V&V – All the Way Through

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Presented by Oliver Hoehne

Agenda

- Author Bio's
- Abstract
- Background
- Request vs Reality
- Root Cause
- QA, Verification &Validation
- Practical V&V Planning

Author Bios

Dale A. Brown

- Assistant Vice President, Transit & Rail – Systems Engineering
- (Seconded) Director of Systems Engineering with MARTA
- Co-Chair, INCOSE Transportation Working Group
- Co-Chair, INCOSE Configuration Management Next Generation Working Group
- Active member of APTA, Systems Engineering subcommittee
- Expertise in embedded control of specialty equipment, mining, heavy construction, military and rail vehicles throughout the US, Canada, South America and Europe
- Licensed PE with extensive design, management and business development experience
- Awarded a number of patents in the areas of PTC, train control and inter-consist communications
- Bachelor's in Electrical Engineering and Master's in Engineering/ Business Administration from the University of Western Ontario

Chamara Johnson

- Principal Systems Engineer
- Active member of INCOSE and various working groups
- Active member of IEEE NY Section Executive Committee
- Co-Chair, IEEE NY Chapter of Vehicular Technology Society
- Experience spans the whole system life-cycle with a strong emphasis on requirements and test; working across various industries; including DOD, non-profit Oceanographic, and Transportation, in the US and UK.
- Certified Systems Engineering Professional
- BS in Electrical Engineering from the Georgia Institute of Technology
- MS in Engineering Management/ Systems Engineering from the University of Maryland, Baltimore County.

Early SE Adopters - Mil/Aero

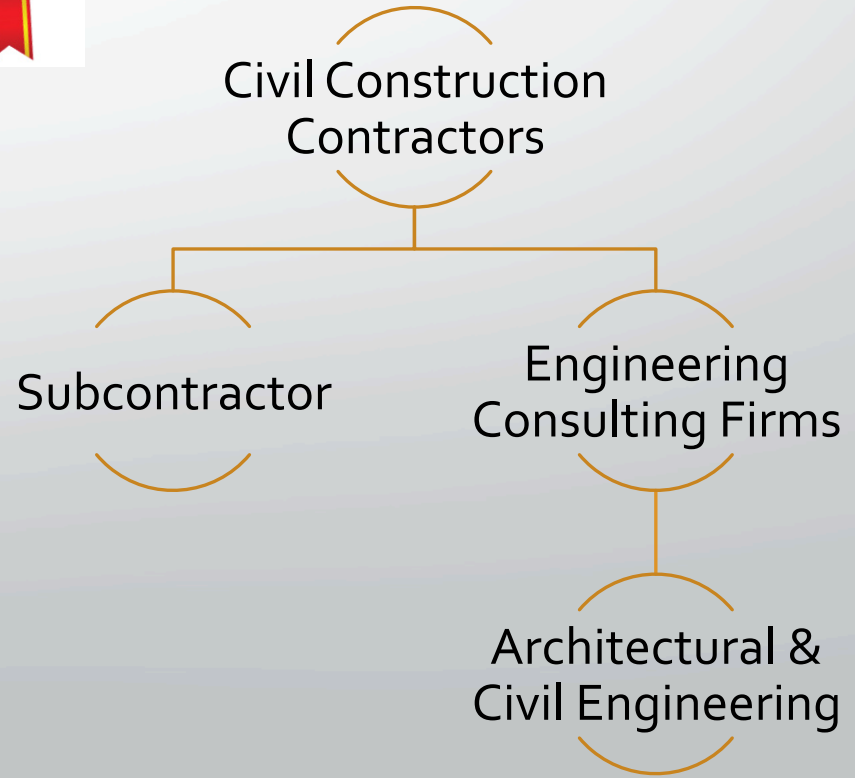
Abstract: Focusing on the late SE process adopters

POSIT: "Verification and Validation shall be executed as a cradle to grave process."

Late SE Adopters - Ground Transportation

Contract Awards – Large Civil Construction firms can supply the bonding ….they are then in control of the project

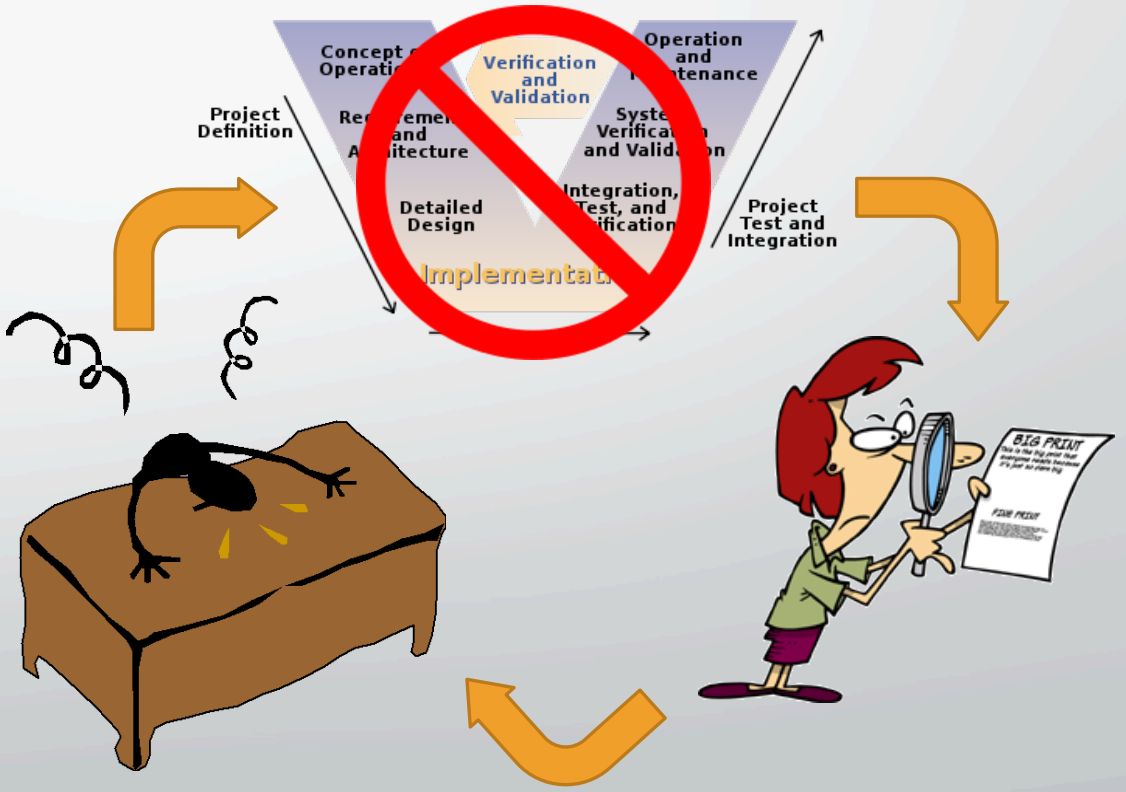
Infrastructure & Ground Transportation projects are typically awarded to Civil Construction Contractors, in which they are the prime supplier/ contractor. Many in which do not have their own Civil Engineering Departments and subcontract to engineering consulting firms who specialize in Architectural and Civil Engineering.



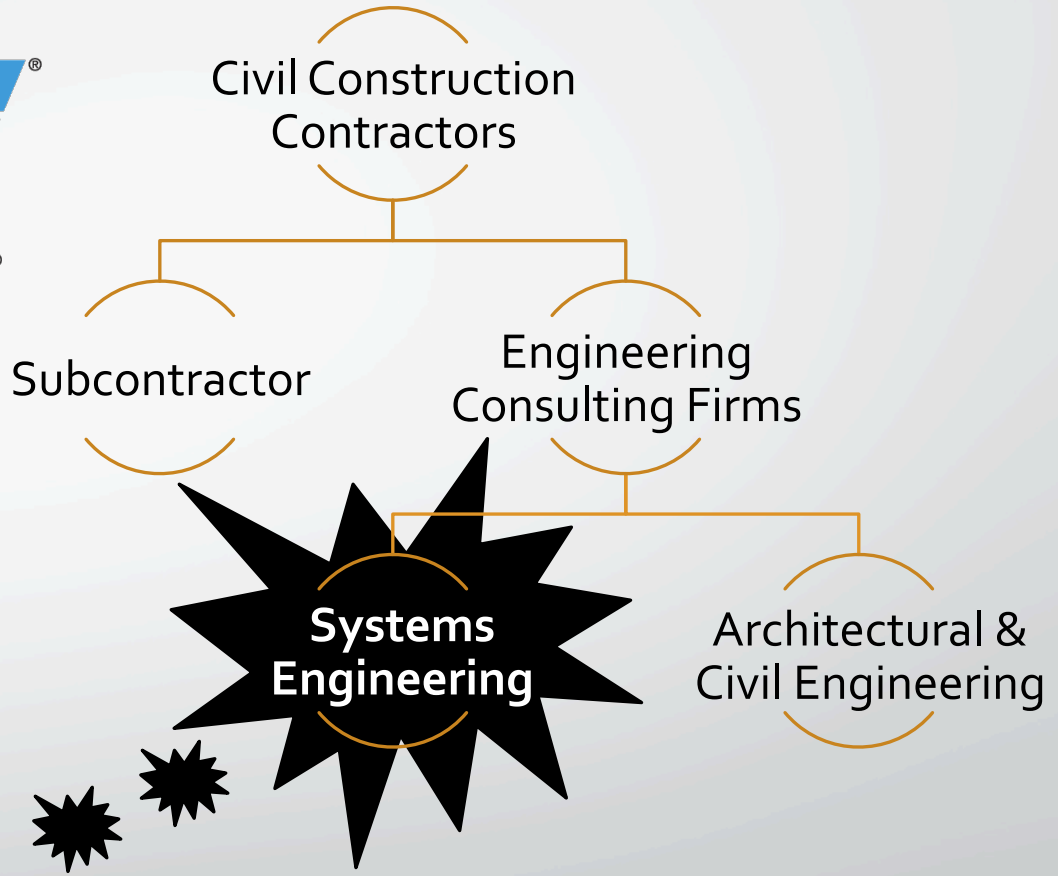
Traditional Approach = non-holistic, partitioned specification formats

The practices, policies and procedures used in the civil construction industry are founded on a design document-based specification and drawing packages, using the Construction Specifications Institute (CSI) group of standards and contract templates …

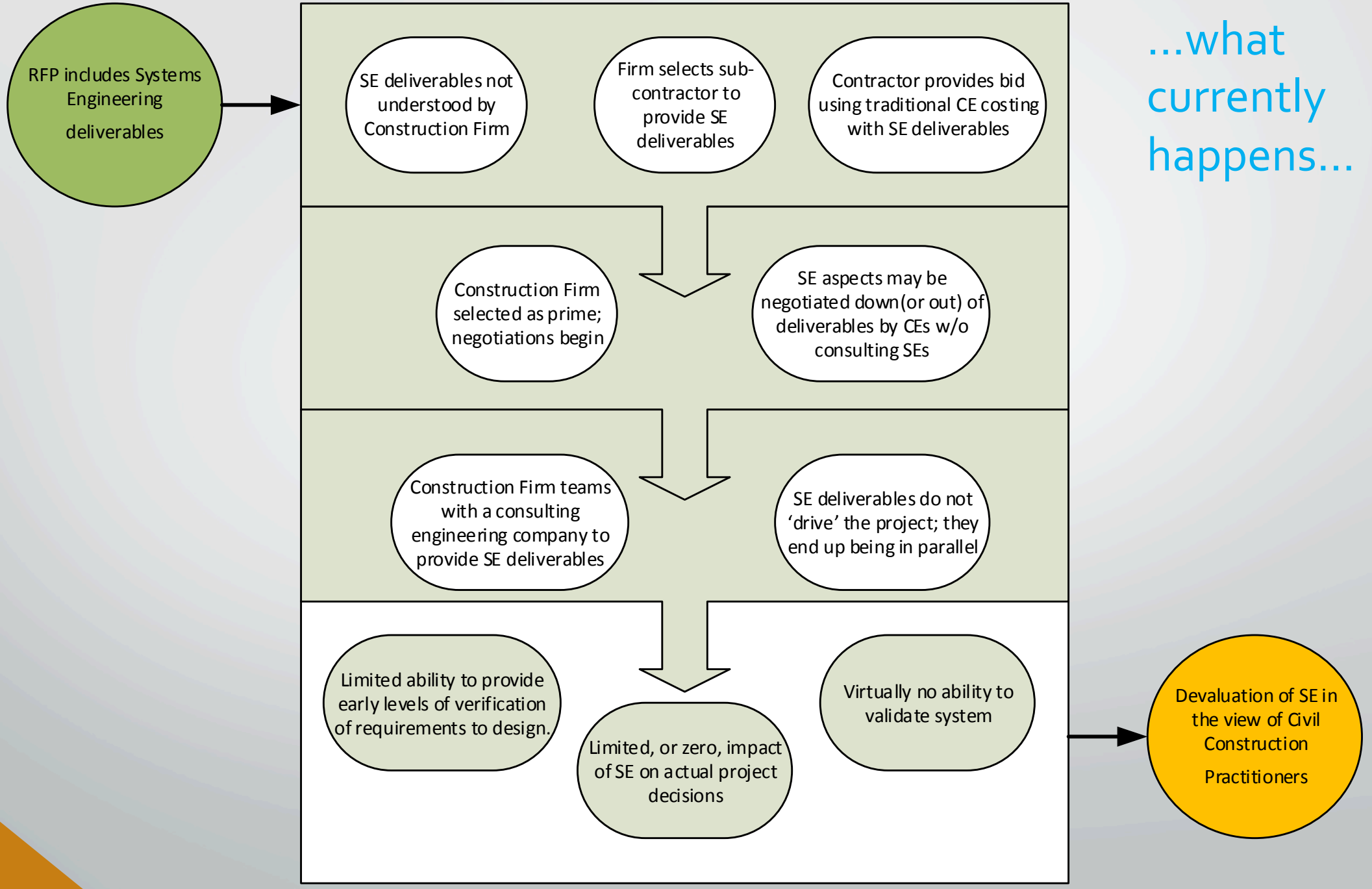
… not the Systems Engineering approach; resulting in missing system requirements, traceability records, system architecture and interface control documentation, and V&V efforts are reduced to drawing inspections before and after construction.



Awareness is increasing…

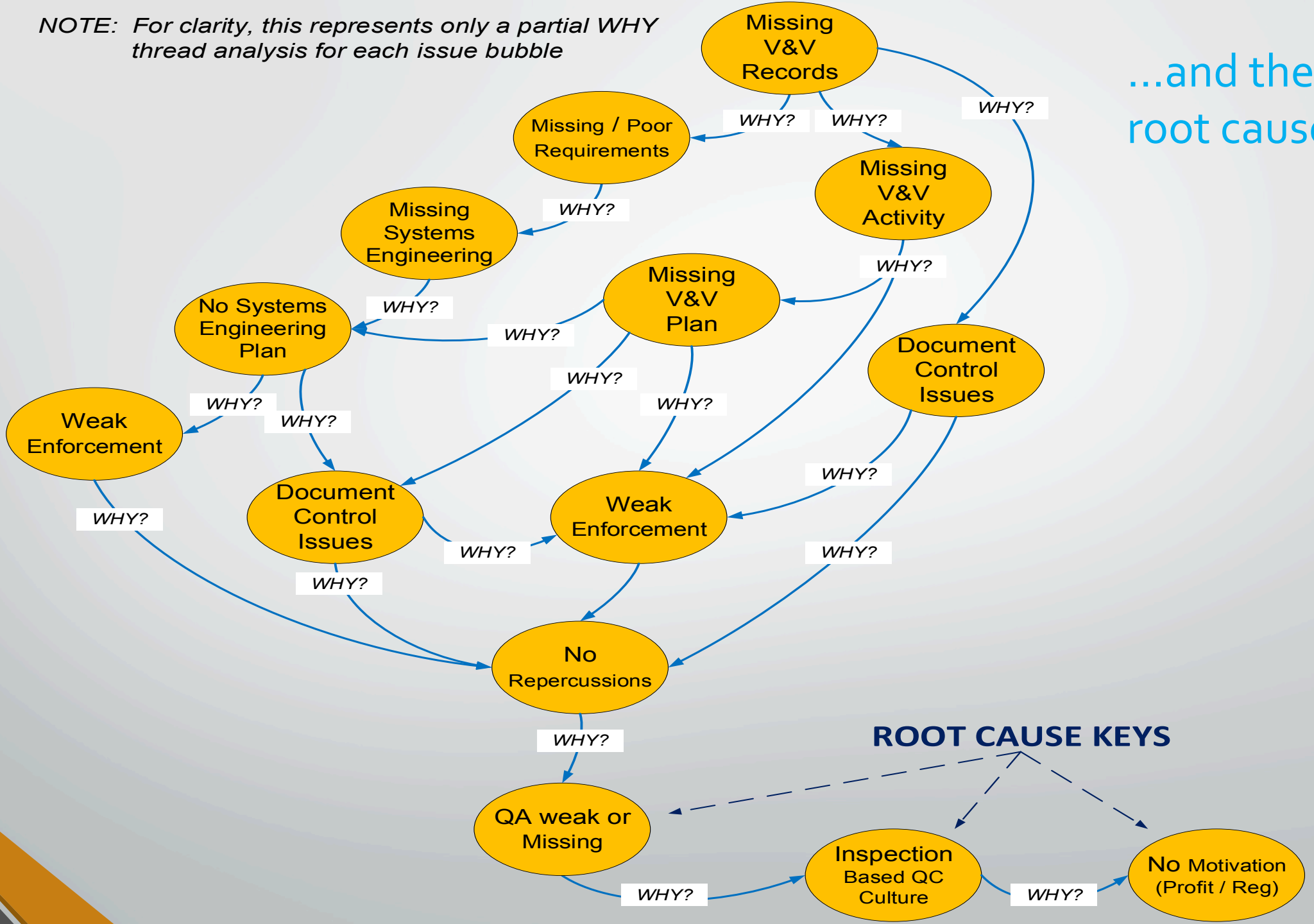


...what currently happens...



NOTE: For clarity, this represents only a partial WHY thread analysis for each issue bubble

...and the root causes




All routes lead to missing or poor V&V

Quality Assurance

enables

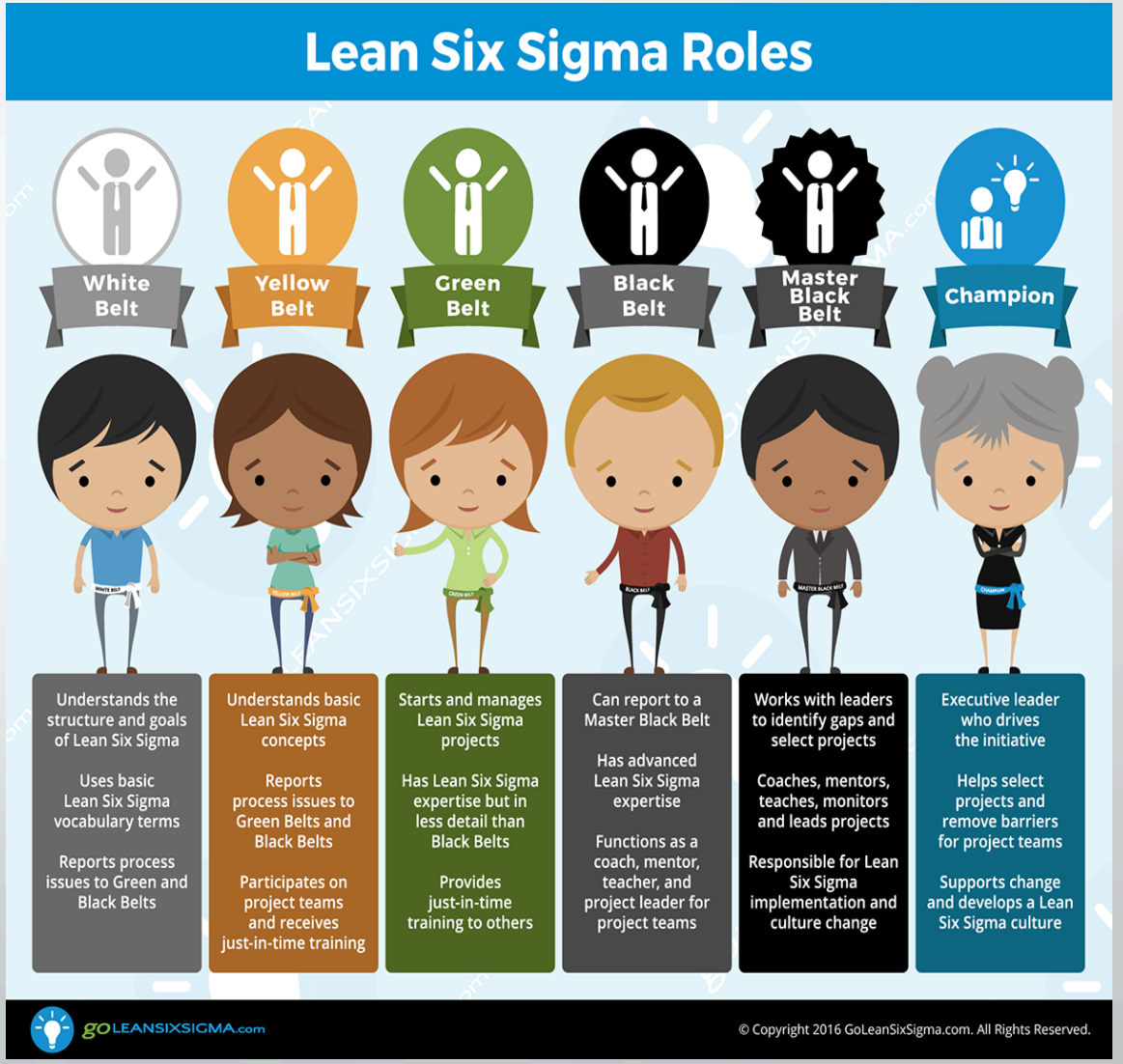
Verification & Validation

Quality Assurance

"*Quality should be involved in all stages of project design and implementation, including being an integral member of the grantee's management organization, separate from projects themselves. It is important to note that individual elements of the grantee's QMS are introduced into projects at different stages, so quality does not start nor does it stop with the projects themselves*"

- The 2012 second edition of the US Federal Transit Authority Quality Management System Guidelines, Section 1.5.1

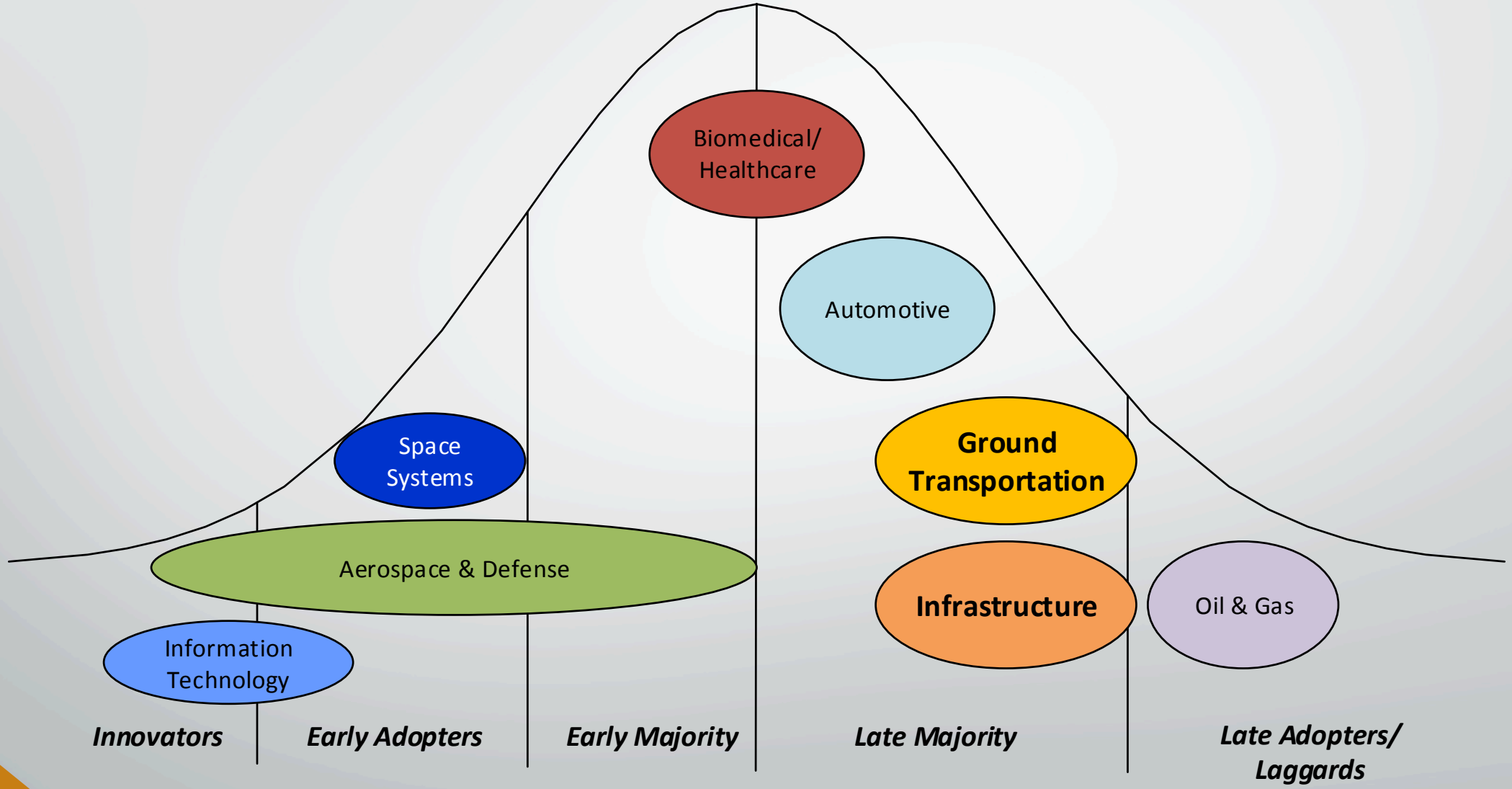
Motivation for Quality Assurance?



Infrastructure QA: USA is lagging the world

…not really a requirement

Industry SE Adoption



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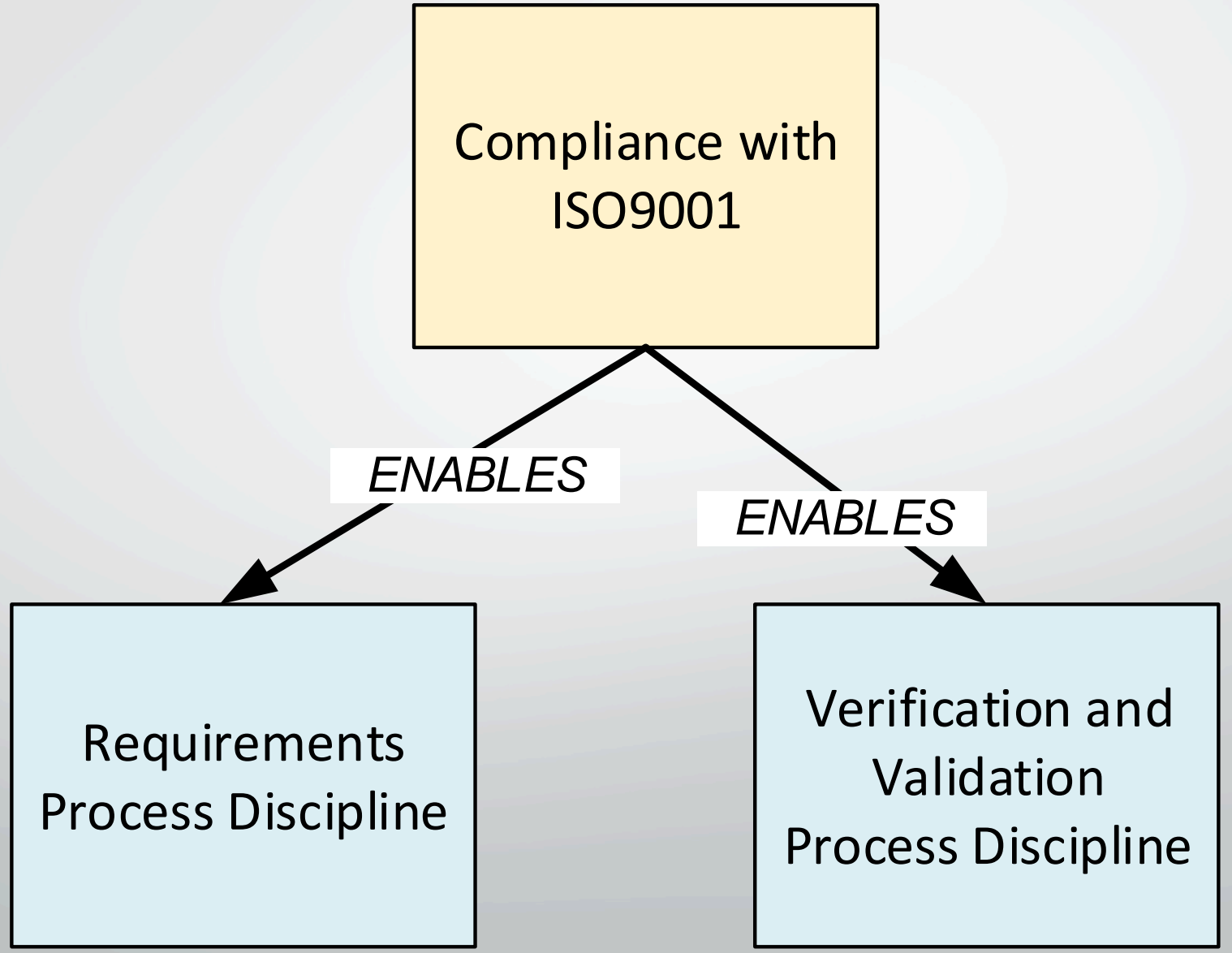
Quality Assurance compliance enables V&V



Enabling Processes are missing

QA culture is weak or missing

Regulations are weak or missing

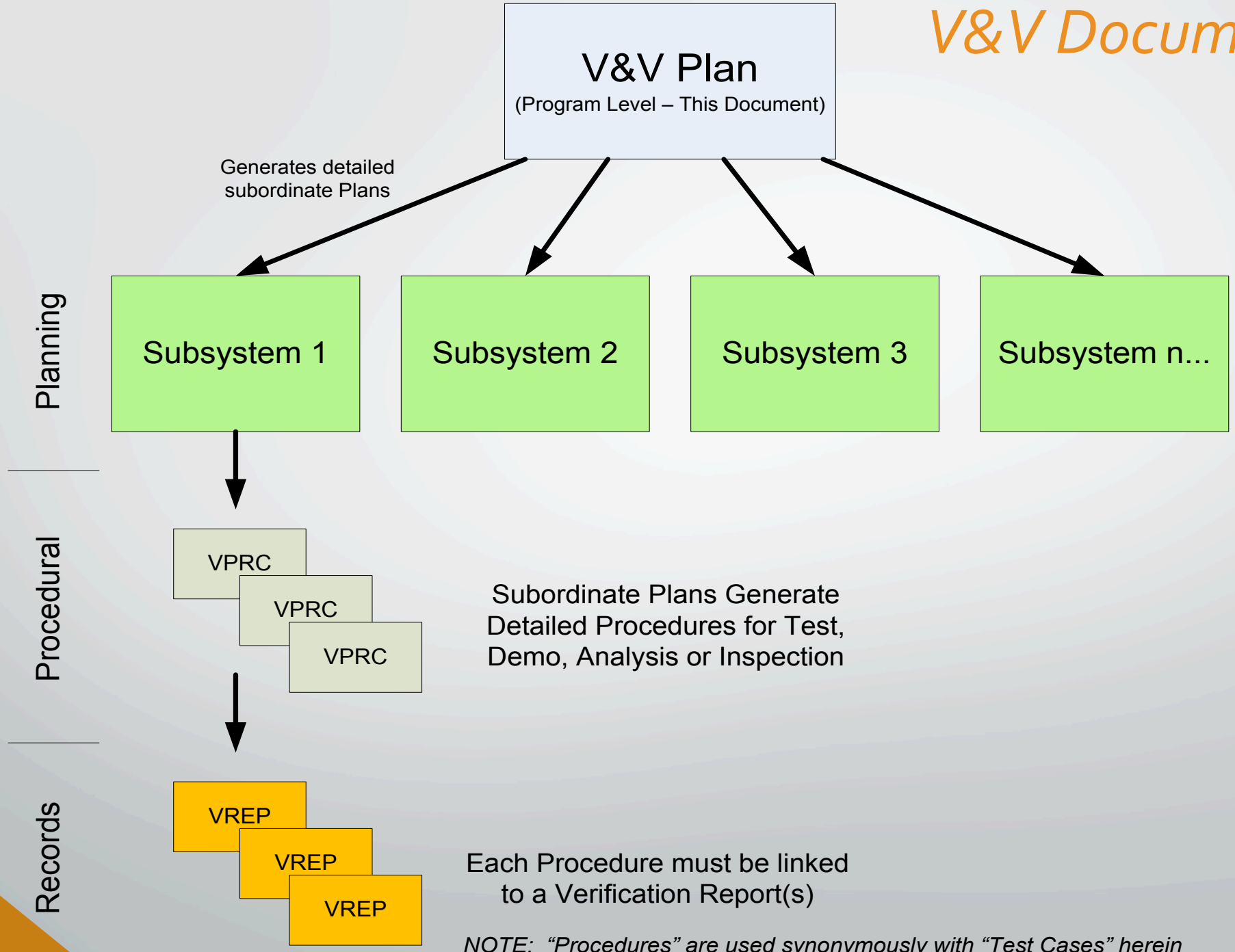
Verification and Validation Planning

Development of a practical V&V Plan template

Closer look … building a plan

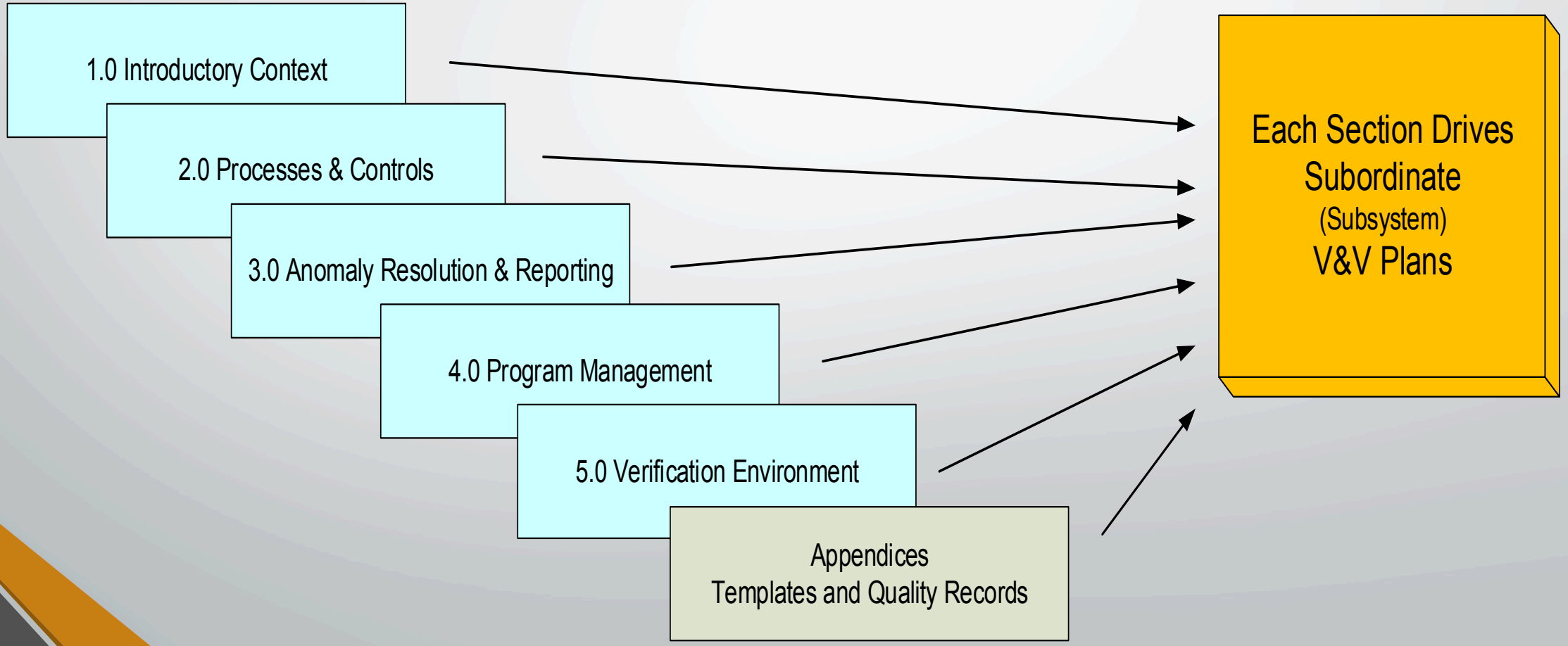
IS2017_VandV_Paper147.pdf

V&V Document Tree

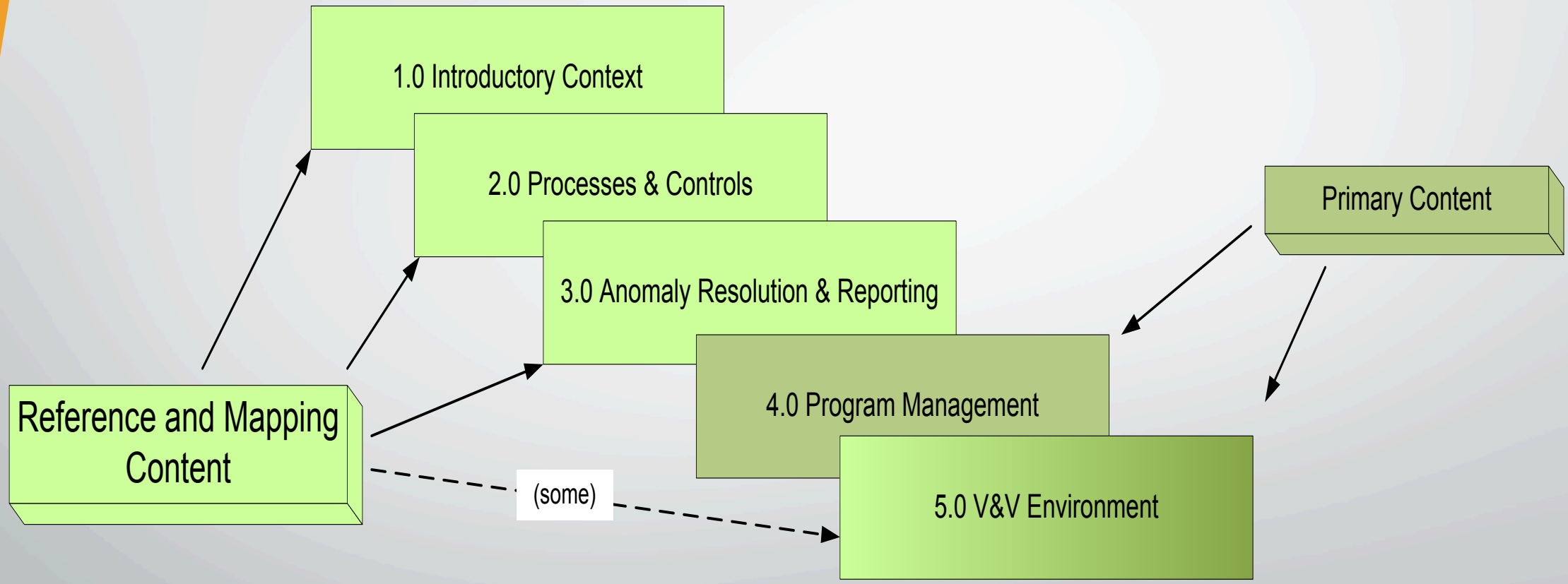


NOTE: "Procedures" are used synonymously with "Test Cases" herein

Program Level V&V Plan – Document Structure



V&V Subordinate Plan Structure



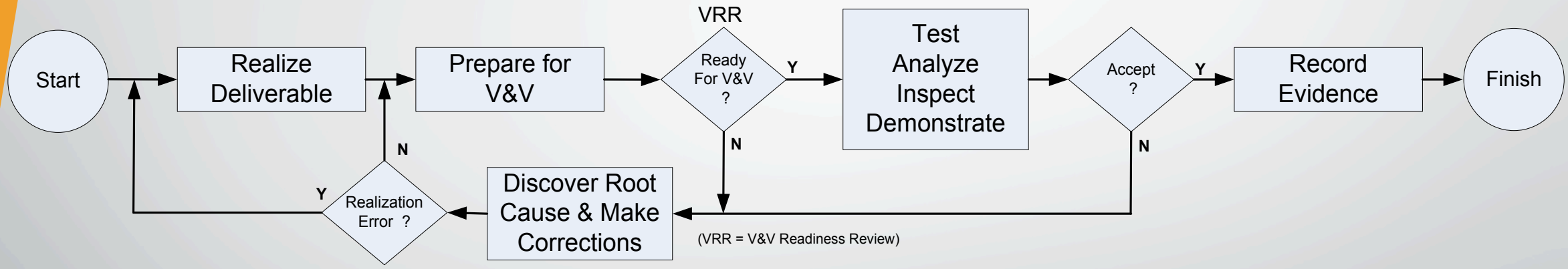
System Overview

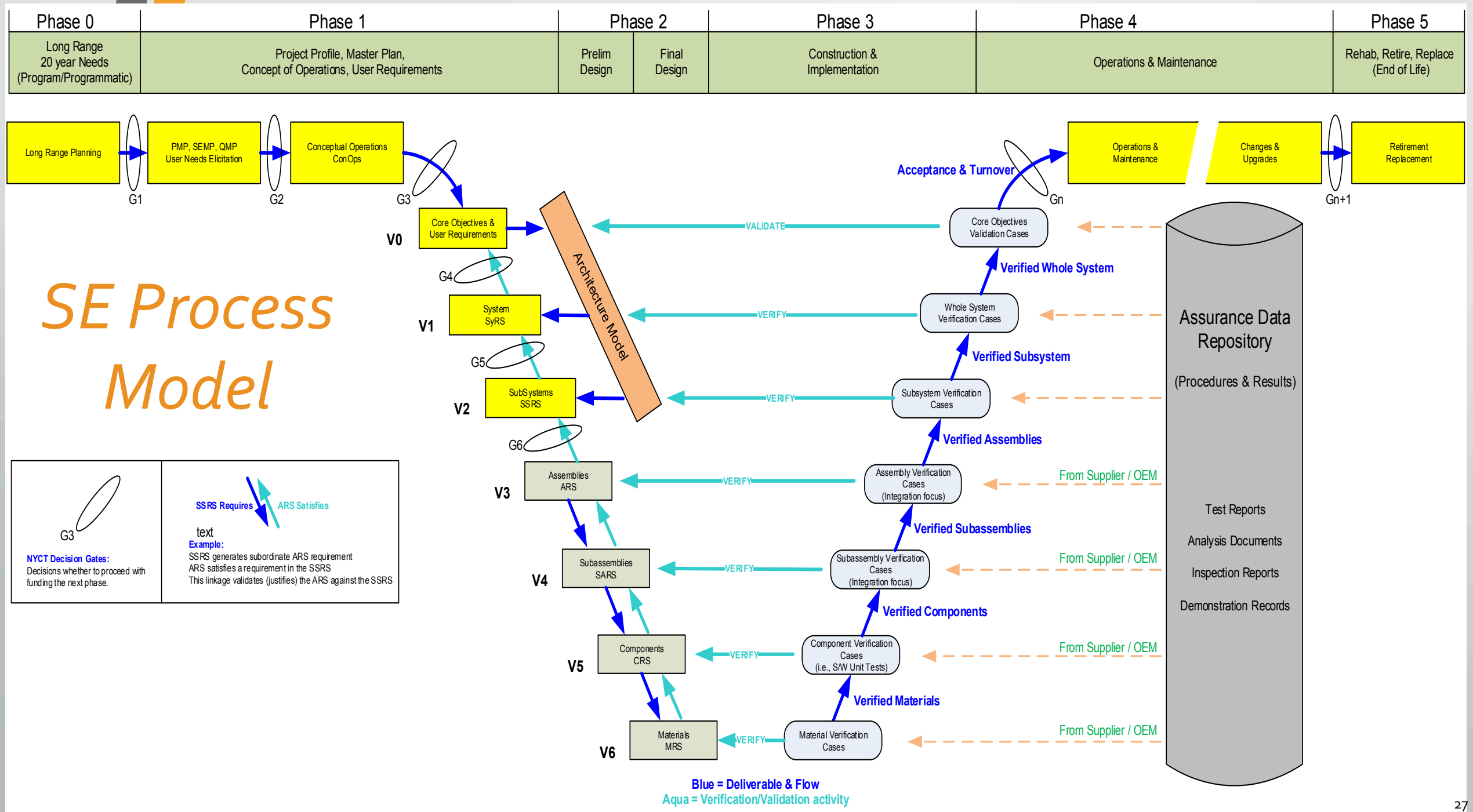
- Context and Interface Description
- System Decomposition
- System Functional Decomposition
- System Interfaces
- System Physical Decomposition

V&V Process Overview

- Supporting Organizational Processes
- Primary V&V Activities
- Generic (Core) V&V Process
- Process Lifecycle Model
- Core V&V Process Mapped into Process Lifecycle Model

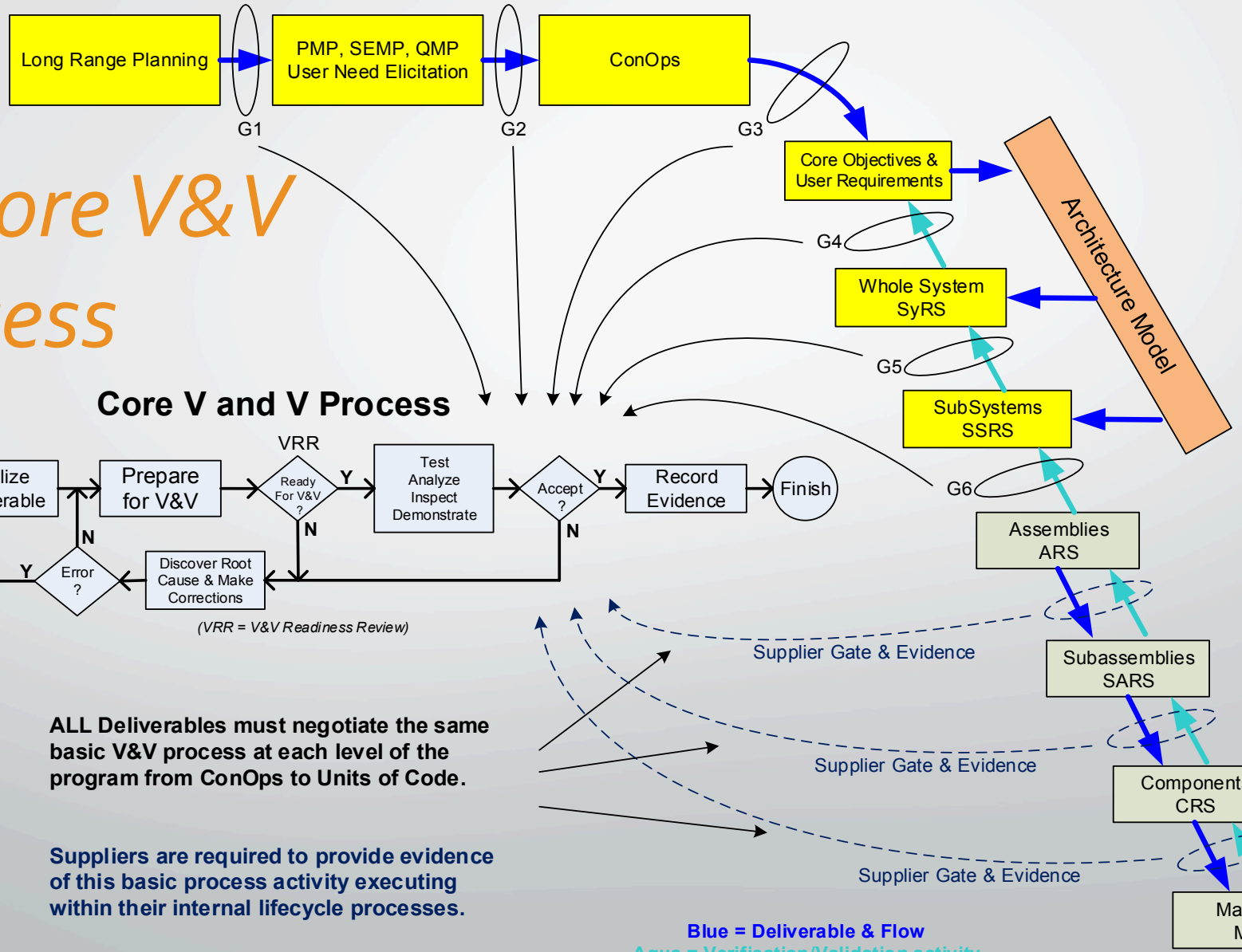
Core V&V Process




Phase 0
Phase 1
Phase 2
Phase 3
Phase 4
Phase 5
Long Range 20 year Needs (Program/Programmatic)
Project Profile, Master Plan, Concept of Operations, User Requirements
Prelim Design
Final Design
Construction & Implementation
Operations & Maintenance
Rehab, Retire, Replace (End of Life)
Long Range Planning
PMP, SEMP, QMP User Needs Elicitation
Conceptual Operations ConOps
Acceptance & Turnover
Operations & Maintenance
Changes & Upgrades
Retirement Replacement
G1
G2
G3
Gn
Gn+1
SE Process Model
V0
Core Objectives & User Requirements
V1
System SyRS
V2
SubSystems SSRS
V3
Assemblies ARS
V4
Subassemblies SARS
V5
Components CRS
V6
Materials MRS
Architecture Model
G4
G5
G6
VALIDATE
VERIFY
Core Objectives Validation Cases
Verified Whole System
Whole System Verification Cases
Verified Subsystem
Subsystem Verification Cases
Verified Assemblies
Assembly Verification Cases (Integration focus)
Verified Subassemblies
Subassembly Verification Cases (Integration focus)
Verified Components
Component Verification Cases (i.e., S/W Unit Tests)
Verified Materials
Material Verification Cases
From Supplier / OEM
Assurance Data Repository
(Procedures & Results)
Test Reports
Analysis Documents
Inspection Reports
Demonstration Records
G3
NYCT Decision Gates:
Decisions whether to proceed with funding the next phase.
SSRS Requires
ARS Satisfies
text
Example:
SSRS generates subordinate ARS requirement
ARS satisfies a requirement in the SSRS
This linkage validates (justifies) the ARS against the SSRS
Blue = Deliverable & Flow
Aqua = Verification/Validation activity

Repeat Core V&V Process

Phase 0	Phase 1		Phase 2	
Long Range 20 year Needs (Program/Programmatic)	Project Profile, Master Plan, Concept of Operations, User Requirements		Prelim Design	Final Design



ALL Deliverables must negotiate the same basic V&V process at each level of the program from ConOps to Units of Code.

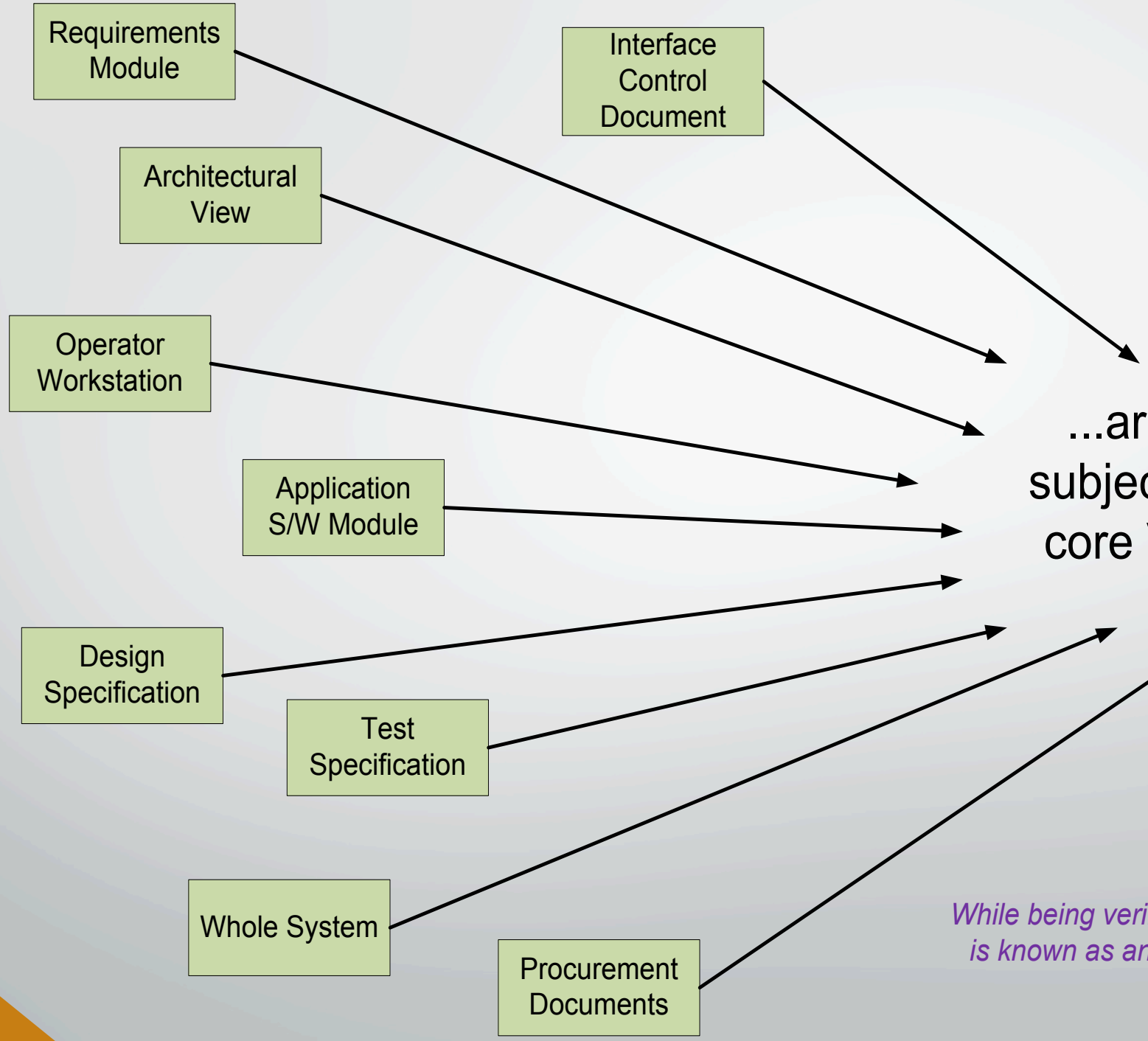
Suppliers are required to provide evidence of this basic process activity executing within their internal lifecycle processes.

Blue = Deliverable & Flow
Aqua = Verification/Validation activity

Key V&V Process Terminology

- Verification
- Validation
- Verification Procedures
- Certification
- V&V Readiness Review (VRR)
- V&V Entity
- Entity Undergoing V&V (EUV)

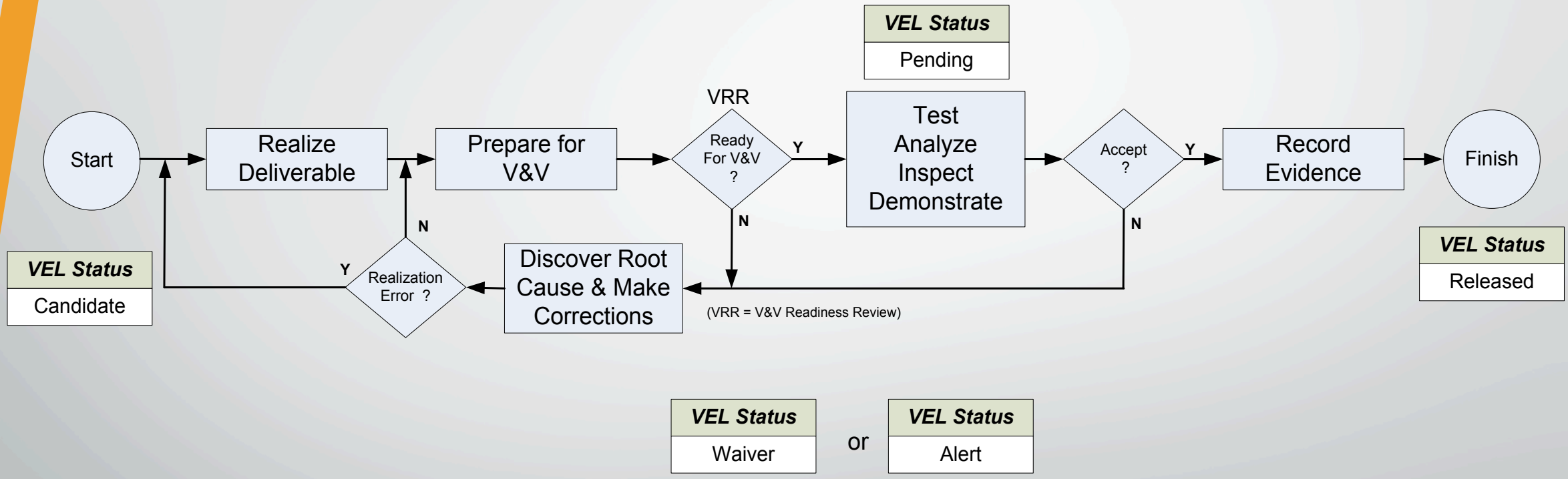
EUV


Requirements Module
Interface Control Document
Architectural View
Operator Workstation
Application S/W Module
Design Specification
Test Specification
Whole System
Procurement Documents
...are all entities subject to the same core V&V process
While being verified or validated, an entity is known as an Entity Undergoing V&V (EUV)

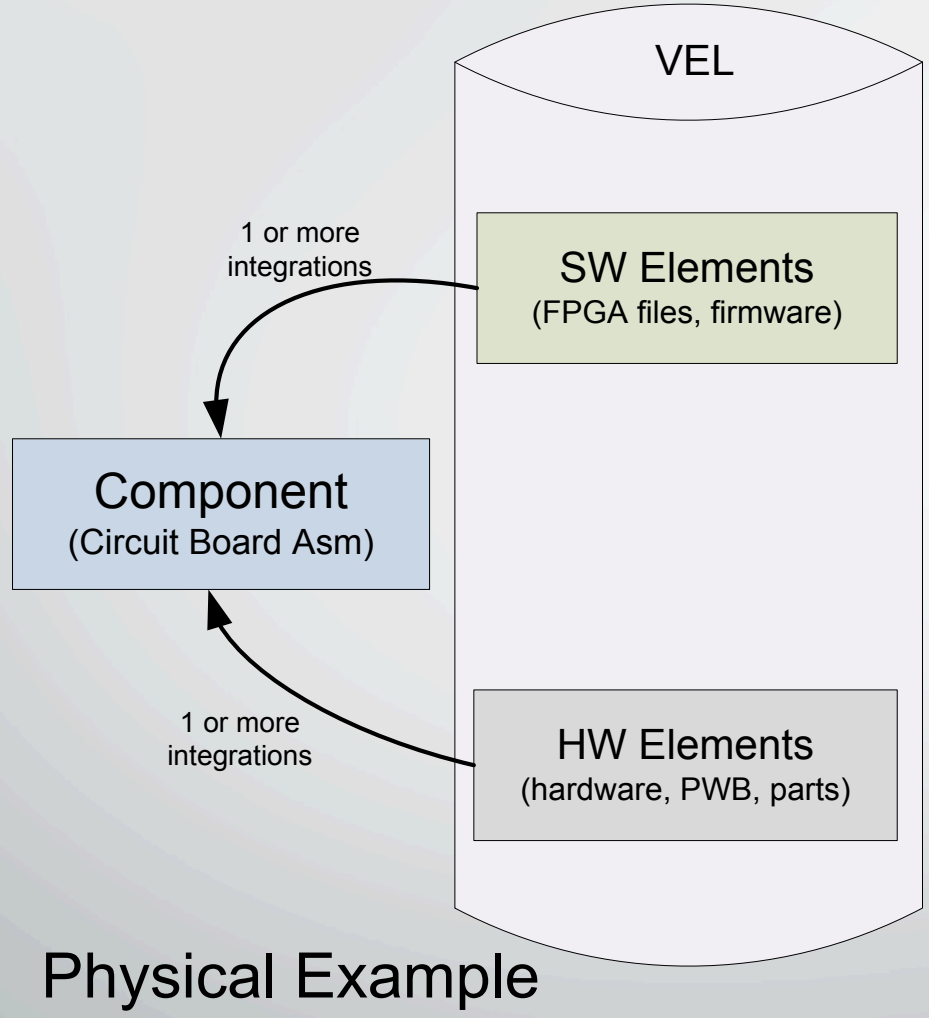
Three Core V&V Process Principles

1. Validated-Entity Library – An Integration Approach
2. Only Validated Entities May be Integrated – Enforced Discipline
3. Use a Repeatable Process Throughout the Hierarchy

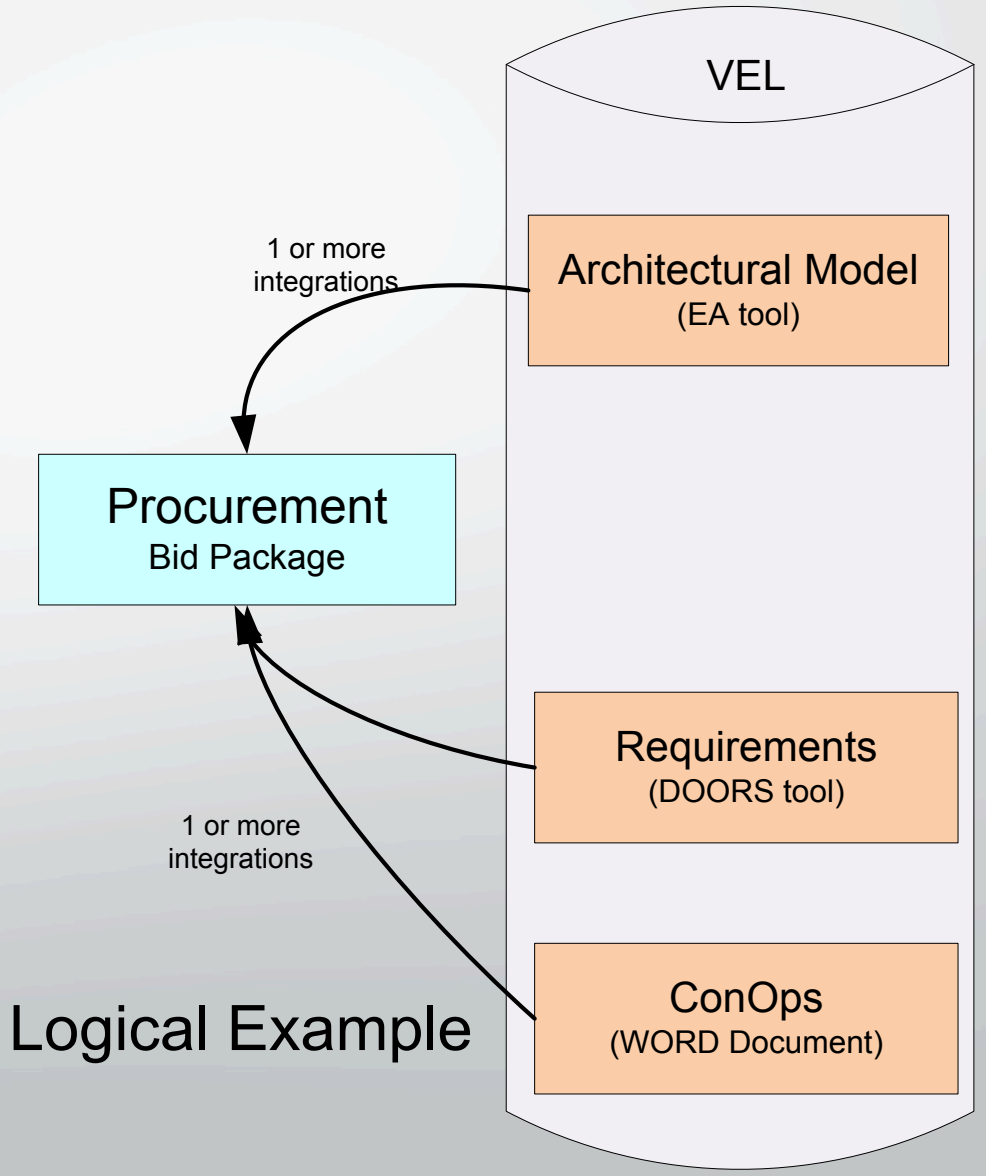
1. VEL Process and Possible Status States



2. Examples of Physical and Logical use of VEL entries

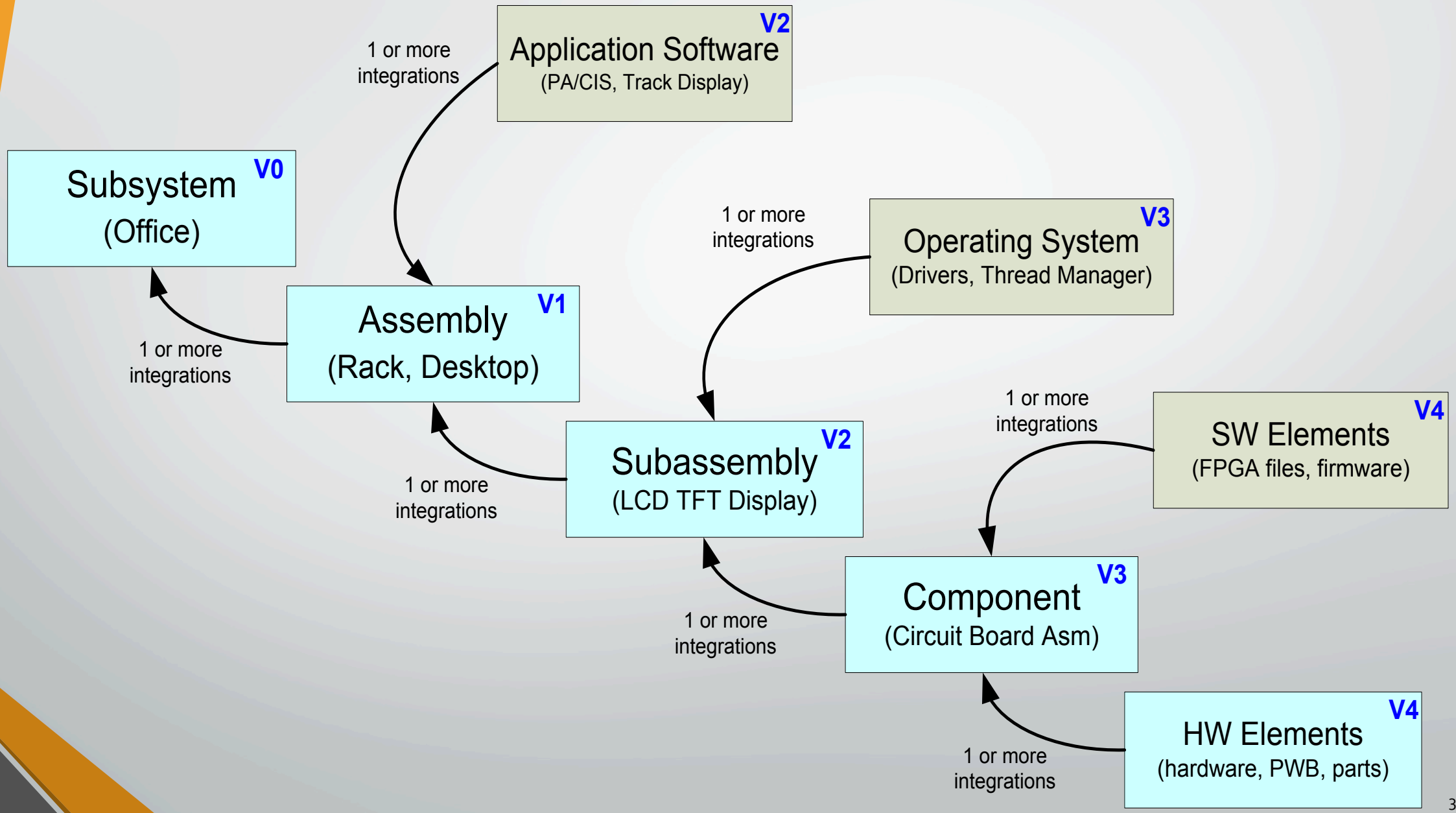


Physical Example

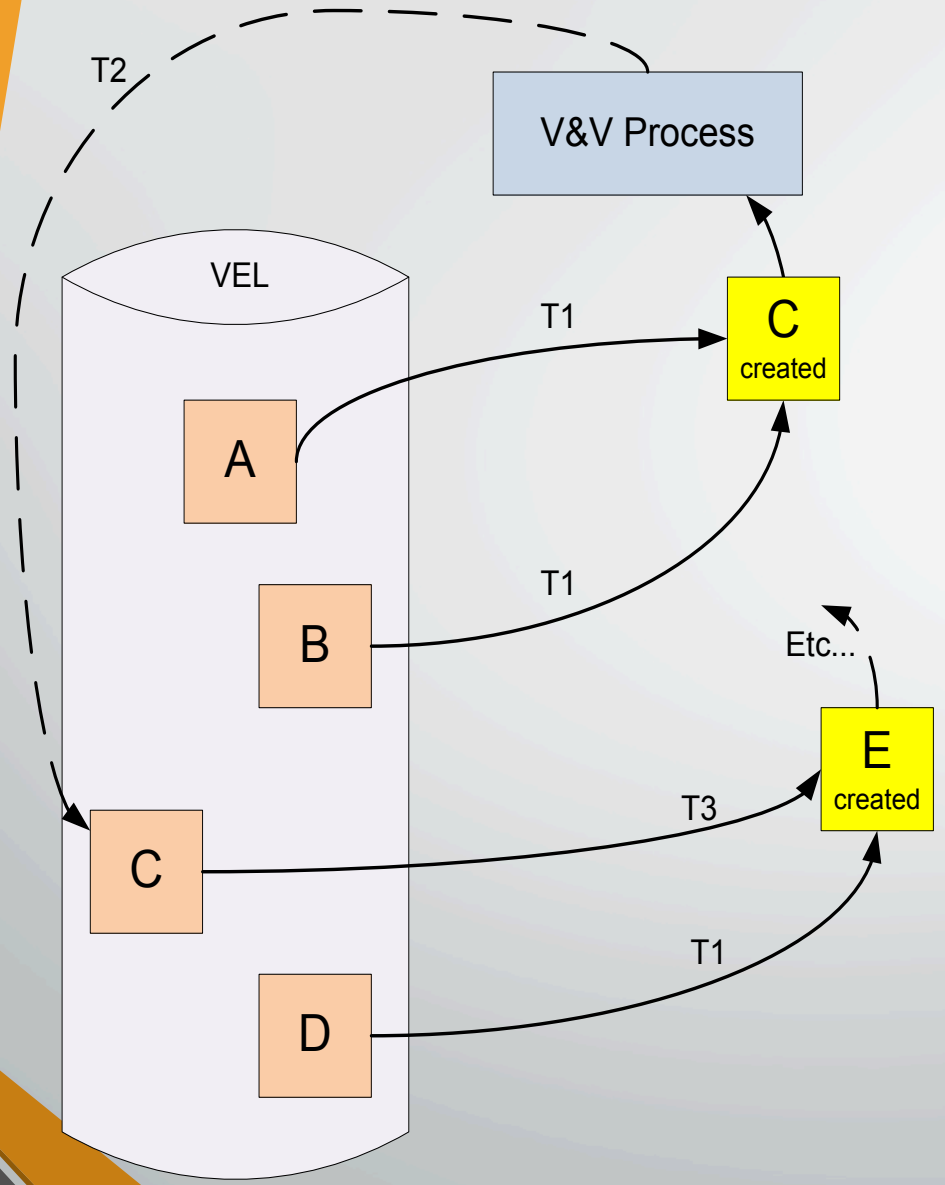


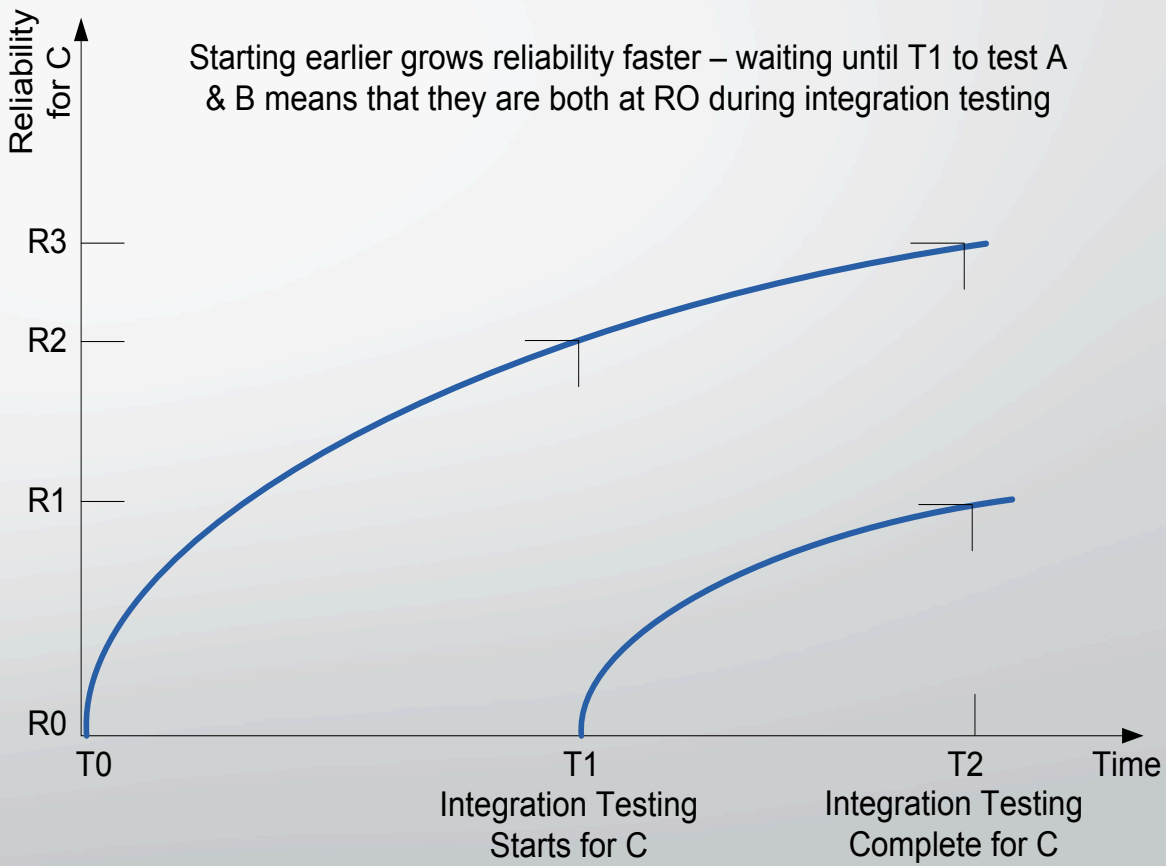
Logical Example

3. Example of Hierarchical Integration

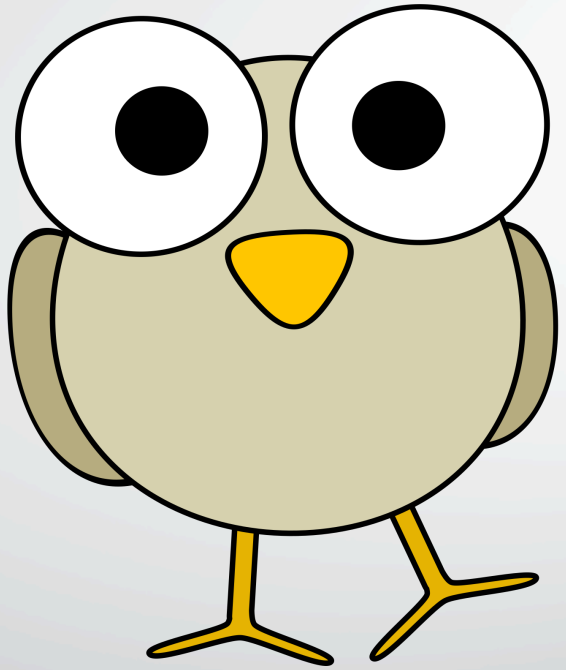


Another Key Benefit: Accelerated Reliability Growth!





Thank You!



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....Questions?