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Automation systems and integration — Oil and gas interoperability —

Part 1: Overview and fundamental principles

Systèmes d'automatisation et intégration — Interopérabilité entre les industries du pétrole et du gaz —

Partie 1: Vue d'ensemble et principes fondamentaux

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 184, *Automation systems and integration*.

This document provides an overview and outlines the fundamental principles of the ISO 18101 series. Future parts of the ISO 18101 series will be developed including sets of industry developed use cases, once the use cases have been documented using the Open Industrial Interoperability Ecosystem (OIIE) use case architecture and validated using the OIIE Oil and Gas Interoperability (OGI) Pilot, with the results captured in Technical Reports. These use cases will incrementally define industry prioritized elements of the secondary business process, which is the scope of the ISO 18101 series.

A list of all parts in the ISO 18101 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

It is difficult for the oil and gas industry, and other asset-intensive process industries, to adopt and adapt digital capabilities for many core business functions. For example:

— Why is it not possible for key industrial systems and applications to "plug and play" like consumer electronics do?

— Why is it so difficult and expensive to find, capture, manage and use the information that we need to:

  — engineer, design and build industrial plants, platforms and facilities?

  — operate and maintain industrial plants, platforms and facilities safely, reliably and profitably?

These issues significantly contribute to consistent patterns of major cost and schedule overruns in capital projects. They also lead to inefficient operations and maintenance spanning the entire life-cycle of the resulting plants, platforms and facilities. Clearly, this group of industries needs a better solutions model to help manage operational risks throughout the life-cycle of its plants, platforms and facilities.

Despite many improvements in individual business functions, the oil and gas industry (upstream, midstream and downstream) as well as other asset-intensive, process industries still struggle with many inefficient business practices. Many of these inefficiencies stem from how the entire industry and its primary participants are organized in ‘silos’. This is particularly true for life-cycle asset management related business processes. These processes span many industry silos, crossing life-cycle phases, while including both intra and inter-enterprise activities. Meanwhile, participating systems, equipment, devices, materials, and services suppliers are also organized in their own industry sector silos. Despite many efforts to break these silos down, they are persistent and are often re-enforced by current industrial IM solutions, practices, and standards.

Digital business transformation is now being discussed as the solution for many of these issues. Unfortunately, this industry group lacks a pragmatic, supplier-neutral basis for achieving this objective and the sought-after business benefits in a timely manner.

The digital ecosystem concept was created for such purposes and has been successfully used in a variety of industry groups, but for the concept to succeed, it needs to be thoughtfully specialized to address included industry sectors, while achieving the largest practical scale. Other industry sectors such as banking, semiconductors, aerospace, consumer electronics and eCommerce have adopted this model using a combination of open standards and proprietary methods. Each industry has unique characteristics resulting in industry specific methods, with some basic common denominators such as the basic standards which define the internet and the World Wide Web.

The oil and gas industry shares many of the same engineering and work practices, while also using many of the same system (software and hardware), equipment and device classes as many other asset-intensive, process industries. This provides a mutually beneficial opportunity to share a supplier-neutral industrial digital ecosystem, where the scale of the aggregated market helps encourage its adoption. A successful industrial digital ecosystem needs to be supplier-neutral, because no single supplier has the scale and coverage to impose its will on the entire industry, including all its key participants.

While standards such as ISO 55000 specify good practices for all types of asset management, this document specifies how those good practices can be implemented using an industrial digital ecosystem. This document is intended to facilitate discussions between process industry decision-makers and the specialists who design, build and maintain the processes and systems that enable enterprises to function. The OIIE provides an example of the proposed, supplier-neutral industrial digital ecosystem. Key inter-enterprise relationships for the process industry digital ecosystem have been represented in Figure 1. It depicts the three-way relationship among Owner/Operators (O/O), Engineering, Procurement, Construction (EPC) organizations and Original Equipment Manufacturers (OEM), which forms the backbone of the secondary business process spanning the entire asset life-cycle.

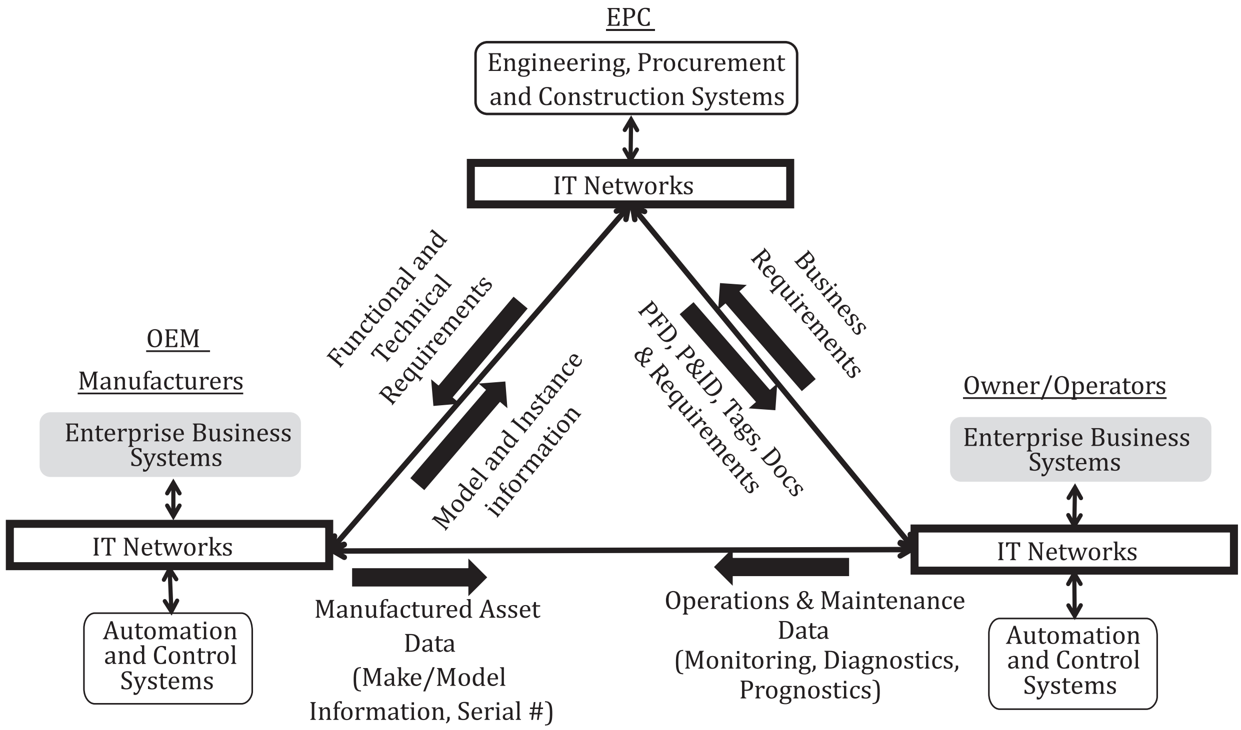

Figure 1 — OIIE inter-enterprise industrial digital ecosystem architecture

The secondary business process establishes and maintains operations capability. It spans both inter and intra-enterprise domains, based on requirements from the standard industry use cases, which are part of the portfolio of published, supplier-neutral standards and specifications which define the digital ecosystem. Using a portfolio of existing, well recognized standards, reduces risks associated with the creation of new standards. The OIIE/OGI Pilot is an interoperability test-bed and is implemented as an instance of the OIIE, which includes standard oil and gas asset classes and use cases, most of which are also applicable to other process industries.

This document identifies a portfolio of supplier-neutral IT and IM standards and specifications, including and driven by standardized industry use cases addressing life-cycle asset management. The included standards and specifications are validated to work with each other, properly supporting the standardized industry use cases, using the OIIE/OGI Pilot. Industry solutions are also validated to interoperate in the OIIE/OGI Pilot, based on the applicable standardized industry use cases, using the included standards and specifications in the specified manner. Three major phases of the OIIE/OGI Pilot have already been used to establish and validate the core methods and standards included in the OIIE. Results from new OIIE/OGI Pilot phases will be documented and published in Technical Reports, since they will be used to validate inclusions in future parts of the ISO 18101 series. This methodology provides a pragmatic, supplier-neutral basis for a digital ecosystem which meets major industry requirements for digital business transformation.

Industry implementation of the Technical Standard has the potential to substantially improve cost and risk management for the entire life-cycle of plants, platforms and facilities, following a pragmatic solutions process based largely on existing standards and widely accepted practices and methods.

Automation systems and integration — Oil and gas interoperability —

Part 1: Overview and fundamental principles

1 Scope

This document provides requirements, specifications and guidance for an architecture of a supplier-neutral industrial digital ecosystem. It includes a standardized connectivity and services architecture, and a standardized use case architecture with methods to specify atomically re-usable scenarios and events, which can be used to specify the characteristics of standardized industry use cases.

NOTE 1 Examples of standard industry use cases included in the secondary business process are included in Annex A along with standardized use case architecture.

This document gives:

— guidance for an architecture applicable to the oil and gas, petrochemical, power generation, public utilities and other asset-intensive industries;

— requirements for interoperability among systems of systems, systems (including hardware and software) and components included in the secondary business process of a plant, platform or facility at any given time;

— guidance on how these interoperability requirements are to be achieved and sustained in support of operations in the same plant, platform or facility;

— specifications enabling the specialization of a digital ecosystem concept for the requirements of the secondary business process in included industries;

— guidance to industry participants, including owner/operators and their product and services suppliers, to support their secondary business process requirements using products, which interoperate based on the specifications included in this document.

NOTE 2 This document is focused on interoperability requirements for systems which play roles in the secondary business process, including those in domains identified in Figure 7.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 15926-1:2004, *Industrial automation systems and integration — Integration of life-cycle data for process plants including oil and gas production facilities — Part 1: Overview and fundamental principles*

ISO 18435-1:2009, *Industrial automation systems and integration — Diagnostics, capability assessment and maintenance applications integration — Part 1: Overview and general requirements*

ISO/TS 8000-1:2011, *Data quality — Part 1: Overview*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
interoperability
capability of two or more entities to exchange items in accordance with a set of rules and mechanisms implemented by an interface in each entity, in order to perform their specified tasks

Note 1 to entry: Examples of entities include devices, equipment, machines, people, processes, applications, computer firmware and application software units, data exchange *systems* (3.2) and enterprises.

Note 2 to entry: Examples of items include *services* (3.7), information, material in standards, design documents and drawings, improvement projects, energy reduction programs, control activities, *asset* (3.5) description and ideas.

Note 3 to entry: In this context, entities provide items to, and accept items from, other entities, and they use the items exchanged in this way to enable them to operate effectively together.

[SOURCE: ISO 18435-1:2009, 3.12, modified — The word “respective” has been replaced with “specified”, Notes 1 and 2 to entry have been modified and Note 3 to entry has been added.]

3.2
system
combination of interacting software and hardware elements organized to achieve one or more stated purposes

Note 1 to entry: Since a system is composed of *system elements* (3.3), a system can include hardware, software (embedded and applications), data, humans, processes, procedures, facilities, materials, and other naturally occurring entities (e.g. water, organisms, minerals), or any combination.

Note 2 to entry: Industrial application software is included in industrial systems.

[SOURCE: ISO/IEC/IEEE 15288:2015, 4.1.46, modified — The words “software and hardware” have been added and Notes to entry have been modified.]

3.3
system element
member of a set of elements that constitutes a *system* (3.2)

EXAMPLE Hardware, software, data, humans, processes (e.g. processes for providing *service* (3.7) to users), procedures (e.g. operator instructions), facilities, materials, and other naturally occurring entities (e.g. water, organisms, minerals), or any combination.

Note 1 to entry: A system element is a discrete part of a system that can be implemented, instructed or used to fulfil specified requirements.

[SOURCE: ISO/IEC/IEEE 15288:2015, 4.1.47, modified — The words "(e.g. water, organisms, minerals)" have been added to the Example and the words “instructed or used” have been added to Note 1 to entry.]

3.4
system of systems
system-of-interest whose elements are themselves *systems* (3.2)

Note 1 to entry: Systems of systems typically entail large-scale inter-disciplinary problems with multiple, heterogeneous, distributed systems.

Note 2 to entry: In ISO/IEC/IEEE 15288:2015, 4.1.48, a system-of-interest is defined as a system whose life cycle is under consideration in the context of this document.

[SOURCE: ISO/IEC/IEEE 24765:2017, 3.4111, modified — The second definition has been removed and Notes to entry have been added.]

3.5
asset
item, thing or entity that has potential or actual value to an organization

[SOURCE: ISO 55000:2014, 3.2.1, modified — Notes to entry have been removed.]

3.6
capital project
long-term, capital-intensive investment project

3.7
service
repeatable business activity that has a specified outcome

Note 1 to entry: The service is self-contained, may be composed of other services and is a "black box" to consumers of the service.

Note 2 to entry: Examples of business activities include: check customer credit, provide weather data, consolidate drilling reports, maintenance work order.

[SOURCE: ISO/IEC TR 30102:2012, 2.1.17, modified — The words "logical representation of a set of repeatable activities that has specified outcomes" in the first half of the original definition have been replaced with "repeatable business activity that has a specified outcome", the content of the original Note 1 to entry has been replaced with the content of the second half of the original term and Note 2 to entry has been added.]

3.8
data set
logically meaningful group of data

[SOURCE: ISO 8000-2:2018, 3.2.4, modified — The word "grouping" has been replaced with "group".]

3.9
digital twin
digital asset (3.10) on which *services* (3.7) can be performed that provide value to an organization

Note 1 to entry: The descriptions comprising the digital twin can include properties of the described asset, *IIOT* (3.24) collected data, simulated or real behaviour patterns, processes that use it, software that operates on it, and other types of information.

Note 2 to entry: The services can include simulation, analytics such as diagnostics or prognostics, recording of provenance and service history.

EXAMPLE A digital model of an aircraft that allows crew training in a simulator; a stream of vibration readings that allows analysis of bearing wear; maintenance records that enable certification checks or total operation time computation.

3.10
digital asset
data set (3.8) describing an *asset* (3.5) that is not necessarily physical

EXAMPLE Digital assets describing non-physical assets include technical specifications, software, algorithms.

3.11
domain
field of special knowledge, which can be further subdivided according to requirements to support a higher level of specialized detail

3.12
reference architecture
IT architecture specialized for the requirements of a particular *domain* (3.11)

EXAMPLE PERA (Purdue Enterprise Reference Architecture) is a reference architecture that can model the enterprise in multiple layers and multiple stages of the architectural life cycle. Initially, PERA was part of the PERA methodology, which consisted of three main building blocks (Purdue Enterprise Reference Architecture; Purdue Reference Model; Purdue implementation procedures manual).

3.13
information model
formal model of a bounded set of facts, concepts or instructions to meet a specified requirement

Note 1 to entry: In this context, the description of *domain* (3.11) entities in a *digital ecosystem* (3.26) addressing lifecycle *asset* (3.5) management.

3.14
reference data
domain (3.11) and sector standardized *data sets* (3.8) that help define the set of values to be used to populate other data sets

3.15
industry standard datasheet
ISD
industry developed, supplier neutral specification for equipment and device classes

Note 1 to entry: The industry standard datasheet includes functional requirements, model and instance level details needed for industry digital transformation.

3.16
industry standard datasheet definition
ISDD
meta data required to enable machine interpretability of all attributes on *industry standard datasheets* (3.15)

3.17
reference data library
RDL
managed collection of *reference data* (3.14)

[SOURCE: ISO 15926-1:2004, 3.1.19]

3.18
supplier catalogue
list of goods and *services* (3.7) provided by an organization to its clients that conform to a specification defined by a supplier

3.19
data quality
degree to which a set of inherent characteristics of data fulfils requirements

Note 1 to entry: Examples of requirements for quality data also include data integrity, *data validation* (3.22), *data portability* (3.23), data synchronization and the data provenance record.

[SOURCE: ISO 8000-2:2018, 3.8.1, modified — Note 1 to entry has been modified.]

3.20
primary business process
process defining principal operations of an enterprise

3.21
secondary business process
process establishing and maintaining operations capability

3.22
data validation
confirmation, through the provision of objective evidence, that the requirements for a specific intended use or application have been fulfilled

[SOURCE: ISO 8000-2:2018, 3.8.6]

3.23
data portability
ability to easily transfer data from one *system* (3.2) to another without being required to re-enter data

Note 1 to entry: The need to manually, find, re-read, re-interpret and re-enter data is one of the main factors which increase industry costs and risks, while also decreasing *data quality* (3.19). Digital Business Transformation eliminates this redundant work, simultaneously reducing costs and risks while increasing data quality.

3.24
Industrial Internet of Things
IIOT
global infrastructure for the information society, enabling advanced *services* (3.7) by interconnecting (physical and virtual) things based on, existing and evolving, interoperable information and communication technologies

Note 1 to entry: The Industrial Internet of Things (IIOT) is used to identify the industrial specializations of the Internet of Things (IOT).

[SOURCE: ISO/IEC 38505-1:2017, 3.6, modified — The original Notes to entry have been removed and a new Note 1 to entry has been added.]

3.25
plant to business stack
P2B stack
vertical data/information axis from sensor to enterprise *systems* (3.2)

3.26
digital ecosystem
distributed, adaptive, open socio-technical *system* (3.2) with properties of self-organisation, scalability and sustainability inspired from natural ecosystems

3.27
asset-intensive industry
industry requiring a significant amount of large-scale industrial equipment to operate

4 Abbreviated terms

ADID	Application Domain Integration Diagram
API	Application Programming Interface
CCOM	Common Conceptual Object Model
CMMS	Computerized Maintenance Management System
EAM	Enterprise Asset Management
EPC	Engineering, Procurement, Construction

ERP	Enterprise Resource Planning
HSE	Health and Safety Executive
IM	Information Management
ISBM	Information Service Bus Model
IT	Information Technology
ITB	Invitation to Bid
MSM	Message Service Model
OEM	Original Equipment Manufacturers
OGI	Oil and Gas Interoperability
OIIE	Open Industrial Interoperability Ecosystem
O&M	Operations and Maintenance
OpenO&M	Open Operations and Maintenance
O/O	Owner/Operators
PERA	Purdue Enterprise Reference Architecture
RSPL	Recommended Spare Parts List
SPIL	Spare Parts Interchange List
SPIR	Spares Parts Interchange Record

5 Overview and general requirements

5.1 Secondary business process

Industry activities can be modelled using multiple axes approaches, where the primary business process concerns itself with the core operations of a given industry group. In the oil and gas industry, this primary business process usually features raw material inputs, which are taken through a conversion process resulting, in desired outputs. The upstream, midstream and downstream sectors of the oil and gas industry, as well as other asset-intensive process industries, can all be modelled in this fashion, although midstream generally provides no conversion process other than transport.

This document focuses on the secondary business process which supports the primary business process as is depicted in Figure 2. The secondary business process is shown in more detail in Figure 3. It includes capital project activities (engineering, design, procurement, and construction), followed by the handing over and maintenance of the associated plants, platforms, and facilities (collectively referred to as facilities in the oil and gas industry). Inefficiencies in capital projects often result in large cost and schedule overruns in capital projects, while also greatly increasing costs and reducing operational efficiencies over the asset life-cycle. Frustrated operators and maintenance personnel then spend too much time struggling with sub-optimal implementations of various operations and maintenance systems. In many cases, they are forced to and re-enter information into their systems, when this information should have been efficiently captured find as machine interpretable information during the capital project phase, then handed over and automatically provisioned into their systems.

