing data to flow between the owner operator, contractors, suppliers, and other third parties as required, and allow the seamless handoff of work process across the project value chain.

The following business packages are currently planned for inclusion:

Management of Change in Projects

In any major greenfield or brownfield project there are typically thousands of engineering changes that need to be managed.

Projects need to be managed as a closed system with a tightly bound scope, schedule, and cost, representing the project baseline. Meaningful measurement of progress can only be made where scope, schedule, and cost are under close management. If a project cannot be managed against its given baseline, then the project steering committee decides if a new baseline needs to be established (or alternatively if the project should be abandoned) and the project managed against the new baseline.

Requirements creep is probably the single greatest influence on project costs and schedule. Therefore it is essential that <u>all</u> proposed changes are captured in advance and subject to an appropriate level of scrutiny before being approved or rejected. Undisciplined implementation of changes undermines the technical integrity of the facility, causes confusion, potentially creates safety hazards, and threatens the successful outcome of the project.

Lack of a good change management process is a major drain on project executive resources and can jeopardize achieving project schedule, budget, and safety targets. The need to distinguish change within the existing project scope (design development) to changes additional to scope (design change) is an important concept that any solution must accommodate.

This business package will facilitate the traceability, auditability, and management of changes from the initial change proposal, through the review, approval, and implementation cycle in both greenfield and brownfield projects. Template workflows will ensure consistent handling in accordance with project procedures and project delegation of authority mandates.

Web services allow the secure exchange of change-related information and documentation with EPC contractors providing a seamless, collaborative workflow and reducing the time and effort required for handling changes.

The linking of changes to the plant breakdown structure and affected tags and documents facilitates the assessment of change impact against other ongoing or pending changes and retrieval of the change from SPO via multiple access routes. Linking of changes to incoming technical queries and non-conformities allows for total traceability of technical case handling.

Change management overview reports provide visibility of the change process in a project and provide a valuable control mechanism for project and corporate management teams.

Non-Conformities and Waivers

Non-conformities to laws, regulations, corporate best practices, and project specifications all need to be closely managed on projects. The process is closely linked to the management of change process and required to demonstrate compliance with regulatory requirements. The capture of non-conformities and linking of these to the affected parts of the plant provide a powerful tool for both avoiding the occurrence of incidents and, where incidents do occur, enabling the rapid presentation of all relevant documentation and rapid return to full production. The avoidance of incidents arising from non-conformities contributes to preserving an owner operator's reputation, the loss of which can have a major economic impact.

This business package will allow non-conformities to be registered either interactively or via Web services from contractor systems. Pre-defined work processes will ensure consistent handling and auditable traceability through the approval of temporary or permanent waivers or rejections.

The linking of non-conformities to affected plant items will facilitate the traceability of non-conformities through the total plant life cycle, enabling a permanent record for traceability purposes.

Technical Queries

On any major development project, thousands of technical queries arise that need to be addressed and answered within a tight schedule to avoid negative consequences on project schedule. The technical query work process is closely related to management of change and managing non-conformities and waivers and provides an important tool to monitor the state of design and construction progress.

This business package will facilitate the registration of technical queries interactively or via a Web service interface with EPCs. Consistent handling and follow-up will be ensured by template workflows and management reports. The linking of technical queries to non-conformities and changes allows the complete handling of complex technical issues to be traceable and auditable. Exception reporting will allow project management to take remedial actions prior to delays impacting project schedules.

Interface Management

A capital greenfield/brownfield development project will typically engage multiple EPC contractors, all of which will have hundreds of technical issues to resolve with each other and the owner operator. These are often managed by individual interface-responsible engineers via ad hoc Excel spreadsheets which lead to a lack of consistency in reporting and visibility to project executive management.

This business package will provide a common, consistent method of registration and mechanisms for proactive follow-up of delayed interface item clarifications. Interface items can be linked to plant items affected, allowing retrieval via multiple search routes.

Status and exception reporting will provide project management with an overview of the current status and potential problem areas, allowing remedial action to be undertaken before problems impact project schedules.

Risk Management

This business package will provide for the registration and follow-up of project risks and opportunities and the proactive measures the project will undertake to minimize the likelihood of risks affecting the project and maximizing the opportunities the project has identified.

Management reports will provide an overview of the status, likelihood, and impact of changes and opportunities.

Fabrication Record Management

This business package will enable the structuring of fabrication records into a digital fabrication record book to facilitate handover to operations. Records related to welder qualification, welding, NDT testing, fabrication drawings, etc. can be assembled and related to the plant breakdown structure to provide multiple access routes to records during the project and operations.

Completion/Start-up

This business package will support the Mechanical Completion and Commissioning process through the creation of completion/commissioning packages, completion of checklists, punch lists, completion certification, and handover of plant systems, units/areas to operations. The definition of standard checklists will ensure consistency in checks performed. Management reports will provide an overview of MOC/Commissioning activities and outstanding packages/punch items.

5. Implementation

SPO comprises preconfigured generic solutions for owner operator work processes. These out-of-the-box processes will typically represent a 60 to 80 percent fit against any customer's needs and will greatly accelerate the implementation process.

In order to further accelerate and ensure consistency in the SPO implementation process and reduce risk, Intergraph has developed a standard implementation methodology. This methodology is divided into two major stages:

- Gap Analysis and Deployment Planning
- Deployment
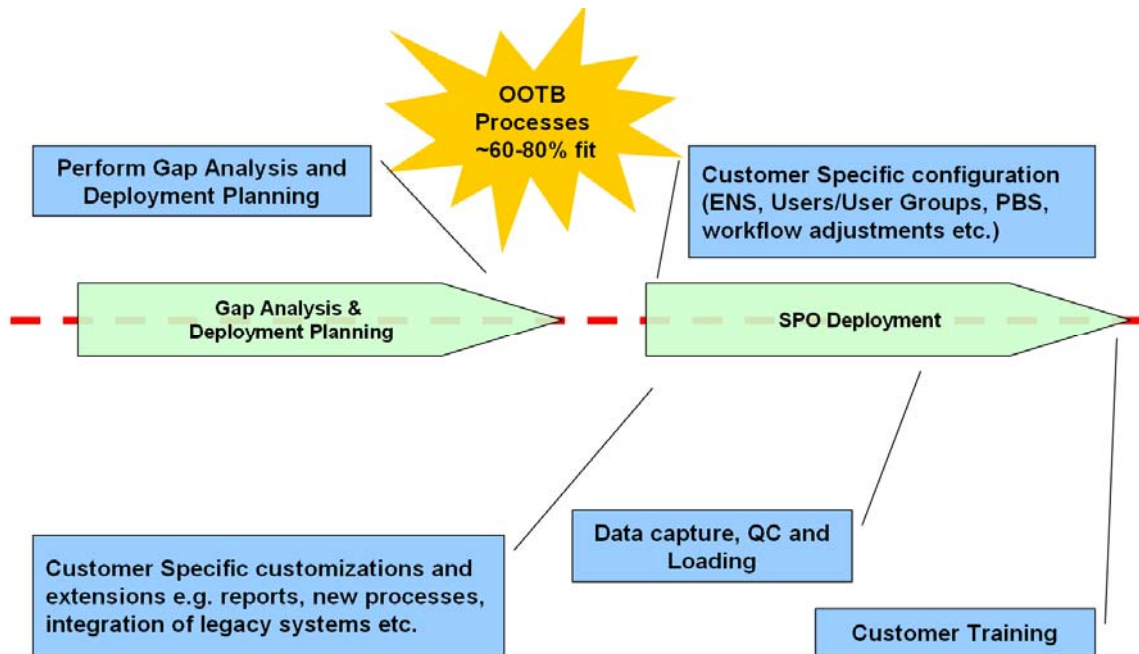
Gap Analysis and Deployment Planning

The duration of this phase varies, depending on the scale and complexity of the SPO implementation, but for a major implementation across several plants or on an enterprise level, eight to ten weeks would be considered typical. For a single plant/site implementation, three to four weeks will normally be sufficient.

Intergraph recognizes that successful deployment of enterprise automation systems such as SPO requires a comprehensive transformation of an organization's personnel, processes, and technology. For this reason, the SPO deployment planning consultancy utilizes a fast-paced, facilitated methodology involving customer business process stakeholders, key management, financial analysts, system users, and IT professionals.

The results of this consultancy include documents that confirm the business case and identify "low hanging fruit" for prioritization; provide a basis to prepare the customer's organization for SPO implementation; reduce risk; and facilitate the SPO Deployment phase.

Outputs include:

- SPO Mandate – Organizational Mandate for Change
- SmartPlant Enterprise Deployment "Roadmap"
- Cost-Benefit Assessment
- Preliminary Risk Mitigation Plan
- SPO Project Brief
- SPO Project Approach

Deployment

The duration of this phase is more variable, typically lasting three to nine months. It is dependent on: the size and number of plants included; which work processes are to be implemented; the volume of data to be migrated and verified, any brownfield data gathering required; the number of other systems to be integrated; the extent of customer-specific adjustment of the configuration; and the readiness of the organization to adopt new working methods and tools.

Typically, a phased implementation approach will be advised to demonstrate rapid results and return on investment.

In order to facilitate rapid pilot implementations without the complications of installation in a customer's IT environment, Intergraph can offer, together with partners, a hosted SPO incubator in which a customer-tailored SPO installation, with customer data loaded, can be provided for evaluation purposes. Tailored pilot systems can then be transferred to the customer's operational environment, or hosting can be extended for the SPO production environment.
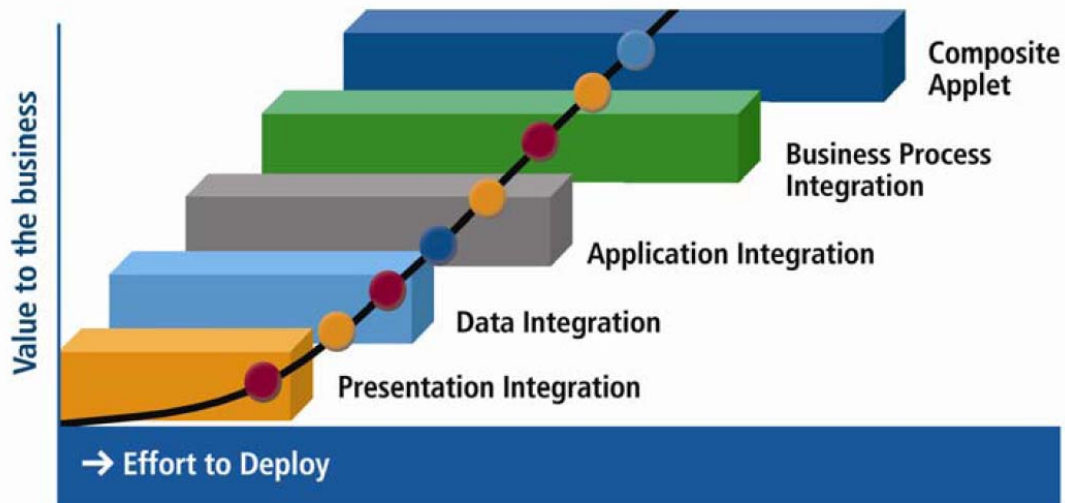
6. Integration and Interoperability

A key aspect of SPO is the interoperability it offers with both third-party systems and owner operator legacy systems, providing seamless access to critical information across IT system boundaries in the context of a specific work process. In order to achieve this, various integration approaches are adopted as appropriate, including:

- **Presentation integration** – Data is displayed in a common portal from multiple systems based on a common identification key that they share. For example, data is displayed for an instrument from both the engineering design basis and the maintenance system in the same Web portal.

- **Data Integration** – Data is consolidated in a common repository from multiple sources. For example, data is imported from multiple contractors into a common engineering data repository.

- **Application Integration** – A mechanism is provided to map and exchange data between multiple applications. For example, tags that are created or updated in the engineering design basis will trigger the update of the equivalent functional locations in a maintenance system.

- **Business Process Integration** – Application integration is extended to take into account the business process involved and provide for user intervention, initiate actions in the receiving system, etc.

- **Composite Applets** – Data from two or more systems are utilized seamlessly in a common user interface to provide a new capability not present in the individual systems.

These different approaches and the increasing value they offer are illustrated below[3].

Tiers of Integration

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[3] To learn more about the tiers of integration approach from Intergraph, consult the white paper "Tiers of Integration"

A technology that SPO uses extensively to provide interoperability is Service Oriented Architecture (SOA). SOA is an IT architecture that provides support to business processes via loosely coupled, independent services on a network. These services are high-level, business-oriented and can be created using various technologies, though Web Services have gained broad industry acceptance. Web Services are based on data exchange via XML, and SOAP for exchanging XML-based messages over a network using HTTP.
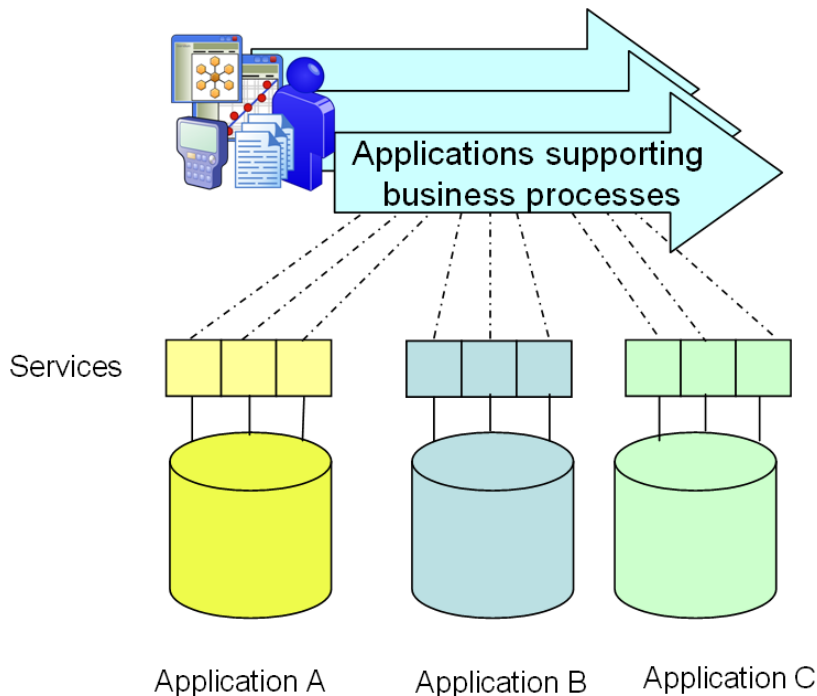
One advantage of SOA is that services can be built on top of existing legacy applications. This means that implementing SPO does not require migration from existing systems, but allows these applications to be incorporated seamlessly into SPO.

SOA has many other advantages, including that it promotes reuse. Services may be reused between applets, reducing costs and ensuring performance consistency. The complexity of underlying applications is effectively hidden (encapsulated) via the services that use standard communication protocols. SOA and Web services function independent of location over intranets and the Internet, effectively promoting intra-company and inter-company collaboration. In the case of owner operators, Web services may be used to effectively facilitate seamless collaboration across the value chain with contractors, suppliers, and other stakeholders.

Data in SPO is exposed through a common, role-based Web portal. The portal is made up of multiple windows or portlets. Each portlet may expose data from one or more underlying systems and being aware of the role the user plays provides information to the user in the context of the work process being executed. Portlets

may be "mixed and matched," potentially even between different solution suppliers as required, promoting effective reuse and rapid development of new applets.

Another advantage of portlets is that they expose data in a similar manner giving a standard "look and feel" independent of the underlying application. This gives the owner operator benefits in that the need for training is reduced compared to where a user must access individual applications. Discovery time is reduced and better decisions can be made more quickly based on data from all relevant systems.

There are several SOA architectures available on the market. The initial release of SPO in 2007 supports SAP NetWeaver®. The SmartPlant Enterprise for Owner Operators integration with SAP has been awarded Powered by NetWeaver certification status by SAP. It is planned that SPO will also support other leading SOA architectures such as Oracle Fusion and Microsoft SharePoint/Biztalk in future releases.

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