

NATIONAL RECONNAISSANCE OFFICE

NRO CAIG O&M WBS and Duration Guidance

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Overview



- + NRO and NRO CAIG

- + Background

- + Duration Analysis
 - Methodology
 - Factors
 - Recommendations

- + O&M Work Breakdown Structure (WBS)
 - Purpose
 - Process
 - Scope
 - Conventions
 - Recommended WBS



About the NRO

- ✦ The National Reconnaissance Office (NRO) is the national program to meet the U.S. Government's intelligence needs through spaceborne reconnaissance
- ✦ Department of Defense (DoD) agency and an element of the Intelligence Community
- ✦ Funded through the National Intelligence Program and the Military Intelligence Program portions of the federal budget
- ✦ NRO existence was declassified by the Deputy Secretary of Defense on September 18, 1992

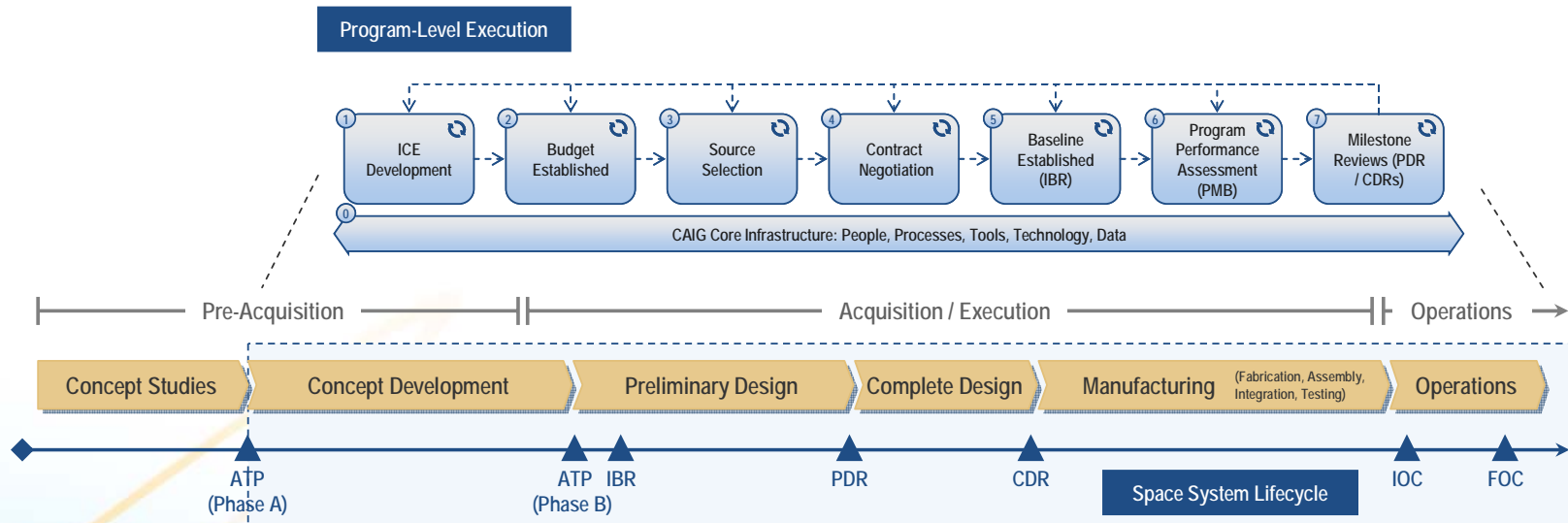




NRO Cost Analysis Improvement Group (CAIG)



- ✦ Incorporates Earned Value Management, Corporate Cost, and Resource Management processes
 - Support annual NRO budget build
 - Support source selections and proposal assessments for competitive awards and should cost analysis of sole-source procurements
 - Provide independent cost and schedule analyses for all major program milestones
 - Earned Value Management Center of Excellence
- ✦ Provide program support as necessary to ensure cost realism
- ✦ Develop “Best in Class” processes and models



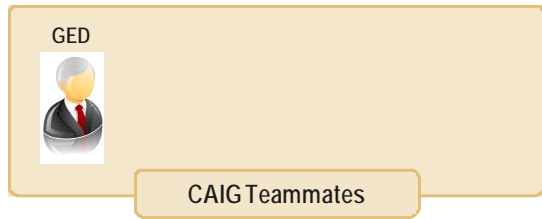


CAIG Cross-Program Perspective

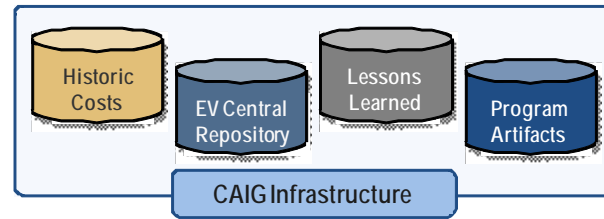


- ✦ In addition to individual program support, the NRO CAIG is uniquely positioned to provide cross-program insight and analysis:
 - Supports operating as a single integrated entity optimized for enterprise not individual-level performance
 - Places renewed emphasis on enterprise-level planning and cross-INT integration

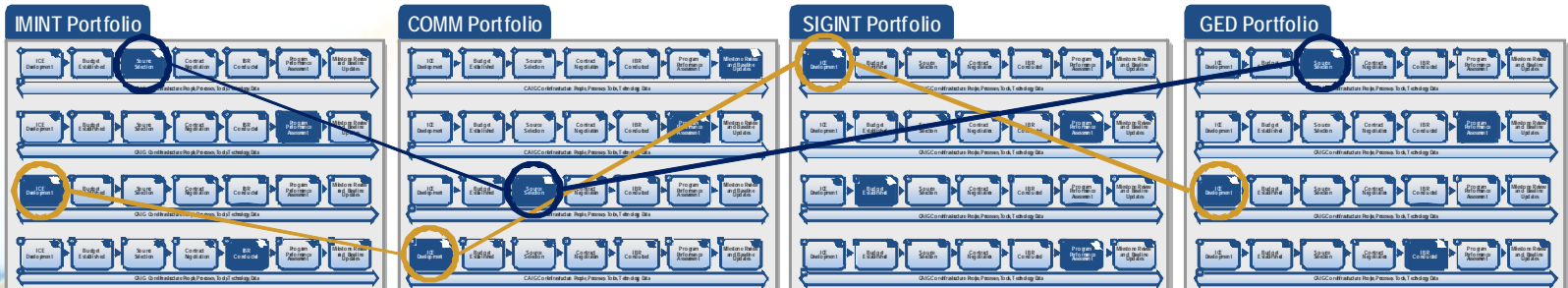
CAIG Perspective & Value Proposition



- ▶ Extensive Knowledge of NRO Corporate History
- ▶ Unparalleled breadth of Enterprise decisions and consequences across programs over time
- ▶ Deep Quantitative Skill Set and Knowledge Base



- ▶ Constantly evolving centralized repositories for all Cost, Schedule, and Program Artifacts
- ▶ Maturing cross-program understanding of lessons learned





Background



- ✦ NRO Inspector General (IG) emphasized the need to estimate O&M consistently across teams and recommended implementation of formal guidance to standardize:
 - Duration of Major System Acquisition (MSA) O&M costs
 - NRO-wide definition of the O&M costs included in an Independent Cost Estimate (ICE)

- ✦ CAIG responded by:
 - Developing a standard recommended duration of ICE O&M costs
 - Developing a standard O&M WBS that serves as the definition of O&M costs

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Existing Duration Guidance

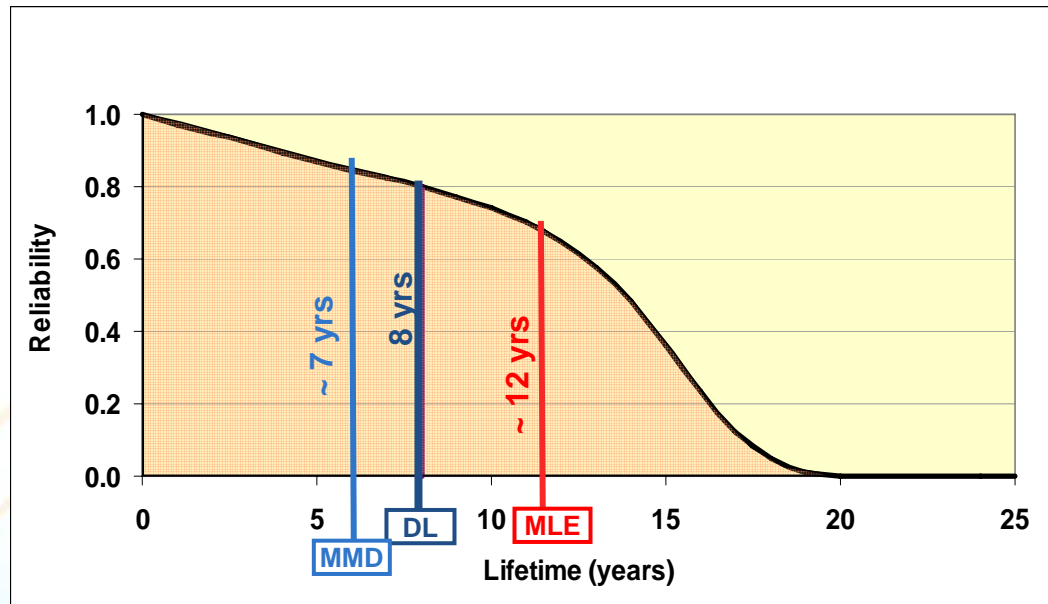


- + Office of Secretary of Defense (OSD): No guidance for Space O&M duration
- + Government Accountability Office (GAO): Estimate life-cycle through “Useful Life” (undefined for Space Vehicles (SVs))
- + Office of Management and Budget (OMB): No guidance for Space O&M duration
- + Office of the Director of National Intelligence (ODNI): ICD 801
 - “In accordance with Title 50, US Code, Section 415a-1, the DNI will prepare an ICE of the full-life cycle cost of the development, integration, and operation of each major system to be acquired by the Intelligence Community (IC).”
 - DNI uses Full Operational Capability (FOC) plus 10 years
- + National Aeronautic and Space Agency (NASA): No guidance provided for O&M in the NASA Cost Estimating Handbook



SV Life Metrics

- ✦ Design Life (DL): “Minimum intended operational time on orbit”; accounts for random failures but not life limiters (e.g. fuel, battery cycles)
- ✦ Mean Mission Duration (MMD): Average time a SV will survive up to design life (Always shorter than DL)
- ✦ Mean Life Expectancy (MLE): Projected average lifetime of all satellites, including those that live beyond DL; is updated periodically, can be much longer or shorter than DL, and is a more realistic measure of lifetime.
- ✦ De-orbit Date: The date the SV is removed from service and is no longer operational in any capacity

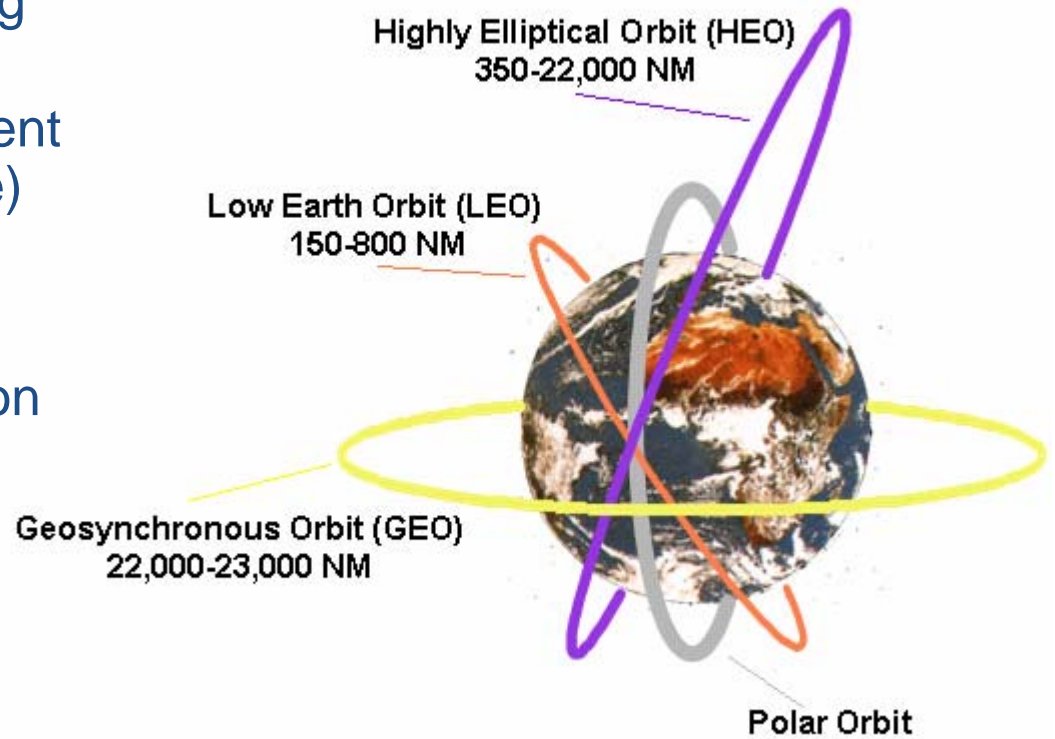




Effect of Orbit Type on SV Life



- + LEO Orbit
 - Greater atmospheric drag (requires more fuel)
 - More solar cycles (frequent battery charge/discharge)
 - Space Weather
- + HEO Orbit
 - Solar and lunar gravitation
 - Space Weather
- + GEO Orbit
 - Requires less orbit maintenance
 - Space Weather

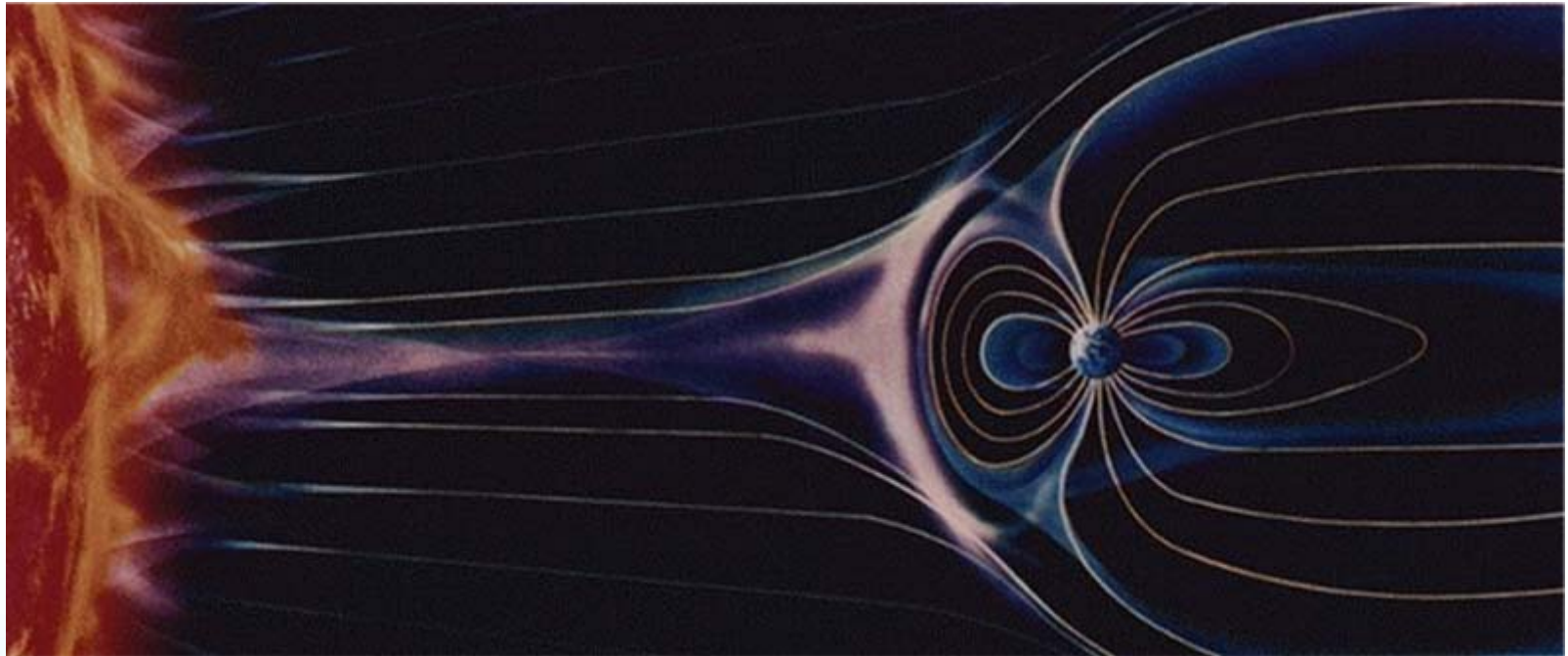




Effect of Orbit Type on SV Life (cont)



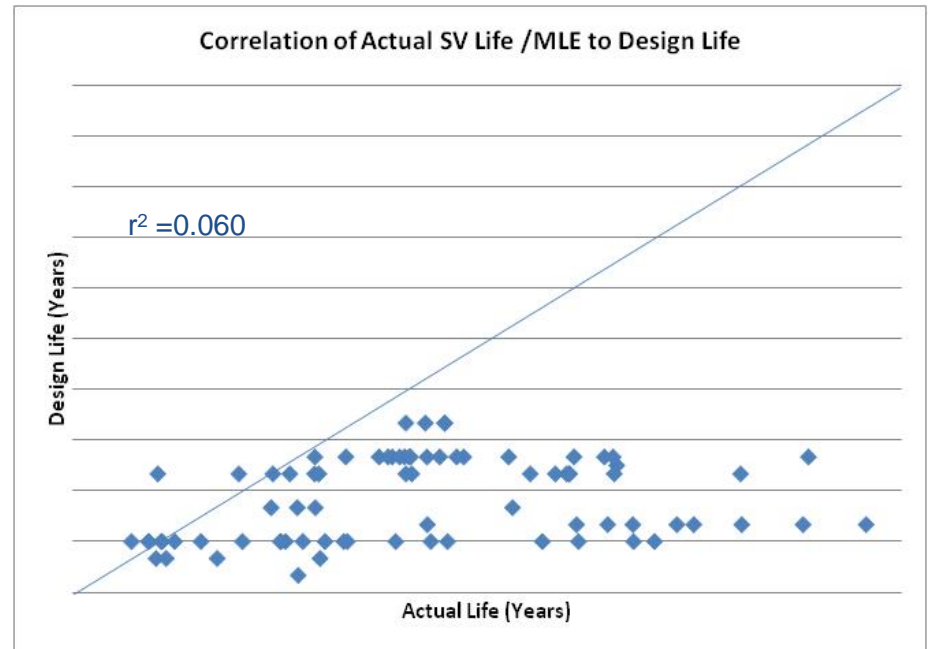
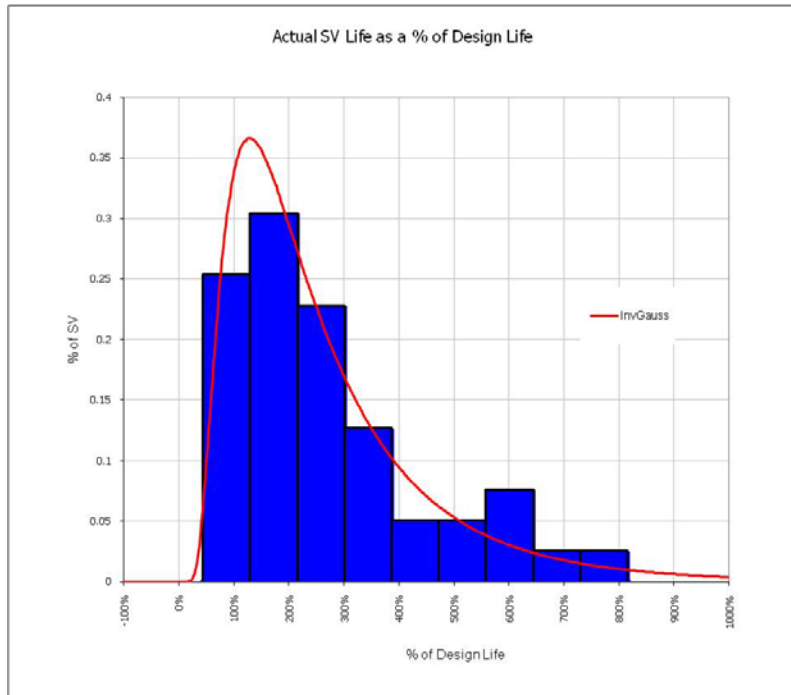
- + Space Weather
 - Van Allen Radiation Belts
 - Solar Flares
 - Solar Wind
 - Geomagnetic Storms





Duration Analysis Results

- + Actual SV life is difficult to predict by:
 - Mission Type, Orbit Type, Series, or DL



Statistical analysis of SV life provides inconclusive results



Residuals



- ✦ Residual - satellite that has reached design life and could be used for additional operations

- ✦ Reasons for operating residuals:
 - Retain in low cost storage mode as a backup to primary SV
 - Continue operations to provide increased production
 - Provide alternate or specialized use at NRO expense
 - Provide alternate or specialized use for a paying user

- ✦ Residual decision considerations:
 - Different technical trade-offs
 - New cost impact

Decision to operate a residual is separate from the acquisition decision



O&M Duration



Conclusions

- + Actual SV life is difficult to predict through statistical analysis
- + SV ICEs support acquisition decisions
- + Design life is an acquisition requirement
- + Residual decision is separate from SV acquisition decision

Recommendation

- + SV acquisition ICEs should include O&M costs through SV DL

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O&M WBS Purpose

- + To define the scope of O&M activities included in an ICE

- + To estimate:
 - Site O&M Costs (Mission Ground Station, Continuity of Operations (COOP) Site, Factory, etc.)
 - Space and Ground System O&M Costs
 - Individual Projects/Programs O&M Costs

- + To perform data collection, improving future estimates



Space Vehicle O&M



- + NASA Astronaut repairing Hubble Space Telescope





Space Vehicle O&M



- + NASA Astronaut repairing Hubble Space Telescope





WBS Development Process



+ Researched Existing O&M Structures

- MIL-HDBK-881A
- NRO Mission Operations Directorate (MOD) Cost Analysis/Management Tool (CAMT)
- NSA O&M WBS
- SCEA Paper “Comparative Analysis of Software Maintenance Modeling in the COCOMO II, SEER, SLIM and True S Cost Models”
- GAO Cost Estimating Handbook
- NASA

+ Developed Initial WBS

+ Compared to Existing NRO Program WBSs

+ Requested feedback from NRO directorates and industry



O&M WBS Scope



- ✦ Provides comprehensive O&M categories
 - Operations, Maintenance, Recapitalization/Technical Refresh
 - SEITPM
 - Sites
 - E1, E2 Maintenance
 - Hardware, Software Maintenance
 - Facilities
 - Terrestrial Communications

- ✦ With NRO Space Segment WBS (1.0), covers system life cycle cost



SEITPM



- ✦ SEITPM is Systems Engineering, Integration and Test, and Program Management
- ✦ Included at multiple levels throughout the WBS hierarchy
- ✦ Associate SEITPM resources with the lowest separable element

Example: Recap/Tech Refresh may have separable SEITPM resources (e.g. testing, documentation), while program security resources may not be separable and would only be identified at the highest level.



Echelon 1 vs. Echelon 2



- ✦ Echelon 1 (E1) Maintenance consists of on-site corrective and preventive efforts to troubleshoot and diagnose failures and restore systems or functions to operations as quickly as possible

- ✦ Echelon 2 (E2) Maintenance
 - Corrective maintenance actions beyond the capabilities of the E1 maintainer which will restore systems to operations
 - Perfective maintenance actions to improve performance, reliability, availability, maintainability (e.g., upgrading system components)
 - Adaptive maintenance actions to allow mission systems to meet changed requirements
 - Enabling maintenance actions allow maintenance activities to occur regardless of location



WBS Construct



- ✦ Each element has a specific pre-assigned title and description to establish the CAIG standard
- ✦ Project/contract specific elements can be added below the lowest standard WBS level
- ✦ Material, ODCs, and Labor, further divided by government civilian, military, and contractor resources, are separated at the lowest possible level



Numbering Convention

- + O&M WBS begins with the element 2.0 as it is considered a continuation of the NRO Space Segment Standard WBS, 1.0
- + Use lower case letters (a-n) after WBS element titles to distinguish multiple discrete occurrences (e.g., multiple ground sites, ground terminals and/or ground operations & processing centers)

- 2.2a Operations (Ground Site 1)
 - 2.2a.1 Operations SEITPM (Ground Site 1)
 - 2.2a.2 Space Operations (Ground Site 1)
 - 2.2a.3 Ground Operations (Ground Site 1)
- 2.3a Maintenance (Ground Site 1)
- 2.4a Recapitalization/Technical Refresh (Ground Site 1)
- 2.2b Operations (Ground Site 2)
 - 2.2b.1 Operations SEITPM (Ground Site 2)
 - 2.2b.2 Space Operations (Ground Site 2)
 - ~~2.2b.3 Ground Operations (Ground Site 2) (Deleted, not applicable to Site 2)~~
- 2.3b Maintenance (Ground Site 2)
- ~~2.4b Recapitalization/Technical Refresh (Ground Site 2) (Deleted, not applicable to Site 2)~~



“Other” Elements

- ✦ At level 3 and below, the WBS contains “other” elements to include items that are not included elsewhere
- ✦ “Other” elements provide flexibility to accommodate a wide range of programs/projects within this WBS structure
- ✦ Improves comparability of estimates/data collects as there is no need to shoehorn data into categories



Unique Elements



- ✦ Use specific contractor names for the titles of unique sub-elements (e.g. hardware units or CSCIs)
- ✦ Assign element numbers that do not duplicate those already used in this WBS
 - Number unique elements as children of a logical existing parent element, adding decimal numbers at the end of the element number to indicate ancestry
 - If a logical parent element does not exist, then add the unique number under the appropriate “Other” WBS element
 - It is not necessary that all numerical sequences be continuous; unused elements should be deleted and their numbers not re-used. Do not delete levels if they have children; consider them “in use” and leave them in the sequence as summing levels
- ✦ Clearly define unique elements in the WBS dictionary



Reserved Elements

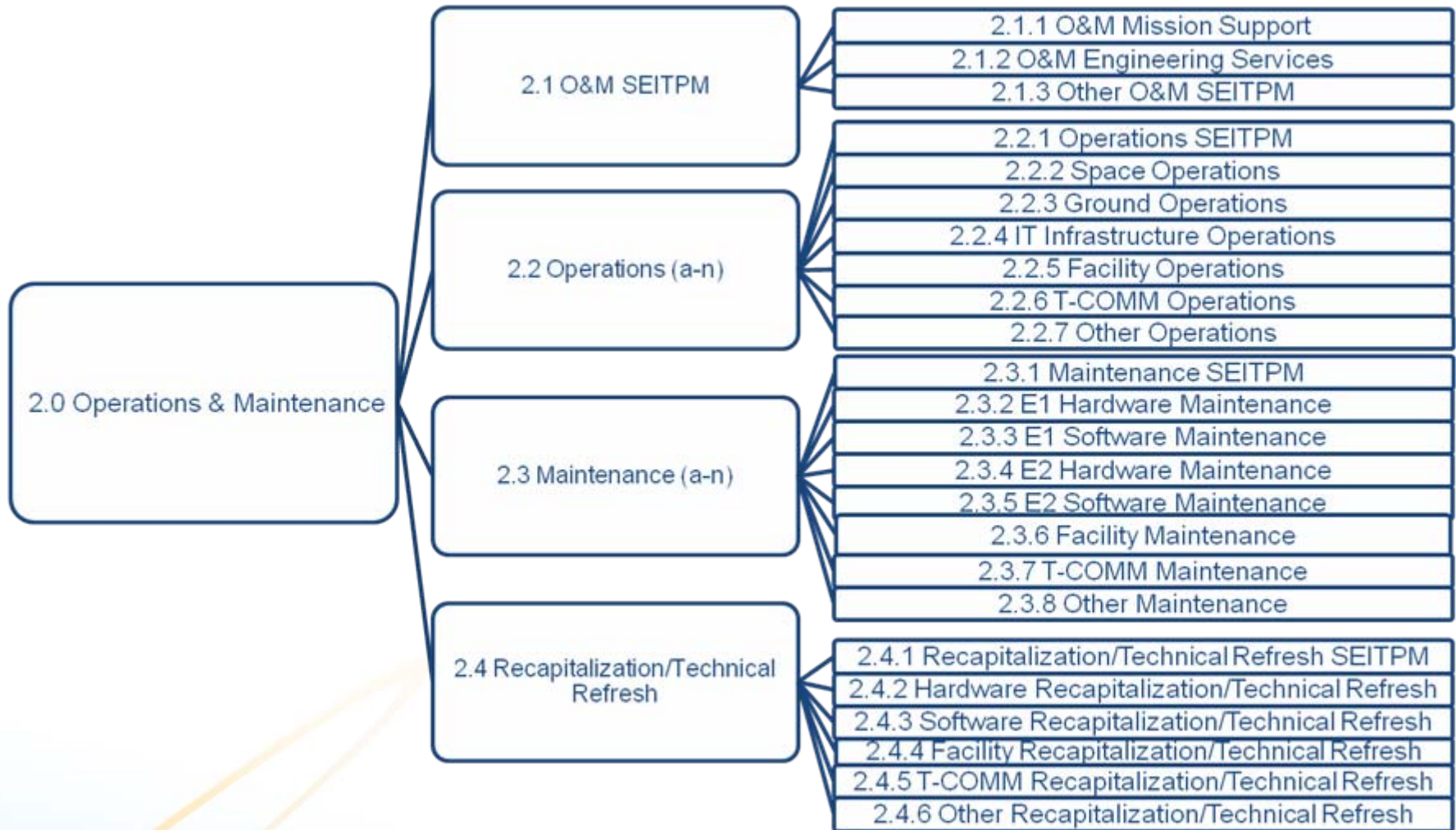


- ✦ Included for consistent numbering and nomenclature of similar elements in different WBS sections which contain similar sequences that are missing one or more elements

Example: An “End-User Devices and Peripherals” element is included in all maintenance, and recapitalization/technical refresh sections, but has no corresponding section in operations. The element is represented by a “Reserved” section in operations to maintain numbering consistency throughout the WBS.

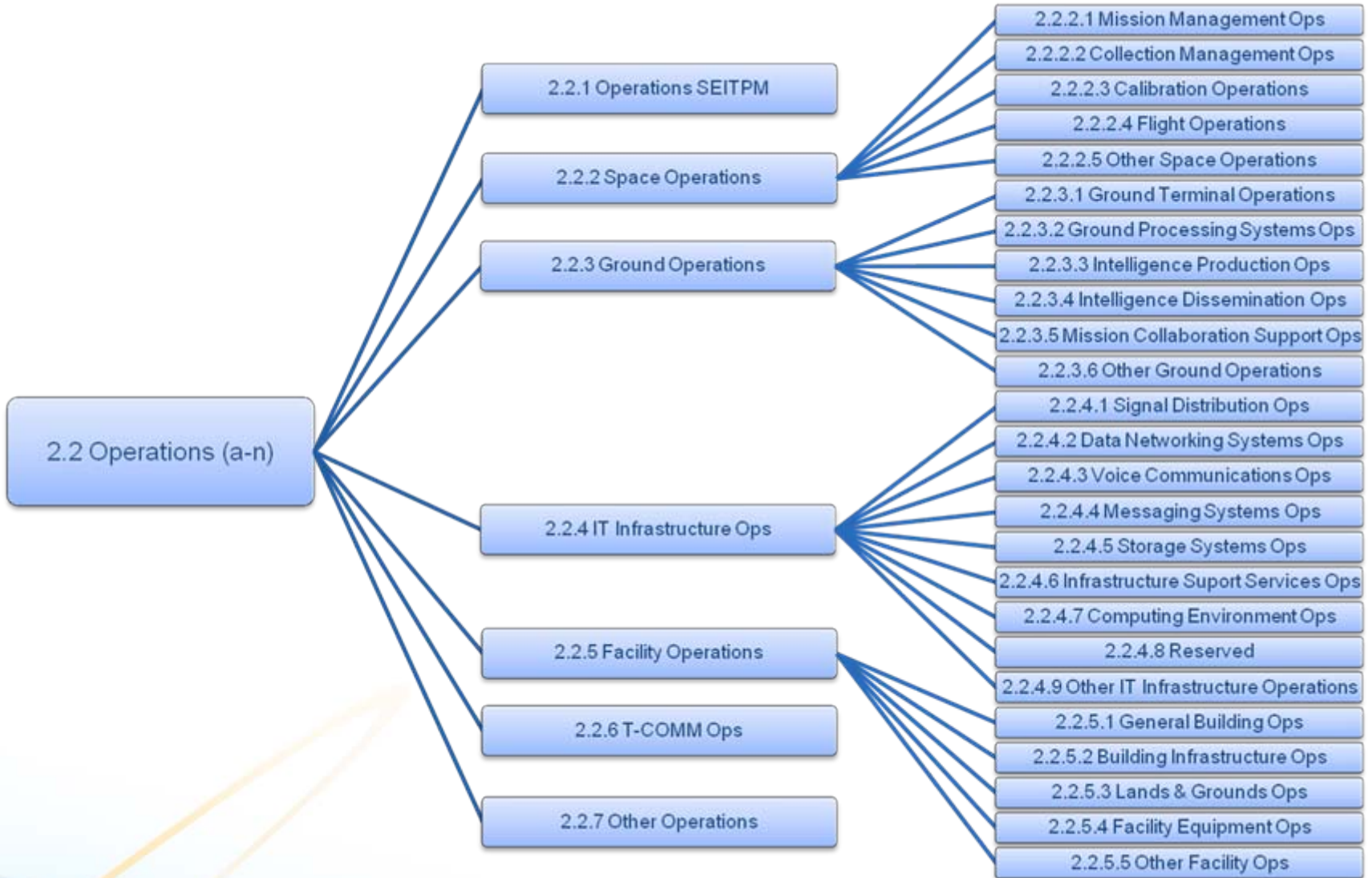


O&M WBS Levels 1-3



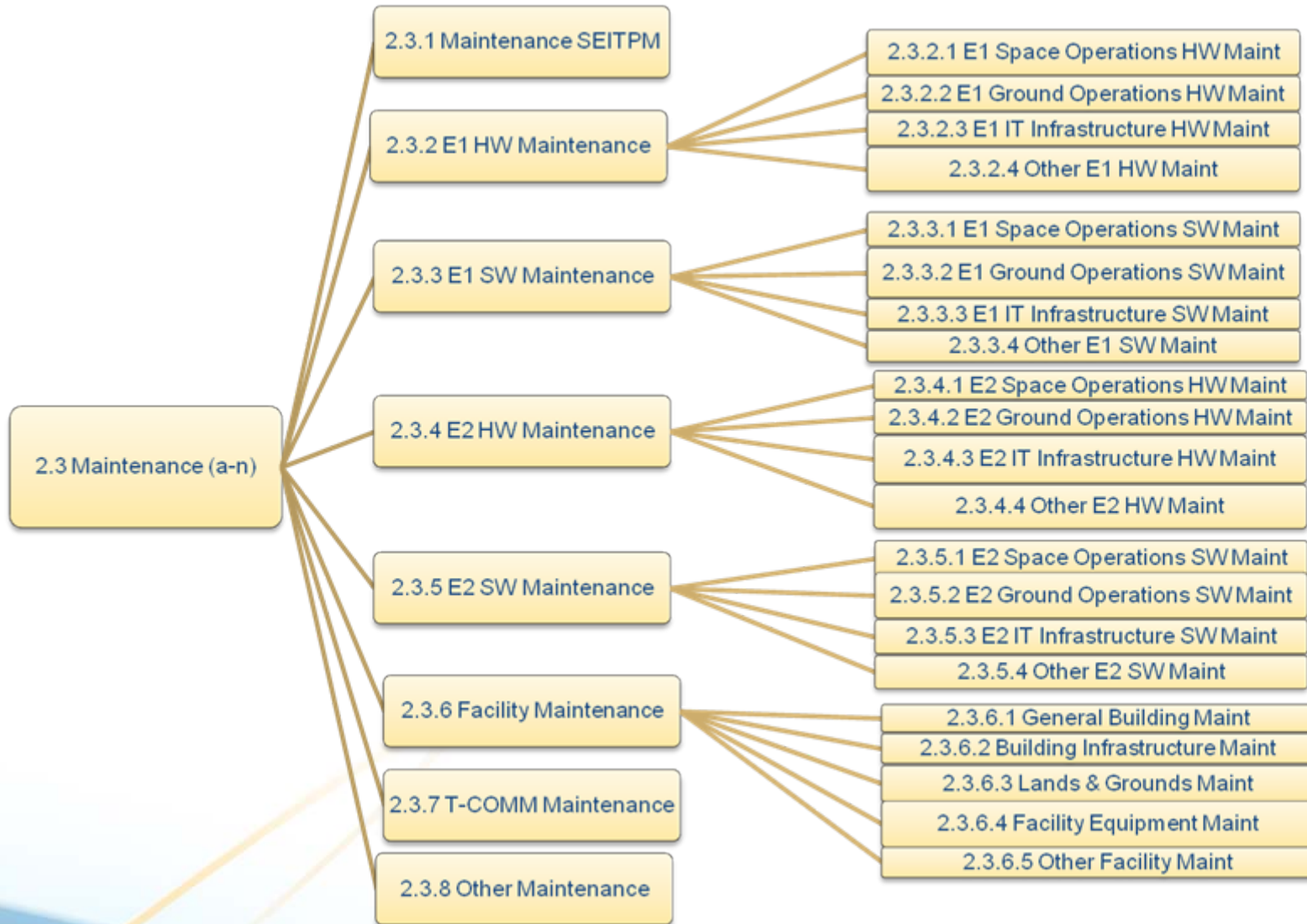


Operations WBS



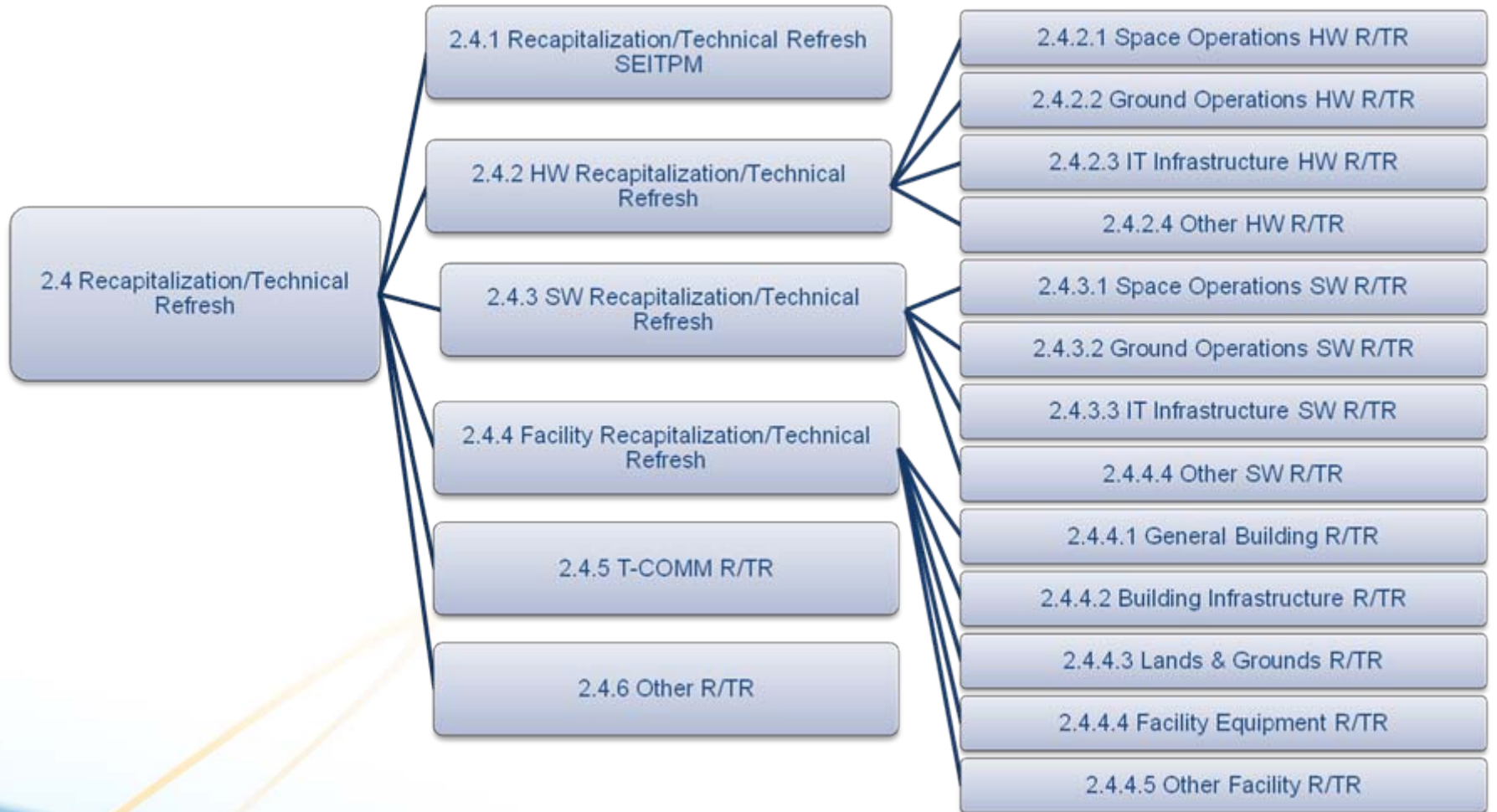


Maintenance WBS





Recapitalization WBS





Next Steps



- + Buy-in from stakeholders

- + Formal incorporation into NRO business processes and socialization

- + Data collection mapped to new O&M WBS
 - Develop cost estimating relationships, factors, and rules of thumb for O&M estimating with data collected and mapped to O&M WBS

- + Refine O&M WBS through stakeholder feedback and periodic updates

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