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Approaches to Civil Space Situational Awareness (SSA)

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FAA Industry Day

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

Today's Goal

- Summarize *conceptually* a subset of approaches and options to provide civil SSA services

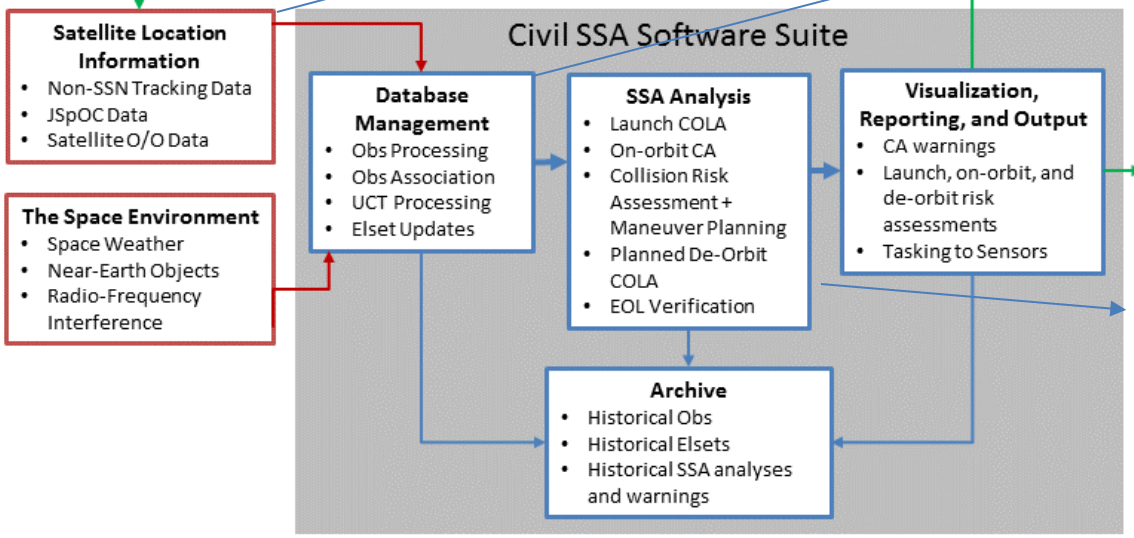
(for the purpose of our report) SSA vs. STM

- SSA refers to the technical act of tracking objects in Earth orbit, including
  - 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

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

Vendors Claim Services in All Areas



Data Providers
- SDA
- ExoAnalytics

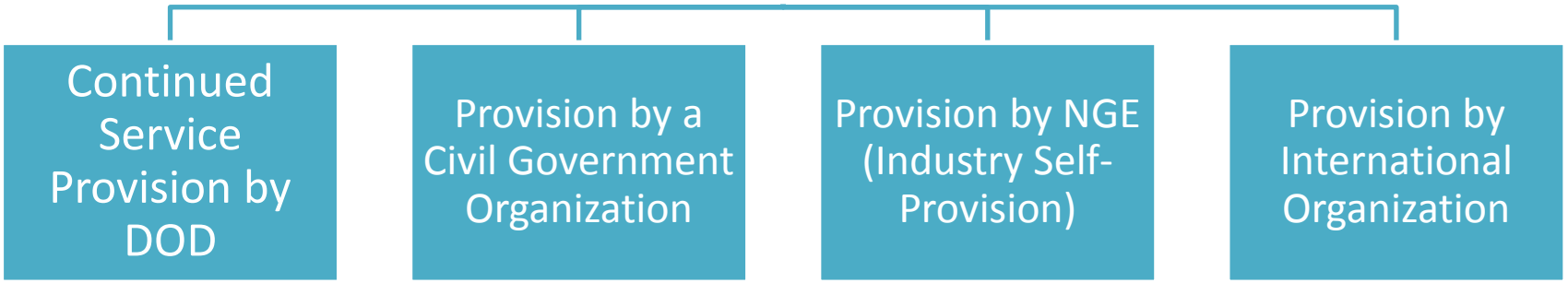
Database Management Software
- AGI
- Applied Analytics Solutions
- Omitron
- Solers
- Schafer
- a.i. solutions
- Lockheed Martin

Analysis Software
- AGI
- a.i. Solutions
- Omitron
- Solers
- Schafer
- Lockheed Martin
- North Star
- Applied Analytics Solutions Inc.

Service Providers
- AGI
- Lockheed Martin
- Schafer
- North Star

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

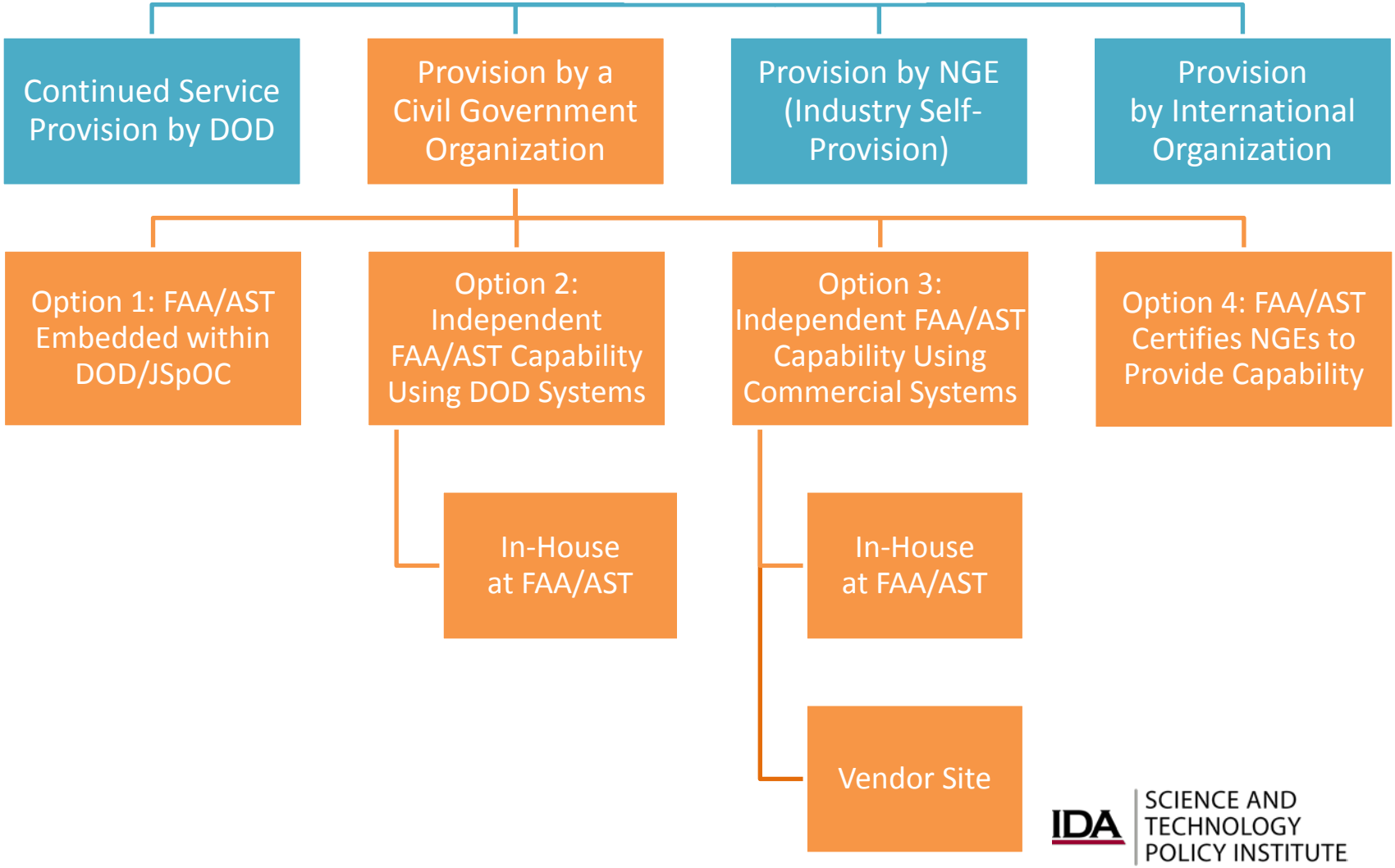
Approach 3: Industry Self-Provision

- 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



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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

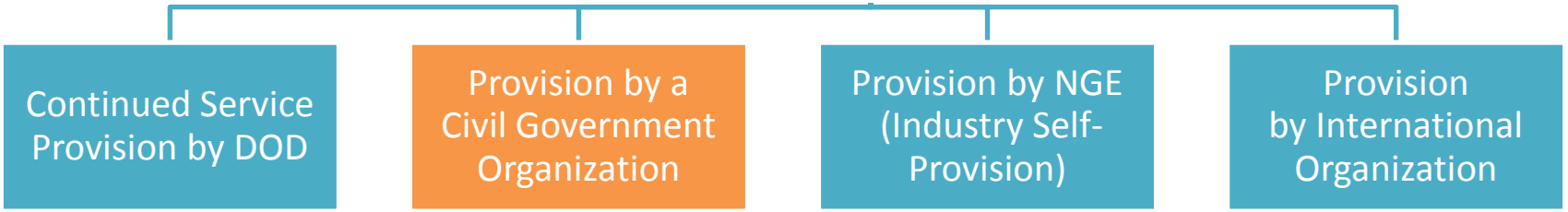
Option 3: Independent FAA/AST Capability Using Commercial Software/Systems

- 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 of FAA/AST *Options*



	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

Questions?


HAPPY
LONELY
JEALOUS
SADNESS
ANGRY
JOYOUS
ENVY
FEARFUL
PRIDEFUL
TROUBLED
TIRED
OFFENDED
HOPEFUL
ANNOYED
EXCITED
CURIOUS