



Important Considerations for Transitioning Ground Systems to Operations

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2018 Ground Systems Architecture Workshop

January 18, 2018

Approved for public release. OTR 2018-00204.



ABSTRACT

Deploying and transitioning a spacecraft ground system (GS) (whether brand new or upgraded software) into operations at the spacecraft ground station needs to be carefully planned well in advance. Aerospace recently created a checklist of tasks to ensure appropriate plans and activities are conducted to ensure a seamless transition from an old ground system to a new ground system. To develop this checklist, Aerospace identified lessons learned and best practices in recently published reference material to ensure a smooth GS transition into operations. These were turned into tasks organized into the following categories to allow program personnel to refer to important GS transition checklist items in their area:

- Program planning tasks

- Deployment & Transition planning tasks

- GS development tasks

- Test planning tasks

- O&M planning tasks

This presentation highlights and discusses some of the checklist items that may be of particular interest to GSAW attendees.



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1.0 Introduction/Background

Ground Segment Transition Checklist

- Aerospace was asked to develop a Ground Segment Transition Checklist to assist in planning all the tasks to be accomplished for a successful transition to operations
 - *Aerospace identified lessons learned and best practices from recently published reports (see References in backup) and turned them into the checklist tasks*
 1. Ground Segment Systems Engineering Handbook (Aerospace)
 2. NIST SP 800-160: Considerations for a Multidisciplinary Approach in the Engineering of Trustworthy Secure Systems
 3. AIAA paper: Implementation of Mission Assurance Processes for Air Force Space Systems' Operational Transitions

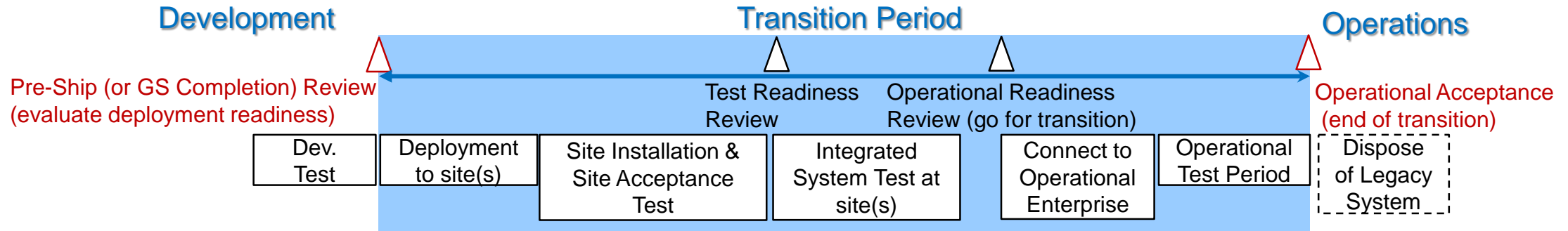
Transition to operations process includes:

- *“All of the tasks necessary to deploy the ground segment to the field and to eventually turn over the system to its owners and operators.” [1: 14.4.6] (Reference 1, Section 14)*



Notional Ground Segment Transition Timeline

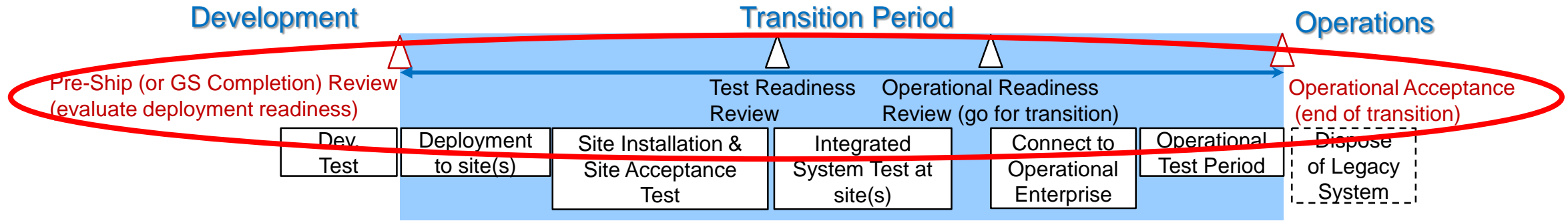
Ground Segment Transition Checklist





1.2 Notional Ground Segment Transition Timeline

Ground Segment Transition Checklist



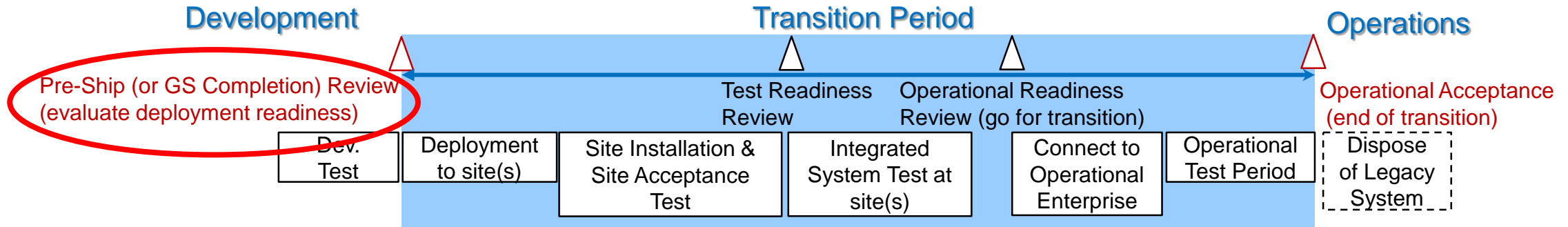
GS = Ground Segment

Transition milestones



1.2 Notional Ground Segment Transition Timeline

Ground Segment Transition Checklist



Pre-Ship Review (PSR)

Assures that hardware and components, software, and procedural documentation are ready to ship to the deployment sites.

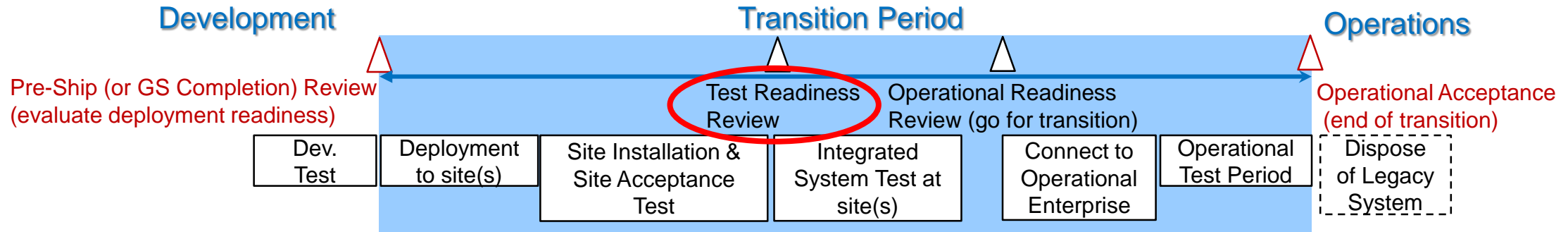
Segment Completion Review (SCR)

Assures that the segment has completed its major development requirements.



1.2 Notional Ground Segment Transition Timeline

Ground Segment Transition Checklist

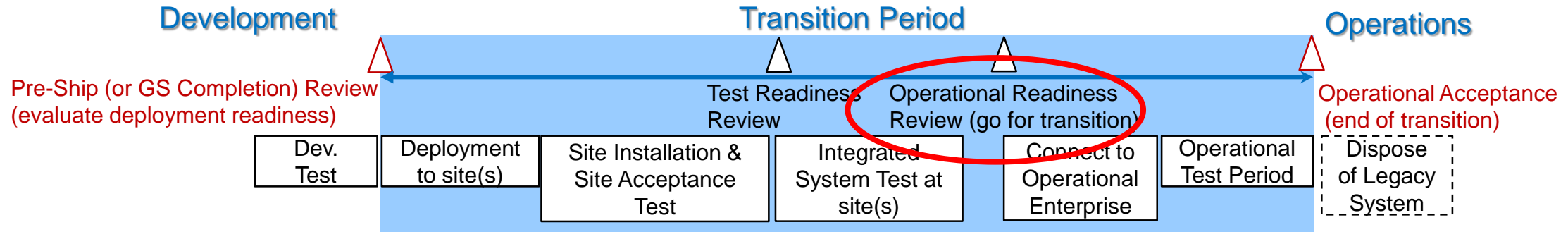


Test Readiness Review prior to site Integrated System Test



1.2 Notional Ground Segment Transition Timeline

Ground Segment Transition Checklist



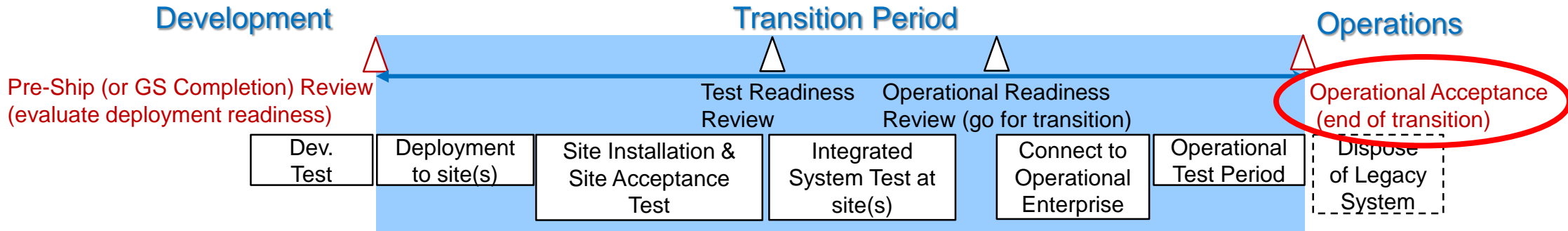
Operational Readiness Review (ORR)

The ORR ensures the delivered capability, segment, system, and enterprise under review is sufficiently stable and functional to transition/deploy; and ensures the necessary plans, procedures, and resources (e.g., facilities, equipment, personnel) are adequate to accomplish the transition to operations; and the participants are prepared to execute the transition.



1.2 Notional Ground Segment Transition Timeline

Ground Segment Transition Checklist

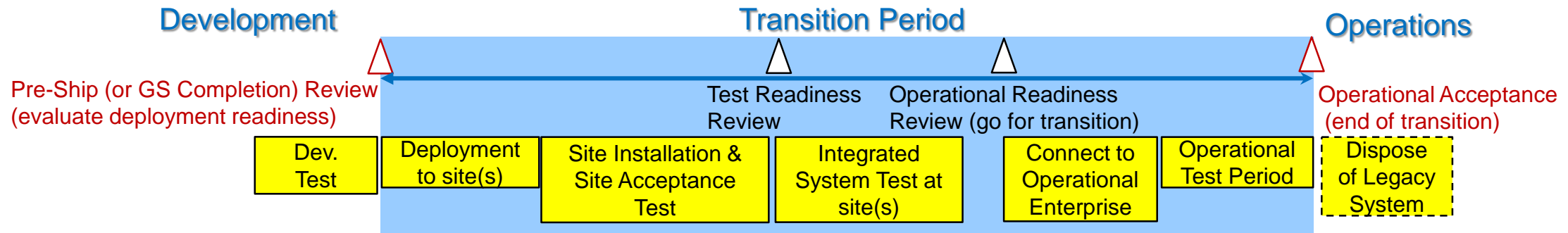


Operational Acceptance (OA) Final decision point in the Operational Transition Process. Once approved, the new capability or system modification is made available for operational users.



1.2 Notional Ground Segment Transition Timeline

Ground Segment Transition Checklist

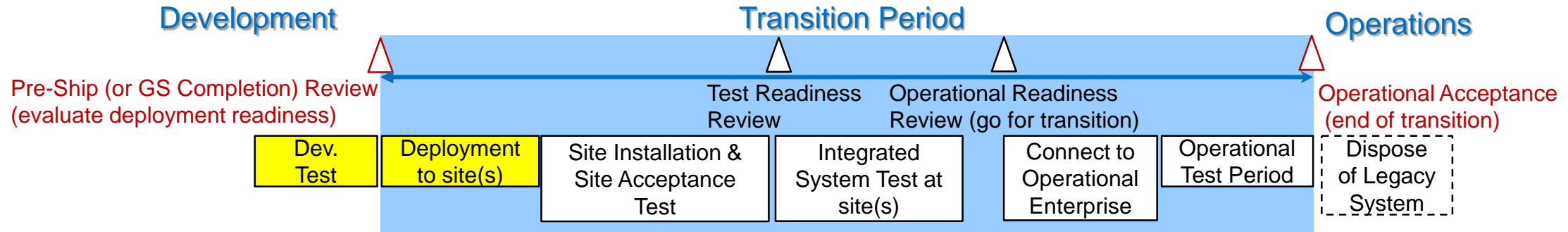


Transition Activities



1.2 Notional Ground Segment Transition Timeline

Ground Segment Transition Checklist

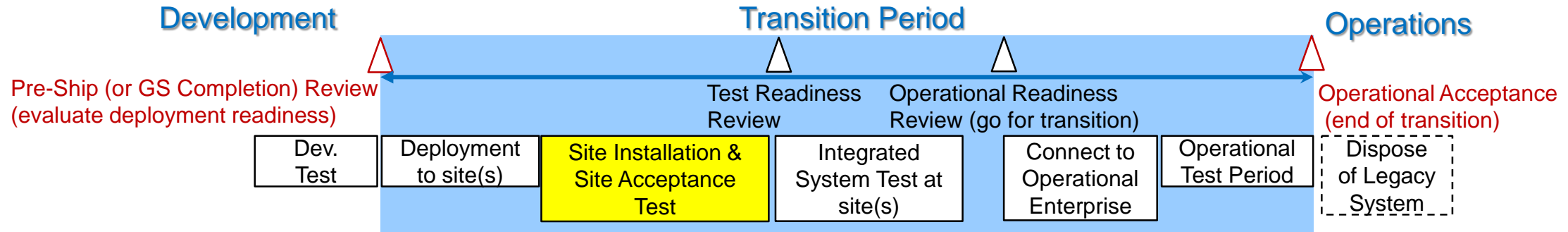


Development test at factory
Deployment to site(s)



1.2 Notional Ground Segment Transition Timeline

Ground Segment Transition Checklist



Site Acceptance Test (SAT)

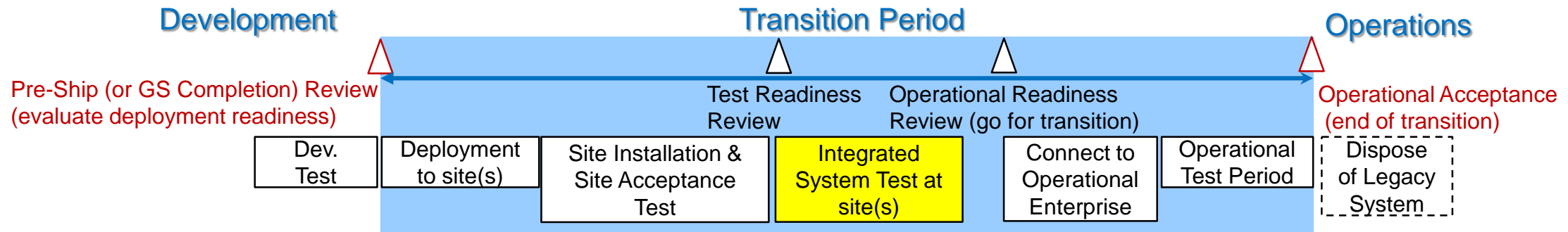
Test to determine if the system has been installed correctly and is ready for site integration and test.

Site installation
Site acceptance test



1.2 Notional Ground Segment Transition Timeline

Ground Segment Transition Checklist

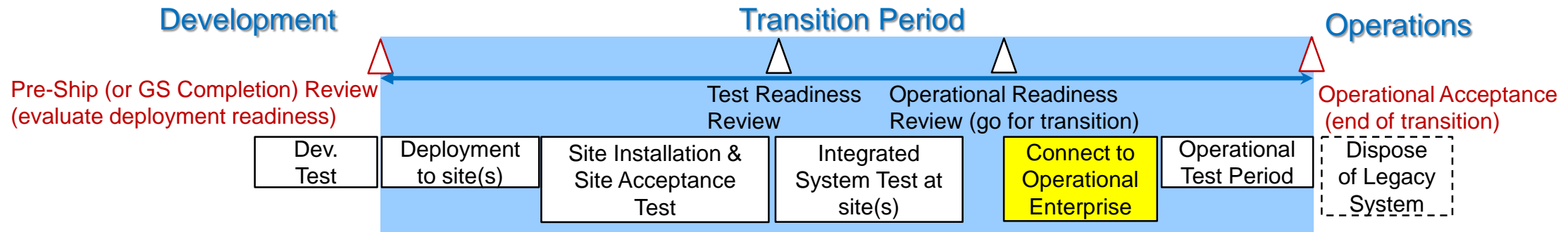


Integrated System Test at site(s)



1.2 Notional Ground Segment Transition Timeline

Ground Segment Transition Checklist

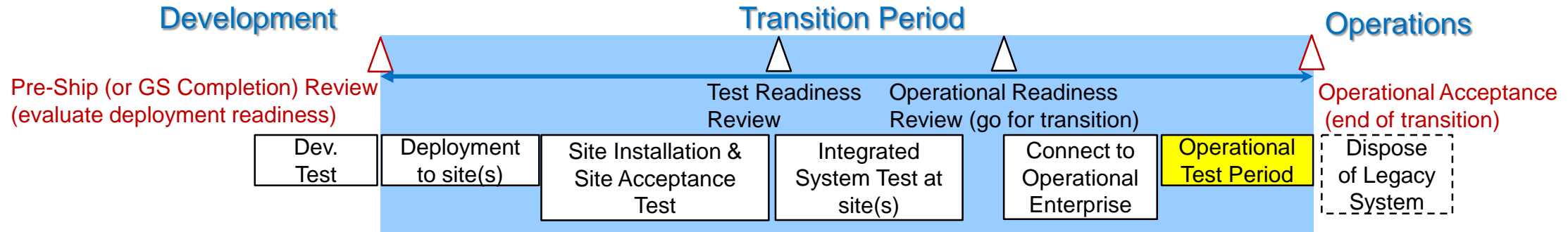


Connect live



1.2 Notional Ground Segment Transition Timeline

Ground Segment Transition Checklist



Operational Test (OT)

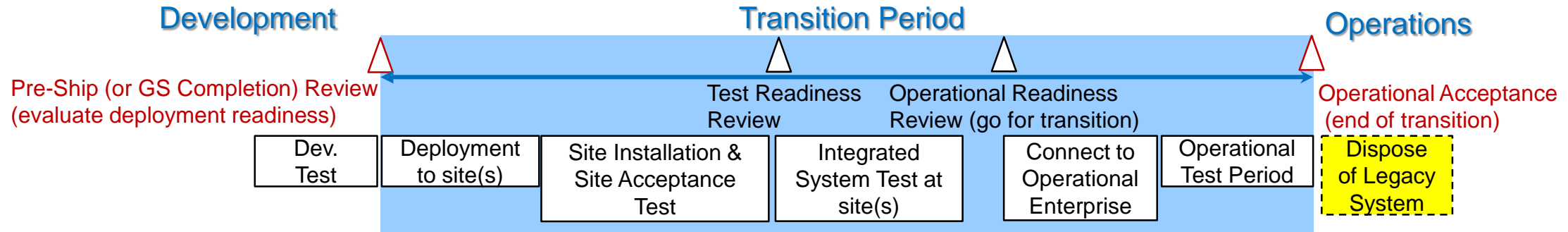
Tests conducted by the user or operator organization to determine suitability for use in operations.

Operational (acceptance) test period



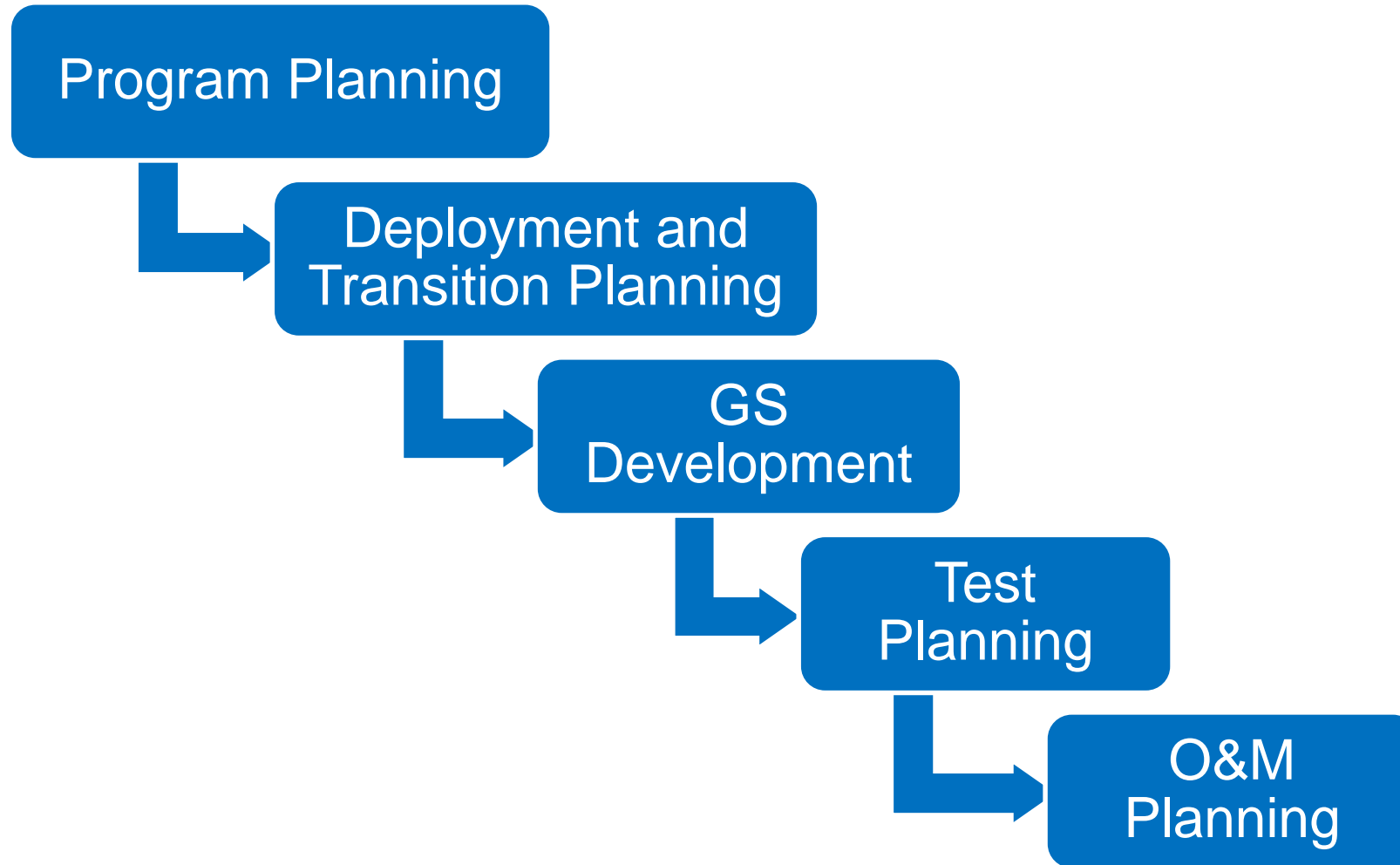
1.2 Notional Ground Segment Transition Timeline

Ground Segment Transition Checklist



Disposal (as needed)

2.0 Ground Segment Transition Checklist Organization

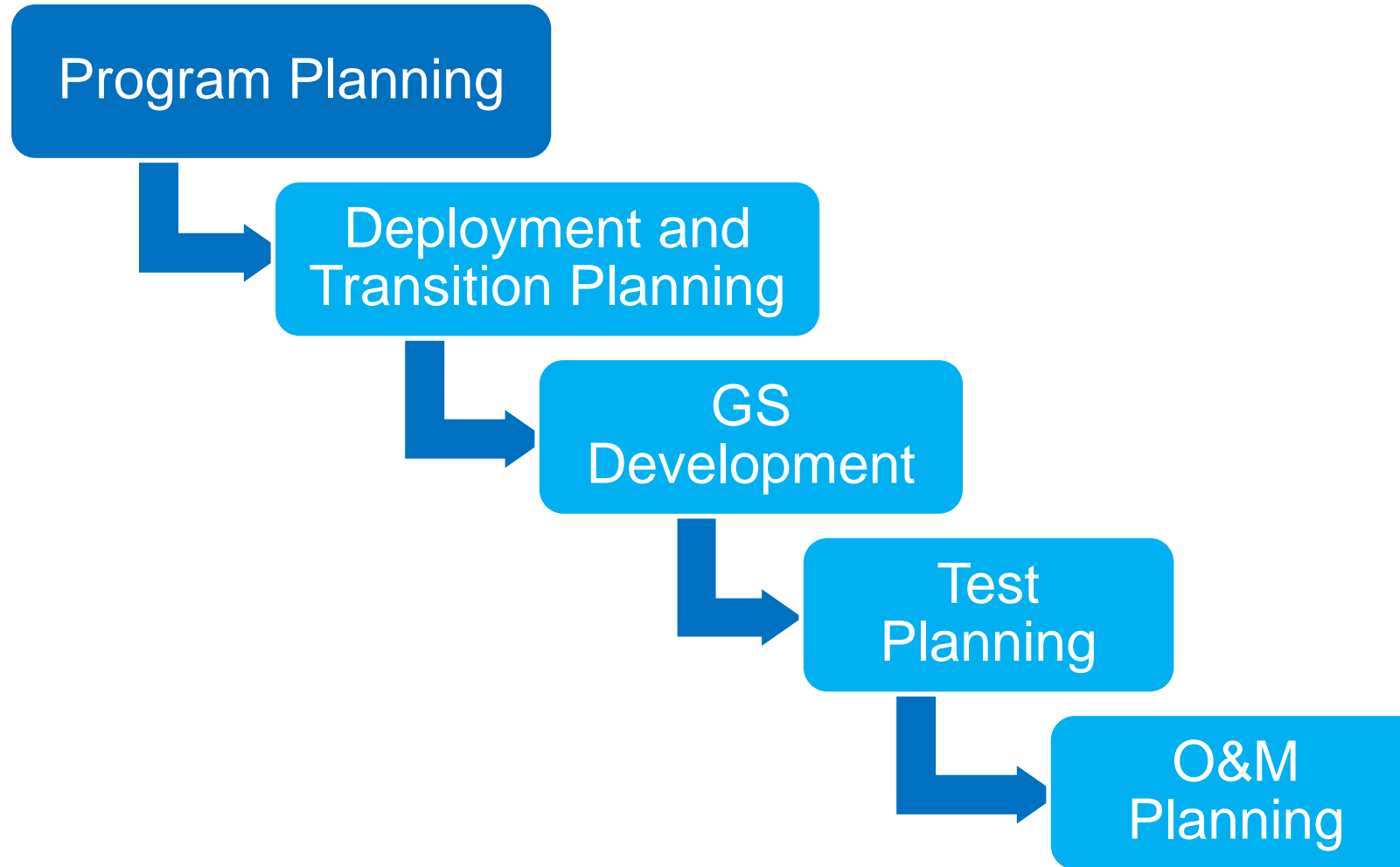


Checklist tasks organized under these groupings

GS = Ground Segment
O&M = Operations and Maintenance



3.1 Program Planning Checklist Tasks



GS = Ground Segment
O&M = Operations and Maintenance

GS transition needs to be an important part of the program plans (including contractor Statement of Work) and replans



Ground Segment Program Planning Checklist Tasks (1 of 3)

- System Architecture: Ensure system architecture considers need for future evolution [1: 24.5]
 - *COTS/FOSS software evolution*
 - *Technology refresh (hardware, software)*
 - *How to transition subsequent increments*

The only constant is change!



Ground Segment Program Planning Checklist Tasks (2 of 3)

- **Certification Plans:** Start early to identify and develop needed Certification Plans [1: 10.4.5]
 - *Security especially*
- **Development Contract:** accommodate transition planning and all expected transition activities [1: 1.5]
 - *Include CDRLs for Transition Plan and Procedures, early O&M Plan*

O&M = Operations and Maintenance

Start with the end in mind!



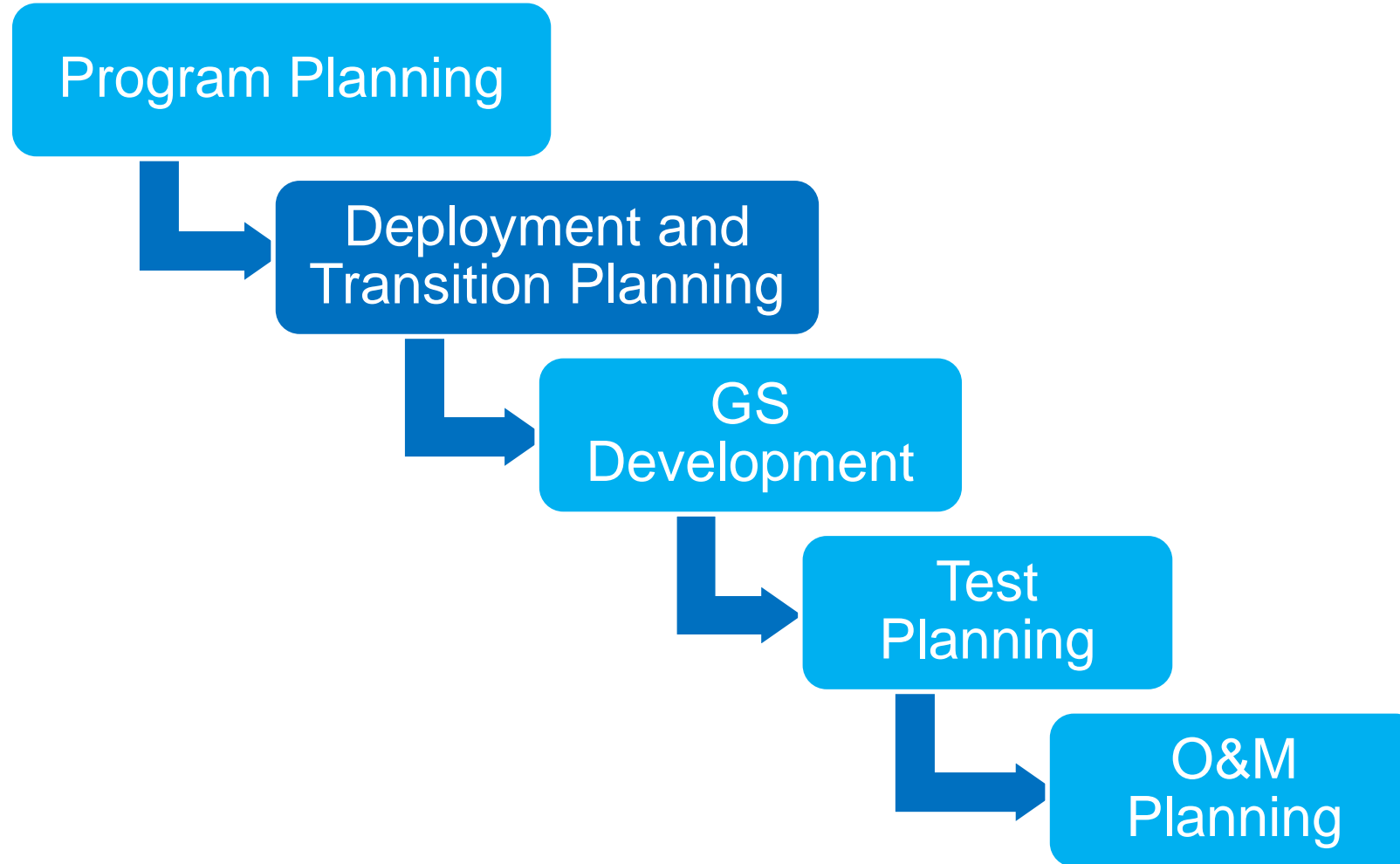
Ground Segment Program Planning Checklist Tasks (2 of 2)

- **Transition Planning: Start early** [3: III E, 5-1]
 - *Designate program office lead*
 - *Ensure stakeholder participation*
 - *Schedule periodic transition plan reviews with stakeholders* [3: III E, 5-2]
- **Operator Involvement: Plan to involve operators in system design and testing** [1: 22.5]
 - *Especially in operations concepts, developmental test activities, and contractor reviews* [3: IIIA, 1-7]
 - *Decisions on format and content of command procedures and telemetry displays* [1: 22.5]

Organize your transition stakeholders to ensure their involvement



3.2 Deployment and Transition



Ensure all aspects and stakeholders are involved and ready to execute

GS = Ground Segment
O&M = Operations and Maintenance



Deployment and Transition Planning Phase Checklist Tasks (1 of 5)

- Analyze each transition event and formulate plans and procedures [3: III C, 3-1]
 - *Provide stakeholder transition requirements to development and test teams [1: 10.4.6]*
 - *Ensure contractor provides a plan for how each product will be deployed and transitioned to operations/sustainment/maintenance [1: 11.3, 11.6]*
 - *Define an approach to fall back to the prior system software if the new system fails severely or is not suitable for operations [1: 11.3.6]*

Transition lead needs to carefully plan each transition event



Deployment and Transition Planning Phase Checklist Tasks (2 of 5)

- Plan to perform the security aspects of transition [2: TR-1]
 - *Identify the security aspects of transition* [2: TR-1]
 - *Prepare to perform the security aspects of transition* [2: TR-2]

Carefully plan the security aspects of each transition event!



Deployment and Transition Planning Phase Checklist Tasks (3 of 5)

- Prepare software deployment plans [1: 18.3.1.6.1]
 - *Ensure contractor prepares a software version description document (CDRL), for each operational site*
 - *Schedule installation and checkout of executable software and COTS/FOSS software at each operational site and at the maintenance depot*
- Prepare hardware deployment plans [1: 18.3.1.6.1]
 - *Provide hardware user instructions and training materials for end users to operate the hardware (preferably in an online format)*

Deployment tasks



Deployment and Transition Planning Phase Checklist Tasks (4 of 5)

- Ensure operator participation [1: 18.3.1.6.1]
 - *All operator positions should participate in the preparation and checkout of their deployment and transition procedures*
 - *Allow operators to participate in the population of operational databases and other data files*

Operators need to be confident in their procedures and data



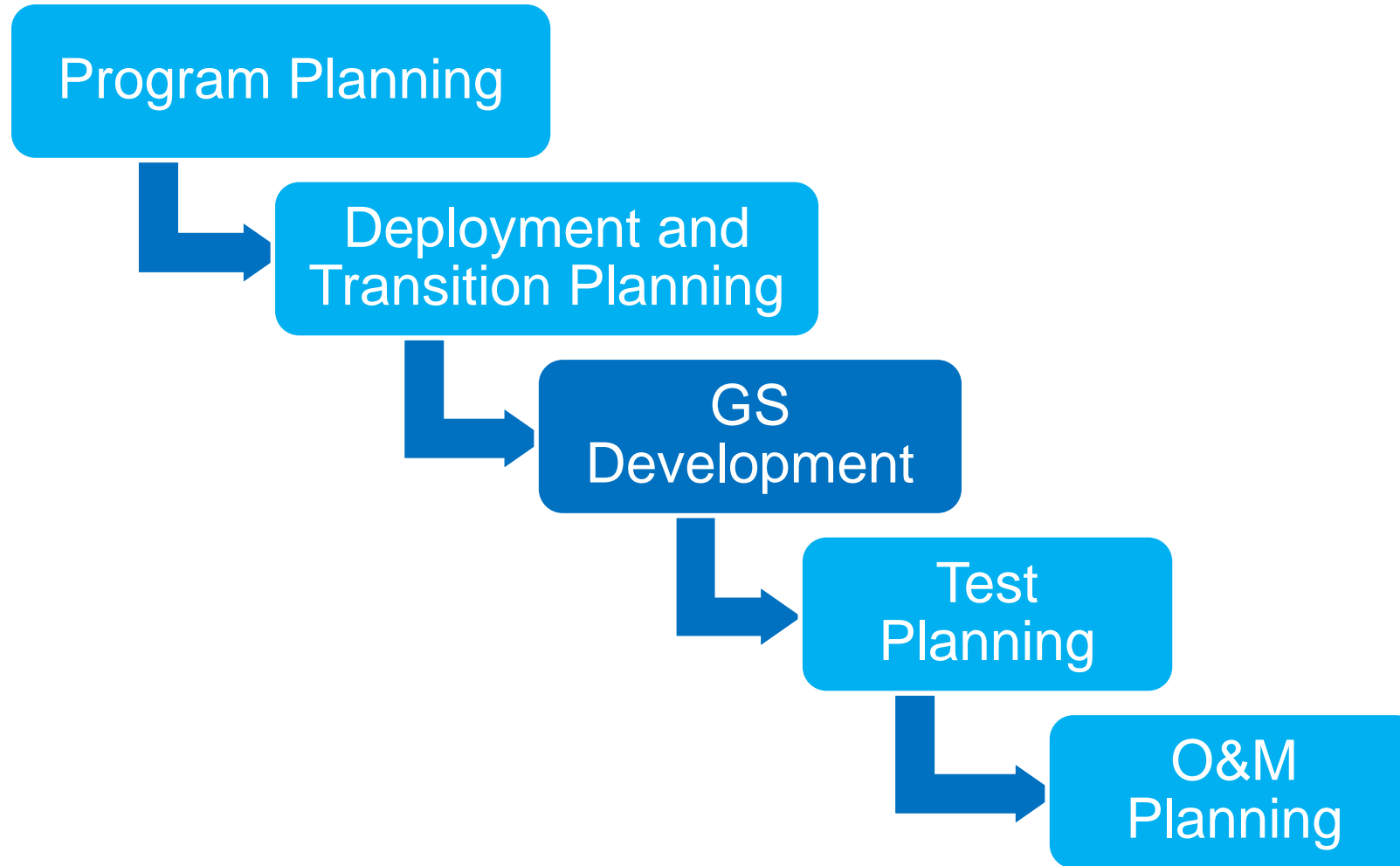
Deployment and Transition Planning Phase Checklist Tasks (5 of 5)

- **Schedule periodic transition plan reviews with stakeholder management**
 - *Define transition planning assessment points with the relevant products that will be available at those points [3: III E, 5-3]*
 - *Ensure all stakeholders are ready for operational acceptance (system ownership change) [3: III E, 5-1]*
 - *Ensure all stakeholders understand the risks and impacts of a delayed transition [3: III C, 3-3]*
- **Re-evaluate transition plans regularly [3: III E, 5-1]**
 - *Especially after program scope changes and replans*

Communicate and update your plans



3.3 *Ground Segment Development*



GS = Ground Segment
O&M = Operations and Maintenance

Plans for transitioning software and hardware are defined in this stage



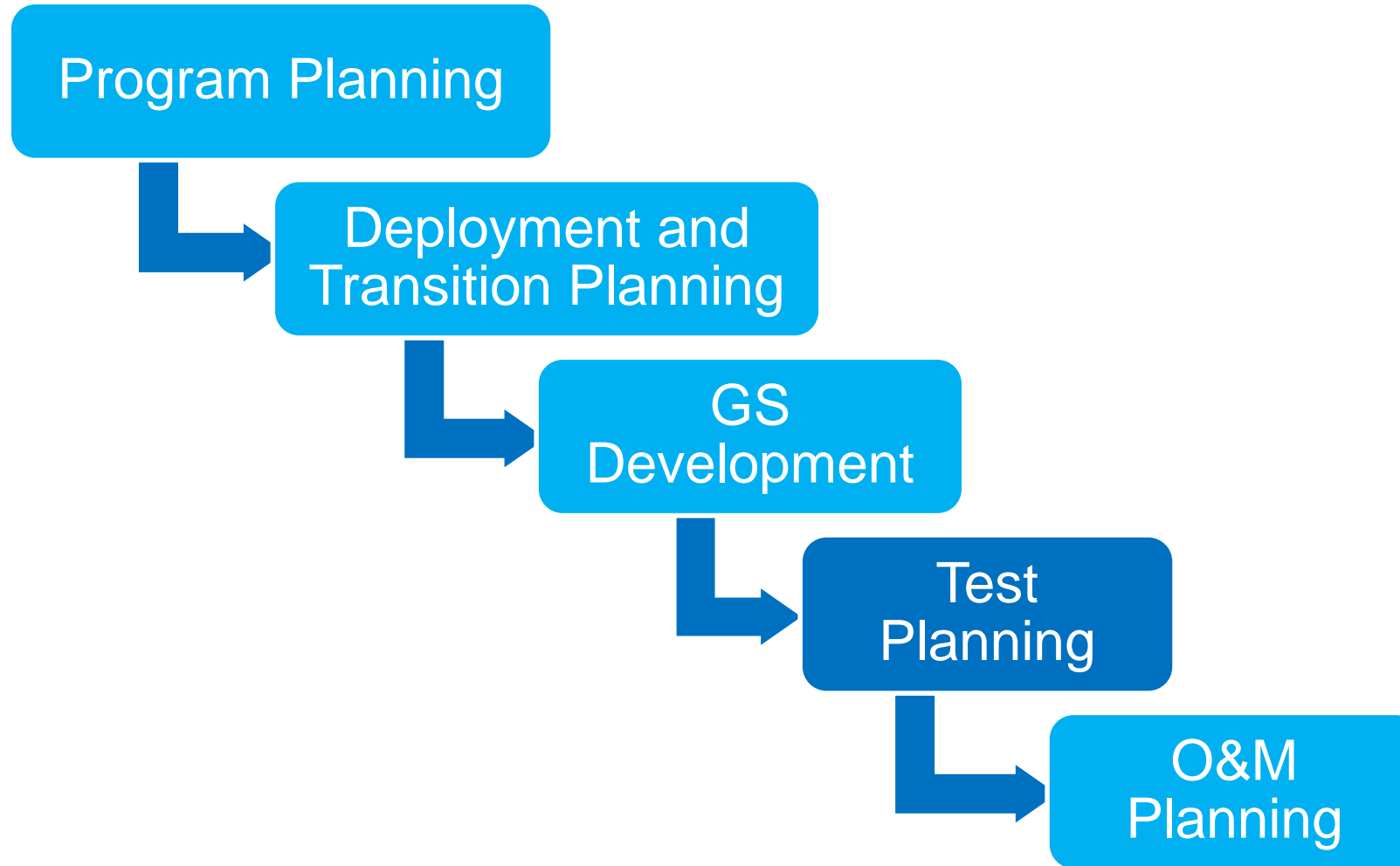
GS Development Phase Checklist Tasks

- Ensure all stakeholder transition requirements are considered in system design and segment testing [1: 10.4.6]
- As concepts of operation evolve, update the contractor requirements baseline and development test procedures [3: III A, 1-10]
- Gather and assess key system maturity metrics periodically [3: III A, 1-13]
 - *Provide to all stakeholders*
- Critical Design Review (CDR)
 - *Review plans for transitioning the hardware and software for completeness, and consistency with operational site requirements [1: 29.5.2.2.5]*

Keep site transition requirements up to date in contractor baseline



3.4 Test Planning



GS = Ground Segment
O&M = Operations and Maintenance

Tests mitigate the risks of GS transition to operations



Test Planning Phase Checklist Tasks (1 of 2)

Development Test (DT)

- Ensure DT test procedures are operationally realistic [3: III A, 1-1; 1: 21.5.1]
- Test plans should include flow of the operational data through all paths, including offline and analysis software [3: III A, 1-4]
- Support equipment (e.g. simulators) and test data used should be sufficient for determining ops readiness (e.g. ops realistic loading) [3: III A, 1-2]
- Conduct DT with operational tester and operator/maintainer (user) involvement [1: III D, 4-4]
 - *Exercise ops product sustainment plans and procedures during development test and operational test* [3: III D, 4-4]

Development Test needs to be robust



Test Planning Phase Checklist Tasks (2 of 2)

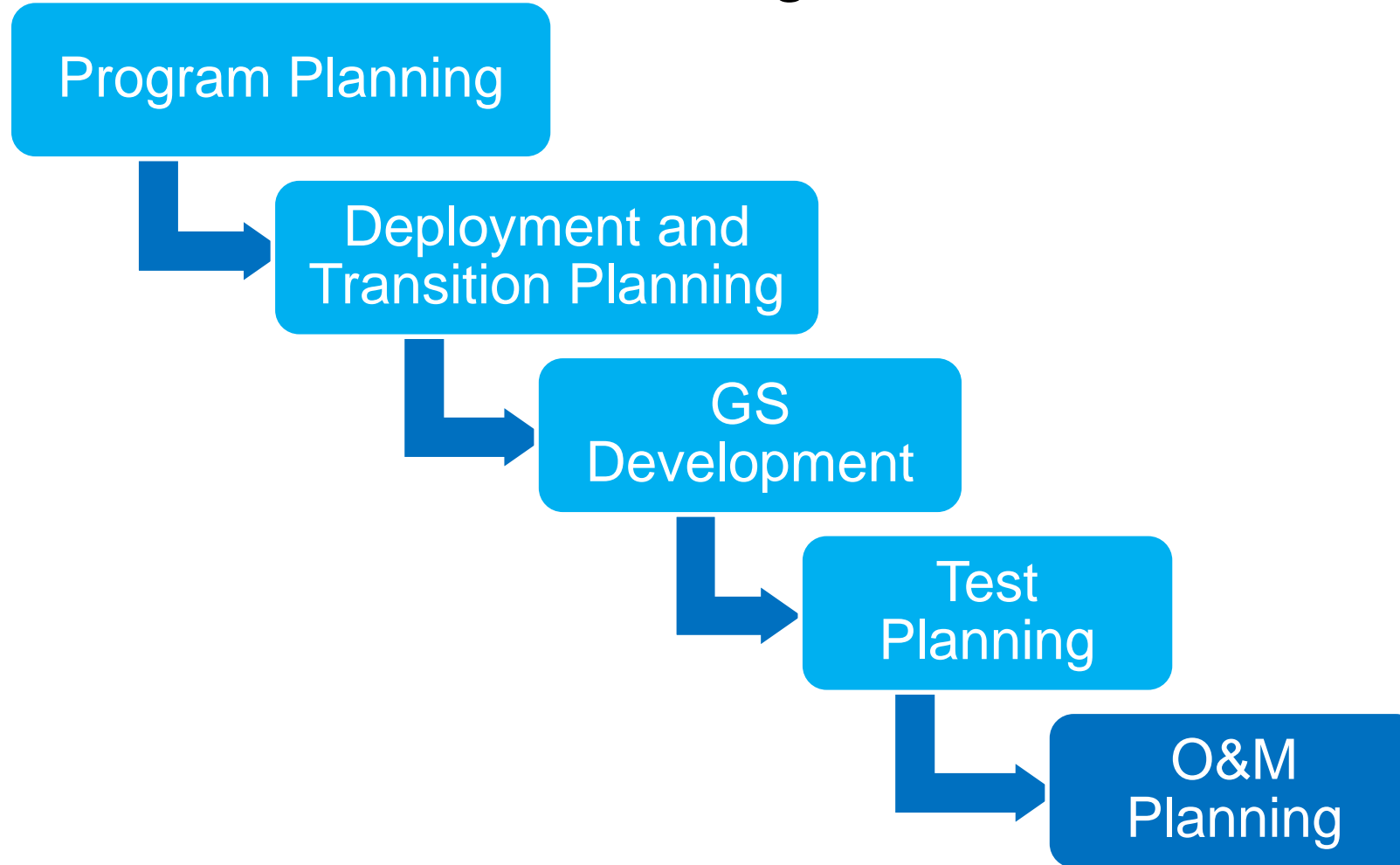
Development Test (DT)

- Include stability and stress test cases in the DT scope [3: III A, 1-3]
 - *Long duration tests without breaks to demonstrate stability under operational load*
 - *Test every possible operational configuration (space and ground) including off-nominal*
 - *Exercise max data volume and max operator interface workload scenarios*
 - *Exercise off-nominal cases, backup locations and data paths, and worst-case scenarios*
- Update Development Test (DT) test plans for updates to the operations concepts [3: III A, 1-11, 1-9]

Ensure test plans are consistent with operational tempo



3.5 Operations and Maintenance Planning



GS = Ground Segment

O&M = Operations and Maintenance

The program needs to include operators and maintainers in vital aspects of the program and ensure they are trained and ready to operate and maintain the delivered capability



O&M Planning Phase Checklist Tasks

- Create the O&M Plan in time to prepare for transition and Operational Test:
 - *Determine O&M staffing levels, skill levels, and training requirements [1: 8.4.4]*
 - *Define logistics, training, tools, products, and other support functions needed [3: III D, 4-2]*
 - *Ensure site support functions are staffed and trained to support site activities [3: III D, 4-2]*
- Prepare for operations acceptance
 - *Schedule operational testing and an interim trial period of operations (If desired) [1: 23.1]*
 - *Update O&M plans and procedures based on evolving concepts of operation [3: III A, 1-10]*
 - *Staff, train and certify adequate operators and maintainers to support transition, operational test, and continued operations [3: III D, 4-1]*

GS = Ground Segment
O&M = Operations and Maintenance

Ensure all operating organizations are involved preparing for your GS



4.0 Summary

Ground Segment Transition Checklist

- A checklist of recommended tasks to ensure a smooth and uneventful transition of a new ground segment into operations has been derived from knowledgeable sources
- These tasks have been organized by the following categories:
 - *Program planning tasks*
 - *Deployment & Transition planning tasks*
 - *GS development tasks*
 - *Test planning tasks*
 - *O&M planning tasks*
 - *Transition readiness evaluation criteria*

GS = Ground Segment
O&M = Operations and Maintenance



Backup

References

Acronyms and Definitions



5.0 References

- Tasks in this paper were derived from the following references:

Reference	Year
1. Ground Segment Systems Engineering Handbook, TOR-2016-01797, The Aerospace Corporation	2016
2. Systems Security Engineering, National Institute of Standards and Technology (NIST) Special Publication (SP) 800-160	2016
3. David H. McCasland, Ibrahim Awwad, Jeffrey J. Vance, Wayne G. Yenne, and Bruce Arnheim. "Implementation of Mission Assurance Processes for Air Force Space Systems' Operational Transitions", SpaceOps 2014 Conference, SpaceOps Conferences (AIAA paper 2014-1674)	2014



6.0 Appendix (1 of 3)

Acronyms

Acronym	Meaning
AIAA	American Institute of Aeronautics and Astronautics
ATC*	Authority To Connect
ATO*	Authority To Operate
CDR	Critical Design Review
COTS	Commercial Off The Shelf
DT*	Development Test
FCA	Functional Configuration Audit
GS	Ground Segment
Hdbk	Handbook
IMP	Integrated Master Plan
IMS	Integrated Master Schedule
IOC	Initial Operational Capability
MA	Mission Assurance

Acronym	Meaning
NIST	National Institute of Standards and Technology
O&M*	Operations and Maintenance
OAR	Operational Acceptance Review
ORR	Operational Readiness Review
OT*	Operational Test
PCA	Physical Configuration Audit
PDR	Preliminary Design Review
PSR	Pre Ship Review
SAT	Site Acceptance Test
SCR	Segment Completion Review
SP	Special Publication
TOR	Technical Operating Report
WBS	Work Breakdown Structure

* See definition next chart



Appendix (2 of 3)

Definitions

Term	Definition
Authority To Connect	Security approval to connect to other secure systems
Authority To Operate	Security approval to operate in the secure enterprise environment
Development Test (DT)	Tests conducted by the acquirer or development contractor to determine specification compliance and readiness for operational test.
Operational Acceptance (OA)	Final decision point in the Operational Transition Process. Once approved, the new capability or system modification is made available for operational users.
Operational Readiness Review (ORR)	The ORR ensures the delivered capability, segment, system, and enterprise under review is sufficiently stable and functional to transition/deploy; and ensures the necessary plans, procedures, and resources (e.g. facilities, equipment, personnel) are adequate to accomplish the transition to operations; and the participants are prepared to execute the transition.
Operations and Maintenance (O&M)	Performing mission operations and maintaining the system's operational capability.
Operational Test (OT)	Tests conducted by the user or operator organization to determine suitability for use in operations.



Appendix (3 of 3)

Definitions

Term	Definition
Pre-Ship Review (PSR)	Assures that hardware and components, software, and procedural documentation are ready to ship to the deployment sites.
Segment Completion Review (SCR)	Assures that the segment has completed its major development requirements.
Site Acceptance Test (SAT)	Test to determine if the system has been installed correctly and is ready for site integration and test.