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A STANDARD-BASED DATA MODEL FOR CONFIGURATION MANAGEMENT AND MAINTENANCE SUPPORT

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ABSTRACT

The goal of this paper is to define an information model for configuration management and maintenance, taking into consideration the full life cycle of assets. the primary step was to review the systems related to configuration management checking the employment of standards and norms which are connected virtually and searching for the connection of the various possible data models used for configuration management systems. A definition of the info model is presented organized in 9 layers of information and it's applied during a use case where is checked the issues of the information model to enhance.

KEYWORDS: Configuration Management, Maintenance, data model, MIMOSA

INTRODUCTION

1. THE CONFIGURATION MANAGEMENT

Configuration management (CM) is that the process to spot the physical and functional characteristics of a configuration item (CI) during all life cycle (software, firmware or hardware), controlling all characteristic changes, recording and processing changes reports and controlling the implementation status.

The configuration management consists of 4 basic functions

(Buckley 93) (Bounds 93):

1. Configuration identification: Physical and functional characteristic identification of a CI in any phase of whole life cycle. It includes a proper CI selection and documents conservation of the CI base where all the system is identified and defined.

2. Configuration control: Systematic request, justification, evaluation, coordination, approval, or disapproval of proposed modifications and therefore the implementation of changes within the configuration of each CI, likewise as within the documentation where is identified the configuration of every CI.

3. Configuration status accounting: Recording and reporting the implementation of all modifications of the configuration and identification documents.

4. Configuration audit: Assess the compliance of the CI with the configuration identification The core purpose of CM is to permit for better decision making, on products, projects, and programs, to control changes through the creation and maintenance of documentation and products with the flexibility to reference this data at any time. In this context, Configuration management ends up in a

more effective maintenance. for instance, it's possible to own a better traceability of apparatus, having in mind all the changes that the equipment has; improve maintenance logistics knowing the particular configuration of an asset; or comparing between two machines configuration to pick out the best one for the corporate. The CM is principally supported by the information model employed. There are several standards for configuration management maintenance performance, but not any previous work has been dispensed trying to integrate a configuration the management data model within the field of maintenance. For this the reason we've got considered the necessity to define an information model in a broad way, taking into consideration aspects associated with maintenance performance, logistics, costs, condition and reliability, join to configuration identification and control.

2. STANDARDS REVIEW

Having in mind this definition, current standards, norms and guides, applications or products of various sectors, patents, and benchmark companies and universities are studied to define a knowledge model for configuration management as a support for operation and maintenance. A set of various standards covering the complete life cycle spectrum were reviewed and used. The standards and guidelines considered are listed in Table 1.

Table 1. Summary of standards related to CM and maintenance

Standard	Description	Data model
ISO 10303	Data standard for a product model	Guides for product data, geometry, part-related information
GEIA 927	Common data schema for complex systems	Guides for product, physical and functional system architecture during life cycle.
ANSI/EIA 836	Interchange of data for configuration mangement	XML schemas supporting CM
ANSI/EIA 649	Configuration management in a general way	Guides for configuration management
MIMOSA OSA-EAI	Architecture for the activities of Operation & Maintenance	XML schemas and a data base for supporting maintenance, condition monitoring, operation and reliability
ASD/AIA S1000D	Specifications for technical publications	XML schemas and a database supporting information types as descriptive, procedural, maintenance schedules, fault isolation and crew/operators
PAS 55	British standard for asset management	Guides for resources managemet, cost-benefit analyisis, risks and life cycle.
IEC 60300	Dependability management and life cycle costing	Guides for Dependability and Life Cycle Costing

2.2 GEIA 927 Common data schema for complex systems

2.1 ISO 10303 Standard for Exchange of Product model data (STEP) STEP may be a standard that deals with product structure, geometry and part-related information (Rachuri 2006). It is quite complex and composed of the many parts. it's been approved as a global set of standards since 1994. The the main drawback of STEP is that manufacturers and software developers perceive it as a rich solution, despite it's been proven to save lots of efficiencies in time, material, and staff. The Government Electronics & Information Technology Association (GEIA) is an ANSI standard that supports its electronic and IT membership. It became a regular in 2006 and is in continuous improvement. Their main target is to provide a unified schema that integrates the most effective available schemas for data representation for contemporary complex systems during their whole life cycle, including the subsequent phases: system engineering, feasibility assessment, requirement definition, domain engineering, system realization, system operation, system support, system maintenance and therefore the decommissioning of the system (Colson 2006).

2.3 ANSI/EIA-836

Configuration management data exchange and interoperability. GEIA launched 2000 a standardization project inpartnership with the Department of Defense of the U.S.A. and several industry participants, whose target was to develop a new CM data exchange and interoperability standard (EIA 2010). the quality ANSI/EIA-836 was proposed, which includes a CM data element dictionary and reference schema, and a group of XML schemas and templates (eXtensible Markup Language) for CM business objects. The usage of XML enables easy interoperability or data exchange among different systems.

2.4 ANSI/EIA-649

National consensus standard for configuration management. The target of ordinary ANSI/EIA-649 is to produce CM principles that are applicable o a broad range of various industries. This standard describes the functions and principles of CM during a neutral terminology to be

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used with any product line. the quality describes the subsequent functions: CM planning, configuration identification, configuration change management, configuration status accounting, and configuration verification (EIA 2011).

2.5 MIMOSA standards MIMOSA standards

(Machinery Information Management Open Systems Alliance) allow the collaboration within the asset
life cycle management, in commercial and military applications. We could affirm that they allow a maintenance infrastructure, that is, a network which integrates and synchronize different applications in maintenance and reliability for compiling and distributing asset information, what you would like, once you need it. One of
The main benefits of those open standards is that allow access to
several information types.
OSA-CBM standard (Open System Architecture for Condition-Based Maintenance) is an architecture for monitoring and diagnosing assets. It integrates all CBM processes, from data acquisition to decision support. OSACBM defines 6 functional blocks for CBM systems (Data Acquisition, Data Manipulation, Condition Monitoring, Health Assessment, Prognostics, and Decision Making) and the interfaces among these blocks. OSA-CBM relies on OSA-EAI specifications, using CRIS as core infrastructure (Common Relational Information Schema). CRIS model represents a static data view produced by a CBM system. It allows communication among diagnosis, health, and prognostics, maintenance model, work orders, providing the desired framework for storing reliability information, CRIS is customized to XML. thanks to the existence of lot asset management systems, the integration process is very difficult since they need their own interfaces for data exchange. For this reason, the OSA-EAI standard (Open System Architecture for Enterprise Application Integration) was developed by MIMOSA to supply a regular for interoperability in asset management (Mathew 2009). OSA-EAI is an open standard for data exchange in several key areas inside the asset management, like identifications, task management, setting diagnosis and prediction, vibration and acoustic data, lubrication, fluids and gases, thermography, and reliability information. The interfaces among these areas are defined through XML schemas. Comparing to OSA-CBM, OSA-EAI provides the info architecture for storing data, that is, a database.

2.6 ASD/AIA-S1000D

S1000D is a world specification for technical publications, developed by the ecu Association of Aerospace Industries (AECMA). the utilization of this standard should handle a good range of knowledge types such as descriptive, procedural, maintenance, schedules, fault isolation, and crew/operators. It used international standards as Standard Generalized terminology, XML and Computer Graphics Metafile for the assembly and use of electronic information. S1000D has been defined in a very modular approach, defining data module as a "self-contained unit of data" and having 2 main sections: one containing required data by the user (content section) and therefore the other one containing metadata needed for controlling the module and configuration (identification and standing section). Any shared information is stored once during a database and used persistently in several context utilizing an identification code for the module.

2.7 PAS 55

The Publicly Available Specification (PAS) was published in 2004 in response to the growing demand of industry of an asset management standard (Bsi 2008). It defines of 28 specifications to implement and audit an integrated and an optimized system taking into consideration the full life cycle of physical assets. Asset Management is defined as "systematic and coordinated activities and practices through which a company optimally and sustainably manages its assets and asset systems, their associated performance, risks, and expenditures over their life cycles to attain its organizational strategic plan". A management system may be a way that practices of a corporation are specified and controlled to enable organizational plans, based normally within the quality cycle

(Plan, Do, Check and Act). BSI PAS 55:2008 establishes how audibly, corporate management plans are obtained, aligning policies, strategies, objectives, and at last plan with specific actions for people with the desired competencies, responsibilities and authority. this manner the asset management system could be a mechanism to assure that total planning during the entire life cycle, risk management, cost/benefit, customer approach, sustainability, etc. principles are implemented in day-to-day work.

2.7 IEC 60300

The International Electro technical Commission (IEC) could be a worldwide organization for standardization. the thing of IEC is to market international co-operation on all questions concerning standardization within the electrical and electronic fields (IEC 2004). IEC 60300 Deals with dependability performance issues including availability performance, reliability performance, maintainability performance, and maintenance support performance. Particularly, IEC 60300-3 Section 3 is an application guide for all times cycle costing. It explains the purpose and value of LCC and descriptions the overall approaches involved. Moreover, it identifies typical LCC elements to facilitate project and program planning.

3. DATA MODEL

Once all standards were reviewed, the subsequent step was to review how they might be combined to get a neater way of working with them. during this way, the answer may be a data model based on the standards and structured in 9 layers in line with different views of the asset:

- Configuration identification: Physical or functional identification of the hardware or software within the whole life cycle.
- Record of asset changes: Modification recording of the asset configuration
- . Location: Asset location related information
- Maintenance performance: Sequence of steps to complete a maintenance task.
- Maintenance Logistic: Tools, materials, and staff to complete maintenance tasks and their location.
- Maintenance policy: Asset applied maintenance policy or strategy. Corrective, preventive, predictive, and related information.
- Costs: Maintenance, reparation and spare parts cost-related information.
- Condition: Asset health condition, health prediction, sensing, measurements, and inspections.
- Reliability: Historic data of completed maintenance tasks, design reliability data, and failures.

  Before defining the content of each layer, has been selected the standard related to them, as detailed in Table 2.

Table 2. Data layers and related standards

Data layer	Norms /Standards
Configuration identification	ISO 10303 GEIA-927 EIA-836 EIA-649 OSA-EAI
Record of redesigns	ISO 10303 GEIA-927 EIA-836 EIA-649
Location	MIMOSA OSA-EAI
Maintenance performance	ASD/AIA-S1000D MIMOSA OSA-EAI
Maintenance Logistic	ASD/AIA-S1000D MIMOSA OSA-EAI
Maintenance policy	PAS 55 IEC 60300
Condition	ASD/AIA-S1000D MIMOSA OSA-EAI
Costs	PAS 55 IEC 60300
Reliability	MIMOSA OSA-EAI PAS 55 IEC 60300

MIMOSA OSA-EAI is assigned in most data layers, making it the foremost suitable standard in a very wide perspective. In this sense, might be coherent to pick OSA-EAI as our standard for configuration management and maintenance data model. But this selection has several inconveniences. First, it is focused more on the communication between different applications than an integration of various styles of data in a very unique data model. For this reason, this database consists of many tables, making it difficult to use and keeps up to date. Moreover, OSA-EAI does support neither configuration management nor life cycle costs. Taking into consideration that, OSA-EAI may be used as a starting point in our data model, but requiring a simplification to be more operative, and integration of other standards covering their gaps. Therefore, our first data model consists by the the conjunction of three standards:

- MIMOSA OSA-EAI: selected standard for configuration identification, asset location, maintenance performance, logistic and policy, condition and reliability.
- EIA-836: Selected standard for recording the asset changes. This standard also provides a database definition, making easier their integration with OSA-EAI.
- IEC 60300: standard providing a value model-based on Life Cycle Costing 4. APPLYING the info

MODEL AND RESTRICTIONS FOUND

Applying this schema during a bus fleet company, data model features are reviewed, and a few none easily and universally solvable restrictions appear for the various data models. When our data model has been applied within the use case, the main objective was to own a better information management and treatment, rather than having a "perfect" model. Ranging from these restrictions, and with a practical view of the tests, the information model has been adjusted, in order to obtain a r placement conceptual model, more agile for future system users, and as a consequence, it'll be more cost effective to maintain. On the one hand, 3 layers, maintenance performance, policies, and logistics are integrated into a novel layer thanks to the relative simplicity of logistics and policy layers. On the other hand, several object definitions are far away from our data model for not proving any relevant information, and others are classes are grouped or converted into other object-associated parameters.

Table 3 is detailed the changes performed within the new 7 layers'. FINAL DATA MODEL finally, a conceptual data model is defined with the desired changes to avoid the described restrictions for future system users.

Table 4 summarizes the new conceptual data model, indicating the most objects in every proposed layer The usage of this data model enables several functionalities

compared to a usual CMMS:

Efficient management of configuration, without duplicities.

· Traceability of changes performed within the asset.

· Asset changing the asset which belongs to (e.g dismantling).

· Asset location, that is, a current site where the asset is located.

· Configuration linked to figure orders.

· Asset costs during their life cycle.

· Costs at Maintenance operation level.

· founded of parameters defining the preventive period.

· Configuration management together with reliability information, taking into consideration the record of changes performed.

5.CONCLUSIONS

Taking under consideration the essential functions of the configuration management (identification, control, status, and audit), the the research was focused on the identification phase with a giant effort within the standard review. Different standards solved configuration management issues, but it's important to prioritize the the use of those guidelines for maintenance and logistics of the transport sector. Configuration standards were reviewed and classified.

It is essential to possess an honest definition of the info model,with several information layers for configuration management, thus it's possible to figure in an exceedingly scalable and coordinated manner. 9 information layers were d fined dealing with "Assets" because the central core of the knowledge. Information layers are associated with operation and maintenance planning, likewise on analysis. A real configuration and maintenance management use case was employed to ascertain deficiencies then evaluate the applicability of our data model supported the standards. In general terms, there are too many classes all told layers. Conceptually the info model is correct, but class excess requires complex and expensive conservation of information management. The definition of this data model will enable a more practical maintenance through better traceability of apparatus, also improving maintenance logistics, knowing the particular configuration of an asset, or enabling comparisons between several machines configuration. The next steps are continuing working within the conceptual data model, additionally to the physic aspect of the information acquisition in line with the model

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