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| **Mission: Large** **Area Fire Detection\*** End User: Local Dispatch, Unit Duty Officers, Geographic Area Coordination Centers (GACC)*Note: Aircraft equipped to fulfill this mission may also have applicability for other missions as described in this document. For example, an aircraft equipped with sensors capable of performing ISR may also be applicable for Large Area Detection.*  | During or following the passage of a lightning event, EO/IR equipped sensor platform performs scan over affected area. The affected area is expected to be large scale, covering multiple national forests and partner jurisdictions. Area of coverage may be as large 400-500 miles, such as Northern California, Western Montana/Norther Idaho, the Colorado Front Range, etc. In recent years FS has utilized DRTI and CO-MMA for these missions as a test of concept over a large area. FS NightWatch and FireWatch Air Attack platforms have been used for fire detection in California on a smaller scale. NIFC Lightning data is typically used to plan detection routes and area of interest. Also utilize IRWIN data to provide awareness of existing/known fires to avoid reporting duplication. Sensor platform would be ordered or pre-positioned by GACC if a large lightning or wind event is forecasted. Data on new fires is expected to be transmitted or uploaded to hosting website while aircraft is in flight for exploitation by the ordering unit. Dissemination would need to be worked out between the ordering unit and all the Agencies Having Jurisdiction (AHJ) within the flight path. Possible options for dissemination include:* Data could be downloaded by GACC and distributed to AHJ within affected area

–or-* All AHJs within the affected area could be notified of the detection flight and given a link to where the data is stored for their own retrieval, exploitation, and dissemination.

FS has also been developing the HawkEye/IgPoint capability to detect new fires using space-borne sensors.  | **Desired Data*** GPS coordinates of new fires displayed as GIS ready points (or polygons if >10 acres) plotted on a map showing agency jurisdictional boundaries for ease in dissemination.
* Detection points will be attributed with fire size up information (i.e. size, characteristic, fuel type, adjacent fuel type, position on slope, proximity to VARs, if fire is already staffed, etc.)
* Short video or still frame grab of the new detection may be desired but is not required.

**Desired Products*** Geo-rectified PDF map showing GPS location of all new fires with pre-selected base layers along with footprint of mission coverage area. The extent of the base map would be the responsibility of the ordering unit to define.
* KMZ or KML of the same data.
* Data table (MS Excel) of all new fires detected with GPS locations and size-up metadata.
* All GIS product will meet the G-STOP fire mapping standards <https://gis.nwcg.gov/standards_agency.html>

**Deliverable Timeframes*** Notification of new fire detection with GPS coordinates as detected (instantaneous).
* Geo-rectified imagery in real time or near real time (+ 10 mins).
* Map products delivered within 30 minutes of completion of the data acquisition unless specified differently.
 | **Basic Requirements**Manned Aircraft:* Day or night capable. Night may require PIC and SIC flight crew.
* Turbine Engine and pressurized cabin is desired
* Meet applicable 14 CFRs (IFR, VFR, flight follow with ATC and avoidance of TFRs)
* Flight profile must avoid conflict with incident aircraft and/or TFR and Fire Traffic Area
* Capability to transmit data while in flight to a website or ground station
* Ability to communicate with ordering unit (voice, text, online chat, email, etc.)
* Capability to conduct a minimum of 4 hour mission that can cover a large area spanning 400-500 miles, or more (for example: sub-geographic area or multiple predictive service areas, etc.).

Satellite:* Sufficient coverage to provide imagery at nadir or no greater than 30 degree side scan
* 2 hour or less latency from image acquisition
* Post-processing of imagery to include geo-rectification and terrain correction,
* Mix of National System, NASA, NOAA, HDDS, and commercial satellites that possess thermal sensors capable of deriving heat signatures
* Ability to differentiate false positives

Sensor and On-board Processor:* Gimbaled mounted EO/IR camera system
* Multi-band IR capability MWIR (3 - 5 μm) and LWIR (8 - 14 μm) required, other bands such as SWIR, and NIR are desirable
* Wide and Narrow EO
* Inertial Measurement Unit stabilized sensor
* Geo rectified Nadir and geo tagged side scan
* Zoom capability to aid with discriminating heat detects from non-fire events.
* Data is capable of being retrieved and exploited in real time or near real time as per the Deliverable Timeframes
* Geo-tagged or geo-rectified target image
* Positional accuracy of detected new fire: meets ASPRS 1:100,000 map accuracy standards.
* Resolution: National Imagery Interpretability Rating Scale (NIIRS) Standard 6 or 7
* Sensitivity: Able to detect a 4” x 4” red hot coals (600 degrees C) from 10,000 ft. AGL at a distance of at least 5 miles
* Capable of providing GPS coordinates, GIS ready points/polygons/lines, and KMZ/KML.
* Capability to provide video or still imagery of new fire detections
* Real time EO video quality of 720p with recording capability
* Ability to see through smoke
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| **Mission: Large Fire Perimeter Mapping\*** (low green)End User: There is a wide range of end-users that depend on these products that include: IMTs, Duty Officer, Dispatch, AAs, GACCs, NMAC, NICC, PAOs, WO Fire Desk, Analysts, etc.*Note: Collection platforms equipped to fulfill other missions may be capable of performing fire perimeter mapping role. However to be considered “best-use”, the collection platform needs to be capable of providing mapping service for multiple large fires that are geographically spread out.*  | Capability to scan and collect desired thermal data on multiple large fires in one operational period to provide fire map products.Currently this mission is primarily carried out by NIROPS with pre-identified surge capacity. Surge capacity platforms may be assigned to provide coverage for fires that NIROPS is unable to fly due to separation from other incidents, duty day limitation, or aircraft availability.Collected imagery is utilize to create map products that are delivered in a specified time frame that can assist fire managers, IMTs, and Agency Administrators with the following:1. Updated situational awareness on what the fire is doing
* Perimeter mapping, detect spot fires, calculate acres
* Monitor fire progression towards key values at Risk (VAR) or Management Action Points (MAP).
* Monitor portions of fire not visible due to smoke
* Provide estimate of fire intensity and direction
* Assist with tactical decisions and assignment of resources
1. Operational or Decision Support
* Use information to support risk assessments
* Support strategic planning/decisions
* Monitor and evaluate effectiveness of strategies
* Assist with fire behavior model calibration (FS-Pro, FARSITE)
* Monitor attainment of long term objectives
 | **Desired Data*** Map perimeter of the fire, characterize intensity, detect spot fires, and calculate acres
* The entire fire or just actively burning portions may be requested for mapping
* Imagery used to create any Geospatial data and products shall be provided in both its raw (collected) and processed (interpreted) and as an imagery mosaic in lossless compression format
* GeoTiff or JPEG 2000 are recommended

**Desired Products*** Geo-rectified PDF map showing areas of intense, scattered, isolated heat, and spot fires outside the perimeter
* Generate GIS ready data (points, lines and polygons)
* Generate KMZ or KML
* All GIS product will meet the G-STOP fire mapping standards <https://gis.nwcg.gov/standards_agency.html>
* Provide notes on significant changes or questionable data that needs ground verification (interpreter’s log)

**Deliverable Timeframes*** Daytime products: Delivered within 2 hours of completion of the incident data acquisition unless specified differently.
* Nighttime products: Delivered within 4 hours of incident data acquisition, no later than 0400 hours.
 | **Basic Requirements**Manned Aircraft:* Day or night capable. Night may require PIC and SIC flight crew
* Turbine engine and pressurized cabin may be desired
* Meet applicable 14 CFRs (IFR, VFR, flight follow with ATC and avoidance of TFRs)
* Flight profile above 6,000’ AGL to avoid conflict with incident aircraft and/or TFR
* Perform data gathering flights under IFR or if VFR then must flight follow with ATC
* Capability to transmit data while in flight to a website or ground station
* Capable of conducting a minimum of a 4 hour mission that can cover multiple incidents in a geographic area

Unmanned Platform (UAS):* Meets IFUAS Guide for operating on a wildland fire incident
* Day or night capable
* Flight profile must avoid conflict with incident aircraft and/or TFR
* Capability to transmit data while in flight to a website or ground station located at ICP
* Ground station has the ability to communicate or co-locate with ordering unit or IMT (voice, text, online chat, email, etc.)
* Mapping software to provide desired map products

Satellite:* Sufficient coverage to provide imagery at nadir or no greater than 30 degree side scan
* 6 hour or less latency from image acquisition
* Post-processing of imagery to include geo-rectification and terrain correction

Sensor and Image Processor:* Line Scanner or EO/IR step-stare camera system
* Inertial Measurement Unit stabilized sensor
* Thermal IR capability such as multi-band IR (3 - 5 μm and 8 - 14 μm)
* Positional accuracy of final product: Meets ASPRS 1:24,000 map accuracy standards
* Ground Sample Distance: 4 meters at nadir or better, not to exceed 10m on edges of usable view
* Sensitivity: Able to detect 6” x 6” red hot coals (600 degrees C) from 10,000 ft. AGL or higher
* Ability to scan 100,000 acres per hour (or greater)
* Ability to differentiate false positives from rock outcrops, bare ground, metal roofs, etc.)
* Ability to mitigate against blooming (saturation) effects caused by hot gases from crown fires
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| **Mission: Intelligence / Surveillance / Reconnaissance (ISR)** med-lo greenEnd Users: IMTs, Duty Officer, Dispatch, AAs*Note: Aircraft equipped to fulfill this mission may also have applicability for other missions as described in this document. For example, an aircraft equipped with sensors capable of performing Large Area Detection may also be applicable for Periodic ISR missions.*  | Fast-moving, dynamic incidents often require additional overhead imaging for operational and decision support at a higher rate than once per night. In recent years the FS has used EO/IR equipped manned and unmanned aircraft to gather additional intelligence and/or surveil portions of fires. There are two primary forms of ISR: 1. Persistent ISR: one platform assigned to a single fire and provide 12-18 hours of on-demand coverage.
* Large UAS may be best-use
* Dedicated coverage of one fire
1. Periodic ISR: one platform assigned to cover multiple fires and provide 1-2 hours of coverage per fire.
* CO-MMA, DRTI, and vendor manned AC equipped with gimbal EO/IR may be best-use
* Assigned to cover multiple fires in one operational period

Imagery is used to create FMV or map products that when delivered in a timely manner can assist fire managers, IMTs, and Agency Administrators with the following:* Monitor portions of large fires experiencing active growth and spread
* Provide perimeter and acreage updates
* Monitor fire progression towards VARs or MAPs
* Monitor portions of fire not visible due to smoke plume or inversions
* Provide update on intensity and direction
* Provide situational awareness for strategic and tactical decisions
* Support burn outs and detect spot fires
* Monitor and evaluate effectiveness of strategies and tactics
* Monitor amount of residual heat to inform mop-up decisions
* Provide data to assist with fire behavior calculation and model calibration
 | **Desired Data*** Near real-time FMV or frame grabs showing areas of interest
* GPS coordinates of heat detections displayed as GIS ready polygons, lines, or points to map areas of new growth or spot fires since last image
* Calculate increase in acres since last flight
* Concentrate on areas of high fire activity and/or heat concentrations

**Desired Products*** FMV showing live or near real-time geo-rectified imagery
* Geo-rectified PDF map
* GIS ready shapefiles (points, lines and polygons).
* KMZ or KML of the above
* All GIS product will meet the G-STOP fire mapping standards (weblink) <https://gis.nwcg.gov/standards_agency.html>
* Access to raw measured data

**Deliverable Timeframes*** Geo-rectified imagery (if requested) is delivered in real time or near real time (+ 10 mins) from data acquisition.
* Map products delivered within 30 minutes of completion of the mission data acquisition unless specified differently.
 | **Basic Requirements**Aircraft (if manned):* Day or night capable. Night may require PIC and SIC flight crew
* Turbine engine and pressurized cabin may be desired
* Meet applicable 14 CFRs (IFR, VFR, flight follow with ATC and avoidance of TFRs)
* Flight profile must avoid conflict with incident aircraft and/or TFR and FTA
* Capability to transmit data while in flight to a website or ground station located at ICP
* Ability to communicate with ordering unit or IMT (voice, text, online chat, email, etc)
* Ability to distribute data/products to responders equipped with mobile devices.
* Capability to transmit video imagery to users outside of cellular or wifi connectivity
* Provide real-time radio communication to air attack or ground resources to warn of significant changes (i.e. spot fire, breach of MAPs or containment lines, blow-ups not visible due to smoke, etc.)
* Capable of providing a minimum of 2 hour coverage over the incident

Unmanned Aircraft System (UAS):* Meets IFUAS Guide for operating on a wildland fire incident
* Day or night capable
* Ability to track platform location
* Flight profile must avoid conflict with incident aircraft and/or TFR
* Capability to transmit data while in flight to a website or ground station located at ICP
* Ground station has the ability to communicate or co-locate with ordering unit or IMT (voice, text, online chat, email, etc.)
* Ability to distribute data/products to mobile devices.
* Provide real-time radio communication to ground resources to warn of significant changes (i.e. spot fire, breach of MAPs or containment lines, blow-ups not visible due to smoke, etc.)
* Capable of providing a minimum of 12 hour (or more) coverage over the incident.

Sensor and On-board Processor:* Gimbaled mounted EO/IR camera system
* Inertial Measurement Unit stabilized sensor
* Geo rectified Nadir and geo tagged side scan
* Thermal IR capability such as multi-band IR (3 - 5 μm and 8 - 14 μm), SWIR and NIR is desirable but not required
* Positional accuracy of final product: meets ASPRS 1:24,000 map accuracy standards.
* Real time video quality of 720p with voice transmission and recording capability
* Wide and Narrow EO
* Data is capable of being retrieved and exploited in real time or near real time (+10 mins)
* Resolution: National Imagery Interpretability Rating Scale (NIIRS) Standard 6 or 7
* Sensitivity: Able to detect body heat (37 degrees C) from 10,000’ AGL at a distance of at least 5 miles out in the open, or from 3 miles in timbered canopy.
* Capable of providing GPS coordinates, GIS ready points/polygons/lines, and KMZ/KML.
* Ability to mitigate false positives from rock outcrops, bare ground, metal roofs, etc)
* Ability to mitigate against blooming (saturation) effects caused by hot gases from crown fire
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| **Mission: Support dashboard displays with infrared heat detects of emerging and on-going large wildland fire to provide common operating picture of the national wildland fire situation**End User: Agency leadership at all levels (WO, RO, Forest), Dispatcher at all levels (NICC, GACC, local dispatch center), fire managers, duty officers, and IMT*Note: Dashboard displays ingest information from a wide range of sources. This mission focuses on using IR detection to support commonly used dashboards to show location of fires and periodic updates based on subsequent heat detections.* | Infrared heat signature data is collected and used in conjunction with other sources of data/fire information in a Dashboard to spatially display location and periodic updates of the fire situation as part of a Common Operating Picture that provides situational awareness for wildland fires nation-wide.* Since inception the FS Enterprise Geospatial Portal (EGP) has been the dashboard display for wildland fires
* Provides common operating picture for wildland fire nation-wide in all jurisdictions
* Utilizes data from a wide range of sources, not just imaging
* Widely used at regional and national levels to inform strategic decisions (non-tactical) and prioritize response and resource allocation
* Primarily intended to support strategic decisions, as such fidelity requirements are less than tactical applications such as Detection or Fire Perimeter Mapping

 Currently using heat signature detection from:* MODIS and VIIRS
* IgPoint and FireFly (new for 2019) detects
* HDDS and commercial satellite imagery that is collected

There is a wide range of satellite systems controlled by governments and commercial entities, each with different orbits, coverages, return intervals, sensor capabilities, etc. As such, the anticipated solution is to use all the different infrared heat detections as they become available during a day/week and display them in the Dashboard. For example: MODIS and VIIRS make several passes each day and heat detects from each pass are added to the EGP display along with IgPoint detects. As additional capabilities become available (e.g. GOES-16/17) they too can be incorporated into the Dashboard. | **Desired Data*** GPS coordinates of heat detection signatures displayed as GIS ready points
* Confidence rating (hi, mod, low) if the heat signature is an actual wildfire, and/or ability to discriminate from false positives (i.e. 3rd party confirmation, algorithms, etc.)
* Data is periodically refreshed, displaying subsequent heat detects in the same location and/or adjacent locations if the fire spreads
* Post-processed imagery that is geo-rectified, terrain corrected, and off-nadir distortion is limited

**Desired Products*** Heat points are geo-rectified as point vectors compatible for display in EGP
* Ortho-corrected geo-tiffs
* Ortho-corrected color tiffs

**Deliverable Timeframes*** Map products <1 hour from acquisition and available to be posted to EGP
 | **Basic Requirements**Satellite:* Mix of National System, NASA, NOAA, HDDS, and commercial satellites that possess thermal sensors capable of deriving heat signatures
* Data from multiple collection platforms would be ingested into EGP to paint an overall picture of the fire situation

Sensor:* Thermal capability using multispectral bands (SWIR, MWIR, LWIR, NIR)
* GSD and interval between returns for strategic applications:
	+ Would like to match or exceed MODIS and VIIRS GSD of 375-500m, with 3-4 returns per 24 hr period
	+ For systems with a higher returns, i.e. increments of every hour or <1 hour, a GSD up to <1KM is acceptable
	+ Ultimately a GSD of <100m with a return interval of 1 hour is desired
* If GSD of <10m can be achieved, that application can be used for tactical perimeter mapping even if it has a return interval of once per 24 hr period

Post-processing:* If wildland agency personnel need to perform analysis of data, desire imagery be post-processed prior to delivery:
	+ Image is ortho-corrected as geo-tiffs and color tiffs
	+ Heat points are geo-rectified and can be produced into a point shapefile
	+ Terrain corrected
* Ideally, raw imagery is post-processed using machine learning or human analysts (if clearance is required) to derive point vector files compatible for upload into EGP
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