Closed Loop Requirements and Analysis Management

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Introduction

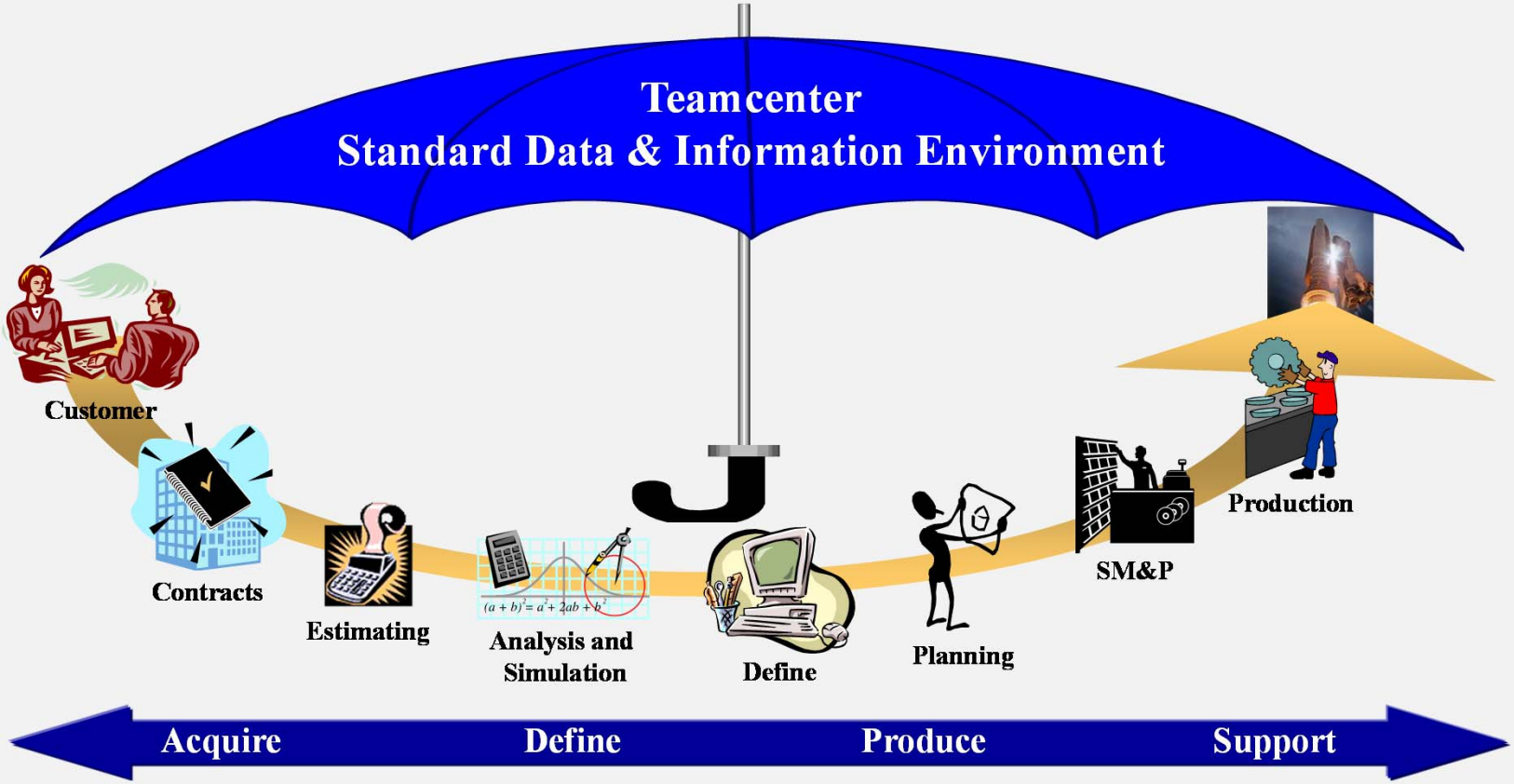
- Propulsion Systems is leading an effort to improve our requirements and verification and analysis data management processes by integrating them into TcUA (Teamcenter, Teamcenter Unified Architecture)
- Expected benefits:
  - Facilitates getting the right data to the right person at the right time to make the right decision
  - Facilitates proper documentation of analysis inputs
  - Enables integrated change management

Outline

- Orbital ATK Strategic PLM Vision
- Requirements and Analysis Interactions
- Current Condition
- Target Condition
- Stakeholder Needs
- Solution Architecture
- Solution Validation Testing

Orbital ATK Strategic PLM Vision

- End-to-end program management in TcUA
- Reuse data in later project phases, enter data once and reuse multiple times
- Interrelate data elements to allow integrated change management



Requirements and Analysis Interactions

- Focus for this presentation is on managing interactions between requirements and verification data management and analysis data management
- Types of requirement/analysis interaction
  - Concept development
  - Requirement derivation
  - Design verification
  - Analysis scope definition
  - Change management
  - MRB evaluation.
- These interactions are not independent of each other. Data from one interaction should be leveraged and sometimes reused for other interactions.

Current Condition

- Interactions between requirements and analysis are not as well coupled as desired
  - Requirement inputs into analysis are often verbal with little or no documentation
    - This includes design development requirements and verification requirements
  - Changes to requirements are often not communicated to analysts
  - Analysts are typically not closely involved in the requirement definition process
  - Analysis feedback to requirements is likewise often verbal with little or no documentation
- Data management
  - Data management for requirements and verification utilizes TcSE
  - Analysis data management has a wide range of implementations
    - Typically files/data are stored on hard drives or shared network drives
    - Formal ePIC documentation typically limited to customer deliverables
  - Connections between analysis and requirements are typically either managed manually in TcSE or only through human memory

Current Condition - Challenges

- Some of the challenges associated with the current condition are as follows:
  - Greater risk of miscommunication
    - Verbal communication relies on human memory
    - Greater risk of misinterpretation without ability to refer to written communication for clarification
    - Can result in inconsistency between desired and actual analysis results. Even if this inconsistency is discovered it would still drive rework.
  - Greater risk of data loss
    - Inconsistent data management techniques can inhibit data retrieval
    - Data may be inadvertently lost during hardware migration or personnel turn-over
    - Can result in unnecessary rework
  - Greater risk of data inaccessibility
    - Difficult to perform complete impact evaluation, often rely on human memory
    - Analysts do not have direct access to requirements data
    - Systems engineers to not have direct access to analysis data

Target Condition

- Manage requirement and analysis data in the same system (TcUA)
- Interconnect related data through database relations (example: trace links)
- Document analysis inputs through soft release/hard release processes
- Engineering processes that drive communication and interaction between systems engineering and analysts
- Benefits:
  - Decreased risk of miscommunication
    - Documented inputs into analysis process
    - Document outputs from analysis process
  - Decreased risk of data loss.
    - TcUA database is backed up and protected during hardware migration
    - User data in TcUA is not loss during personnel turn-over
  - Decreased risk of data inaccessibility
    - Accessibility via database relations between data elements

Stakeholder Needs

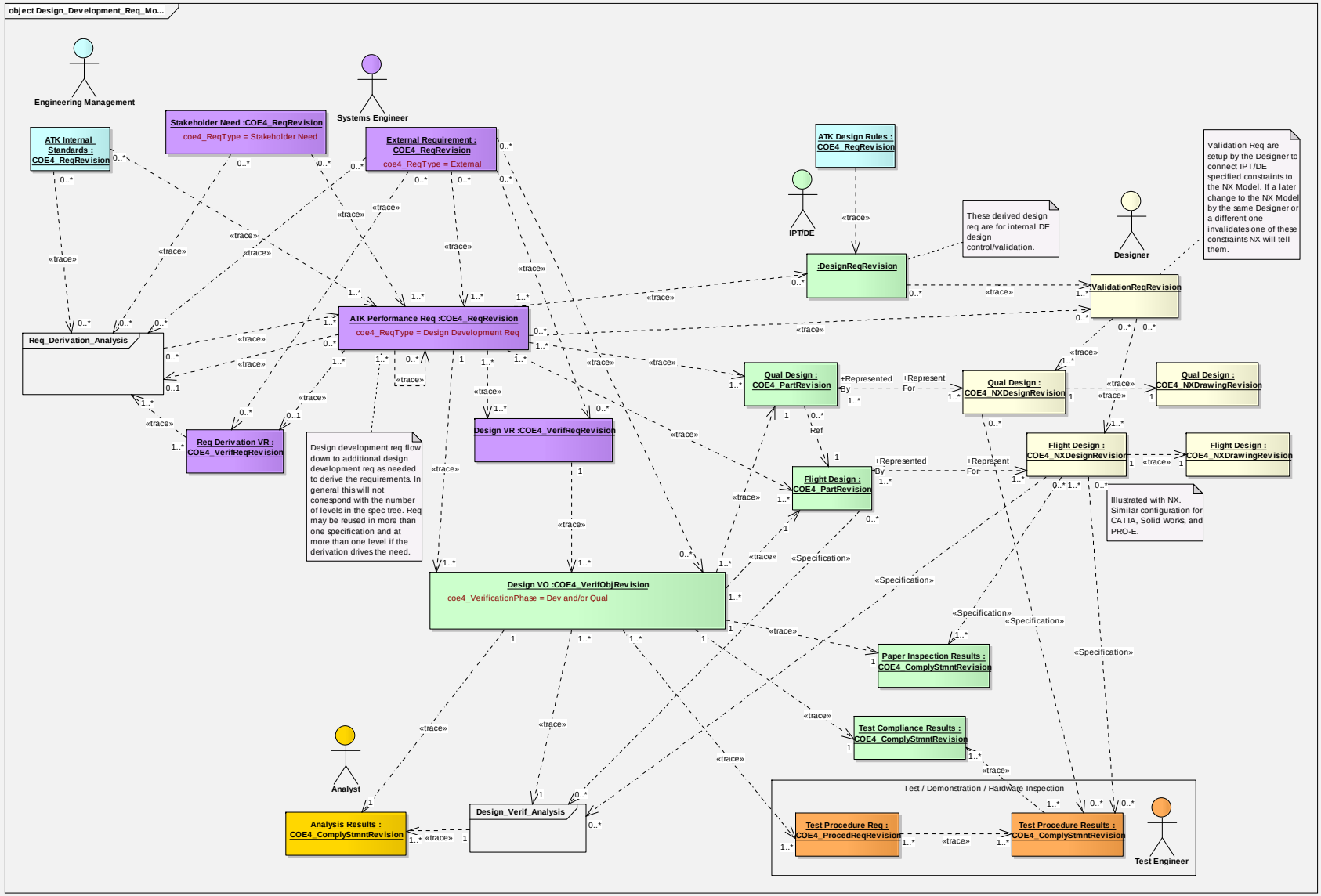
- Stakeholder needs gathered to allow TcUA architecture development and evaluation
- For this paper the focus was on the needs relating to requirement/analysis integration
- User needs (generalized):
  - Systems engineer (req & verif) needs:
    - Accessibility* of analysis data:
      - Analysis inputs
      - Assumptions/simplifications
      - Type of analysis performed
      - Applicable tools
      - Detailed results
      - Summarized results
    - Apply problem report to requirement and analysis data elements

* Accessibility is about providing the right data to the right person at the right time to make the right decision

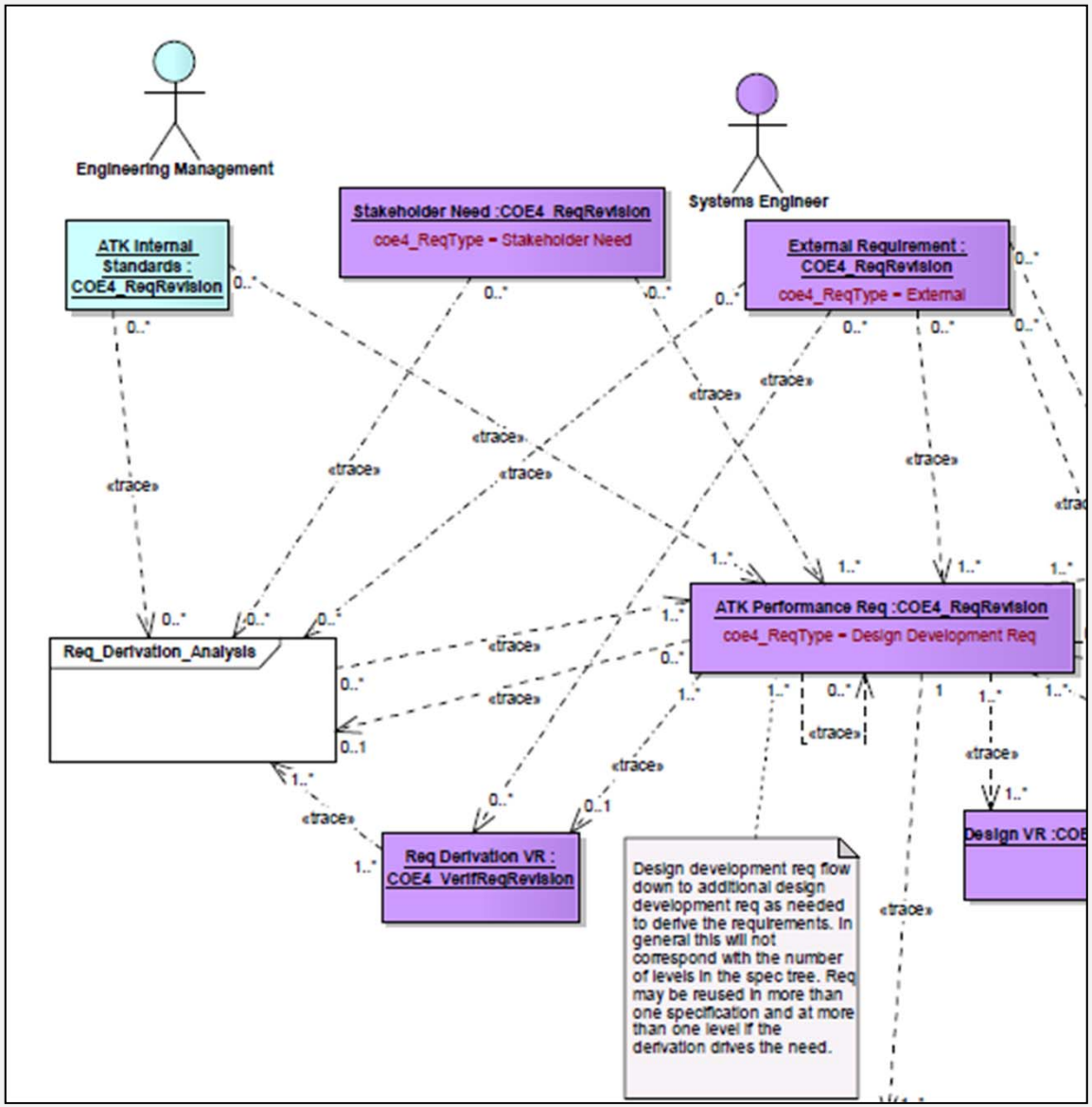
Stakeholder Needs (cont.)

- User needs (generalized, cont.):
  - Analysis engineer needs:
    - Accessibility of the engineering analysis request (EAR)
    - Accessibility of the requirements model
    - Input stability (soft release/hard release)
    - Change visibility
  - Design engineer needs:
    - Accessibility of applicable requirements
    - Accessibility of verification objectives
    - Accessibility of analyses

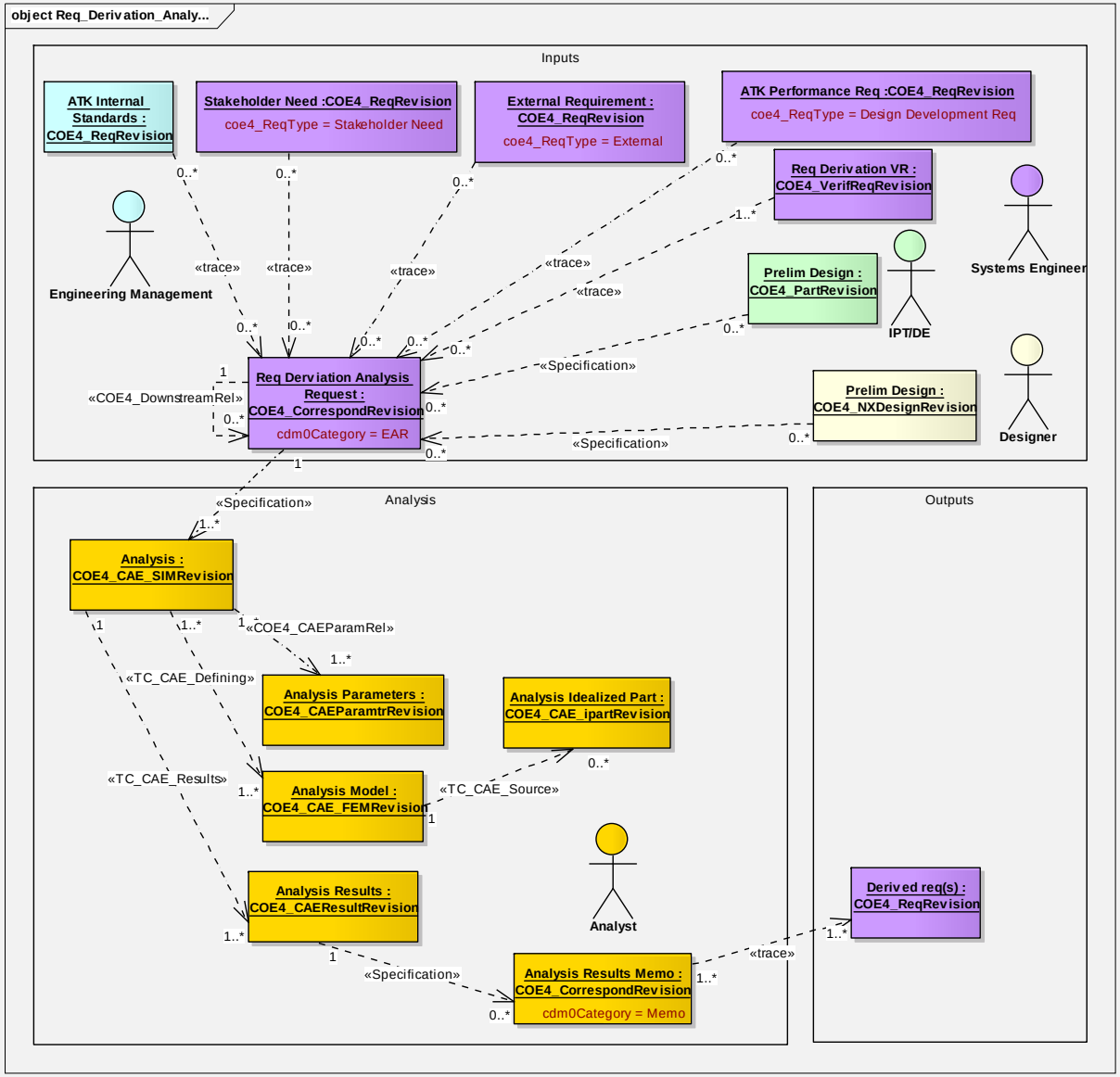
Solution Architecture – Design Development



Solution Architecture – Req Derivation



Solution Architecture - Req Derivation - Detailed

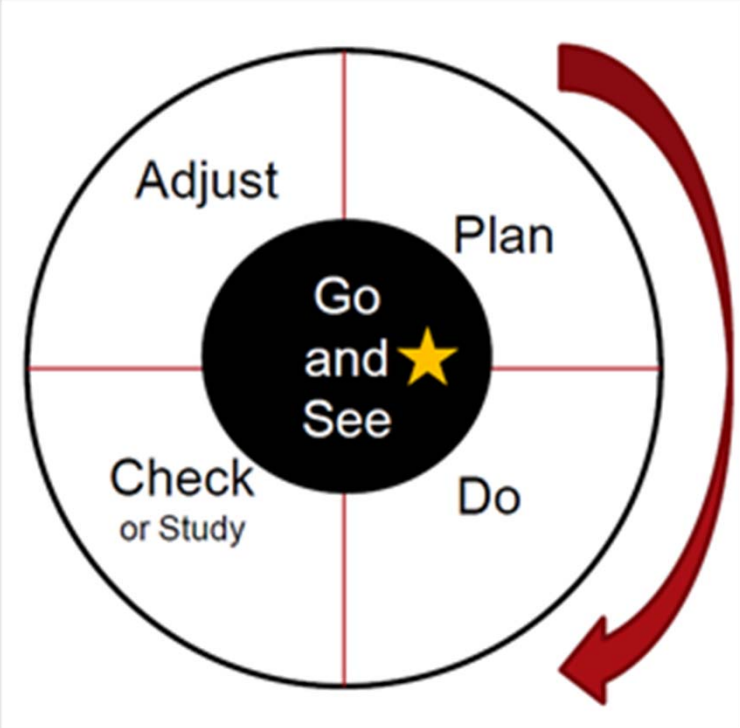


Database Relations

- Investing time in creating/maintaining relations pays off in the long run
  - Data is readily accessible to support engineering processes
  - Enables effective change management

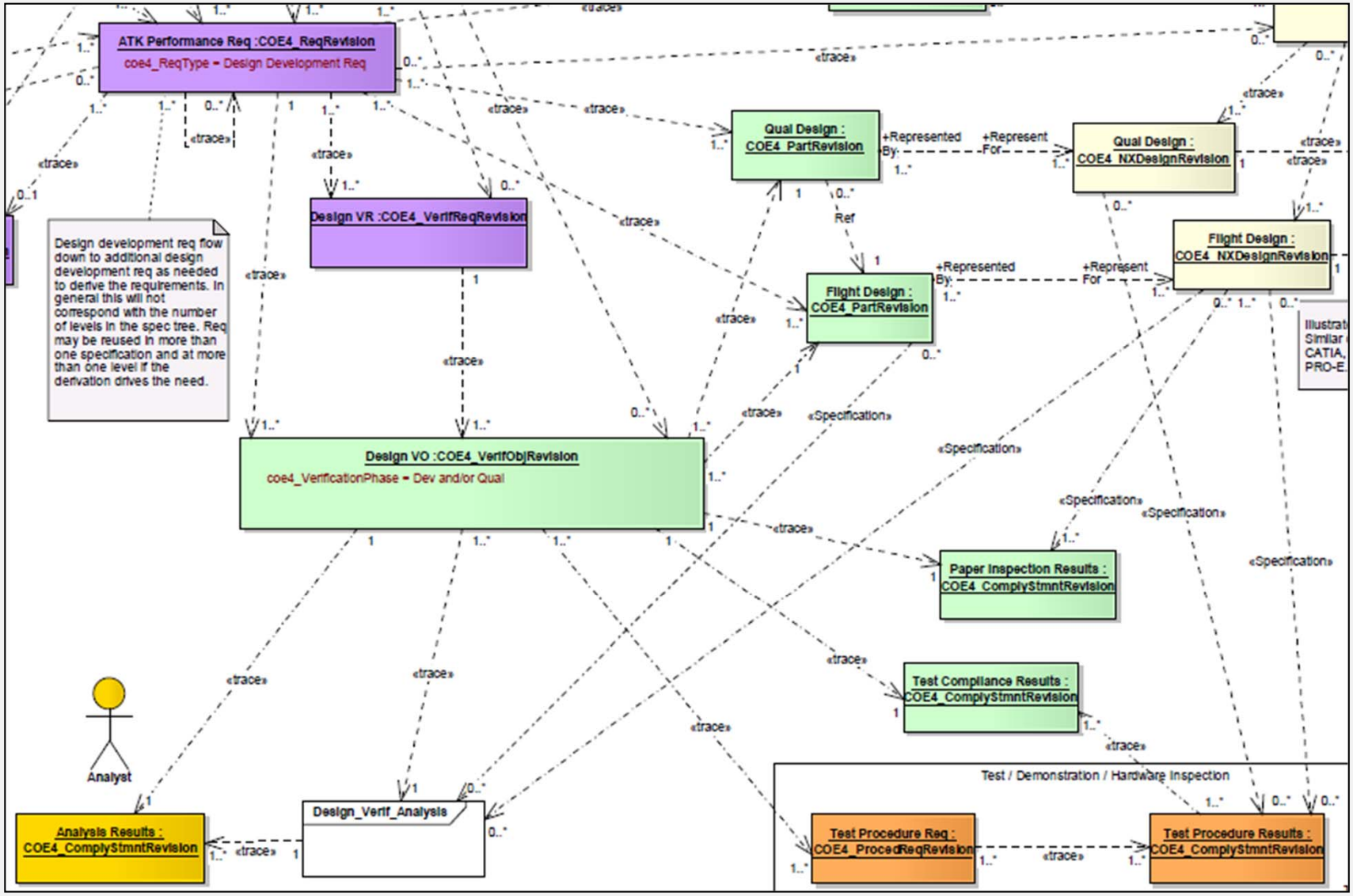
Engineering Analysis Request

- Investing time in planning analysis before execution is consistent with PES continuous improvement process
- Analysis results will be applicable for the intended use the first time*
- Deliberate decision about input maturity minimizes unnecessary analysis iterations

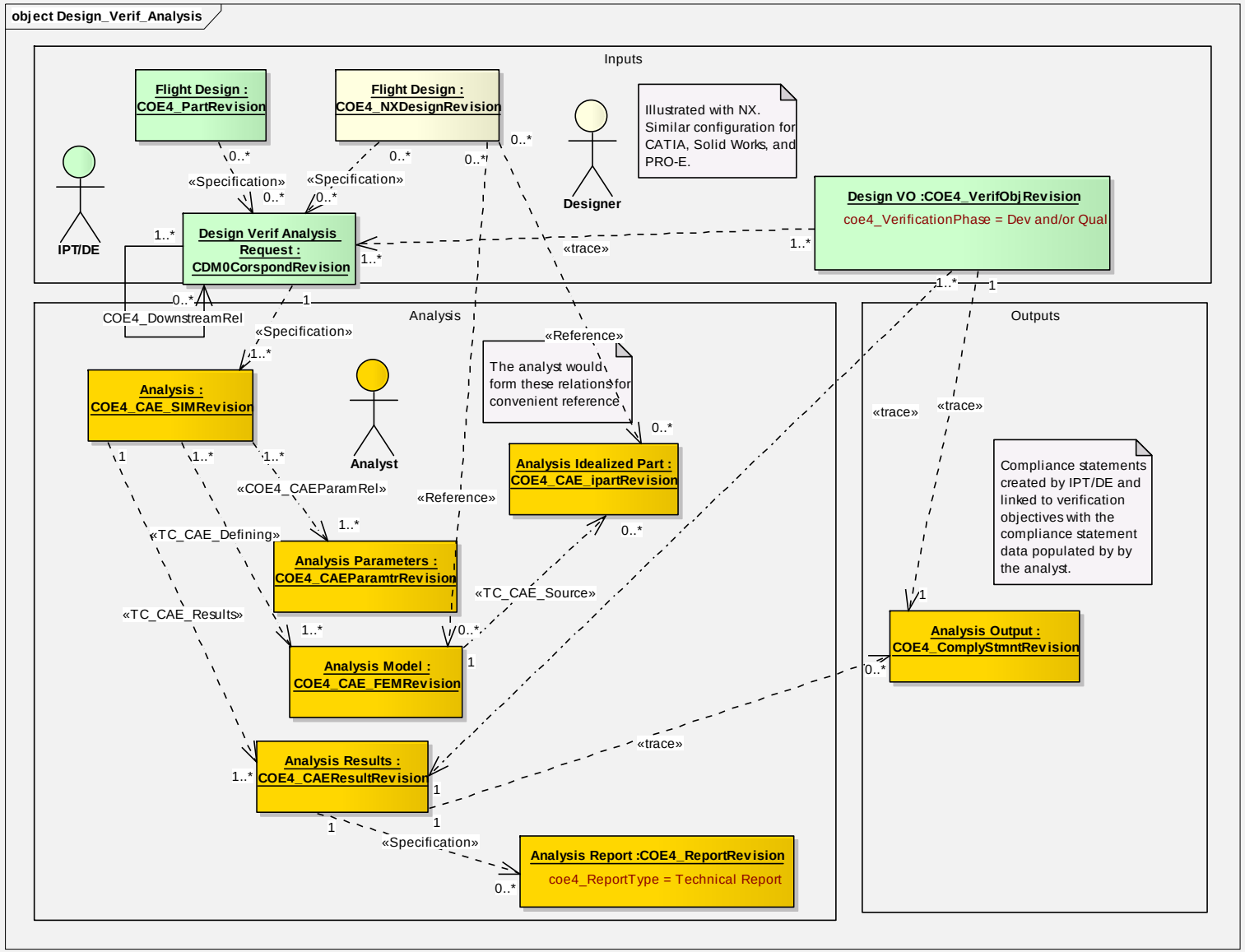


* “There is never enough time to do it right the first time, but there is always enough time to do it over.” - anonymous

Solution Architecture – Design Verification



Solution Architecture - Design Verif - Detailed



Solution Validation Testing

- iDev testing (individual development environment on virtual machine)
  - Primarily tested by engineers developing the requirements and analysis data management architectures
  - Work out details of requirement/analysis interactions
  - Validate the concept prior to deployment to development server
- Development server testing
  - Involvement of key supporters from several different sites
  - Involvement of systems engineers and analysts
  - Validate that solution works with multiple users
  - Validate accessibility of data to users
  - Get early feedback from users on the progress of the solution architecture

Case Study 1: Simple Timing Tolerance Analysis

- Input:
  - Dummy customer requirement for FTS S&A safe timing
- Objectives:
  - Demonstrate an analysis performed by systems engineer using spreadsheet
  - Demonstrate derivation of requirements through analysis
  - Demonstrate iteration of the derivation process driven by req and design changes
  - Demonstrate reuse of req derivation analysis for design verification
  - Demonstrate data accessibility

Case Study 2: Hardware Structural Analysis

- Inputs:
  - Dummy customer requirements for loads and factors of safety
  - Dummy preliminary design concept
- Objectives:
  - Demonstrate a more complex analysis performed by a dedicated analyst
  - Demonstrate design analysis driven through verification objectives
  - Demonstrate generation of compliance statements
  - Demonstrate data accessibility

Case Study 3: Thermal Conditions Determination Analysis

- Inputs:
  - Dummy customer requirements for loads and factors of safety
  - Dummy preliminary design concept
- Objectives:
  - Demonstrate a more complex analysis performed by a dedicated analyst
  - Demonstrate derivation of requirements through analysis
  - Demonstrate iteration of the derivation process driven by req and design changes
  - Demonstrate the evolution of analysis when design matures to a higher fidelity analysis
    - Create traceability between new and old analyses
  - Demonstrate generation of compliance statements
  - Demonstrate data accessibility

Conclusion

- The proposed solution architecture for requirements and analysis data management in TcUA is expected to provide the following benefits
  - Facilitates getting the right data to the right person at the right time to make the right decision
  - Facilitates proper documentation of analysis inputs
  - Enables integrated change management
- Continuing efforts to validate these solutions and expand our TcUA capability should be supported by management through budget and resource allocation