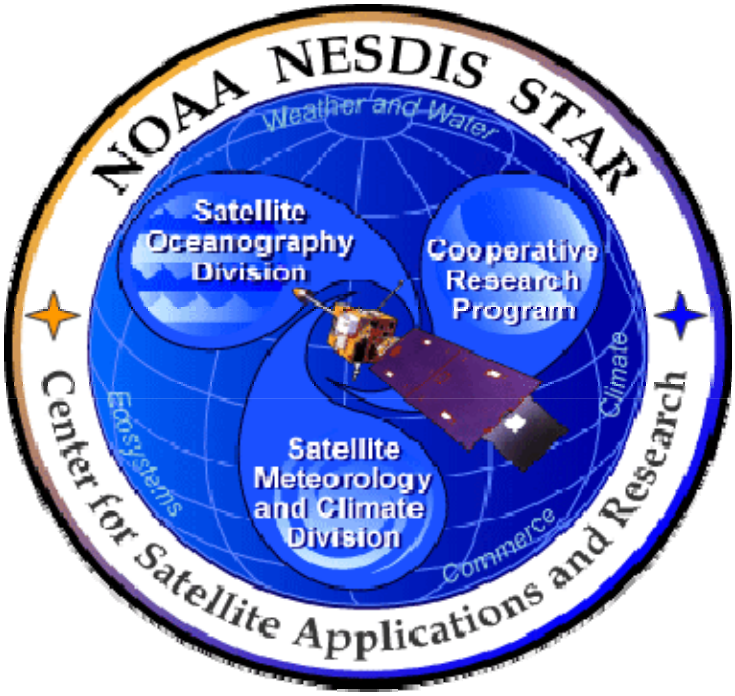

NOAA NESDIS
CENTER for SATELLITE APPLICATIONS and RESEARCH (STAR)

TASK GUIDELINE

TG-7
PRELIMINARY DESIGN (STEP 7)
TASK GUIDELINES

Version 3.0

TITLE: TG-7: PRELIMINARY DESIGN (STEP 7) TASK GUIDELINE VERSION 3.0

AUTHORS:

Ken Jensen (Raytheon Information Solutions)

VERSION HISTORY SUMMARY

Version	Description	Revised Sections	Date
1.0	No version 1		
2.0	No version 2		
3.0	New Task Guideline adapted from CMMI guidelines by Ken Jensen (Raytheon Information Solutions)	New Document	10/01/2009

TABLE OF CONTENTS

LIST OF FIGURES

Page

LIST OF TABLES

Page

LIST OF ACRONYMS

ATBD	Algorithm Theoretical Basis Document
BB	Baseline Build
CDR	Critical Design Review
CI	Cooperative Institute
CICS	Cooperative Institute for Climate Studies
CIMSS	Cooperative Institute for Meteorological Satellite Studies
CIOSS	Cooperative Institute for Oceanographic Satellite Studies
CIRA	Cooperative Institute for Research in the Atmosphere
CL	Check List
CLI	Check List Item
CoRP	Cooperative Research Program
CM	Configuration Management
CMMI	Capability Maturity Model Integration
CREST	Cooperative Remote Sensing and Technology Center
DG	Document Guidelines
DM	Data Management
DPP	Development Project Plan
DPR	Development Project Report
EPG	Enterprise Process Group
EPL	Enterprise Product Lifecycle
IPT	Integrated Product Team
NESDIS	National Environmental Satellite, Data, and Information Service
NOAA	National Oceanic and Atmospheric Administration
OCD	Operations Concept Document
PAR	Process Asset Repository
PBR	Project Baseline Report
PDD	Preliminary Design Document
PDR	Preliminary Design Review
PDRR	Preliminary Design Review Report

PG	Process Guidelines
PP	Project Proposal
PRD	Project Requirements Document
PRG	Peer Review Guidelines
PRR	Project Requirements Review
PRRR	Project Requirements Review Report
PSR	Project Status Report
QA	Quality Assurance
R&D	Research & Development
RAD	Requirements Allocation Document
RAS	Requirements Allocation Sheet
RNM	Requirements/Needs Matrix
SG	Stakeholder Guideline
SPSRB	Satellite Products and Services Review Board
STAR	Center for Satellite Applications and Research
SWA	Software Architecture Document
TD	Training Document
TG	Task Guideline
VVP	Verification and Validation Plan

1. INTRODUCTION

The NOAA/NESDIS Center for Satellite Applications and Research (STAR) develops a diverse spectrum of complex, often interrelated, environmental algorithms and software systems. These systems are developed through extensive research programs, and transitioned from research to operations when a sufficient level of maturity and end-user acceptance is achieved. Progress is often iterative, with subsequent deliveries providing additional robustness and functionality. Development and deployment is distributed, involving STAR, the Cooperative Institutes (CICS[1], CIMSS[2], CIOSS[3], CIRA[4], CREST[5]) distributed throughout the US, multiple support contractors, and NESDIS Operations.

NESDIS/STAR is implementing an increased level of process maturity to support the development of these software systems from research to operations. This document is a Task Guideline (TG) for users of this process, which has been designated as the STAR Enterprise Product Lifecycle (EPL).

1.1. Objective

The STAR EPL is designed as a sequence of 11 process steps that take a product from initial conception through delivery to operations. These steps are:

- Step 1 - Basic Research (TG-1)
- Step 2 - Focused R & D (TG-2)
- Step 3 - Project Proposal (TG-3)
- Step 4 - Resource Identification (TG-4)
- Step 5 - Development Project Plan (TG-5)
- Step 6 - Project Requirements (TG-6)
- **Step 7 - Preliminary Design (TG-7)**

---

1 Cooperative Institute for Climate Studies

2 Cooperative Institute for Meteorological Satellite Studies

3 Cooperative Institute for Oceanographic Satellite Studies

4 Cooperative Institute for Research in the Atmosphere

5 Cooperative Remote Sensing and Technology Center

- Step 8 - Detailed Design (TG-8)
- Step 9 - Code & Test Data Development (TG-9)
- Step 10 - Code Test And Refinement (TG-10)
- Step 11 - System Integration and Test (TG-11)

The objective of this Task Guideline (TG-7) is to describe how to perform the standard tasks of STAR EPL process step 7, “Preliminary Design”.

The intended users of this TG are all participants in the STAR EPL process who are involved in performing the standard tasks of step 7. Participants are referred to as STAR EPL stakeholders.

To determine whether or not they should be involved with this step, the readers of this TG should first determine what stakeholder roles apply to their participation in a STAR research-to-operations development project. Generic stakeholder roles are listed in Section 3 of this TG and discussed in Section 3.2 of the EPL Process Guideline (PG-1)[6]. PG-1 and this TG will direct stakeholders to Stakeholder Guidelines (SG) that are pertinent to their roles.

1.2. Version History

This is the first version of TG-7. It is identified as version 3.0 to align it with the release of the version 3.0 STAR EPL process assets.

1.3. Overview

This TG contains the following sections:

Section 1.0 - Introduction
Section 2.0 - References
Section 3.0 - Stakeholders
Section 4.0 - Preliminary Design Review
Section 5.0 - Project Artifacts
Section 6.0 - Task Descriptions

[6] It is recommended that potential STAR EPL stakeholders either review PG-1 prior to using this TG or use it as a reference while using this TG.

2. REFERENCE DOCUMENTS

All of the reference documents for the STAR EPL process are STAR EPL process assets that are accessible in a Process Asset Repository (PAR) on the STAR website. http://www.star.nesdis.noaa.gov/star/EPL_index.php.

Process assets include:

- Process Guidelines
- Stakeholder Guidelines
- Task Guidelines
- Peer Review Guidelines
- Review Check Lists
- Document Guidelines
- Training Documents

2.1. Process Guidelines

Process Guideline (PG) documents describe STAR's standard set of practices and guidelines for tailoring them to specific projects.

- STAR EPL Process Guidelines (PG-1)
- STAR EPL Process Guidelines Appendix (PG-1.A)
- STAR EPL Tailoring Guidelines (PG-2)

PG-1 and PG-1.A apply generally to each EPL step. Each stakeholder performing tasks during each step can benefit from a familiarity with these documents.

PG-2 is primarily useful for project planners and project plan reviewers during steps 4 and 5. It is also useful during steps 6-11 for project plan revision tasks.

2.2. Stakeholder Guidelines

A Stakeholder Guideline (SG) is a description of how to perform all STAR EPL standard tasks assigned to a given type of stakeholder. It should itemize the actions to be taken. It should contain appropriate standards, conventions, and (where appropriate) examples. It should point to the appropriate references and the required artifacts.

Stakeholder roles are identified in Section 3 of this TG. For each type of stakeholder, the appropriate SG provides that stakeholder with a complete description of the standard tasks for that stakeholder role, along with references to all appropriate process assets and project artifacts (c.f. Section 5 of this TG). This functions as a complement to the TGs (c.f. Section 2.3 of this TG), which provide a completion description of all stakeholder tasks for a specific process step.

Table 2.2.1 lists the Stakeholder Guidelines that are relevant to this step.

TABLE 2.2.1 – Stakeholder Guidelines for Step 7

ID	Stakeholder
SG-4	STAR CM/DM
SG-5	STAR Web Developers
SG-6	STAR Quality Assurance
SG-13	Development Leads
SG-14	Development Scientists
SG-15	Development Testers
SG-16	Development Programmers
SG-17	Technical Review Leads
SG-18	Technical Reviewers

2.3. Task Guidelines

A Task Guideline (TG) is a description of how to perform the tasks of a STAR EPL process step. It should itemize the actions to be taken. It should contain appropriate standards, conventions, and (where appropriate) examples. It should point to the appropriate

references and the required artifacts. There is one Task Guideline for each step in the STAR EPL. The relevant TG for this step is TG-7 (this document).

2.4. Peer Review Guidelines

For each review (c.f. Section 4), there is a Peer Review Guideline (PRG) that describes the objectives of the review, the required artifacts, standards for reviewers, requirements for approval, and options other than approval. For step 7, the relevant PRGs include:

- Preliminary Design Review Guidelines (PRG-7)

2.5. Review Check Lists

For each review (c.f. Section 4), there is a Review Check List (CL) that captures all the objectives for a review as a set of check list items. Each item in the check list should have a "Disposition" column that contains "Pass", "Conditional Pass", "Defer", "Waive", or "N/A" (Not Applicable). Each item will also have columns for Risk Assessment and for Actions generated. For step 7, the relevant CLs include:

- Preliminary Design Review Check List (CL-7)

2.6. Document Guidelines

There is a Document Guideline (DG) for each standard STAR EPL document. Each DG includes a description of the purpose for the document, a standard document outline (table of contents), a brief description of each subsection in the outline, and an Appendix containing an example document.

Table 2.6.1 lists the Document Guidelines that are relevant to this step.

TABLE 2.6.1 – Document Guidelines for Step 7

ID	Document
DG-1.1	Algorithm Theoretical Basis Document (ATBD)
DG-1.2	Software Architecture Document (SWA)

DG-5.1	Development Project Plan (DPP)
DG-5.4	Project Baseline Report (PBR)
DG-6.1	Operations Concept Document (OCD)
DG-6.2	Requirements Allocation Document (RAD)
DG-6.3	Verification and Validation Plan (VVP)
DG-7.1	Preliminary Design Document (PDD)
DG-7.1.A	PDD Appendix
DG-7.2	Preliminary Design Review Report (PDRR)

2.7. Training Documents

Training Documents (TD) assist the stakeholders (c.f. Section 3) in performing the process tasks. By using the TDs, the stakeholders should be able to perform the tasks more effectively.

Table 2.7.1 lists the Training Documents that are relevant to this step.

TABLE 2.7.1 – Training Documents for Step 7

ID	Training Document
TD-9	Project Requirements

3. STAKEHOLDERS

The STAR Enterprise is comprised of a large number of organizations that participate and cooperate in the development and production of environmental satellite data products and services. Individual project teams are customarily composed of personnel from these organizations, supplemented by contractor personnel. These organizations and project teams are referred to as the STAR Enterprise stakeholders.

An overview of the stakeholder roles is provided in the STAR EPL Process Guidelines (PG-1, c.f. Section 2). A more detailed description can be found in the Stakeholder Guidelines (SGs, c.f. Section 2).

Stakeholders who have a role during step 7 include:

- STAR CM/DM (SG-4)
- STAR Web Developer (SG-5)
- STAR QA (SG-6)
- Development Lead (SG-13)
- Development Scientist (SG-14)
- Development Tester (SG-15)
- Development Programmer (SG-16)
- Technical Review Lead (SG-17)
- Technical Reviewer (SG-18)

STAR CM/DM is the Configuration Management (CM) and Data Management (DM) group for the STAR organization. CM/DM is responsible for establishing and maintaining project baselines for code, test data, documentation, and reports. CM/DM works with each Development Lead to ensure that project artifacts are maintained in accordance with STAR standards. CM/DM works with Operations CM/DM on the transition of the project baseline from pre-operational development to operations.

STAR Web Developer is responsible for maintenance of the STAR web pages. The Web Developer works with STAR CM/DM to ensure that all project baseline items are posted to the appropriate project artifact repository in a timely fashion. The Web Developer works with the STAR EPG and STAR CM/DM to ensure that all STAR EPL process assets are posted to the PAR, and to ensure that all process measures are posted to the STAR Measurement Repository.

STAR QA is the quality assurance (QA) group for the STAR organization. QA is responsible for ensuring that each project's tailored process meets STAR EPL process standards and ensuring that each project meets its process requirements during its pre-operational development phases. QA works with the STAR EPG to ensure effective implementation of the process throughout the organization.

Development Lead is nominally a STAR scientist who leads a project's development efforts after a Project Proposal (PP) has been approved. The Development Lead is typically identified in the PP and is often the same person who was the Research Lead. The Development Lead works with STAR Management to tailor the STAR EPL process to the project and leads the project's development efforts during the Design and Build phases as the lead of the Integrated Product Team (IPT).

Development Scientist is nominally a STAR scientist who has been assigned by the Development Lead to one or more of the tasks of reviewing the technical content of project proposals, maturing a research algorithm into an operational algorithm, developing project requirements, supporting product design, coding and testing, and providing product validation and science maintenance.

Development Tester is any person located at a research organization who has been assigned by the Development Lead to one or more of the tasks of identifying pre-operational test data, acquiring and integrating the test data into the pre-operational product processing system, creating pre-operational unit and system test plans, executing unit and system tests, and analyzing and reporting test results for review.

Development Programmer is a programmer who has been assigned by the Development Lead to one or more of the tasks of preliminary design and detailed design of pre-operational code, writing pre-operational code, integrating code into a pre-operational system, and supporting Development Testers in testing pre-operational code.

Technical Review Lead is responsible for leading the team of Technical Reviewers for one or more of the six Technical Reviews. The Technical Review Lead works with the Development Lead and the Technical Reviewers to ensure that the review is prepared for, conducted, and closed according to review standards.

Technical Reviewer is responsible for reviewing and approving project artifacts and project status at one or more of the six Technical Reviews. Technical Reviewers work with the Technical Review Lead to ensure that the review is prepared for, conducted, and closed according to review standards.

Stakeholder satisfaction is a critical component of the process. The intention is for the process to be more of a benefit that a burden to stakeholders. If stakeholders are not satisfied that this is the case, the process will require improvement.

Stakeholders are strongly encouraged to provide feedback to the EPG. Comments and suggestions for improvement of the process architecture, assets, artifacts and tools are always welcome. Stakeholders can provide feedback by contacting:

Ken.Jensen@noaa.gov

4. PRELIMINARY DESIGN REVIEW

Preliminary Design Review (PDR) is a Design Phase Technical Review. Its purpose is to assess the preliminary design for the pre-operational system. Upon completion of this review, step 8 (Detailed Design) commences.

Standard PDR objectives:

- Identify relevant stakeholders and document their involvement according to the project plan.
- Identify requirements changes since the Project Requirements Review (PRR)
- Identify a set of alternative solutions to meet the requirements.
- Provide all applicable technical data for each alternative solution, including:
    - Operations concept
    - Theoretical basis
    - Architecture, specifications, interfaces
    - Performance requirements, QA procedures, test data requirements
    - Verification and validation plans
    - Risks and benefits
- Provide an updated allocation of requirements to product components and system components of the preliminary design.
- Identify and update project risks for the selected solution. Make recommendations for risk mitigation plans and actions.
- Document the closing of all action items since PRR. Make recommendations for open actions and new actions.

Standard PDR entry criteria:

- Entry # 1 - A Project Requirements Review Report (PRRR) has been written. The PDR reviewers have access to the current baseline version of the PRRR.
- Entry # 2 - A Development Project Plan (DPP) has been written. The PDR reviewers have access to the current baseline version of the DPP.

- Entry # 3 - An Operations Concept Document (OCD) has been written. The PDR reviewers have access to the current baseline version of the OCD.
- Entry # 4 - A Requirements Allocation Document (RAD) has been written. The PDR reviewers have access to the current baseline version of the RAD.
- Entry # 5 - An Algorithm Theoretical Basis Document (ATBD v2r0) has been written. The PDR reviewers have access to the current baseline version of the ATBD.
- Entry # 6 - A Software Architecture Document (SWA) has been written. The PDR reviewers have access to the current baseline version of the SWA.
- Entry # 7 - A Verification and Validation Plan (VVP) has been written. The PDR reviewers have access to the current baseline version of the VVP.
- Entry # 8 - A Preliminary Design Document (PDD) has been written. PDR review objectives are clearly stated in the PDD.
- Entry # 9 - A Project Baseline Report (PBR) has been written. The PDR reviewers have access to the current baseline version of the PBR.

Standard PDR exit criteria:

- Exit # 1 – PRR "Conditional Pass" items have been satisfactorily disposed of.
- Exit # 2 – PRR "Defer" items have been satisfactorily disposed of.
- Exit # 3 - Project plan and DPP are satisfactory.
- Exit # 4 - Operations concept and OCD are satisfactory.
- Exit # 5 – Requirements changes since PRR are approved.
- Exit # 6 – Algorithm theoretical basis and ATBD are satisfactory.
- Exit # 7 – Software architecture and SWA are satisfactory.
- Exit # 8 – Verification and validation plan and VVP are satisfactory.
- Exit # 9 - Requirements allocation and RAD are satisfactory.
- Exit # 10 - Project baseline and PBR are satisfactory.
- Exit # 11 - A selected solution has been consistently identified in the project artifacts.
- Exit # 12 - The selected solution is approved.
- Exit # 13 - The PDR reviewers' assessment of outstanding risks and actions is documented in the PDR Report.

- Exit # 14 - Project risks and actions are acceptable.

Refer to PRG-7 for a more detailed description of the PDR. The standard PDR Check List Items (CLI) are documented in the process asset CL-7 (c.f. Section 2).

PDR objectives, entry criteria, exit criteria, and check list may be tailored. Tailoring guidelines are provided in the process asset PG-2 (c.f. Section 2). Refer to the Development Project Plan (DPP) Section 5 to determine whether there has been any project-specific tailoring for the PDR.

5. PROJECT ARTIFACTS

Project Artifacts are a set of items that must be produced by the appropriate stakeholders during the product life cycle to support the reviews. They are established and maintained under Configuration Management (CM) by an Enterprise Process Group (EPG) under the direction of a Steering Committee.

The project artifacts are maintained in a project artifact repository. This is a complete set of configuration-managed artifacts developed by each project in accordance with STAR standards. When a project artifact has been approved at a Technical Review or Gate Review, it is placed in the project artifact repository under CM.

Project artifacts that are recommended for development during step 7 are listed in Table 5.1.

TABLE 5.1 – Step 7 Artifacts

Artifact	Type	Review	Baseline Build
Development Project Plan v2.x	Document	PDR	2.2
Algorithm Theoretical Basis Document v2.0	Document	PDR	2.2
Software Architecture Document v2.0	Document	PDR	2.2
Operations Concept Document v1.1	Document	PDR	2.2
Requirements Allocation Document v1.1	Document	PDR	2.2
Verification and Validation Plan v1.1	Document	PDR	2.2
Preliminary Design Document	Presentation	PDR	2.2
Project Baseline Report v2.2	Report	PDR	2.2
Preliminary Design Review Report	Report	CDR	2.3
Project Baseline Report v2.3	Report	None	2.3

Development Project Plan v2.x: The Development Project Plan (DPP) documents the plan for the development, testing, review, and transition to operations for the project, including stakeholders, tasks, work breakdown structure (WBS), schedule and resources. The initial DPP v2.0 should have been produced in step 6 for the PRR, and may be revised

(v2.x) as a result of PRR actions, and preliminary design impacts on the plan. Refer to DG-5.1 for detailed DPP guidelines.

Algorithm Theoretical Basis Document v2.0: The Algorithm Theoretical Basis Document (ATBD) provides a theoretical description (scientific and mathematical) of the algorithm that is used to create a product that meets user requirements. The ATBD v2 is typically updated from the v1 version, as preliminary design provides additional maturity. The purpose of ATBD v2.0 is to demonstrate to the PDR reviewers that the algorithm requirements are well understood, well documented and achievable. Refer to DG-1.1 for detailed ATBD guidelines.

Software Architecture Document v2.0: The Software Architecture Document (SWA) complements the ATBD by providing the software architecture for the processing code that will implement the algorithm. The SWA v2 is typically updated from the v1 version, as preliminary design provides additional maturity. Refer to DG-1.2 for detailed SWA guidelines.

Operations Concept Document v1.1: The Operations Concept Document (OCD) is distinct from a concept of operations (ConOps). A ConOps may be generated by a potential user to provide an overview of how the user envisions a potential product system to operate. It provides a mechanism for users to describe their expectations of the target system in terms that need not be quantifiable and testable. The ConOps is typically used as input to the development of formal testable system and software requirements specifications. The OCD is a technical document created by the development team to describe how the users' vision can be realized in an operational environment. It should build on the users' ConOps, if available, and on the organization's ConOps, where relevant. OCD v1.1, produced for the PDR, adds to v1.0 by providing operational scenarios for product operation and user interaction for each alternative solution under consideration at PDR. Its purpose is to assist in the selection of a preferred solution by identifying risks and constraints associated with each solution in the preliminary design. Refer to DG-6.1 for detailed OCD guidelines.

Requirements Allocation Document v1.1: The Requirements Allocation Document (RAD) contains the basic and derived requirements for the work products and the allocation of the requirements to system components and product components. RAD v1.1, produced for the PDR, adds to v1.0 by updating the allocation of requirements to system and product components, based on the maturing of solutions and design since PRR. Refer to DG-6.2 for detailed RAD guidelines.

Verification and Validation Plan v1.1: The Verification and Validation Plan (VVP) describes the work products to be verified and validated, the requirements for each selected work product and the verification and validation methods for each selected work product. VVP v1.1, produced for the PDR, adds to v1.0 by updating the listing and description of verification and validation items and plans, based on the maturing of the requirements allocation, solutions and design since PRR, as documented in RAD v1.1 and SWA v2.0. Refer to DG-6.3 for detailed VVP guidelines.

Preliminary Design Document: The Preliminary Design Document (PDD) consists of the presentation slides for the Preliminary Design Review (PDR). Refer to DG-7.1 and DG-7.1.A for detailed PDD guidelines.

Project Baseline Report v2.2: The Project Baseline Report (PBR v2.2) is the document that describes the status of the configuration items that comprise the project baseline at the PDR. Refer to DG-5.4 for detailed PBR guidelines.

Note that these artifacts are typically included in STAR Baseline Build (BB) 2.2. BB 2.2 provides the artifacts for the PDR. **STAR CM/DM** executes BB 2.2, in consultation with the developers of the BB 2.2 artifacts.

Preliminary Design Review Report: The PDR Report (PDRR) summarizes the PDR Reviewers' assessment of the preliminary design, including identified risks and risk mitigation actions. Refer to DG-7.2 for detailed PDRR guidelines.

Project Baseline Report v2.3: When the PDRR is completed, it is added to the baseline for BB 2.3. The PBR is updated to v2.3 to include the addition of the PDRR as well as any PDR artifacts that are revised as the result of PDR actions.

6. TASK DESCRIPTION

6.1 Requirements Development Process

Requirements development is an iterative process that occurs throughout the Design phase of the product lifecycle, as explained in the Project Requirements Training Document (TD-9). This phase includes three steps that produce a detailed requirements allocation through an iterative (spiral) development of requirements, solutions, and design:

- Project Requirements (step 6 of the STAR EPL)
- **Preliminary Design (step 7 of the STAR EPL)**
- Detailed Design (step 8 of the STAR EPL)

Figure 6.1 illustrates the Requirements Development process, with step 7 highlighted.

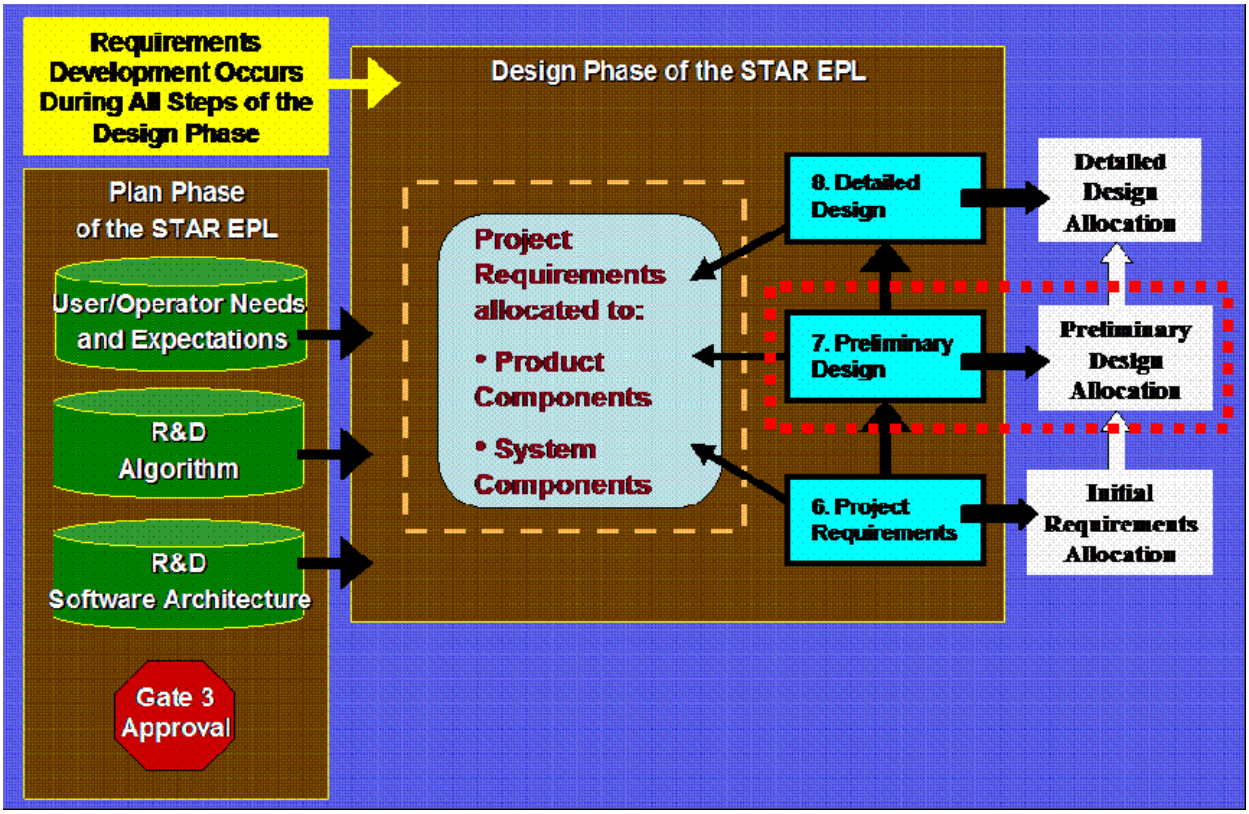

Figure 6.1 – Requirements Development Process

As Figure 6.1 shows, the objective of step 6 is to produce an initial requirements allocation that consists of requirements derived from user/operator needs and expectations and the allocation of these requirements to product components and system components that have been identified in the Research and Development (R&D) algorithm and software architecture.

Note that steps 7 and 8 continue the requirements development process. This is because the requirements development process produces the requirements statements ***and*** their allocation to product components and system components of a design that is matured to an increasing amount of detail and completeness throughout the Design phase.

The process of producing an increasingly mature and complete requirements allocation involves an iterative development of the requirements, solution, design, and requirements allocation. Figure 6.2 illustrates this.

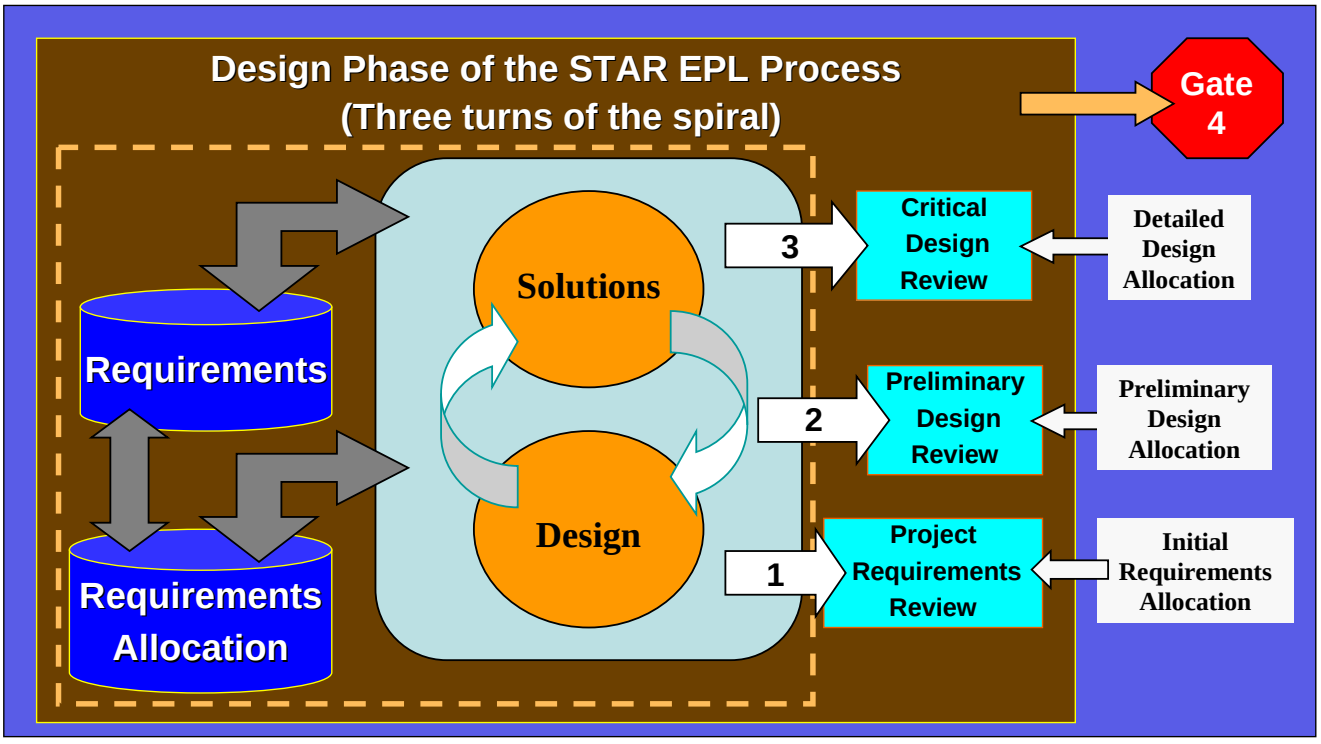

Figure 6.2 – Iterative (Spiral) Development of Requirements Allocation

As shown in Figure 6.2, requirements drive solutions, solutions drive design, and design determines requirements allocation. Gaps and/or inconsistencies between the requirements and the requirements allocation will then drive revisions to solutions and design. Revised solutions and design then drive revisions to requirements and/or requirements allocation, etc.

As the project matures throughout the Design phase, an increasingly comprehensive and mature requirements allocation is reviewed at each of the three technical reviews of this phase (Project Requirements Review (PRR), PDR, and Critical Design Review (CDR)).

This process is continuous and iterative, but is also characterized by three distinct milestones:

1) The Initial Requirements Allocation is achieved when it is determined that the set of stated requirements is complete. That is, it is not expected that additional maturation will result in additional requirements. At that point, a PRR is conducted to complete step 6. Refer to TG-6 for a description of the tasks that achieve an Initial Requirements Allocation.

2) The Preliminary Design Allocation is achieved when it is determined that a preferred solution has been identified to meet the set of requirements that were approved at the PRR. That is, it is not expected that additional maturation will result in a different solution. At that point, a PDR is conducted to complete step 7. This does not preclude the possibility that the set of requirements will be revised during step 7, as a result of issues discovered during the preliminary design development.

3) The Detailed Design Allocation is achieved when it is determined that a complete design has been developed to implement the preferred solution that was approved at the PDR. At that point, a CDR is conducted to complete step 8. This does not preclude the possibility that the set of requirements will be revised during step 8, as a result of issues discovered during the detailed design development. This will be discussed in TG-8.

The iterative nature of this development means that requirements are not expected to be finalized until the complete convergence of requirements, solution, and design is finalized at the end of step 8, resulting in the detailed design allocation. Once this is accomplished, the project is ready to proceed to a Gate 4 Review and the Build phase.

6.2 Preliminary Design Process Flow

Figure 6.3 shows the process flow for step 7.

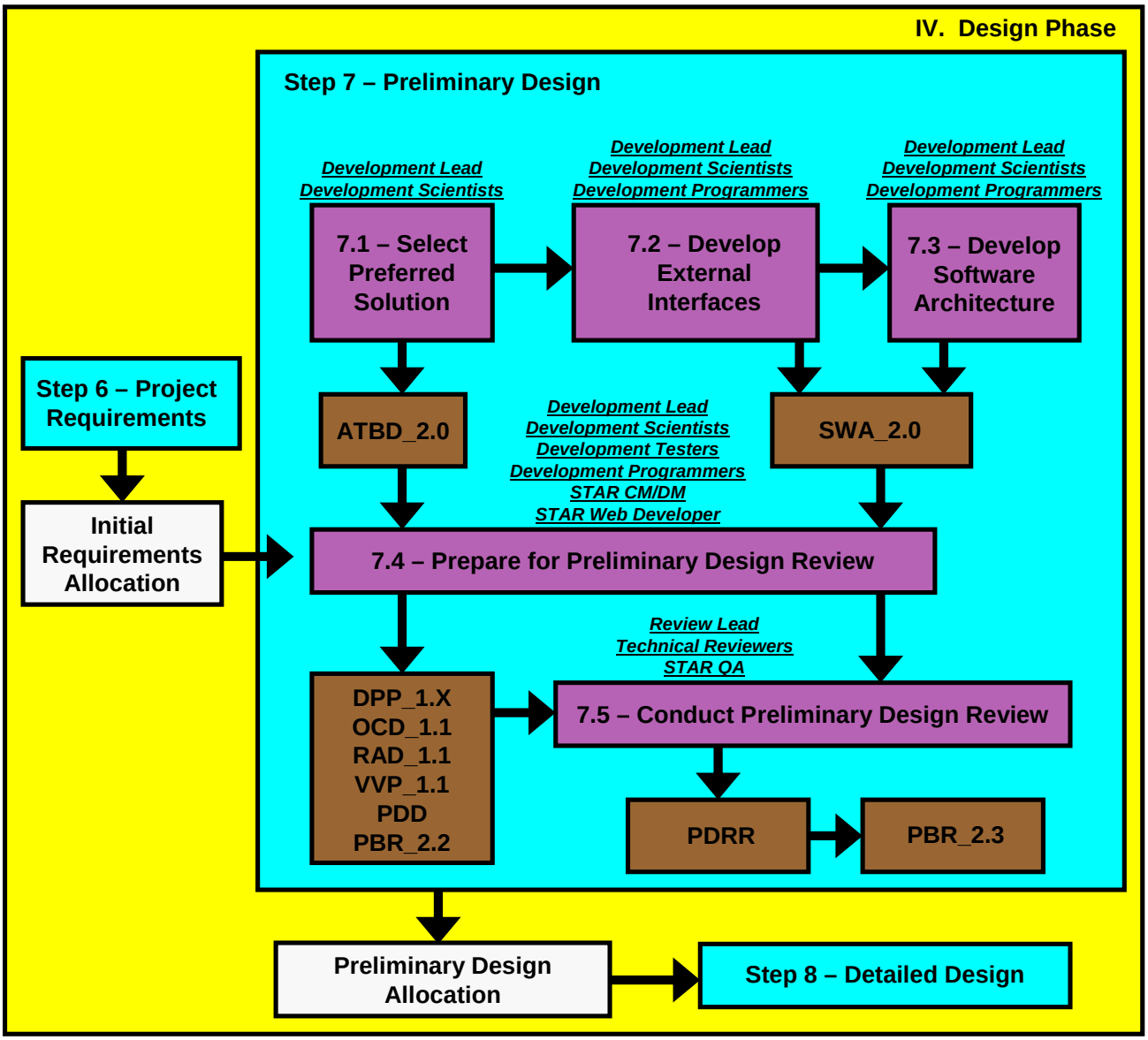

Figure 6.3 – Step 7 Process Flow

6.3 Expected BEGIN State

- REQUIRED: A PRR has been conducted
- REQUIRED: An Initial requirements Allocation has been developed and approved
- REQUIRED: Baseline Build (BB) 2.1 has placed the following items in the project artifact repository:
  - DPP, including Appendices
  - OCD
  - RAD, including Appendices
  - VVP
  - Project Requirements Document (PRD)
  - Project Requirements Review Report (PRRR)
- EXPECTED: BB 2.1 has placed the following items in the project artifact repository:
  - R&D code
  - R&D test data
  - ATBD
  - SWA
  - PP
  - Gate 2 Review Report (G2RR)
  - Gate 3 Review Report (G3RR)
- REQUIRED: PBR_2.1 documents the status of the BB 2.1 project baseline
- REQUIRED: PRR reviewers have approved the project to proceed to the Preliminary Design step, and have documented this approval in the PRRR.

6.3.1 Task Inputs

Task inputs consist of the following BB 2.1 items:

- DPP_1.x,
- OCD_1.0
- RAD_1.0, including Requirements/Needs Matrix (RNM) and Requirements Allocation Sheet (RAS)
- VVP_1.0

- ATBD_1.1
- SWA_1.1
- Project Risks and Actions (PSR_1.x Appendix)
- PRD
- PRRR
- PBR_2.1

6.3.2 Corrective Actions

The PRRR will document any actions that are needed to reduce risk during step 7. Usually, these actions should be closed before the PDR.

Additional corrective actions are typically generated during step 7, to mitigate project risks that are identified during preliminary design. Project risks and risk mitigation actions should be identified in the PSR Appendix.

The needed corrective actions may require revisions to the project plan, typically by the addition of sub-tasks and revisions to the task schedule. The **Development Lead** should determine whether these revisions are manageable or are so significant that a re-plan is needed. If necessary, the **Development Lead** should consult STAR Management on the advisability of a re-plan. Re-planning is expected to be a rare event, but it may occur if the project requirements have added significant scope or if unexpected technical issues have been discovered.

6.3.2.1 Delta Gate 3 Review

If it is determined that a re-plan is needed, actions should be taken to conduct a delta Gate 3 Review. A delta Gate 3 Review should be prepared for and conducted in the same manner as the normal Gate 3 Review. Refer to the step 5 Task Guideline (TG-5) and the Gate 3 Peer Review Guideline (PRG-5) for guidance. Following approval of the re-plan, the project can return to its step 7 activities under the new plan.

6.4 Desired END State

- An operations concept, developed from user/customer needs and expectations, explains what products are to be produced, why they are being produced, and how they will be produced in an operational environment,
- Basic project requirements have been developed from the operations concept
- Requirements have been analyzed in light of the customer's needs, mission objectives, system constraints, and design constraints to develop more specific product, system, and process requirements for the system.
- Derived project requirements have been developed from analysis of the basic requirements and other derived requirements
- A preferred solution to meet the requirements has been identified and approved.
- A Context-Layer software architecture has been developed.
- A System-Layer software architecture has been developed.
- A preliminary design allocation of the requirements identifies product and system components down to the System-Layer, and traces each component to one or more requirement so that a detailed system architecture that will meet all project requirements can be designed.
- A plan has been developed for monitoring the status of the requirements and their allocation to ensure that the integrity of the requirements allocation is preserved as the detailed design is developed.
- A plan has been developed to verify the identified work products, validate the identified requirements, and validate the identified products.
- The project plan has been updated as necessary
- The status of project risks and actions has been updated
- A PDR of the project plan, operations concept, requirements, software architecture, and requirements allocation has been conducted
- A PDRR has been written
- Baseline Build 2.3 has placed the required items in the project artifact repository
- PBR_2.3 documents the status of the BB 2.3 project baseline

6.4.1 Task Outputs

Task outputs consist of the following BB 2.3 items:

- DPP_1.x
- ATBD_2.0
- SWA_2.0
- OCD_1.1
- RAD_1.1, including RNM and RAS
- VVP_1.1
- Project Risks and Actions (PSR_1.x Appendix)
- PDD
- PDRR
- PBR_2.3

6.5 Preliminary Design Activities

Step 7 activities include:

1) Select preferred solution
2) Develop external interfaces
3) Develop software architecture
4) Prepare for PDR
5) Conduct PDR

6.5.1 Select Preferred Solution

The **Development Lead** selects a preferred solution, assisted by **Development Scientists**.

First, a defined set of potential solutions should be identified. A wider range of alternatives can surface by soliciting as many stakeholders as practical for input. Input from stakeholders with diverse skills and backgrounds can help teams identify and address

assumptions, constraints, and biases. Brainstorming sessions may stimulate innovative alternatives through rapid interaction and feedback. A literature search may provide a deeper understanding of the problem, alternatives to consider, barriers to implementation, existing trade studies, and lessons learned from similar decisions.

Some of this may have occurred during the Basic and Exploratory phases, Refer to ATBD version 1 to see whether the Research Scientists have identified and evaluated alternatives.

Selection criteria would typically address costs (e.g., time, people, money), benefits (e.g., performance, capability, effectiveness), and risks (e.g., technical, cost, schedule). Alternative solutions need to be analyzed to enable the selection of a balanced solution across the life of the product in terms of cost, schedule, and technical performance. Considerations for detailed alternative solutions and selection criteria include the following:

- Ability to meet product-component requirements
- Cost (development, procurement, support, product life cycle)
- Performance reliability
- Reliability of the required inputs
- Complexity of the product component and product-related life-cycle processes
- Testability
- Robustness to product operating and use conditions, operating modes, environments, and variations in product-related life-cycle processes
- Technology limitations
- Capabilities and limitations of end users and operators

Often, the preferred solution is apparent from a brief analysis of the criteria. In that case, there is no need to proceed further than documenting the rationale for this clear selection in the ATBD. If this is not the case, perform a more comprehensive analysis by ranking each viable solution with respect to each of the selection criteria. This ranking may be qualitative (e,g, Good, Better, Best) or quantitative (e.g., scale of 1-10). If necessary, prioritize and/or weight the selection criteria.

Obtain a complete requirements allocation for each viable alternative solution, as a means of analyzing cost, complexity, testability and robustness.

Identify and resolve issues with each viable alternative solution.

Alternative solutions may require alternative inputs. Risks associated with these inputs should be a factor in the selection of the preferred solution.

Document the results from the analysis, noting the solution that scores best, alternatives whose scores are close, and the critical discriminators between the preferred solution and the higher scoring alternatives.

When a preferred solution is selected, identify its requirements allocation as the preferred allocation. This establishes the Preliminary Design Allocation. Upon PDR approval of the solution, this will become the starting point for the development of the Detailed Design Allocation during step 8.

Development Scientists produce version 2 of the project ATBD, in accordance with DG-1.1. This version of the ATBD should identify and fully describe the preferred solution. The process used to select the preferred solution should be documented, either in the ATBD or in the PDD. If a comprehensive analysis of competitive alternative solutions was performed, it is recommended that this documentation be included in the ATBD. This is particularly recommended if the preferred solution involves a departure from established algorithm heritage.

6.5.2 Develop External Interfaces

The **Development Lead** leads the identification of the external interfaces to the product processing system, assisted by **Development Scientists** and **Development Programmers**.

6.5.2.1 External Inputs

An external input is defined as a data source needed by the system that is produced or made available by a process external to the system. Examples are raw sensor data, ancillary data, etc.

External inputs are often identified prior to the Design phase. These will be documented in the DPP and the Satellite Products and Services Review Board (SPSRB) plan. Identify the inputs that are needed for the preferred solution. Confirm that these external inputs are identified correctly in the DPP. Confirm that any needed supplier agreements are in place

and that the suppliers identified in the DPP understand the agreements and are committed to and capable of supplying the needed inputs on schedule.

Additional external inputs may be identified during the process of requirements development and preliminary design. This will occur as the functional requirements and functional architecture uncover the need for additional input to support the designed functionality of the product processing system. It is important that risks associated with these additional inputs are identified and considered as a factor in selecting the preferred solution (c.f. Section 6.5.1). This feedback between the design and the solution is an example of the iterative nature of the requirements development process that was discussed in Section 6.1. Consider the possibility that newly identified risks should cause a reconsideration of the selected solution.

The identification of additional inputs will typically result in the generation of additional derived requirements associated with the inputs. It is important that the requirements allocation be revised and documented in the RAD to capture the new external input requirements.

Identify risks associated with the external inputs. Document these in the RAD, the PSR Appendix, and the PDD.

6.5.2.2 External Outputs

External output is defined as a data sink that is produced by the system for an external user; for example, archived environmental products (e.g. Sea Surface Temperature).

External outputs are often identified prior to the Design phase. These will be documented in the DPP and the SPSRB plan. Confirm that these external outputs are identified correctly in the DPP. Confirm that any needed end user agreements are in place and that the end users identified in the DPP understand the agreements. Note that end users include the customers for the products and the operators that will produce the products.

Additional external outputs may be identified during the process of requirements development and preliminary design. This will occur if additional requirements are identified to respond to additional requests from approved end users. It is important that risks associated with these additional requests be identified and evaluated as soon as possible. This is essential to the containment of requirements creep. If additional end user requests are received during step 7, the **Development Lead** should consult with **STAR Management** to determine whether a delta PRR is needed to approve or reject them. A delta PRR is recommended if the additional requirements may affect the selection of a preferred solution. A delta PRR may also be decided upon if the additional requirements are determined to add significant cost, schedule, and/or technical risk. If a delta PRR is not

conducted, it is still important to document the changes to the requirements allocation for review at the PDR.

6.5.3 Develop Software Architecture

Development Scientists usually develop the preliminary design software architecture for the product processing system, possibly assisted by **Development Programmers**.

The software system is an integrated collection of software elements, or code, that implements a solution, producing well-defined output products from a well-defined set of input data. The software architecture describes the structure of the system software elements and the external and internal data flows between software elements.

The software architecture is structured in four layers, as illustrated in Figure 6.4.

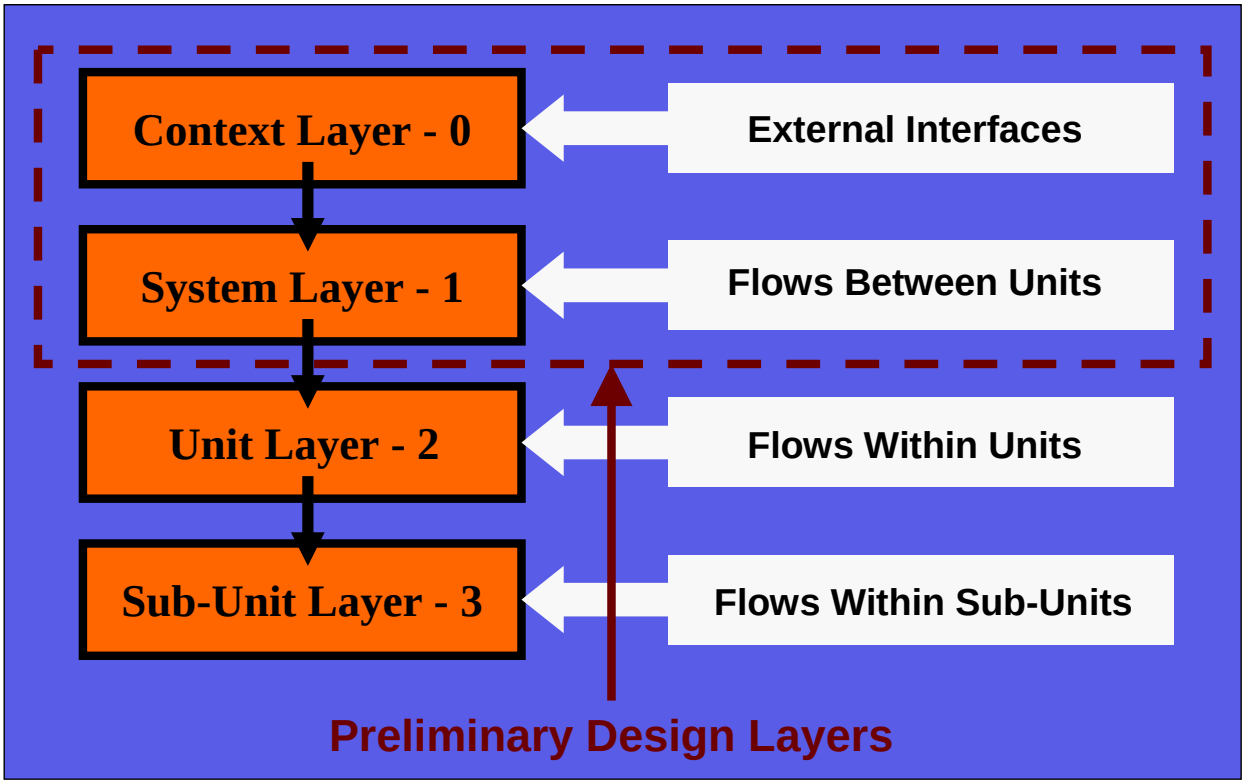

Figure 6.4 – Software Architecture Layers

As shown in Figure 6.4, the preliminary design software architecture consists of the Context Layer and the System Layer.

The Context Layer describes the flows between the system and its external interfaces (c.f. Section 6.5.2).

Develop a Context Layer flow diagram that illustrates these flows. An example is shown as Figure 6.5.

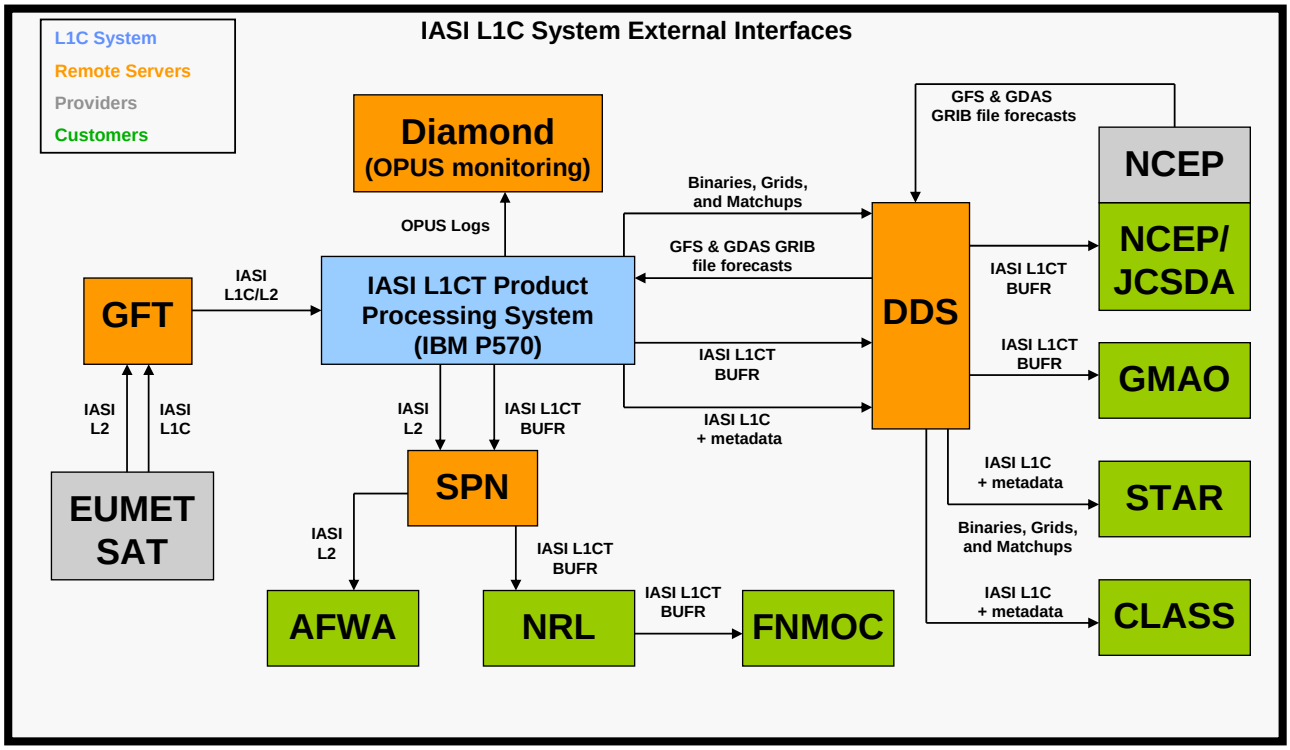

Figure 6.5 – Context Layer Data Flows

The System Layer expands upon the Context Layer shown in Figure 6.5, describing the first layer of decomposition. In addition to the System Layer inputs and outputs, the major processing units are identified along with their inputs and outputs.

The identification of the software units should be made with care. A software unit should contain a set of functions that meet the functional requirements. Functional requirements

should have been developed during step 6 (c.f. TG-6) and may be refined iteratively with the solution and the preliminary design during step 7. Examine the functional requirements to determine which can be grouped together in a common software function. Determine which software functions can be grouped together in a common stand-alone software program that has well-defined inputs and outputs that are conducive to unit testing and integration into a System Layer scheduler. This group of functions will constitute an identified software unit.

This process of identifying the software units should result in well-defined System Layer data flows. Develop a System Layer flow diagram that illustrates these flows. An example is shown as Figure 6.6.

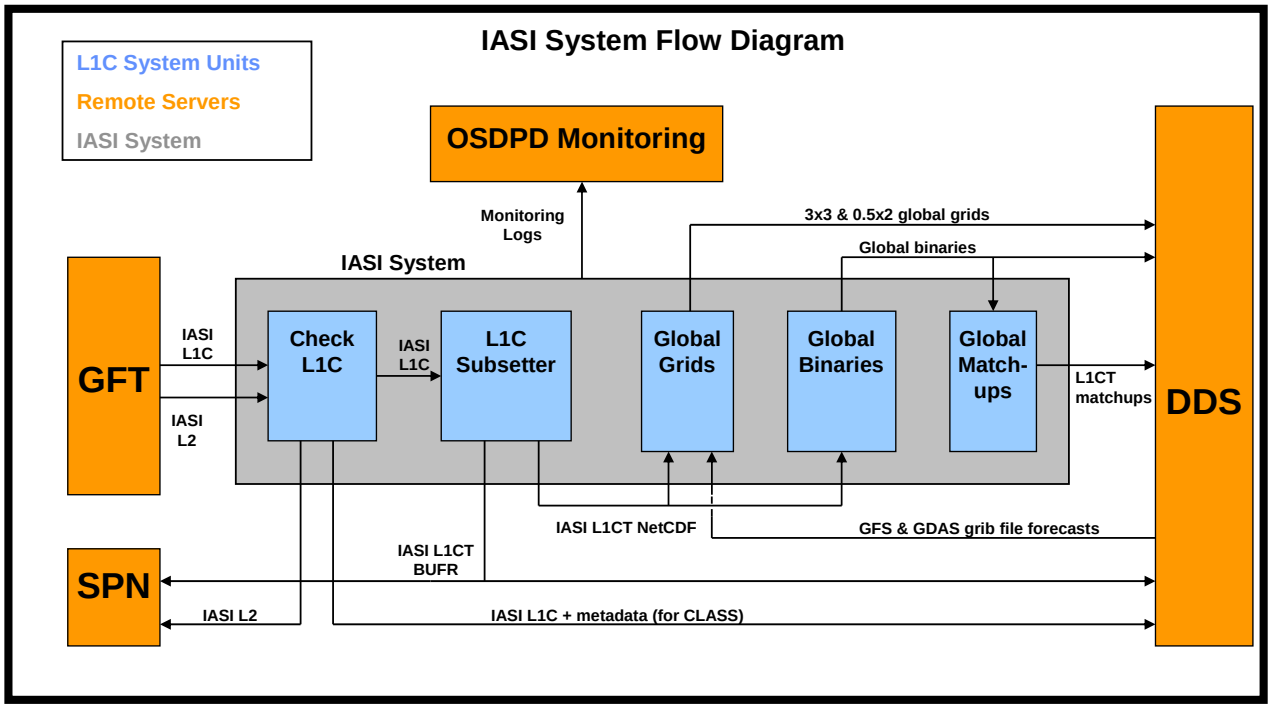

Figure 6.6 – System Layer Data Flows

When the software units are identified and traced to the functional requirements, the Preliminary Design Allocation can be completed by tracing the functional requirements to the other system requirements. The Requirements Allocation Sheet (RAS) should match each requirement to a system component. The highest layer of system components

consists of the software units. Allocation of the requirements to the software units completes the Preliminary Design Allocation.

Once the Preliminary Design Allocation is completed, the **Development Scientists** and **Development Programmers** produce version 2 of the project SWA, in accordance with DG-1.2. This version of the SWA should provide a complete description of the preliminary design software architecture, in accordance with DG-1.2.

6.5.4 Prepare for PDR

The PDR review lead (**Technical Review Lead)** and review team (**Technical Reviewers)** should have been selected during step 5 or 6, and listed in the DPP. If this selection was not completed in step 6, the **STAR Branch Chief**, in consultation with the **Development Lead**, should make this selection as soon as possible during step 7.

Development Scientists assist in a revision of the OCD, following the guidelines in DG-6.1. OCD v1r1 adds to v1r0 by providing operational scenarios for product operation and user interaction for each alternative solution under consideration at PDR. Its purpose is to assist in the selection of a preferred solution by identifying risks and constraints associated with each solution in the preliminary design.

Development Scientists and **Development Testers** assist in a revision of the RAD, following the guidelines in DG-6.2. RAD v1r1 adds to v1r0 by updating the allocation of requirements to system and product components, based on the maturing of solutions and design since PRR, as documented in SWA v2r0. It is possible that the requirements themselves must be changed by addition, deletion, or modification, based on feedback from the development of solutions and design during step 7. In that case, the RAD update should document the changes and the PDD should note what has been changed and provide a rationale for the changes.

Development Scientists and **Development Testers** assist in a revision of the VVP, following the guidelines in DG-6.3. VVP v1r1 adds to v1r0 by updating the listing and description of verification and validation items and plans, based on the maturing of the requirements allocation, solutions and design since PRR, as documented in RAD v1r1 and SWA v2r0.

If the project plan has been modified since the PRR, the **Development Lead** prepares a revision to the DPP for presentation at the PDR.

The **Development Lead** leads the preparation of the PDR presentation.

The PDR slide package is the PDD. The PDD is prepared by the **Development Lead**, **Development Scientists, Development Testers,** and **Development Programmers,** in accordance with PDD guidelines DG-7.1. DG-7.1.A provides PDD slide templates that can be adapted for the project's PDD. The PDD developers should examine the DPP to determine whether the PDR objectives, entry criteria, exit criteria and/or CLI have been tailored. If so, the PDD slide templates must be adapted to accommodate the tailoring. The PDD developers should use the project's PRD as a source for PDD slides, as many PRD slides can be re-used or adapted.

The **Development Lead,** assisted by the **Development Scientists, Development Testers,** and **Development Programmers,** updates the status of the project risks and associated risk mitigation actions for inclusion in the PDD and the PSR Appendix. Risk management guidelines can be found in PG-1.

The **Development Lead** determines which members of the development team will present the PDD sections. These presenters should be noted in Section Title slides. See DG-7.1.A for examples.

STAR CM/DM inserts the standard BB 2.2 items in the baseline, and updates the Project Baseline Report (PBR) to version 2.2, in accordance with PBR guidelines DG-5.4.

The **Development Lead** informs the **STAR Web Developer** that the PDR artifacts are ready for posting on the STAR EPL website. The **STAR Web Developer** works with **STAR CM/DM** to acquire the project baseline items and post them on the website.

Once these are posted the **STAR Web Developer** informs the **Development Lead**, who then informs the **Technical Review Lead** that the PDR artifacts are available for review. The **Technical Review Lead** then informs all review team members that the artifacts are available to them.

The **Technical Review Lead** and **Technical Reviewers** may at their discretion examine the artifacts and communicate issues to the **Development Lead** prior to the review date, so that the artifacts and/or review presentation may be revised to respond to reviewer concerns.

6.5.5 Conduct PDR

The “Preliminary Design” step culminates with a PDR. The PDR consists of the presentation of the Preliminary Design Allocation by the development team (**Development Lead**, **Development Scientists, Development Testers,** and **Development Programmers)** and the disposition of the review CLI, including entry and exit criteria, by the reviewers (**Technical Review Lead** and **Technical Reviewers**).

The **Technical Review Lead** and the **Technical Reviewers** conduct the PDR to determine whether the project preliminary design is complete and sufficiently mature to proceed to detailed design. Reviewers should be familiar with the PDR guidelines (PRG-7) and check list (CL-7).

The PDR reviewers complete a Preliminary Design Review Report (PDRR), following guidelines in DG-7.2. The PDRR will include the reviewers’ assessment of the status of the PDR artifacts, the project risks, and associated risk mitigation actions, and an Appendix that consists of the reviewers’ disposition of each PDR CLI.

On the basis of its disposition of the PDR CLI, the **Technical Review Lead** and the **Technical Reviewers** determine whether the project is ready to proceed to the next step, “Detailed Design”. If not, the PDRR should direct the **Development Lead** to revise the PDR artifacts through specified actions. These actions may include a new assessment of revised PDR artifacts at a delta review.

If a delta review is required, the **Development Lead** and support team upgrade the PDR artifacts as requested by the PDR reviewers and present them at a delta PDR. This is repeated until the **Technical Reviewers** pass the project to step 8.

If a delta review is not required, the revision of the PDR artifacts will be deferred to actions performed during step 8 for review at the CDR, or during later steps for review at later reviews. All of this should be documented in the final version of the PDRR.

STAR QA verifies that the PDR was conducted in accordance with STAR EPL standards.

STAR CM/DM updates the project baseline via BB 2.3, and updates the Project Baseline Report (PBR) to version 2.3, in accordance with PBR guidelines DG-5.4. BB 2.3 will include all post-PDR revisions to the PDR artifacts, the PDRR, and PBR_2.3.

Each stakeholder who performed activities during step 7 is encouraged to document an assessment of the experience in a personal record. This assessment should include: what was good, what was bad, what worked, what did not work, what can be improved, how it can be improved.

The **Development Lead** should remind the stakeholders to do this. At the conclusion of Development (step 11), the **Development Lead** will collect the final edited personal stakeholder records and incorporate them into a Development Project Report (DPR).

END OF DOCUMENT