

Approaches to Civil Space Situational Awareness (SSA)

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GOALS AND DATA COLLECTION

STPI's Task and Approach

- Identify potential approaches—and their costs, strengths and drawbacks—available for civil SSA
 - Interviews with/surveys of vendors, end users, and others
 - Review of lessons from other sectors
- Consider future directions for space traffic management (STM)
- Lay out policy considerations relevant to potential SSA and/or STM regimes going forward
- Caveats
 - Capabilities and cost not validated/verified independently
 - Rapidly evolving sector—new companies are emerging continually
 - Some entities still in “stealth” mode
 - List of vendors not exhaustive, especially for data sources

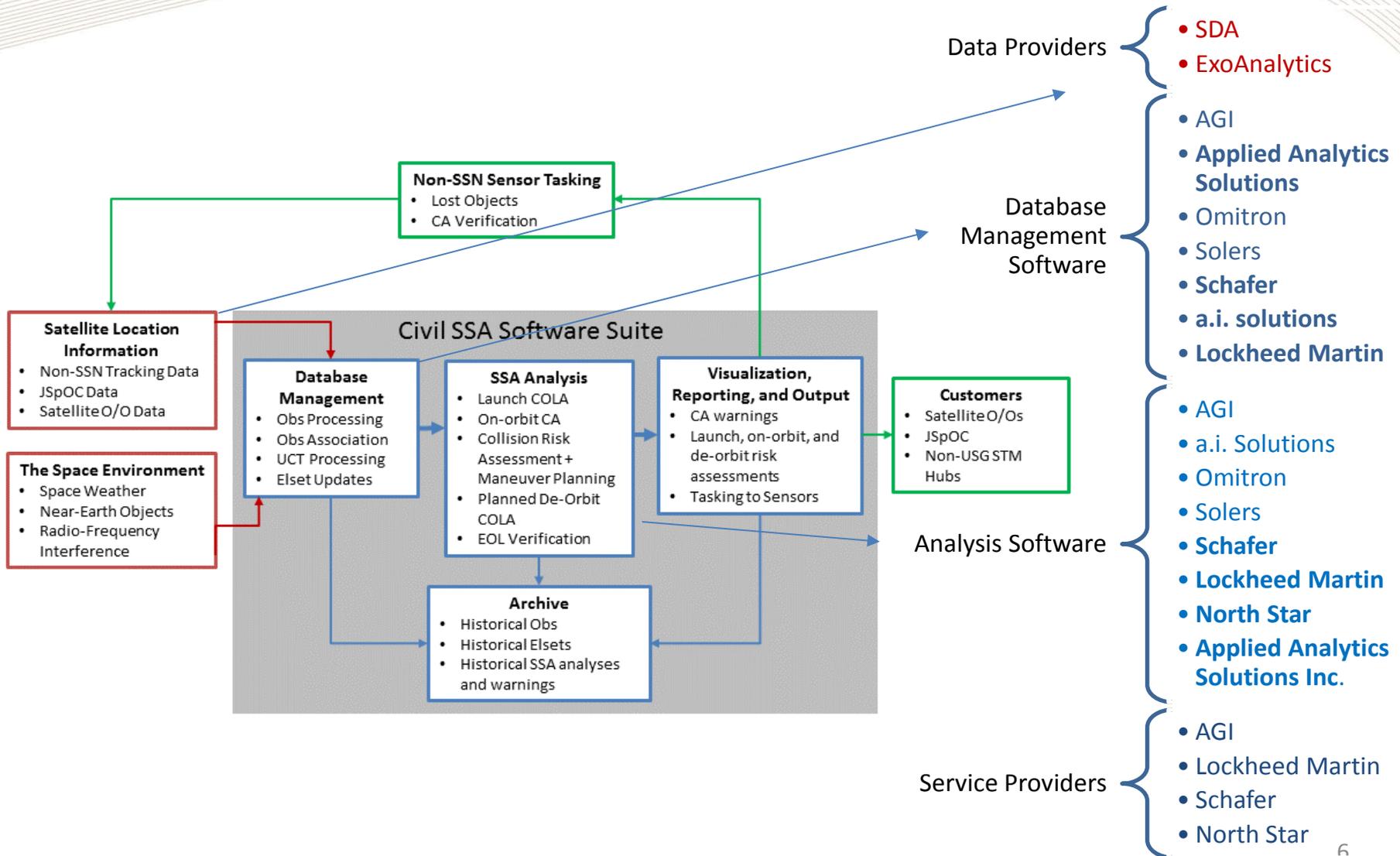
SSA vs. STM

- SSA refers to:
 - The technical act of tracking objects in Earth orbit
 - Understanding the space environment (near-Earth objects, space weather, and radio-frequency interference)
 - National security activities such as object characterization and identification of intent
- STM relates to the oversight, coordination, regulation, and support of space activities, often utilizing SSA information to inform decisions

Commercial Software/Service Providers Surveyed in 2015 and 2016

| | | 2015 | | 2016 | |
|-----------------------------------|-----|-----------|---------------------|-----------|---------------------|
| | | Contacted | Responded to Survey | Contacted | Responded to Survey |
| A.i. Solutions | Yes | Yes | Yes | Yes | Yes |
| Aerospace Corporation | Yes | No | No | No | No |
| Analytical Graphics, Inc. | Yes | Yes | Yes | Yes | Yes |
| Applied Analytics Solutions, Inc. | N/A | N/A | Yes | Yes | Yes |
| The Boeing Company | No | N/A | Yes | No | No |
| CAESAR | Yes | N/A | No | N/A | N/A |
| CS Systems | Yes | N/A | No | N/A | N/A |
| Kratos | Yes | N/A | No | N/A | N/A |
| Lockheed Martin | No | N/A | Yes | Yes | Yes |
| MIT Lincoln Labs | Yes | No | No | N/A | N/A |
| North Star | N/A | N/A | Yes | No | No |
| Omitron | Yes | Yes | Yes | Yes | Yes |
| Schafer | N/A | N/A | Yes | Yes | Yes |
| Space Data Association | Yes | N/A | No | N/A | N/A |
| Solers | Yes | Yes | Yes | Yes | Yes |
| SpaceNav | Yes | No | No | N/A | N/A |
| TASC Engility | Yes | Yes | Yes | No | No |

Vendors Claim Services in All Areas



APPROACHES/OPTIONS FOR CIVIL SSA

Full Suite of *Approaches* for Future U.S. Civil SSA Services



Approach 1: Continued Provision by DOD (Status Quo)

- Strengths
 - Continuity in provision of services
 - No additional latency or increased friction in system
 - Minimizes some level of duplication that will necessarily occur if a civil agency were to provide SSA services in addition to DOD
 - Allows the national security community to continue to exert control over SSA data to protect sensitive activities and satellites
- Weaknesses
 - Inflexibility of DOD to respond rapidly to civil and commercial users' growing needs or advances especially in software technology
 - DOD systems (JMS) delayed and not ready for full implementation
 - Continued gap between SSA data collection agency and future regulation/oversight agencies
 - Reduced focus on industry needs as compared with DOD mission needs
 - Future increases in potentially hostile or threatening activities may cause de-prioritization of civil and commercial operator needs
 - More difficult to extend to an international SSA regime

Approach 2: Provision by Civil Government Agency

- Strengths

- Greater flexibility to respond to industry needs and collaborate internationally (e.g., add non-U.S. sensors or extend to an international regime)
- Greater flexibility to incorporate non-DOD data and leverage commercial advances in software
- Ability to mandate the use of SSA services through licensing
- Easier pathway to civil STM and international coordination
- Provides redundancy to a critical national security and public safety relevant system

- Weaknesses

- Additional costs into tens of millions of dollars annually
- Creates some duplication of activities
- Learning curve for a civil agency to develop operational expertise
- Need to address concerns over possible confusion stemming from multiple satellite catalogs
- Potentially lower ability to mask national security activities in space, particularly if using non-DOD data sources

Approach 3: Industry Self-Provision

- Strengths
 - Supports a more industry-driven community of practice
 - Low cost for the Federal Government
 - Provides redundancy to a critical national security and public safety relevant system
- Weaknesses
 - Enforcement would be difficult
 - Industry may be unwilling to bear the cost, particularly for new and smaller satellite operators
 - Concerns over masking national security activities in space, particularly if using non-DOD data sources

Approach 4: Provision by International Organization

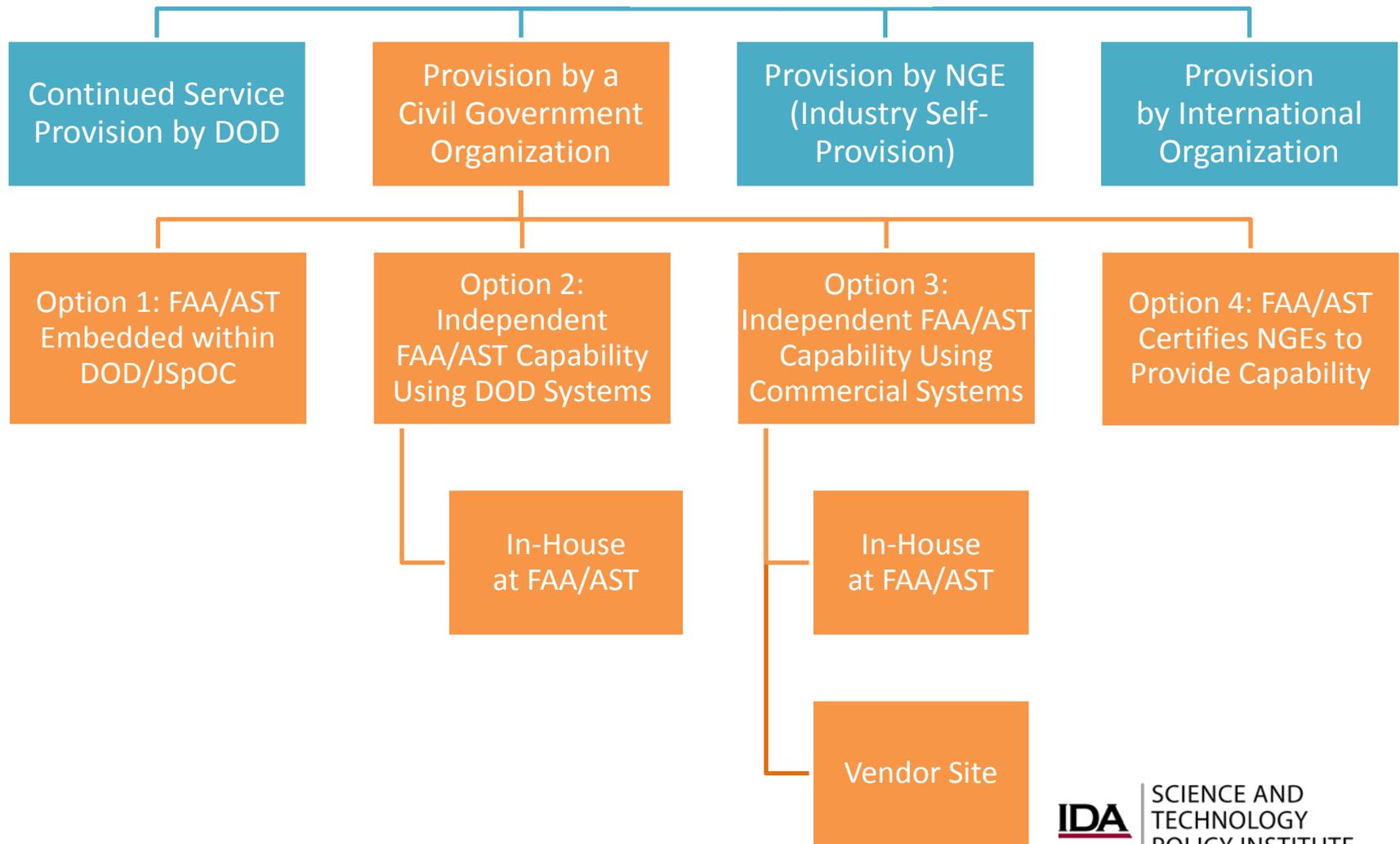
- Strengths

- End-state an SSA system needs to be in given that it is an inherently international activity
- Could provide the most accurate data and services, if it included access to data from multiple countries
- Would create a level playing field for all countries and satellite operators, regardless of national capability
- Could help support the development of international standards for space traffic management
- Provides redundancy

- Weaknesses

- Lack of trust in international institutions
- High transaction costs to negotiate and implement
- Would need to overcome significant challenges stemming from sensitive national security activities in space
- Unclear which international body would have the competence, credibility, and resources to perform the service
- Issues of sovereignty to be negotiated and decided

Full Suite of *Options* for FAA/AST to Provide Civil SSA Services



Civil/FAA-AST Options for Future U.S. Civil SSA Services

| | Continued Service Provision by DOD | Provision by a Civil Government Organization | Provision by NGE (Industry Self-Provision) | Provision by International Organization |
|---------------------------|---------------------------------------|--|--|---|
| | Option 1 | Option 2 | Option 3 | Option 4 |
| Description | FAA within JSpOC | FAA capability dependent on JSpOC software | FAA capability independent of JSpOC software | FAA certifies non-governmental entities (NGE) |
| Sensors Used | DOD | DOD, Commercial | Commercial, DOD (if available) | Commercial |
| Analyst | DOD, FAA/AST | FAA/AST | FAA/AST, NGE | NGE |
| Communicator | FAA/AST | FAA/AST | FAA/AST | NGE |
| Timeframe of availability | 2018 | 2018 | Immediate | Immediate |
| Primary Data Source | DOD High-Accuracy Catalog (HAC) | DOD HAC and Commercial | DOD Observations or HAC and Commercial | Commercial |
| Software | DOD Astrodynamics Support Workstation | DOD ASW Replica | Commercial | Commercial |
| Database | DOD HAC | Compiled Database | Integrated or Compiled Database | NGE DB |
| Location | JSpOC | FAA/AST* | FAA/AST* or NGE | NGE |

Option 1: FAA/AST Embedded within DOD/JSpOC

- Strengths
 - Expected to somewhat reduce JSpOC's workload not related to national security mission
 - Preferred by stakeholders who would like to: minimize near-term cost, reinforce the role of USSTRATCOM as primary hub for SSA, remove possible confusion of a competing FAA/AST database, and reinforce political backing for improvements to JSpOC's core hardware and software
- Weaknesses
 - Capabilities subject to the limitations of JSpOC's software and data
 - Flexibility and innovation limited to improvements in JMS
 - Continue to have significant restrictions on ability to share data with commercial and international customers
 - FAA has little value added compared to DOD's current service provision

Option 2: Independent FAA/AST Capability Using DOD Software/Systems

- Strength
 - Only slightly changes the status quo
 - FAA/AST has more insight into the DOD SSA process
 - May better prepare FAA/AST for a future role in STM
- Weaknesses
 - FAA/AST would face significant hurdles to make modifications to any processes or software that DOD has
 - Unclear how difficult it will be for FAA/AST to add value-added software services and a database on top of the DOD architecture
 - Dependence on DOD data (by not being able to augment with commercial data) could be detrimental if FAA/AST loses data stream
 - Potential challenges in linking JMS data on SIPR to FAA/AST capabilities on DOT networks

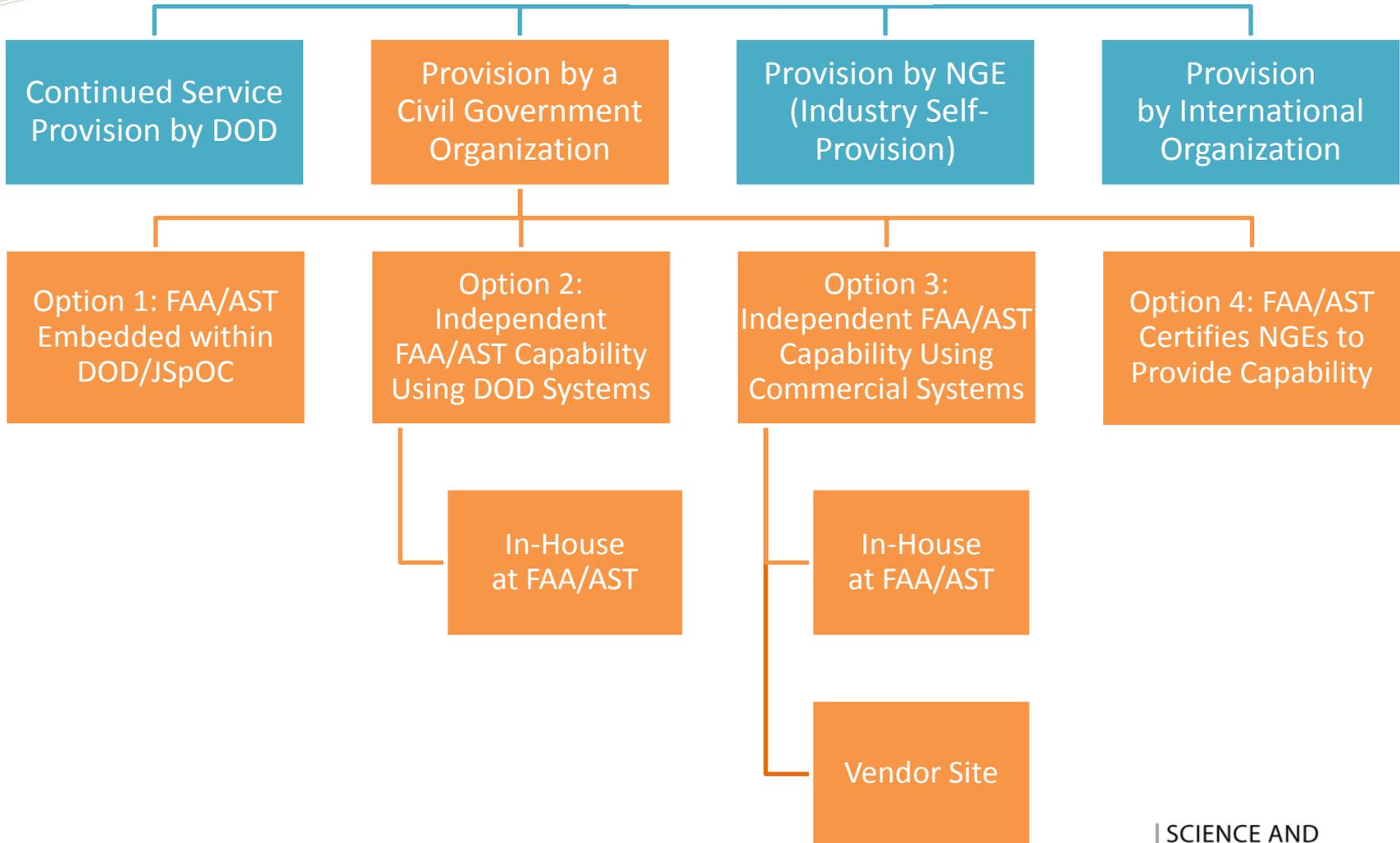
Option 3: Independent FAA/AST Capability Using Commercial Software/Systems

- Strengths
 - FAA/AST has significantly greater control and flexibility to align service with civil and commercial requirements
 - Changes to the system based on NGE software will likely be lower priced than changes to DOD software (long term prices will likely be lower than Option 2)
 - If properly designed, could promote greater flexibility and rapid development of software than utilizing DOD software and data
 - Likely the best option to prepare FAA/AST for a future role in STM
- Weaknesses
 - Increased upfront costs over previous two options
 - Using a different database than the DOD catalog could lead to conflict across agencies
 - If systems are customized (i.e., do not remain commercial), would deter quick/agile improvements
 - Liability concerns when using NGE software

Option 4: FAA/AST Certifies Non-Governmental Entities to Provide Services

- Strengths
 - Supports commercial SSA industry while still protecting civil space assets through governmental oversight
 - Low cost burden for government
 - Greatest flexibility for service improvements
- Weaknesses
 - Not appropriate if SSA services are deemed to be inherently governmental
 - May not meet the requirements for government oversight under international obligations
 - Unclear who would bear the cost of services: government or users
 - Liability concerns
 - May cause issues with current international partners
 - Owner/operators may choose the least restrictive or expensive vendors, which could be counterproductive to safety in space

Summary



Questions?

