Open Systems Engineering Measurement Process

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Open Systems Engineering Measurement Process

- Open System Engineering (OSE) Concepts
- Measurement Process Overview
- Open System Engineering (OSE) Measurements
- Future Measurement Areas
- Project Application
- Conclusions

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Open System Engineering Concepts

What is an Open System?

Open Systems Engineering Concepts

- "An Open System is a system that implement sufficient open specifications for interfaces, services and supporting formats to enable properly engineered components to be utilized across a wide range of components with minimal changes, to inter-operate with other components on local and remote systems, and to interact with users in a style that facilitates user portability."

- Open commercial interface standards are used as the fundamental engineering guide in the choice of products and development of applications using the products for a system.
  - Open Systems Engineering involves the effort necessary to use the standards appropriately to achieve open system economic benefits
  - Interface Standards are specified; components meeting the interface standards are used and developed

- Terms of significance include:
  - Profiles of standards which specify and constrain the configurable features of a standard to those appropriate for a particular system
  - Conformance Engineering - Ensures that products (used and built) meet the open standard interface specifications or in a system profile

Why build an Open System?
Open Systems Engineering Concepts

- An open systems engineering effort is a business approach for developing affordable and maintainable systems (weapon, C3I,...)
- An open systems engineering effort is an architecture effort undertaken to provide a resilient infrastructure that can accommodate rapidly changing information technology and commercial products
- An open systems approach has the potential to significantly reduce the risks associated with the use of commercial products in mission critical military systems both technically and economically
- Benefits are realized in inter-operability, the ability to better handle commercial product volatility, and vendor independence

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General Open Systems Engineering Issues
Open Systems Engineering Concepts

- Open Systems has become a cliché, with systems claiming to be open because it is programmatically appropriate
- Open Systems are often erroneously equated to COTS
  - References to standards are often the only open engineering effort
  - Open Systems Engineering requires and employs disciplined management and systems engineering processes throughout a system's life cycle to develop and maintain a system's open architecture
- Military Systems have a long life, while mandated to be built with short-lived and volatile commercial products
- The engineering effort involved in open systems engineering is not yet well understood

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Measurement Process Overview

Measurement Process Overview

- Three components of the OSE measurement process
  - A definition of measurable <u>open system objects</u> (products, processes, and resources). These objects are unique with respect to open systems engineering and help to focus the applied measures.
  - The overall <u>measurement process model</u>, which defines the activities which must be implemented, and the relationships between these activities.
  - The COSE/Open Systems <u>Issues - Categories - Measures</u> (ICM) structure, a tailorable measurement implementation mechanism that helps to map project specific open system technical and management issues to appropriate measures.

Product
Open System Objects

- System
  - Incremental system technical characteristics
  - Delivered system characteristics
  - System profiles
- Open System Specific Products and Components
  - Commercial off-the-shelf components
  - Application components
  - Interface profiles
  - Standards

Process
Open System Objects

- Phase Related Process Activities
  - Planning activities
  - Development activities
  - Deployment and sustaining engineering activities
- Open System Specific Process Activities
  - Profile development, application, and management
  - Conformance qualification, testing and management
  - Interoperability qualification and testing
  - Component integration
  - Interface compatibility qualification and testing
  - Component functional verification
  - Profile configuration management
  - Vendor interaction
  - Profile to product configuration management
  - Standards body interaction
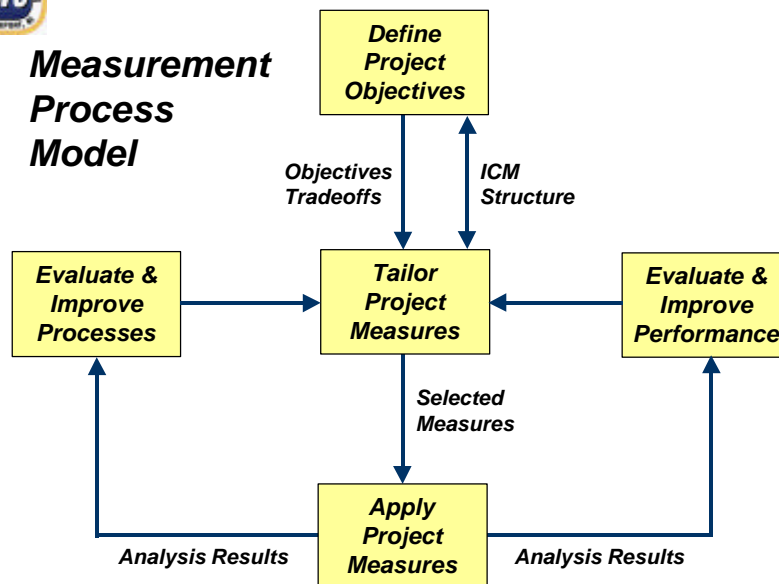
Resources
Open System Objects

- Phase Related Planned and Applied Resources
  - Personnel
  - Effort
  - Time/schedule
  - Support structure
- Open System Specific Planned and Applied Resources
  - Personnel
  - Effort
  - Time/schedule
  - Support structure

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Measurement Process Model

Define Project Objectives

Objectives Tradeoffs

ICM Structure

Evaluate & Improve Processes

Tailor Project Measures

Evaluate & Improve Performance

Selected Measures

Analysis Results

Apply Project Measures

Analysis Results

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Issues - Categories - Measures
Currently Under Development

- **Product Issues**
  - Product Stability
  - Product Quality
- **Process Issues**
  - Process Stability
  - Process Quality
- **Resource Issues**
  - Development Resources (Investment)
  - Sustaining Engineering Resources (Return)

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Open System Engineering Measures

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OSE Measures

- Open Systems Scope and Objectives
- Open System Engineering Capabilities
- Commercial Product Stability
- Profile Adherence
- Profile Use
- Implementation Conformance Qualification
- Application Conformance and Portability
- Product Interoperability Qualification
- Scalability and Extensibility
- User Portability

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Issue: Process Stability
Measure: Open Systems Scope and Objectives

- Discussion:
  - Quantifies organization's ability to set realizable OSE objectives. Addresses:
    - % of Lowest Replaceable Units (LRU)s and Functional Configuration Item (FCI)s are based on open commercial interface standards?
    - Which LRUs and FCIs are the focus of an OSE effort? - Where is a reasonable return on open systems engineering investments expected?
    - Useful in budgeting and planning and in focusing the OSE effort

- Selection Guidance
  - Applied during the planning and development phases

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Issue: Process Stability
Measure: Open Systems Scope and Objectives

- Specification Guidance
  - Typical Data Items
    - Number of LRUs and FCIs within the system/ using open commercial standards interfaces/ using unique interfaces
    - Type of interface (hardware, software and protocol)
    - Interface technology – (ex: Ethernet, FDDI, POSIX, etc.)
    - Specific scalability goals (ex: Network growth capacity)
      - Applications targeted to move to different capability platforms
  - Typical Attributes
    - Collected in hardware, software and protocol groupings
    - Further segmented into specific technology types, such as Ethernet, TCP/IP, Operating System
    - Specific applications and target platforms for scalability should be identified

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Issue: Development Resources
Measure: Open System Engineering Capabilities

- Discussion
  - The OSE Capability measure addresses the ability of the organization to identify and comprehend the project's different hardware, software and protocol interfaces, as well as the different technologies associated with them

- Selection Guidance
  - Useful in all Open Systems Engineering efforts
    - A table of required skills in a technology area vs. available skills provides a tool for estimating training, hiring and contracting needs.
  - Applied during the planning and development phases

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Issue: Development Resources
Measure: Open System Engineering Capabilities

- Specification Guidance
  - Typical Data Items
    - Number of persons with experience in
      - planning & budgeting an open systems engineering effort
      - addressing a particular interface
      - addressing a particular interface using project specified open systems engineering standard.
    - Number of persons with similar experience in addressing a particular interface, using the project specified open systems engineering standard.
    - Number of years of experience in /addressing a particular interface standard /anticipated to be necessary in addressing a particular interface

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Issue: Product Stability
Measure: Commercial Product Stability

- Discussion:
  - Volatility of commercial products. Specifically it attempts to identify order in the patterns of product release, change and support. It provides information useful to maintaining systems and understanding the patterns of operation of particular vendors regarding a product line.
- Selection Guidance
  - Applied during the development and sustaining engineering phases
  - Applicable to all projects using commercial products
  - Requires regular and specific interactions with commercial product vendors

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Issue: Product Stability
Measure: Commercial Product Stability

- Specification Guidance
  - Typical Data Items
    - Number of
      - vendors providing implementations of the same technology within the project
      - different implementations of the same interface
      - times per system cycle (project defined) the project (developer) interacts with a product vendor
      - times per system cycle (project defined) the project (developer) interacts with an alternative product vendor
      - ways in which product updates occur (example: hardware, driver, software) per system cycle
    - Vendor-product information avenues available to project developer/maintainer (example: web, user groups)
    - Vendor-product change cycle planning
      - Number of announced product changes per system cycle
      - Number of product fixes and minor updates per system cycle
      - Number of problems discovered and reported
    - Vendor product configuration management compared to LRU management schema
    - Vendor product support interval compared to system cycle time

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Issue: Product Quality
Measure: Profile Adherence

- Discussion:
  - Reflects mapping of functional/performance requirements to architecture's open interface standards. The degree of capture:
    - Is indicator of commitment to OSE approach.
    - Mitigates risk from marketplace volatility.
  - After initial generation, profile maintenance aids decision making as requirements, standards, and market-place evolve.
- Selection Guidance
  - Applied during development and sustaining engineering phases
  - Profiles are generally interface and technology specific
  - Implemented (as built) profiles may identify non-standard features to meet system requirements

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Issue: Product Quality
Measure: Profile Adherence

- Specification Guidance
  - Typical Data Items
    - Number of interface-technology profiles identified
      - Number of requirements mapped to interface standard features/ options addressed/ vendor-product definable features identified
    - For "as built" profiles:
      - Number of non-standard product features used/ different applications using non-standard product features
    - Frequency of profile maintenance, update cycle per program cycle/ interaction with standards organizations per program cycle
  - Typical Attributes
    - Profile type
    - Functional features
    - Physical features

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Issue: Product Quality
Measure: Profile Use

- Discussion:
  - Addresses consistency of applying profile requirements and objectives. Rigorous application of profiles throughout the development and sustaining engineering phases fosters platform and/or vendor independence. Processes for ensuring profile use are often incorporated into software development plans, product purchasing plans, and associated documentation.

- Selection Guidance:
  - Process is established, then monitored, documented, and maintained throughout the life cycle.
  - Requires initial resource commitment, frequent review and revision.

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Issue: Product Quality
Measure: Profile Use

- Specification Guidance
  - Typical Data Items
    - Number and uses of profiles in the system
    - Number of uses in product purchase specification and screening
    - Number of uses in application development guidance
    - Number of uses in interface configuration management
    - Availability of profile information throughout the project
      - Number of publication avenues and update notifications
      - Method of response required for availability of profiles
    - Number of interface profile checklists applied to a particular technology product.
    - Frequency with which profiles are reviewed and revised.

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Issue: Product Quality
Measure: Implementation Conformance Qualification

- Discussion:
  - Reveals the type and extent of conformance testing to which a product/product-line has been subjected. Conformance testing may be done along two paths:
    - Public: uses independent third-party sources to qualify components
    - Local: tests tailored/specific subset of features
- Selection Guidance
  - Applied prior to product/component selection and integration
  - Applied any time a new standard interface component considered
  - Requires familiarity with standards, third-party test results, vendor architecture evolution

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Issue: Product Quality
Measure: Implementation Conformance Qualification

- Specification Guidance
    - Typical Data Items
        - Number of interface standard profiles features required to be supported by product
        - Availability of public testing sources for individual interface-technologies
        - Cost of:
            - Publicly tested products
            - Subjecting product to public testing agency
            - Locally tested products
        - Number of interface standard profiles features:
            - Confirmed through Public testing
            - Not supported by a product
            - Required to be tested Locally
            - Not supported, and OF SIGNIFICANCE to the project

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Issue: Product and Process Quality
Measure: Application Conformance and Portability

- Discussion
    - Measures application developed software conformance to a project's applicable standards and profiles.
- Selection Guidance
    - Application conformance dealt with during late system specification phase
    - Process should be integrated into the Software Development Plan

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Issue: Product and Process Quality
Measure: Application Conformance and Portability

- Specification Guidance
  - Typical Data Items
    - Software tools assessment reports
    - Software development guidelines and procedures
    - Conformance certification of implementation
    - Training in the use of standard and profile
    - Process for verifying programmer adherence to standards

Issue: Product Stability
Measure: Product Interoperability Qualification

- Discussion:
  - Provides insight into the type and level of open standard interoperability qualification testing to which a vendor has subjected a product or a product-line, and the extent to which local interoperability testing is appropriate. This measure addresses the risk in mixing products from different vendors
- Selection Guidance
  - Applied during the development and sustaining engineering phases
  - Applicable to all projects using commercial products
  - Useful in making purchasing decisions during development and System Engineering phases
  - Useful in planning integration efforts

Issue: Product Stability
Measure: Product Interoperability Qualification

- Specification Guidance - Typical Data Items
    - Whether a process exists addressing interoperability on an interface-technology basis
    - Which interface-technologies (of those identified as important) have an associated interoperability process?
    - Whether or not the process has reasonable quality
        - Does the process interact with product vendors?
        - Are product vendors participants in interoperability testing organizations and activities?
    - What level of product to product testing is used?
        - Interoperability testing results from 3rd party testing agencies, local or other local testing
    - To what extent is the process applied with rigor?
        - How often is interoperability qualification conducted with respect to the product update and release cycle for a particular interface-technology product?
    - Does the process interact with interoperability testing agencies?
    - Conformance test results comparison made between products that are to inter-operate?
    - Product interoperability testing and qualification processes include direct product to product testing in the targeted design configuration?

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Issue: Product Stability
Measure: Scalability and Extensibility

- Discussion:
    - It is expected that two separate measure will be developed from this one:
        - Scalability concerns include whether or not the performance of an application will be adequate or even possible on a machine of lesser capability.
        - Extensibility reflects an architecture's ability to accommodate growth, such as additional users
        - This measure addresses questions such as:
            - To what extent has anticipated been planned into or unanticipated growth been considered in the development of an architecture?
            - Which architectural elements need to have architectural capacity to accommodate growth and change?
- Selection Guidance
    - Important during planning and requirements phases as well as the design and implementation parts of the development and sustaining engineering phases

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Issue: Product Stability
Measure: Scalability and Extensibility

- Specification Guidance
  - Typical Data Items
    - Extensibility - Anticipated delivered system capacity, and subsystem or component capacity allocation
    - Extensibility - Anticipated system, subsystem, and component growth anticipated
      - Number of fibers allocated to a subsystem in a network, number of switch ports allocated, number of redundant paths, etc. to be delivered at system start
      - Number of growth paths anticipated (additional fibers, switch ports, etc.)
      - Number of growth paths allocated
    - Scalability - applications targeted for use on different capacity platforms
    - Scalability - modularity of applications (dependencies on database sources, etc.)
    - Scalability - targeted platform capacity and characteristics

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Issue: Product Quality
Measure: User Portability

- Discussion
  - The ability to provide a consistent interface between a human user and the display items on a monitor. User portability is obtained when a user is able to comprehend and operate displayed program interfaces with little or no additional training.

- Selection Guidance
  - Project Application:
    - This measure is applicable to all programs using open standards
  - Process Integration
    - This measure may be somewhat subjective in nature. Analysis should focus on a quantification of the user interface characteristics which support user portability

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Future Measures

- Interface Standards Stability
- Technology Stability
- Compatibility
- Contracting
- Additional measures are under discussion

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Projects

- COSE (Collins Open Systems Extension)
  - Adjunct to an existing submarine combat system, being built using open systems engineering
    - Concerned with measuring progress toward success
- UK (POST-Practical Open Systems Technology)
  - Royal Navy R&D project interested in assessing its open system engineering approach

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Conclusions

- Open Systems Engineering Measurement is currently in its infancy
    - Work-to-date is promising
        - The measures illustrated are being applied on the COSE program
        - Significant refinement over the next 12 months is expected
- The Practical Software Measurement, issue driven approach, provides a framework for the open systems engineering environment
- As progress is made, appropriate information will be published as part of the Practical Open Systems Engineering (POSE) home page maintained by NUWC http://arch6.npt.nuwc.navy.mil/pose/

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