Instantiating Product-Specific Processes
A Framework for Product Quality Achievement

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Session Outline

1. Motivation

2. Approach

3. Case Study

4. ISO TS30103

5. Conclusion

Motivation: Diversity in Deliverables

Consider two deliverables

Website to submit proposals for telescope observing time

- Focus on user experience
- Performance focus: overloads
- Availability by horizontal scaling
- Web security threats & measures
- Agile development using web technologies

Control software to carry out observations using the telescope

- Focus on orchestration & integration
- Performance focus: timing
- Availability: fault handling & failover
- Fault & security zones
- SCADA platforms, V-model development

Different concerns, different solutions, different technologies, different practices

Should the processes for developing both be the same – or different?

➢ Today, often we use same processes – part of the same project!

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Product Agnostic Processes: Impact

Currently processes are product-agnostic

Capture engineering best practice

- No guidance on how to address concerns of specific product
- Total dependency on team technical competence whether right requirements identified, right technical decisions taken
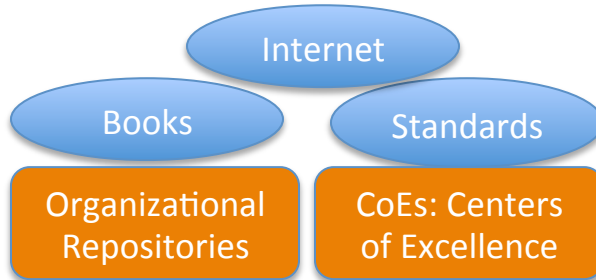
Impact

➢ Process maturity does not always translate to product quality
➢ Quality concerns such as security, performance and interoperability may or may not be identified correctly and addressed properly

Note

❑ Diversity is a problem in large projects with diverse subsystems
❑ Also a problem in project organizations, where projects span a variety of domains and concerns
❑ Less of a problem in product organizations or for specialized teams, that work on a series of similar problems: they evolve processes to address those specific concerns and practices

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Related Challenges

Knowledge is available, but not utilized consistently

Internet

Books

Standards

Organizational Repositories

CoEs: Centers of Excellence

Bodies of knowledge on concerns, patterns to address them

Management has little visibility to product progress towards Quality

Management views focus on activities, defects

Little or no in-process visibility into how quality is being built into product

Cannot see impact of technical decisions on product quality aspects (performance, usability, security, availability etc)

➤ Uptake by projects depends on awareness, individual initiative
➤ Process does not generally help to systematically identify & pull in relevant knowledge

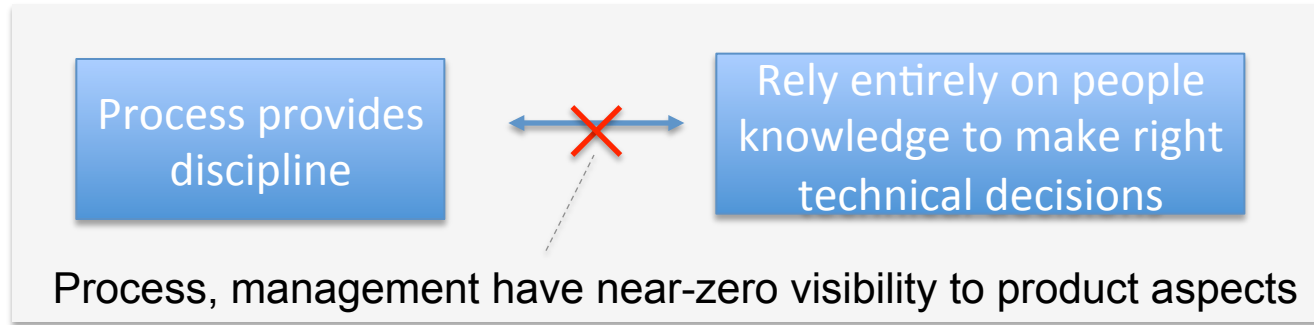TATA CONSULTANCY SERVICES
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Solution Approach

- Instantiate the generic processes needed to create each PBS item
  - Add a layer of tasks specific to the particular PBS item, based on its quality goals
  - This instantiation is based on knowledge, of quality concerns and how to achieve them
  - Use the process as a vehicle to systematically deploy knowledge of how to achieve functional and quality goals
    - Right technical decisions are the key to product quality
- Make each process instance a locality of quality responsibility
  - Connect them up with a network of consistency relationships
  - Detect consistency gaps with verification activities, track to closure
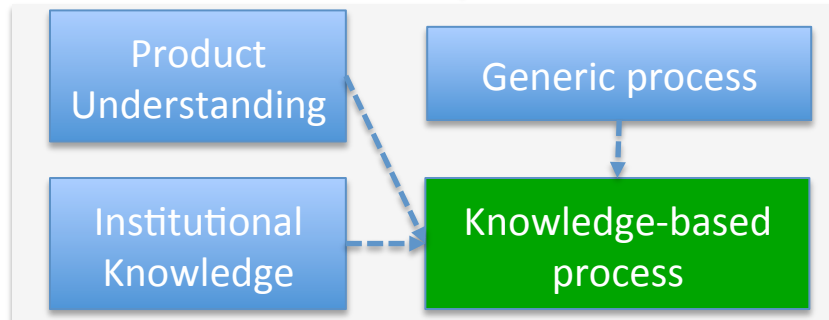
Published recently as ISO TS30103

Ultimate Goal: Product-Process Correlation

Current situation

Process provides discipline ✕ Rely entirely on people knowledge to make right technical decisions

Process, management have near-zero visibility to product aspects

Target state

Product Understanding

Generic process

Institutional Knowledge

Knowledge-based process

In other disciplines, process indicates what exactly needs to be done to deliver specific product

Establish process-product correlation Enable process to be the carrier of technical knowledge

Conceptual Foundation

Granular Product Breakdown Structure

Deming's Process Step – Product Quality

Commute Principle (Mathematics)

Framework – Core Principles

Institutional Knowledge: Assets, Practices

Manage Network of Consistency Relationships
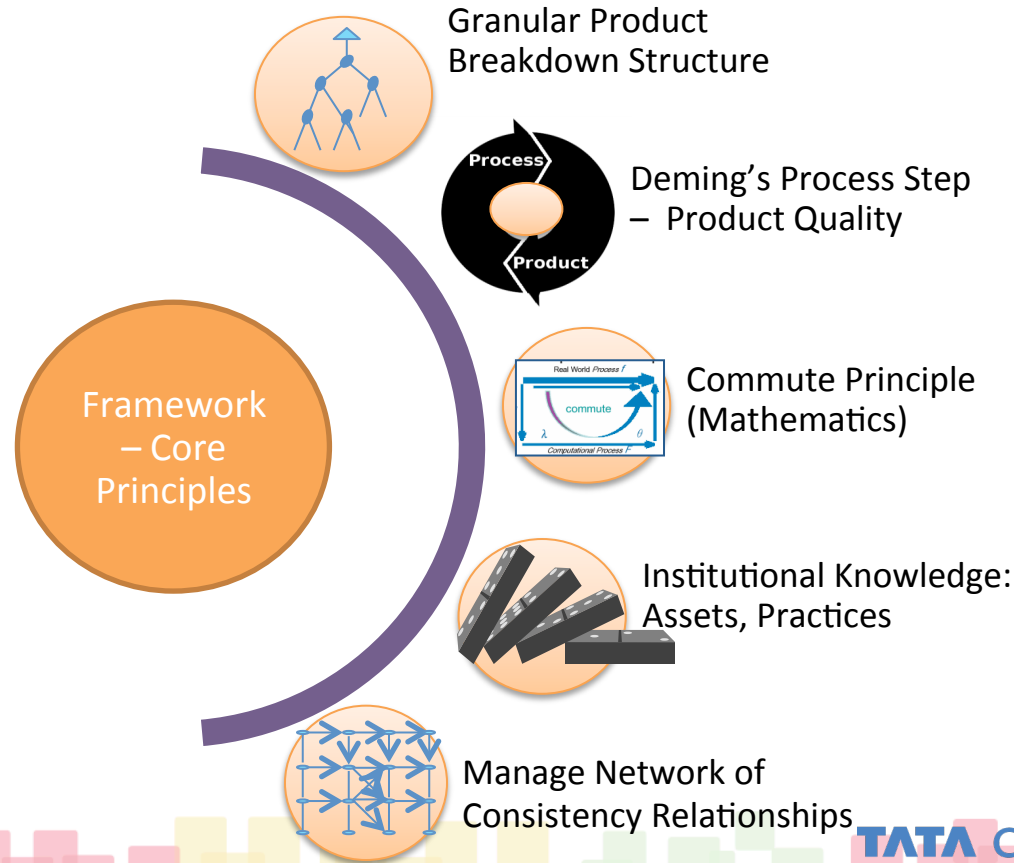
Approach: Principles

Decompose product requirements to establish quality specifications for each PBS item

Identify the collection of process instances needed to produce each PBS item

Process and product decisions must be consistent with institutional knowledge

Augment the activities and tasks in the generic process with the specific technical tasks needed to achieve the quality concerns of the PBS item

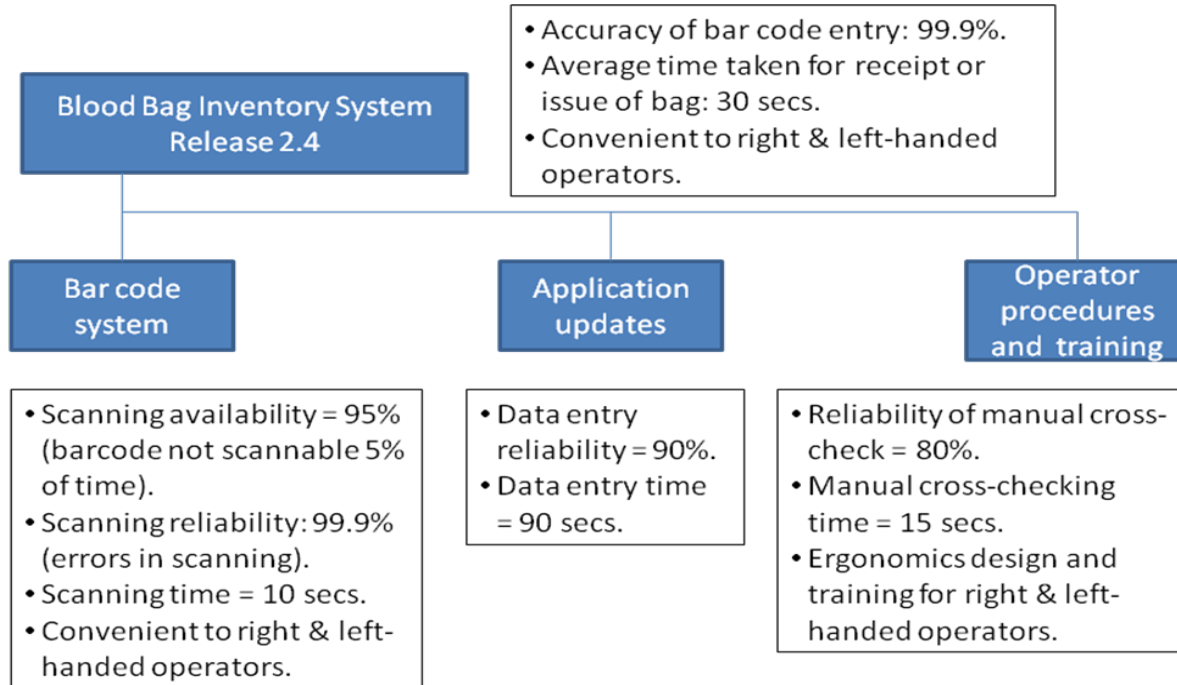Monitoring and management of consistency relationships among project artifacts

Separates progress model from process

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Instantiation: Concept
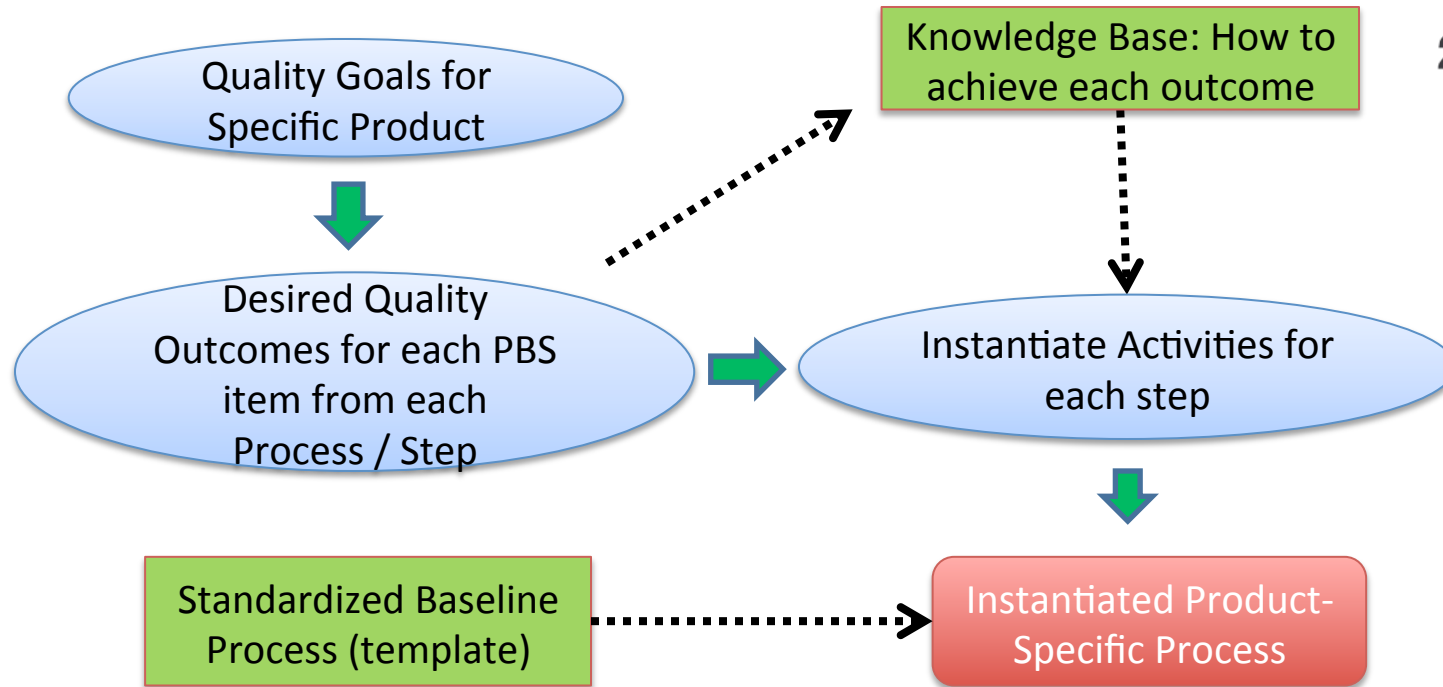
PBS and Quality Requirements Drilldown

Example application: Adding bar codes to a blood bag inventory system

Blood Bag Inventory System Release 2.4

- Accuracy of bar code entry: 99.9%.
- Average time taken for receipt or issue of bag: 30 secs.
- Convenient to right & left-handed operators.

Bar code system

- Scanning availability = 95% (barcode not scannable 5% of time).
- Scanning reliability: 99.9% (errors in scanning).
- Scanning time = 10 secs.
- Convenient to right & left-handed operators.

Application updates

- Data entry reliability = 90%.
- Data entry time = 90 secs.

Operator procedures and training

- Reliability of manual cross-check = 80%.
- Manual cross-checking time = 15 secs.
- Ergonomics design and training for right & left-handed operators.

Quality concern checklists for each item type used to identify key concerns.

Knowledge indicates practices to establish specific requirements e.g. elicitation, analysis, best practice

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Process Instantiation: Adding Subtasks

Generic process	Quality Goals → Subtasks	Synthesized process

Goal A **Goal B** **Goal C**

Task 1

Subtask A1

Task 1

Task 2

A2

Task 3
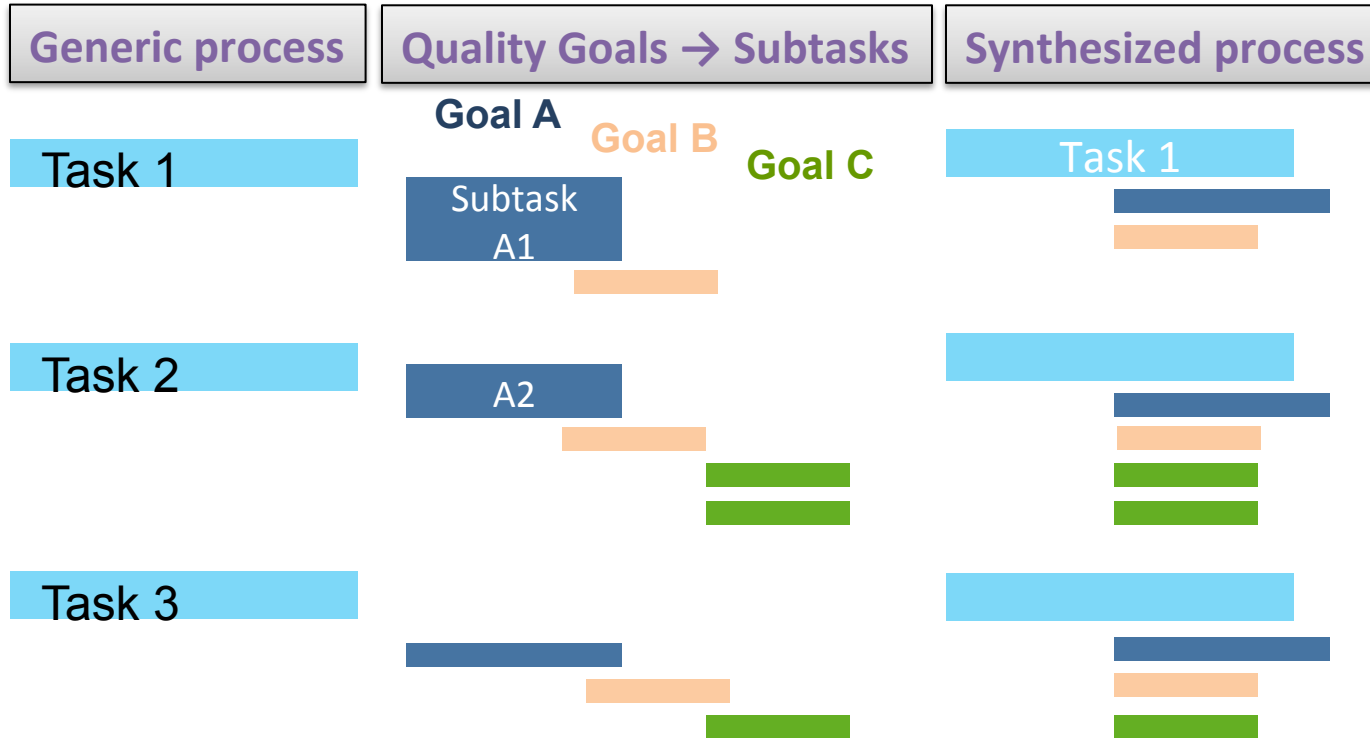
Add subtasks for each problem-specific goal based on knowledge.

Example: Requirements Process Synthesis

Elicit requirements

Determine reliability goal based on customer & user expectations

Observe & survey operators to identify ergonomics requirements

Analyze requirements

Perform reliability analysis using fault trees

Perform task & motion analysis for each user subgroup

Capture requirements

Define scanner reliability, scanning availability

Define requirements on scanner placement, barcode placement

Verify requirements

Review targets with customer

Validate based on prototypes

Synthesis identifies & delivers knowledge to point of use.

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Instantiated Process: Example

Bar Code Scanner Requirements Process Instance Description

Outcomes → success sriteria for process instance

- **The required functions and quality characteristics are specified**
  - The target accuracy of bar code entry is defined, including target availability of the scanning function (ability to scan the bar code on the sticker) and target scanning reliability (code scanned incorrectly).
  - Fault modes are identified for scanning of barcode labels, including possible operator errors, malfunctions, defects in the item being scanned and errors in the software system state.
  - Productivity goals are defined for the bar code system in terms of average time for scanning a bar code.
  - Usability goals are defined for bar code operators.
- **Constraints that will affect the architecture and design are identified**
  - APIs are defined to support the verification of the scanned / manually entered data against the contents of the bar code.

Tasks

- **Create specifications for desired levels of each of the quality attributes**
  - Decompose the overall product requirements for availability, reliability and productivity to derive bar code scanner availability and accuracy requirements, and targets for scanning time.
  - Identify the set of fault modes for the bar code system.
  - Identify user characteristics of barcode operators.
 - Elicit bar code operator requirements through stakeholder interaction.

Deployment of Institutional Knowledge

Goal: Consistent uptake of available knowledge

Institutional Knowledge
- Concerns
- Processes & tasks to address concerns
- Methods & practices
- Patterns & other technical knowledge

Standards, expert inputs
Trusted sources, internet
Books, reference sources

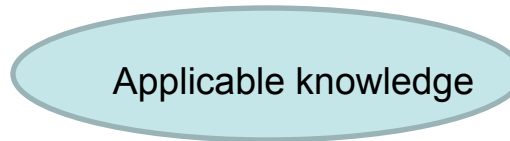Categorized Knowledge from external sources

Organizational Knowledge
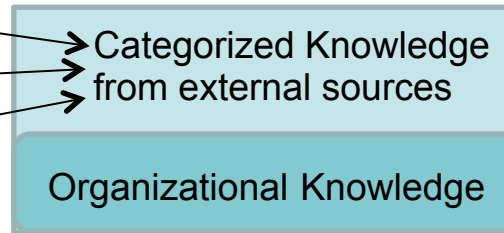
Tagged by domain and subproblem, quality attributes, process, contexts (technologies, situations) applicable

Retrieve based on tag matching, select based on applicability & decisions

May include technical knowledge to support application of practice

Applicable knowledge

Filter based on project, deliverable & context characteristics

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Artefact Consistency Management

Managing network of consistency relationships among project artefacts as problem & solution evolves
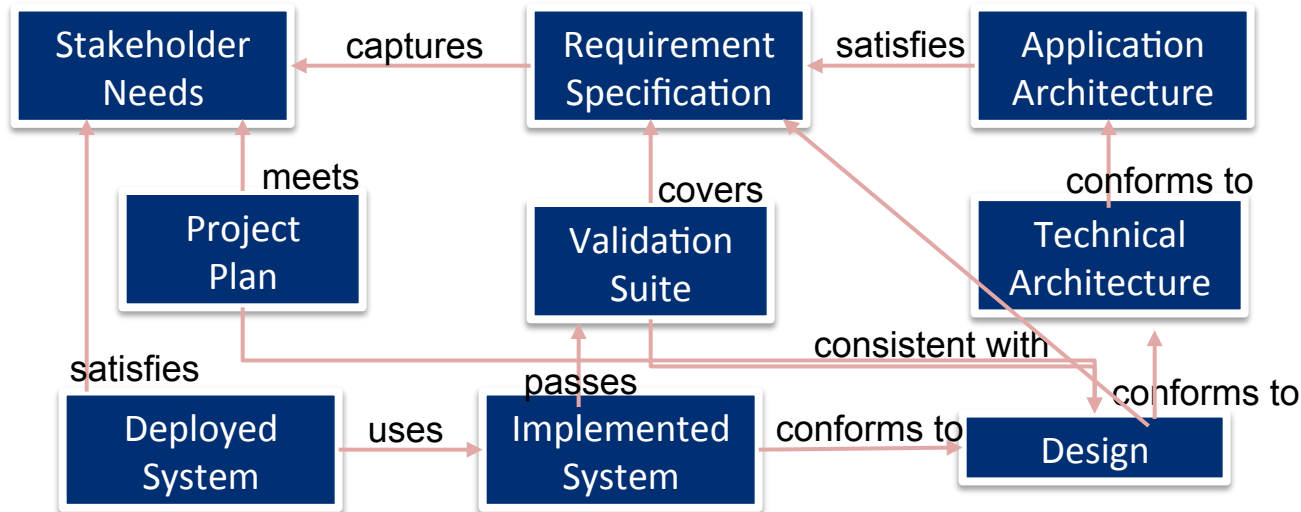
V&V activities (reviews, design analysis) continuously monitor and track consistency relationships to closure.

Network of Consistency Relationships

- Each process instance is a locality of quality responsibility
  - Perform identified tasks to achieve targeted quality outcomes
- The deliverables (artefacts) produced by each process have consistency relationships with each other
- Development is viewed as a network of concurrent processes
  - Not necessarily sequential or iterative: relationships are informational dependencies, not control flows
  - Mutual consistency among artifacts needs to be maintained in the presence of change and evolution
- Continuously monitor gaps in consistency, track to closure
  - Releases when acceptable levels of mutual consistency achieved

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Project Context

- End to End system to implement a New Pension Act with a vision of 'helping millions save for their retirement'

- Complex System with multiple stakeholders

- Mission Critical System - need for highest quality

- Demanding requirements for security, rich user experience, stringent performance, high availability...

PBS & Activity Planning

Portal - Quote Platform
1.1 Quote Request
1.2 Maintain Quote Basis
1.2.1 Maintain requestor
1.2.2 Maintain Intermediary Details
1.2.3 Maintain Lives
1.2.4 Maintain Quote Basis
1.2.6 Maintain Benefit Basis
1.2.7 Maintain Funds
1.2.8 Maintain Competitor Info.
1.3 Request underwriting decision
1.4 Request quote calculation
1.5 Request output
Work Management
Underwrite Quote
Price Quote
Quote Output
Apply for Annuity
Internal Book …………………..

Activity Plan

The activity plan is created by expanding the generic process with respect to each PBS item.

Process instances in the activity plan corresponding to PBS items :
- Elicit Requirements for "Quote request"
- Elicit Requirements for "Maintain Quote Basis - requestor"
- Elicit Requirements for "Underwriting decision"
- Elicit Requirements for "Quote calculation"

Process constraints arising from consistency relationships:
- The responsibility to sign-off that "the requirements are specified for identified Outcomes of the system" assigned to Business analyst
- The responsibility to sign-off that "the requirements are specified for Functionality + the major quality characteristics further elaborated with "Quality Map" is assigned to Business analyst…

Quality Approach
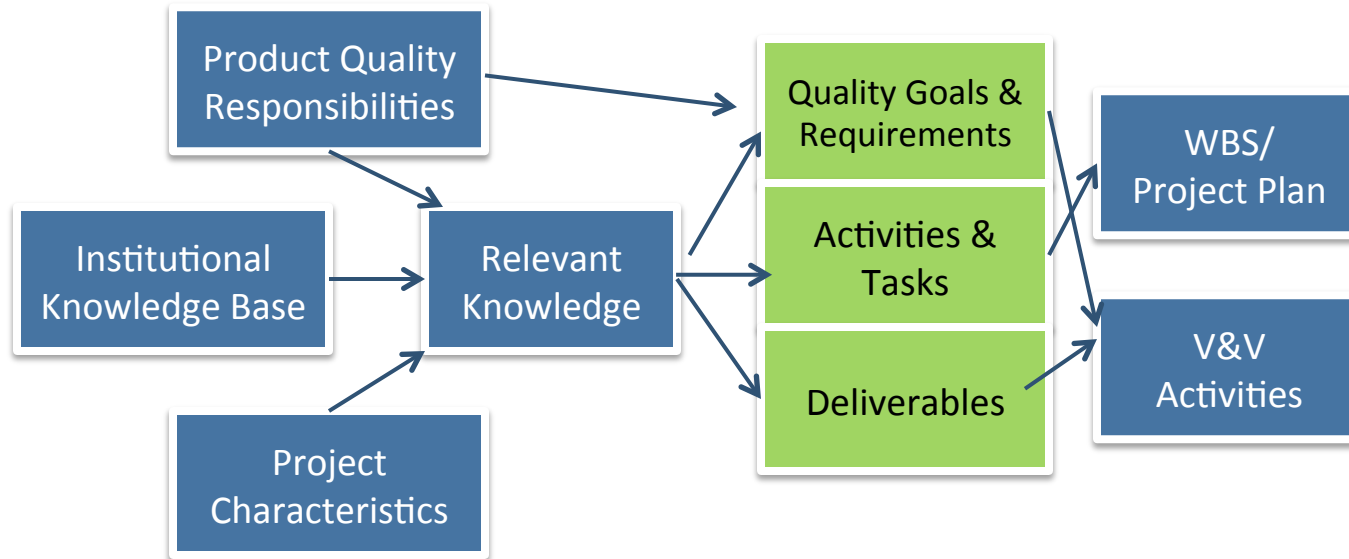
Product Quality is addressed at each phase of development life cycle process; results tracked and gaps identified.

Quality Achievement Framework
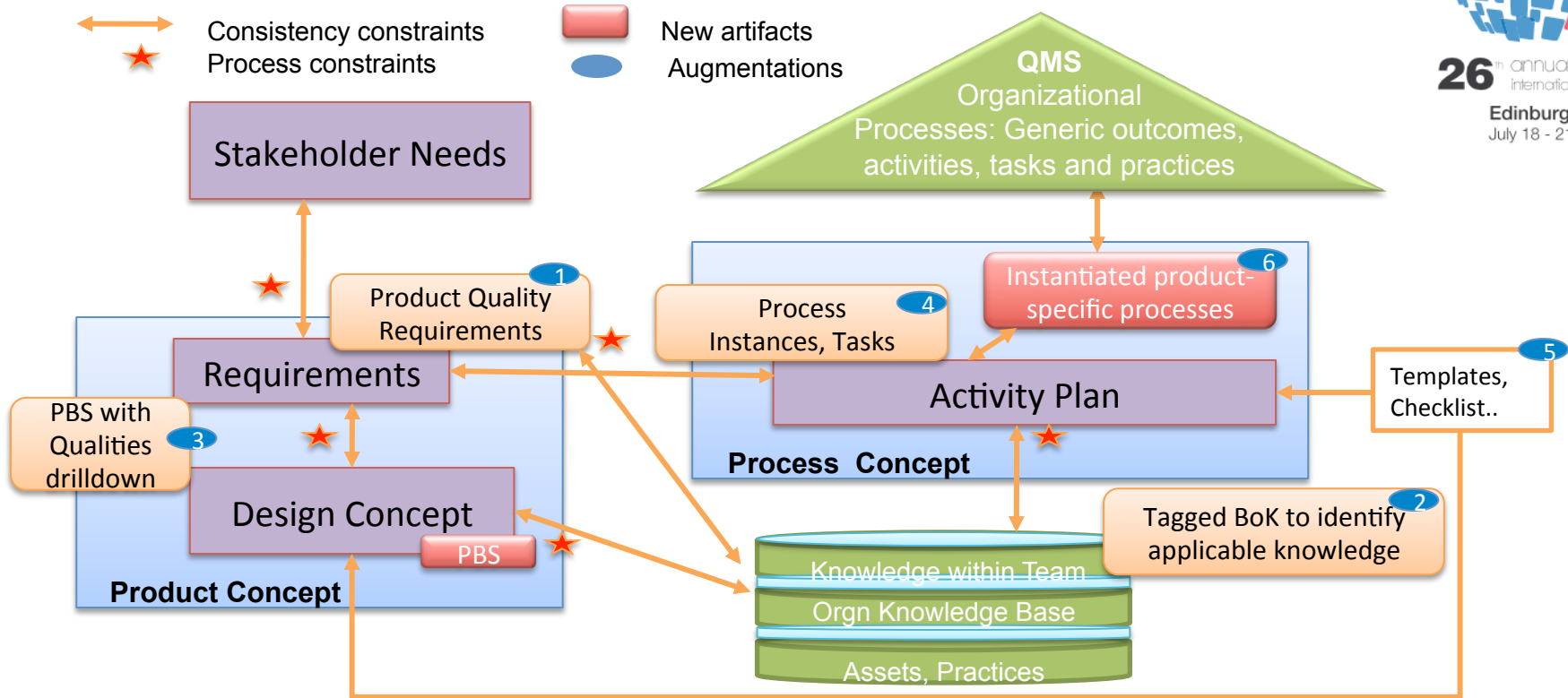
Instantiated Process

Outcomes

- **The required functions and quality characteristics for the "Quote Portal" are specified**

- The portal to have the ability to provide indicative quotes for clients
- The portal to provide enhanced quote request to the following clients: Existing and new clients
- The portal to enable customers the ability to engage through various communication channels: Portals, Post, Fax, Telephone and Emails
- The portal to deliver a high quality customer and user experience across all distribution channels, and enable customers the ability to engage through their preferred channel…..
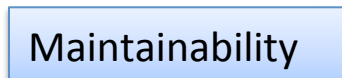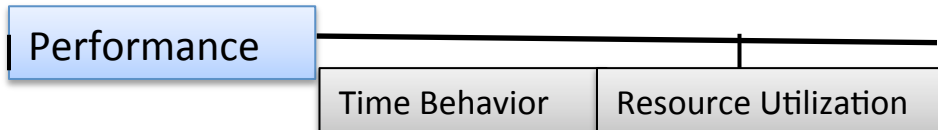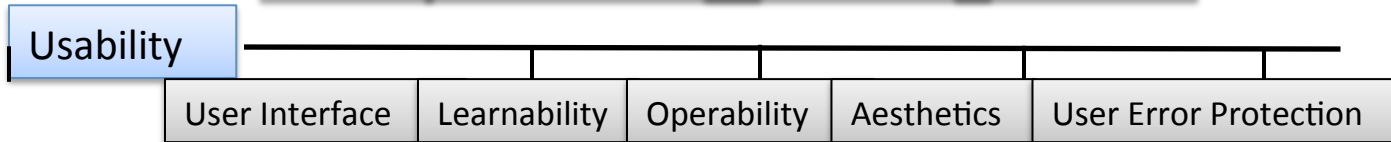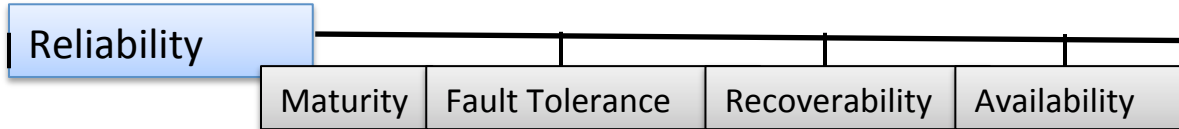
Tasks

- **Create Functions and elicit requirements for the desired levels of each of the quality attributes as identified in Outcomes**

- To register new customer and to retrieve existing customer information
- To request Quote through multiple channels as email, post, fax, telephone
- To Capture Medical & Lifestyle Information……….
- **Create the PBS through establishing relationship between the Outcomes, Functions and Requirements**
- **Populate the consistency tracker with the gaps between Outcomes, Tasks, Functions & Requirements**

Process Constraints

- Business Analyst to use "Non Functional Requirement Template" during requirements elicitation
- Business Analyst to sign-off that "the requirements are specified for Functionality + the major quality characteristics further elaborated with "Quality Map".
- Project Manager to check that "the Outcomes are clearly traceable in the Requirement specifications"
- Project Manager to check that "the Gaps in the Consistency tracker are closed"…..

Product Quality Breakdown

Security
- Confidentiality
- Integrity
- Non-repudiation
- Accountability
- Authenticity

Compatibility
- Interoperability
- Co-existence

Reliability
- Maturity
- Fault Tolerance
- Recoverability
- Availability

Usability
- User Interface
- Learnability
- Operability
- Aesthetics
- User Error Protection

Performance
- Time Behavior
- Resource Utilization

Maintainability

Portability

Relevant Knowledge
ISO 25010

Check applicability of each concern to each part of the system

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Contextual Quality Concerns

Security
- Safety and integrity of the Scheme data and effective security policy, plan and procedures

Performance
- Scalability and performance demands on Scheme services

Reliability
- Business continuity and disaster recovery of services & operations

Usability
- Rich user experience and simplicity of use

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Derived System Quality Goals

Quality

Security	
Performance	
Compatibility	
Reliability	
Usability	

Quality Goals

- Well defined Information Security Management System (ISMS) - ISO 27001 compliance

- Response Time targets for Business Services and Interfaces
- Capacity planning for anticipated peak demands
- Continuous monitoring of Performance

- Straight through processing and e-enabled services
- Compatibility to 95% of browsers used in country

- Highest possible availability for services
- Failover at all levels of system including software, network, operational and hardware failure
- Uninterrupted services during disaster scenarios and recovery service levels
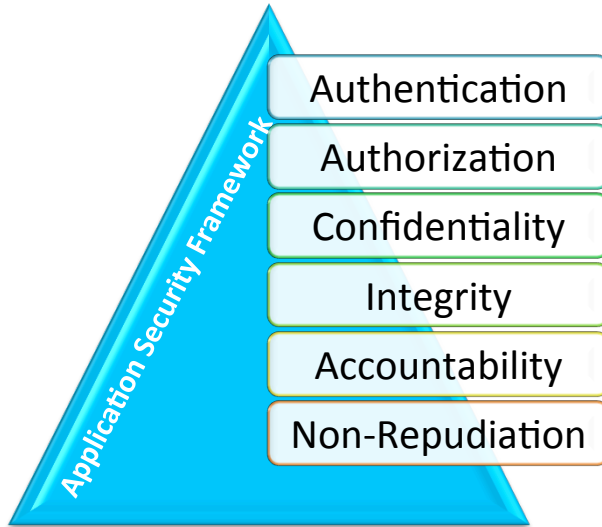
- Seamless user journey through web user interface and Interactive Voice Response (IVR) and consistent style

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Example: Security Requirements

Security: Separation of Concerns				
Policy	APP	INFRA	HR	Operations

Application Security Framework

- Authentication
- Authorization
- Confidentiality
- Integrity
- Accountability
- Non-Repudiation

Authentication Requirements:

Property that an entity is what it claims to be.

- User registration
- User password management
- Review of user access rights
- User responsibilities
- Password use
- User identification and authentication
- Password management

Accountability Requirements:

Responsibility of an entity for its actions.

- Audit logging
- Monitoring system use
- Protection of log information
- Administrator and operator logs
- Fault logging
- Clock synchronization
- Publicly available information

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System Quality Requirements

- ~500 System Quality Requirements or NFRs elicited and analyzed based on Quality goals and quality map.

Quality Requirements

Bar chart legend:
- Security
- Performance
- Reliability

Consistency Check on Quality Requirements

- Security confidentiality – Encryption in transit?
- Performance Service levels – do not have corresponding max and concurrent users
- SLA definition – not complete
- Regulatory requirements ?
- MI – data warehousing performance requirements
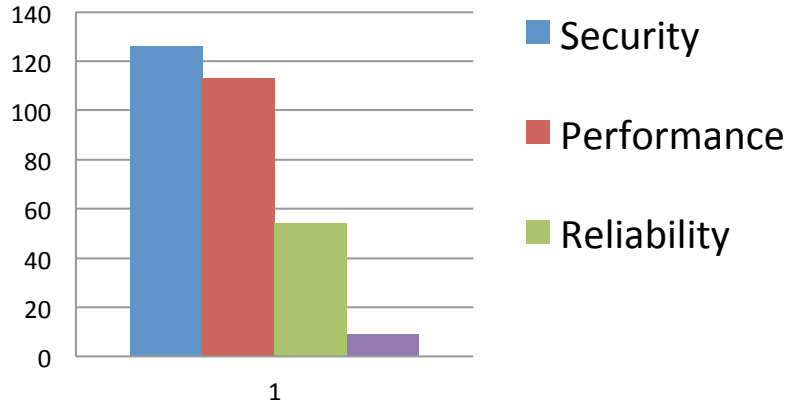
- Consolidation of System quality requirements
- Consistency check identified critical gaps in NFRs.

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Security Process Instantiation
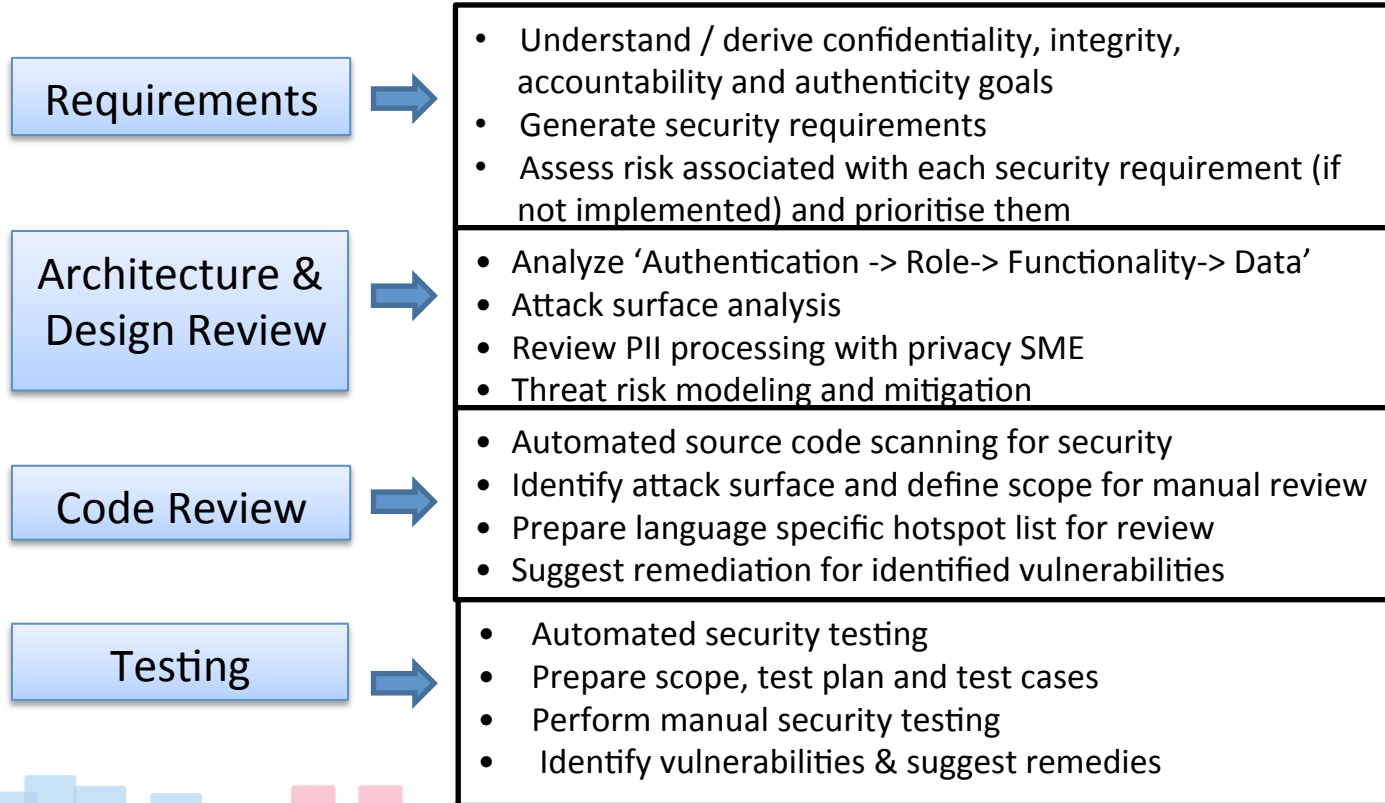
Process

Security Tasks

Requirements →
- Understand / derive confidentiality, integrity, accountability and authenticity goals
- Generate security requirements
- Assess risk associated with each security requirement (if not implemented) and prioritise them

Architecture & Design Review →
- Analyze 'Authentication -> Role-> Functionality-> Data'
- Attack surface analysis
- Review PII processing with privacy SME
- Threat risk modeling and mitigation

Code Review →
- Automated source code scanning for security
- Identify attack surface and define scope for manual review
- Prepare language specific hotspot list for review
- Suggest remediation for identified vulnerabilities

Testing →
- Automated security testing
- Prepare scope, test plan and test cases
- Perform manual security testing
- Identify vulnerabilities & suggest remedies

PII: Personally Identifiable Information

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Testing Plan

Security Testing

- App Security Test: To test the various aspects of application security such as authentication, authorization, data integrity, confidentiality etc.
- Infrastructure (IS) Security: To test that security of IS: network, communications, equipment, data center

Performance Testing

- Load Test & Soak Test: To test the performance and behavior of the fully integrated system for the anticipated production load under different conditions for an extended period
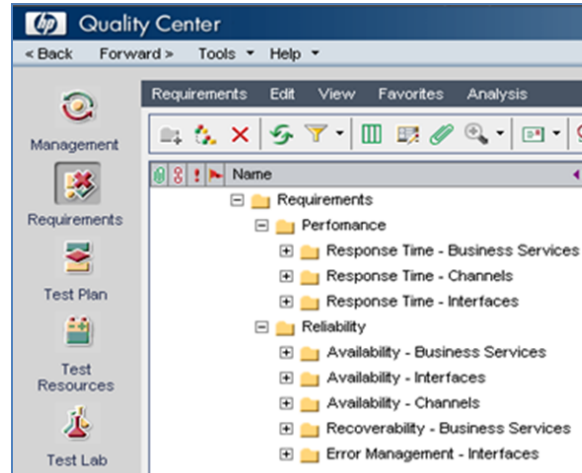
Usability Testing

- To evaluate the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use
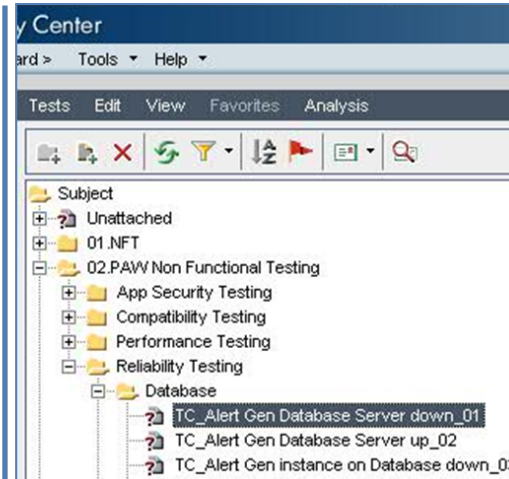
Compatibility Testing

V&V: Traceability & Consistency

QC Tool - Requirements

QC Tool - Test Scenarios

Verification & Validation activities for consistency relationships

Security vulnerabilities
- Sensitive data communicated thru unsecured channel
- No proper logging mechanism
- SSL 3.0 protocol not implemented
- Directory listing is enabled

Results

- Clear establishment of quality goals and requirements
- 100% pass in system and NFR (performance, security...) testing
- System went to production without major issues

- Knowledge from CoEs leveraged at every phase
- Transparency in engineering of Quality through process

- Granular Traceability for Quality goals and requirements
- Automated consistency checking

- Smooth compliance to Security audit ISO 27001
- A successful case study for many more projects

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ISO TS 30103 Framework for Product Quality Achievement

This Technical Report provides guidance on the application of ISO/IEC/IEEE 15288:2008 [1] life cycle processes with specific reference to addressing quality in projects that deliver systems and software products and services.

It focuses on a systematic approach to achieving quality, involving
the development of certain information items,
the inter-relationships between these information items and
the maintenance and mutual consistency management of these
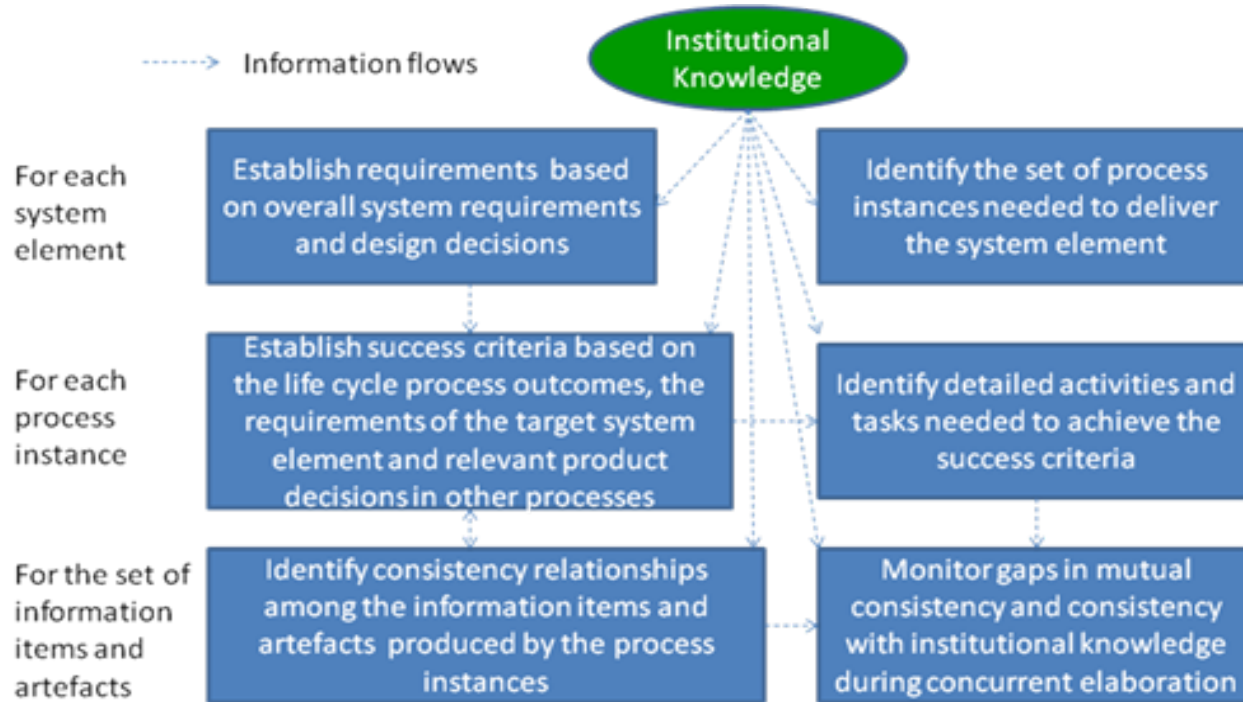information items.

Practice augmentation to ISO 15288 & 12207

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ISO TS 30103: Principles

The approach to Quality achievement incorporates four principles:

- Establishing Quality Goals and Localizing Quality Responsibility
    - Identify key quality concerns, establish requirements for each, decompose these product-level goals to establish quality specs for each item in the PBS (product breakdown structure)

- Creation of Product-specific Processes
    - Identify the processes needed to produce each item. For each quality goal of the item, identify the specific tasks and practices needed to achieve quality, and add them as detailed tasks within the corresponding process (e.g. req tasks, design tasks)

- Deployment of Institutional Knowledge
    - For each quality goal, identify relevant knowledge from repositories, use to identify tasks & practices needed for each process

- Maintenance of Consistency Relationships
    - As the artifacts associated with each item evolve, monitor consistency relationships among them & track to closure

ISO 30103: Framework Overview

Information flows

Institutional Knowledge

For each system element

- Establish requirements based on overall system requirements and design decisions
- Identify the set of process instances needed to deliver the system element

For each process instance

- Establish success criteria based on the life cycle process outcomes, the requirements of the target system element and relevant product decisions in other processes
- Identify detailed activities and tasks needed to achieve the success criteria

For the set of information items and artefacts

- Identify consistency relationships among the information items and artefacts produced by the process instances
- Monitor gaps in mutual consistency and consistency with institutional knowledge during concurrent elaboration

Explicit linkage between process and product

Processes viewed as potentially fully concurrent: consistency monitoring delinks from progress model

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Conclusion

- Enable project organizations to systematically achieve product quality
  - Instantiate generic organizational processes to the specific deliverables
  - Enable applicable knowledge to flow in consistently into process and product decisions
- Major contributions
  - ➤ Establish the linkage between product & process that has been lost in systems engineering
  - ➤ Eliminate the disconnect: process as contributing discipline, sole reliance on people technical expertise to get product decisions right
    - Utilize process as vehicle for consistent knowledge delivery
  - ➤ Facilitate management visibility to product quality achievement
    - Status of network of consistency relationships

Thank you!

Questions?