Addendum 10: Electro-Optical Sensor Provider (LEO)

12.4 Data Products

A. Data Products

1. (Threshold) Provider shall utilize Company services to develop Electro-Optical (EO) tracking products capable of delivering continuous coverage of objects in Low-Earth Orbit (LEO) and LEO-crossing orbits (examples include Geo Transfer Orbits with perigee near LEO regime and highly elliptical orbit perigees). These products must support high-fidelity, real-time monitoring to ensure precise tracking and situational awareness. Proposal submissions should detail the service capabilities, specifically addressing the required quantity, quality, and applicable orbital regimes.

2. The JCO created the JCO Data Requirements document that **must** be adhered to in support of population of data to the UDL in support of JCO mission operations. Vendors can access the document at: https://docs.google.com/document/d/1WoZlMrf1YHQFV8Gehnw1aQxsFaa3V3lBW7_tkK4LT4E/edit?usp=sharing

3. (Threshold) The JCO will provide an unclassified 'High-Rate Revisit' (HRR) list to the UDL, made available to the providers via the UDL notification message. The providers should price bids for objects in LEO (defined as a period of less than 225 min. The JCO Command and Control (C2) operations centers may modify the HRR list at any time and the Provider will have 10 minutes (during duty hours) to adjust the focus of its processing outputs.

When responding to the JCO Electro-Optical Sensor Provider PWS, vendors are asked to:

- Describe the cost of each package as a function of the Service License Agreement (SLA) distribution options if multiple service levels are offered.
- Include details regarding sensor surveillance architecture proposed including processing delays for metric data delivery from sensor to UDL and, as applicable, product delivery to the UDL, estimated accuracy as a function of noise+bias (arcsecond, millisecond timing), and as applicable, covariance and orbit determination accuracy.
- Provide a quote for collection and/or processing of "catalog" by orbit regime, as well as other purchasing variations for additional capabilities, specifically near-earth (period less than 225 min), deep space, XGEO/cislunar separately. Include any cost increase or decrease for rates for catalog maintenance or other variations in separate bids.
- Include a list of all that will be utilized to support JCO-related tasks.

The table (starting on page 2) outlines Provider requirements related to data, tasks and products for JCO sensor provider operational support. Responses to this PWS may be provided in the "Provider Response" column in this table for each requirement:

Addendum 10: Electro-Optical Sensor Provider (LEO)

Table 1: JCO Electro Optical Sensor Provider Requirements (LEO)

Para. / Task Name	Threshold (text)	Objective (text)	Provider Response
a. Data Delivery Timelines	For 90th percentile of observations delivery metric data from sensor to UDL in 30 minutes or less.	For 95th percentile of observations delivers metric data from sensor to UDL in 5 minutes or less.1. Space Based metric data	
b. UDL Data Delivery	Fulfill data requirements outlined in UDL Schema Requirements for the JCO by adhering to "required" JCO requirements and data formats. Reference the link in this document to the JCO schema requirements. In addition to the eoobservation mandatory fields outlined in the EO Observations UDL Schema for JCO, populate the UDL sensor schema for each sensor, with WGS-84 latitude, longitude, and height above the ellipsoid, measured from the computational center of the sensor and should be accurate to less than 1 meter Report sensor updates to the UDL team within 3 days, with DOK and all data curation teams in copy, and initiate UDL sensor card updates within 3 days of change. Sensor data must be delivered to the Global Data Marketplace (GDM) endpoint associated with the JCO data purchase.	Same as threshold, **but in addition**, fulfill additional data requirements outlined in UDL Schema Requirements for the JCO by adhering to some or all of the "recommended" requirements and data formats	
c. Sensor Accuracy	Sensor accuracy must be maintained at: Angles Sigma: 10 arcseconds Timing Accuracy: .004 seconds	Same as threshold but angles accuracy of 5 arcseconds	
d. HRR Tasking	Receive/ingest the HRR UDL notification message to update sensor tasking to your network. During normal (sensor operator duty hours) duty hours, update HRR tasking to sensor network within 10 minutes of HRR update via the UDL notification schema. During off-duty hours update within 2 hours of the next shift start time.	Same as threshold but receive and process the HRR list via UDL notification messaging autonomously and update tasking across sensor network within 10 minutes of receipt. This applies to 24/7 HRR updates.	

Addendum 10: Electro-Optical Sensor Provider (LEO)

e.	Calibration Tasking Fulfillment	Access the JCO sensor calibration list that includes required calsats for collection using the JCO UDL onorbit list available in the UDL. The following requirement must be met for each LEO EO sensor provider for 50% of their sensor network nightly: Each LEO sensor must provide a minimum of 4 tracks comprised of at least 5 observations and a total of 100 observations of LEO CalSats taken from the current CalSats list ideally spread across the night.	Same as threshold but the requirement must be met for 100% of the provider sensor network	
f.	Sensor List to Data Curation Teams	Each provider must provide JCO data curation teams with a list of JCO contracted sensors each month; this list must include any sensor supporting JCO operations.	*Same as Threshold*	
g.	Revisit Rate Requirements	Collect against JCO HRR objects, prioritizing by rank (rank 0 being the highest priority, 5 being the lowest). Collect ranks 1-3 at every available pass. Collect rank 4 four times per day and rank 5 twice per day based on visibility from sensors to object. Maximum gap times for Rank 4 is 12 hours outside of solar exclusion Maximum gap times for Rank 3 is 4 hours outside of solar exclusion Maximum gap times for Rank 2 is 45 minutes outside of solar exclusion Maximum gap times for Rank 1 is 15 minutes, with the ability to stare outside of solar exclusion. Rank 1 objects require stability assessments at least once per day to support light curve characterization.	Same as threshold, but coverage gaps are: Rank 2: maximum of 20 minutes Daylight monitoring capability is highly encouraged	

Addendum 10: Electro-Optical Sensor Provider (LEO)

h.	Sensor out of limits reporting and correction	Perform internal analysis and periodic maintenance to ensure sensors maintain accuracy requirements. Monitor curation communication in JCO chatrooms for updates and coordination. Should the sensor provider be notified by JCO C2, a JCO fusion provider, or a curation provider that the sensor is performing poorly based on the accuracy requirements outlined, take the following action: 1. Trouble shoot the sensor and remedy within 4 hours of notifications 2. Remove the sensor from JCO operations and conduct recovery actions within 2 hours of fault identification. 3. Notify JCO C2 of the fault, recovery action, and timeline 4. Coordinate with JCO C2 and the curation providers to verify accuracy of sensor prior to introducing data into JCO operations.	*Same as Threshold*	
i.	Aberration Corrections	Aberration corrections compensate for the optical distortion caused by the relative motion of the observing platform. There are two primary components that should be considered: Diurnal - caused by the motion of ground-based sensors as a result of Earth's rotation. Annual - caused by the motion of Earth in its orbit around the sun Orbital - caused by the motion of the viewing platform/satellite Any ground-based optical sensor data shall be corrected for annual aberration at a minimum, when provided to the JCO via the UDL.	*Same as Threshold*	

Addendum 10: Electro-Optical Sensor Provider (LEO)

j.	UCT Collection and Delivery	Utilize sensor network to collect SDA data on Uncorrelated Track (UCT) objects. Identify the UCT in the eoobservation schema by flagging the UCT to "true." Observations and candidate satellites may be considered a UCT under the following both conditions: Observations that do not correlate to something in the 18 SDS public catalog at time of collect when tasked on a nominated satellite.	Same as threshold, but report UCT objects in orbit near nominated HRR satellites, prioritizing any that may be consistent with a potential threat and report these objects via chat to the JCO C2 team.	
k.	Dynamic Tasking	Support dynamic tasking via JCO chat or JCO operational channel (voice) during vendor support duty hours. Tasking updates must be processed within 1 hour of tasking. Tasking must scheduled and either be awaiting visibility, priority or be complete within this 1-hour timeframe.	Support dynamic tasking 24/7 from JCO collectrequest schema through the UDL. These sensor requests are either direct to a sensor or incorporated into the sensor entity tasking/scheduling solution for immediate execution. This tasking focuses on high priority JCO needs and must be executed within 20 minutes of JCO request (depending on visibility of sensor to tasked object).	
l.	Tasking Response	Respond to JCO dynamic tasking via JCO chat or JCO operational channel (voice) during vendor support daily hours. Respond that tasking will be fulfilled along with an expected timeline for fulfillment. Response must be made within 30 minutes of JCO operator request.	Support both dynamic and HRR tasking reponses via the UDL collectresponse schema. Reply using the UDL schema with relevant information for the JCO to understand when the tasking may be fulfilled. For HRR Tasking, reply with tasking messages (collectresponse) forecasting the HRR execution for each object based on pending sensor availability, weather, tasking priority, and sensor visibility. HRR tasking responses must be provided withing 4 hours of HRR tasking updates during vendor duty	

Addendum 10: Electro-Optical Sensor Provider (LEO)

		hours, or by noon the following duty day outside of vendor duty hours. For dynamic tasking, the task response must occur within 10 minutes of task request via the UDL collectresponse schema.	
l. Sensitivity	*Not Applicable*	The below applies during nighttime collection: Sensitivity for HRR list objects will enable custody of satellites down to 20 cm. Resolution must support at least 100 m separation between a 1 m and 20 cm pair of objects at LEO.	
m. Sensor Outage Reporting	Notify JCO C2 (via ops channel or chat) if HRR collection may not be maintained as planned, or if a dynamic task will not be executed due to weather or another sensor outage within 1 hour prior to revisit violation or task execution, or immediately upon noticing impact.	Currently unavailable, but in the future the below may be implemented: Provide M2M messages via UDL to report sensor outages due to weather or any other purpose. This data will inform the JCO team of sensor availability across the network at any given time. Updates must be provided hourly.	
n. Correlation Requirements	If correlation is supported, follow the JCO observation correlation process outlines here The mandatory fields in the observation message must be adhered to. This process ensures that correlation is attempted and makes use of the JCO Correlation message (not developed at this time).	Same as threshold, but the mandatory AND RECOMMENDED fields in the observation message must be adhered to.	

Addendum 10: Electro-Optical Sensor Provider (LEO)

o.	State Creation and Delivery	Maintain internal state database (or catalog) and update state information as new metric observations are provided. Fuse metric data (RF, EO, Radar) to update object states, prioritizing JCO HRR objects. Post state update cadence (posting state vectors and TLEs to UDL) for HRR objects to UDL upon state update generation, driven by new metric information to for a state update. State updates must occur automatically in the fusion system and also have the capability to support manual intervention through residual plots for manual differential corrections. Both State Vectors and TLEs must be generated. Deliver state updates to UDL must adhere to the UDL statevector and elset schemas defined in the UDL, and include sigma values. Post state update information as requested by JCO C2 to JCO mission systems (MMB and/or chat). Elsets must meet AstroStandards compatibility requirements, to include the below: • Mean elements with Kozai mean motion and ephemType set to 0 • epehmType2 with Brower mean motion is acceptable as well • Coordinate frame is TEME of Date (or TEME of Epoch) • If converting from SP vectors, do not use single point conversions from a state vector to a TLE, instead propagate the vector and fit the TLE over a larger percentage of the orbit	*Same as threshold, and additionally generate* ephem Type 4 SGP4-XP TLEs	

Addendum 10: Electro-Optical Sensor Provider (LEO)

p. Maneuver Alerting	*Not Applicable*	Deliver maneuver alerts to the UDL and as appropriate (HRR ranks 0-2) report maneuvers in JCO chat rooms. Maneuver Alerting is defined as the initial identification and alerting of a satellite maneuver and should be identified through residuals rather than waiting for a state update. This alert should be sent as quickly as possible to JCO chat or voice, or M2M to a JCO COP, while minimizing false alarms. Ideally, maneuver alerts drive geographical and phenomonology diverse sensor tasking to drive towards fast maneuver recovery (post maneuver state generation).	
q. Photometry Change Detection	*Not Applicable*	Photometric alerting, if a capability from the EO provider, should be automated and also include information on any follow-on activity based on specific satellite pattern of life behavior. Alerts for pattern of life should be made within 24 hours of the identified change.	
r. Launch Tasking and Collection	Support launch tasking by receiving nominal states prior to launch and posturing for the launch event, AND by receiving updates during the launch and orbit-raising to dynamically task in order to support collection. Tasking and data delivery timelines outlined must be maintained.	In addition to threshold requirements, execute search volumes to acquire launched objects to support launch, orbit raising and orbit insertion collection.	
s. Coverage	Sensor network support must provide ground-based access for expansive global coverage of LEO, including North America, South America, Africa, Europe, Asia, and Australian access.	*Same as threshold.*	

Addendum 10: Electro-Optical Sensor Provider (LEO)

B. Orbital Analytics Support

1. (Threshold) Provider shall provide an expert system analyst to utilize its analytical services to process purchased SDA data in support of orbital analytics, feature analytics, and visualization functions across operations. Expert system analyst support must be forward-leaning and proactively support JCO throughout mission execution. This includes but is not limited to the following support:

    a. (Threshold) Analyst will continuously monitor the JCO Mission Systems (MMB and chat) and/or JCO video conferences throughout normal hours of operation.
        i. (Threshold) JCO-Americas operating time is Monday-Friday, 1430Z - 2230Z, with 30 min required for changeover receipt on the front end of the time period.
        ii. (Threshold) Analyst will be available to support another JCO Global site (Pacific and/or Meridian) for 8.5 hours (operations period and change-overs). JCO-Pacific operating time is 2300Z to 0700Z and JCO-Meridian operating time is 0700Z-1500Z in the Nov 2023 period of performance, with 30 min required for changeover receipt on the front end of the time periods.
    b. (Threshold) When Analyst receives a request for information from the Chat or Voice reporting from JCO leads, they shall A) acknowledge receipt of the request in the corresponding Chat Thread within 15-minutes of transmit of the tasker, B) shall briefly describe their anticipated course-of-action (COA) with timelines.
    c. (Threshold) When Analyst receives a request for information from the Chat or Voice reporting from JCO C2 leads, they shall A) acknowledge receipt of the request in the corresponding Chat Thread within 15-minutes of transmit of the tasker, B) shall briefly describe their anticipated course-of-action (COA) with timelines.
    d. (Threshold) During crew support hours, the orbital analysis support must include interpreting metric (position, velocity data). Orbital analytics tools will be capable of orbit determination as well as initial orbit determination with no initial seed state.
    e. (Threshold) Orbital analyst supporting each crew shall provide feature analysis support, including interpreting imagery, signals, and behavioral analytics.
    f. (Threshold) Orbital analyst supporting each crew shall provide graphical / visualization support.

Addendum 10: Electro-Optical Sensor Provider (LEO)

g. (Threshold) Provide sensor tasking support in NRT during SME/crew-support periods on objects of interest, including UCTs, close approach objects, new HRR objects, launches, searches, or other events.
h. (Threshold) The Provider shall support the following SSA Data analyses in near-real time on nominated satellites using data sources that may not originate from the analytical Provider.
    i. (Threshold) EOObservations messages (astrometric and photometric) with uncertainty information
    ii. (Objective) ManueverDetection in UDL
    iii. (Objective) Conjunction messages in UDL
    iv. (Objective) StateUpdate messages in UDL (with covariance information)
    v. (Objective) ELSET (Two Line Element (TLE)) messages in UDL
    vi. (Threshold) Visual magnitude (with uncertainty information)
    vii. (Objective) Photometric change alerts
    viii. (Threshold) Provider sensors (locations of contributing sensors); sensor schema in UDL
    ix. (Threshold) Sensor status (e.g., sensor OPSCAP)
    x. (Threshold) Tasking status
    xi. (Objective) Other data types as applicable to the Protect & Defend mission
i. (Threshold) Provider shall maintain separation in data sets in accordance with data rights across various user groups (e.g., UK user group may have access to different data sets from US user group). Additional time and materials may be priced to establish separate network enclave(s), as required.
j. (Objective) Provider shall enable network access to analytical processing enclaves on US servers from global outstations with minimal delay
k. (Objective) Provider shall maintain separation in data sets in accordance with data rights across various user groups (e.g., UK user group may have access to different data sets from US user group). Additional time and materials may be priced to establish separate network enclave(s), as required.
l. (Threshold) Initial tool familiarization training shall be provided for all govt users, though Govt Current Operations leads are battle management / Current Ops personnel focused on prioritization, Space Domain Awareness (SDA) resource allocation, threat and space flight safety event comprehension and implications, and reporting; and not expected to be power users of IODET capabilities, as that role is executed by commercial SMEs in operations. However, govt leads should be capable of understanding all products from tools that may be reported up / out and their application and implications on space activities.

Addendum 10: Electro-Optical Sensor Provider (LEO)

m. (Objective) Advanced / Power user training for full use of all capabilities of tools, including manual piece separation, manual orbit determination, dynamic trajectory update through forced motion circumnavigation, etc. It is understood that several of these functions may be automated/in-the-background during nominal operations, but advanced / SME users are expected to be able to pull the system out of automated processing for manual override and review of complex scenarios, as needed.

2. (Threshold) All data – including processed products - will be published to the UDL data repository or JCO defined interfaces.
   a. (Threshold) Data submission in compliance with UDL formats
   b. (Threshold) Providers shall begin working to submit products machine-to-machine using methods defined by JCO Dragon Army as available to be made available in the JCO Mission Management Board (MMB). If posting directly to MMB is unavailable, Providers should use Chat as tertiary backup.
   c. (Threshold) Provider shall reach out to the Air Force Research Lab Dragon Army Integration Team to work a single sign on (SSO) log in to the MMB, if one is not already activated, within 24 hours of proposal acceptance.
   d. (Threshold) – In event that a processing system is to be offline, the provider will send notifications 2 weeks in advance, or within 2 hours for unexpected outages which will result in an extended outage to JCO Site Lead and program management office.
   e. (Objective) Provide UDL status messages to convey planned and unplanned outages, ETROs and system health messages

C. Wargame Support

***NOTE**: Vendors should include all costs associated with Section C. Wargame Support as an "add on"/option separate from the cost supporting Sections A and B of this PWS.*

(Objective) The Provider shall provide support for wargame activities to include:

a. (Objective) Planning and Design
   i. Collaborate with stakeholders to identify key focus areas and desired outcomes.

b. (Objective) Logistical Support:
   i. The provider shall ensure that all required personnel with relevant subject matter expertise are available and able to attend in person, if required. The number of personnel shall not exceed two (2) individuals. These individuals must possess the necessary expertise in their respective areas to effectively contribute to the wargame activities.
   ii. The wargame activities and the engagement of the SMEs shall be limited to a maximum of three (3) business days, with each business day consisting of eight (8) hours. This includes all planning, facilitation, and participation in the wargame session.

Addendum 10: Electro-Optical Sensor Provider (LEO)

iii. Travel and accommodation arrangements for all personnel involved in the wargame activities shall adhere to government locality per diem rates. These arrangements are limited to locations with the Continental United States (CONUS).

c. (Objective) Facilitation and Execution:
   i. Actively participate in wargame sessions, in scenarios and discussions.
   ii. Maintain the flow of the wargame, ensuring adherence to timelines and objectives.

d. (Objective) Data Collection and Analysis:
   i. Collect and analyze data throughout the wargame to assess outcomes and insights.

D. Deliverables

Description	Frequency
Space Surveillance Data – Steady-State Monitoring	NRT through PoP
Space Surveillance Data – UCTs	NRT through PoP
Space Operations Analyst Support – 1 FTE	8.5-hour shifts/5 days per week
Advance Sensor Change/Removal Notification	2 weeks prior to anticipated change
Monthly status reports (MSR) emailed to designated JCO Global Coordinator, Program Management Office, and JCO Ops Integration	Monthly, by the 10th of each month
Processing Issue, Outage Notification	Within 24 hours of Occurrence
A comprehensive post-wargame report that summarizes the findings and provides actionable recommendations. The report should include an overview of the wargame activities, key observations, and strategic insights. *The analysis and preparation of the post-wargame report shall not exceed eight (8) hours of work.*	As instructed by GOV
A detailed data analysis report that includes key insights and actionable outcomes derived from the wargame activities. These reports should highlight significant trends, patterns, and observations, and provide a thorough analysis of the data collected during the wargame. *The preparation and analysis for each data analysis report shall not exceed sixteen (16) hours of work.*	As instructed by GOV