Application Form

Note: Background on the "GEO-Amazon Earth Observation Cloud Credits Programme" and Instructions for the Application Form can be found here.

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Executive summary (2 pages max)

Problem: Despite today's amazing telecommunications services, there are still too many people in harm's way who do not get timely alerts so they can protect lives and livelihoods. This gap in effective alerting is especially acute in least-developed and developing countries, which are often the most vulnerable as well.

Solution: This project addresses the public alerting gap by providing free tools for developing countries to implement the same transformative approach already delivering greatly enhanced public alerting in most other countries worldwide. Specifically, these countries will be offered free toolsets enabling their alerting systems to easily leverage the international standard Common Alerting Protocol (CAP)[1]. A CAP message communicates, in a standard format, the key facts and the recommended actions for any emergency. Use of the CAP format greatly increases warning efficiency and effectiveness, primarily because a CAP message carries data intended for machine processing as well as information targeted to humans. Two toolsets are of primary importance: one to create and publish CAP alerts, and one to globally aggregate all published alerts so that every place on Earth can access all alerts affecting that place.

Global Policy Goals: This project supports Target (g) of the Sendai Framework for Disaster Risk Reduction 2015-2030: to "substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030". In the context of the Paris Agreement, this project supports the adaptation agreement of Governments to strengthen societies' ability to deal with the impacts of climate change. It is specifically focused on the agreement of Governments to provide continued and enhanced international support for adaptation to developing countries. In terms of the UN Sustainable Development Goals, this project most closely aligns with SDG 11, "Make cities and human settlements inclusive, safe, resilient and sustainable". It is especially relevant for Target 11.5, "Reduce the Adverse Effects of Natural Disasters" and it also supports Target 13.3, "Build Knowledge and Capacity to Meet Climate Change".

[1] For an overview of CAP, a 15 minute video is available here. There is also a 2-hour self-directed "CAP Basics" course, available here.

Project plan (15 pages max)

Scope: This application requests funding for a 3-year follow-on of a project that has been running for two years with grants from AWS. The application focuses on two toolsets: the cloud-based Filtered Alert Hub (FAH) for aggregating and filtering CAP alerts from all available CAP alert sources worldwide, and the cloud-based CAP Editor for creating and publishing CAP alerts. (Note: For a description of how the FAH work relates to the GEO Work Programme, see the Appendix.)

Filtered Alert Hub Toolset: Operating at global scale, the cloud-based FAH aggregates CAP alerts from national, international, and hazard-specific sources. It has grown from about twenty CAP alert sources two years ago to about 80 sources today.

FAH offers an aggregate feed of all, unfiltered alerts, but it also offers thousands of subset feeds. These other feeds are customized by area (city, province, country...) but can also be customized by priority, hazard type (typhoon, tsunami...) and other criteria. Because seconds can be life-critical in the case of sudden-onset threats, the FAH near-real-time event processing is optimized for speed. The FAH system uses AWS EC2 and a Rabbit MQ architecture for the event processing, with Elastic Search for geospatial filtering. It also uses AWS S3 for storing alert inputs and feed outputs. The FAH project site, http://alert-hub.org, links to the detailed project documents about the system overall and its component parts.

It is worthwhile to note that the FAH architecture is being considered for adoption, at least in part, by other large-scale alerting systems, e.g., MeteoAlarm, the Global Disaster Alert and Coordination System, the U.S. Integrated Public Alert and Warning System, and China's National Early Warning Release System. These are in addition to the cloned version of the FAH aggregator which is already in use for aggregating official weather warnings for the WMO Severe Weather Information Center (SWIC), the planned cloning of FAH by Brazil to serve all of South America, and interest by Facebook in the FAH architecture.

CAP Editor Toolset: The cloud-based CAP Editor toolset for creating and publishing CAP alerts is available at https://cap.alert-hub.org Here it can be seen that sources have been initialized for 126 nations, focused primarily on places that have yet to implement CAP-enabled alerting. Many of these are initialized with multiple sources and/or in multiple languages. Anyone can use these in guest mode, but to create a draft alert or to publish a final alert requires an official designation of persons in authorized roles. A "CAP Editor Operations Guide" is under development.

Launched only a few months ago, the cloud-based CAP Editor has rapidly gained popularity with developing countries. Three are now using it operationally (Afghanistan, Botswana, and Zimbabwe) and thirteen others are using it in an evaluation or testing

mode (Comoros, Egypt, Fiji, Guinea Bissau, Honduras, India, Iran, Liberia, Samoa, Saudi Arabia, Sierra Leone, Tuvalu, and Vanuatu).

Role of Earth Observations: Any communication of alerts to people begins with the means to perceive a potential or actual hazard threat. Earth Observations are essential to alerting of natural hazards and man-made hazards, although specific technologies and analysis techniques vary by type of hazard.

FAH is set up to disseminate alerts over the entire range of hazard types. Natural hazard types include: biological (e.g., disease in humans, disease in animals, insect plague, algal bloom, invasive species); hydro-meteorological (e.g., cyclones, tornados, severe weather, storm surge, dust storm, air quality, smog, avalanches, floods, flash floods, dam failures, glacial lake outflow, drought, wildfires, cold spell, heat wave, high wind, rough seas, rip tides); geophysical (e.g., earthquakes, landslides, mudslides, tsunami, volcanic ash, volcanic eruption, lahars); and space weather (e.g., geomagnetic storm, asteroid). Man-made hazard types include: chemical spills, oil spills, debris flows, toxic waste, water pollution, conflict, terrorism, famine, displaced populations, industrial accidents, transportation accidents, radiation release, and illegal fishing, among others.

It is perhaps obvious that, across these many hazard types, alerting relies on a diverse array of Earth Observation systems, including *in situ* and remote observing, and systems based in space, on land, in the air, and on the sea. Looking at sensor systems, we see that weather forecasting uses Earth Observations from satellites, radar, weather stations, lightning detectors, human observers, balloon radiosondes, drifting buoys, and commercial aircraft flights, among many others. Flood forecasting uses data from satellites, river gauges, tide gauges, and even webcams and microphones in the case of monitoring for dam failure. Wildfire detection uses data from satellites and drones. Air quality monitoring depends on *in situ* sensors for gasses and particulates. Earthquake detection uses seismometer networks, supplemented by human observers. Tsunami warning depends on earthquake detection, seafloor pressure sensors and tide gauges. Volcano monitoring uses data from satellites and seismometer networks.

In addition to data from sensors, alerting relies on Earth Observations for base data. For example, accurate and precise topography is essential for forecasting flash floods, landslides, and avalanches. Accurate and precise bathymetry is essential for forecasting of tsunami and storm surge effects. Characterizing the built environment is essential for forecasting the effects of many hazard threats, and such characterization is reliant on Earth Observations to a great extent. Emergency alerting in the context of humanitarian operations also makes use of Earth Observations in various ways.

Role of the Cloud: FAH focuses on the alert creation and publishing needs of those involved in emergency management before and during an evolving emergency

situation. As noted above, emergency alerts collectively derive from a vast variety of data and information resources, and many of these are cloud-based. This is especially the case for very large datasets, which is often characteristic of Earth Observations.

In some cases, the hazard occurs so suddenly that seconds can mean the difference between timely, life-saving alerts and alerts that arrive too late. Speed of processing and dissemination is then paramount, and effective speed is only affordable at scale with cloud-based solutions such as FAH.

Emergency management typically relies on "shared situational awareness" tools wherein relevant data and information are compiled for ease of reference, and these tools are often cloud-based. Of course, alerts comprise one of the essential classes of data and information in such tools.

FAH Collaborators: At present there are eleven members formally on the FAH Team within the governing NOAA Big Data Project CRADA. The project lead also maintains liaison with two other major organizations that support CAP-enabled alert hubs: Google and the International Federation of Red Cross and Red Crescent Societies (IFRC). Here below is a brief description of what each of these collaborators focuses on.

AccuWeather - AccuWeather is actively supporting FAH in its progress toward an operational, global-scale resource. Their particular interest is the WMO Alert Hub prototype operated by FAH because that official resource will be key to Accuweather dissemination of alerts for weather. AccuWeather apps and partner apps reach 1.5 billion people globally. It is useful to FAH that their systems also use AWS.

Amazon Web Services (AWS) - AWS advises on FAH technical matters. Also, AWS Disaster Response creates specific products and services for selected major events, and alert hubs can be part of such an effort.

EUMETNET MeteoAlarm - MeteoAlarm ingests CAP alerts and emits CAP alerts as news feeds. From an FAH perspective, MeteoAlarm acts as a regional alert hub.

Facebook - Facebook Disaster Maps creates specific products and services for selected major events, and alert hubs can be part of such an effort. Also, the Facebook Local Alerts product is a candidate for use of the CAP standard.

Global Disaster Alerting Coordination System (GDACS) - GDACS ingests CAP alerts and emits CAP alerts as news feeds. In some respects GDACS acts as an alert hub.

Google - Google Public Alerts has much in common with FAH from an architectural perspective. Google also creates specific products and services for selected major events, and alert hubs can be part of such work.

Hong Kong Observatory (HKO) - HKO, a WMO Centre, operates a cloned version of FAH for aggregating official weather warnings on the WMO SWIC 2.0 website.

IBM and The Weather Company - The Weather Company, an IBM business, is actively supporting FAH in its progress toward an operational, global-scale resource. Their particular interest is the WMO Alert Hub prototype operated by FAH because that official resource will be key to their dissemination of alerts for weather. The Weather Company distributes meteorological alerts and forecasts, powering over 2 billion global mobile devices. Coincidentally, their systems also use AWS.

IFRC - The IFRC Global Disaster Preparedness Center operates a Hazards App that provides emergency alerts to individuals who download the app to their smart phones. It is supported by an alert hub that ingests CAP alerts from CAP news feeds. This alert hub is very similar to FAH in architecture, and it runs on AWS. Collaboration is useful with regard to CAP sources, tools for creating CAP alerts, and some other aspects.

Knowledge Integration Limited - The owner of this company, Ian Ibbotson, is the main architect and developer for the current version of FAH.

OASIS Emergency Management Technical Committee (EM TC) - The OASIS EM TC is the maintenance agency of the CAP standard (ITU Rec. X.1303).

Open Commons Consortium (OCC) - OCC is a non-profit venture which provides cloud computing and data commons resources to support "scientific, environmental, medical and health care research." OCC focuses on helping cloud-based systems to be operable on any cloud infrastructure rather than just one particular cloud infrastructure.

USAID Office of Foreign Disaster Assistance (OFDA) - OFDA provides emergency humanitarian assistance in response to international crises and disasters and leads the U.S. Government’s humanitarian assistance efforts overseas. OFDA is helping to promote FAH as well as implementation of CAP in countries worldwide.

FAH Research (example): As noted above, many observing systems rely on sensors for gathering input data (e.g., river gauges, seismic monitors, and lightning sensors). The Internet of Things (IoT) provides an increasingly common mechanism for sensor communication. In some cases, such sensor data is in the form of CAP alerts, and CAP alerts can also be used to convey messages to IoT actuators such as sirens and devices that re-route traffic or stop trains.

FAH is researching use of the IoT publish/subscribe protocol MQTT (Message Queue Telemetry Transport) as an communications mechanism for the consuming and producing of CAP alerts, in parallel with Internet news feeds (RSS and ATOM), which are the common publish/subscribe protocols for the World Wide Web. Architecturally,

MQTT would be a supplement to rather than a replacement of Internet news feeds, because the Web will be current technology for at least another decade.

MQTT is simpler and lighter weight than RSS or ATOM news feeds. In RSS and ATOM, the CAP alert is not carried directly--the actual CAP XML must be obtained by following a link to the file. (The link is found in an ATOM feed/entry or in an RSS channel/item.) In MQTT, the equivalent of a news feed item or entry is the message itself, and the MQTT message payload can be the actual CAP XML text. Conveniently, MQTT messages can be encrypted via TLS, the same way RSS and ATOM files are encrypted when they are transmitted via HTTPS.

The current Rabbit MQ version of FAH uses a front end subsystem ("feedFacade") to transform each RSS or ATOM source into a Rabbit MQ broker "topic". The FAH main processing then ingests CAP alerts by subscribing to these topics. Processing of a CAP alert is accomplished by a "CAPCollator" subsystem, ending when FAH publishes the CAP alert into each of its matching topics (in addition to publishing the alert in its matching RSS subscriptions). At present, these services use the default Rabbit MQ broker, but adaptors are available to expose these services via MQTT as well.

Credit Estimate: Steady increases in the monthly cost are anticipated as the toolsets experience further uptake worldwide. Assuming costs double by the end of the 3-year period, the overall credit estimate is $10,400. This estimate is based on an initial monthly cost estimate of $193, derived from actual AWS bills for this project and use of the AWS Simple Monthly Calculator, available here.

Appendix: FAH and the GEO Work Programme

FAH has a natural tie-to various components of the 2017-2019 GEO Work Programme, categorized as: GEO Initiatives, GEO Foundational Tasks, and GEO Community Activities. Here below is a brief note on the relevance of FAH to selected components.

GEO Initiatives:

Data Access for Risk Management (GEO-DARMA) - The objective is fostering the use of Earth observation data to support disaster risk reduction and raising the awareness of policy and decision-makers and major stakeholders of the benefits of using satellite Earth observation in all phases of disaster risk management. "Shared situational awareness" is essential to disaster management and involves ingesting and emitting all manner of alerts. For alerts that are in CAP format, FAH should be a key component.

GEO Geohazard Supersites and Natural Laboratories (GSNL) - Objectives are to enable the global scientific community to have open, full and easy access to a variety of space- and ground-based data; to innovate technologies, processes, and communication models; and to ensure that new knowledge generated by the wider scientific community is rapidly taken up to benefit hazard assessment, disaster monitoring and response actions. Local geohazard scientific institutions and researchers are providing authoritative geohazard information. Where that information takes the form of an alert, it should be in CAP format and disseminated by FAH and other alert hubs.

GEO Global Network for Observation and Information in Mountain Environments (GEO-GNOME) - First tasks provide a platform for mountain-related observations, and focused campaigns relate to known issues such as elevation-dependent warning. Warnings can be in CAP format, as they are currently in Switzerland, and these can be disseminated by FAH and other alert hubs.

GEO Global Water Sustainability (GEOGLOWS) - The intent is to facilitate the use of Earth observation assets to contribute to mitigating water shortages, excesses and degraded quality. Public and private alerts associated with such hazards can be in CAP format and disseminated by FAH and other alert hubs.

GEOSS-EVOLVE - The objective is to advance and evolve GEOSS architecture based on technology watch and user requirements. The cloud-based and service-oriented FAH architecture is simple and based on international standards; it should be melded into the GEOSS architecture.

Global Drought Information System (GDIS) - Goals include providing near-real-time global drought monitoring and rapidly identify “hot spots” of food vulnerability and

insecurity arising out of drought-induced interruptions of water supply. GDIS alerts are already generated by GDACS and disseminated by FAH.

Global Wildfire Information System (GWIS) - Earth observations have a critical role in helping first responders and risk managers to rapidly map natural hazards and assess impacts. GWIS fire alerts should be in CAP format and disseminated by FAH and other alert hubs.

Oceans and Society: Blue Planet - The monitoring of marine debris; off shore and coastal industries; and illegal fisheries operations can prompt the issuance of CAP alerts, which would be disseminated by FAH and other alert hubs.

GEO Foundational Tasks

GEONETCast Development and Operations - GEONETCast disseminates high-priority emergency alerts in CAP format as aggregated by FAH or other alert hubs.

GEO Community Activities:

Advancing Communication Networks - The intent is to assess network requirements and possible improvements of data dissemination and to investigate state of art information technologies, such as cloud services. The FAH architecture can be very relevant, as it is simple and based on international standards.

AirNow International: Expanding Networks & Integrating Methods for Air Quality & Health Data --AirNow alerts are already provided in CAP format and are aggregated and disseminated by FAH.

Chinese Tsunami Mitigation System - China is extending its existing national alerting system, based on CAP, to encompass all types of hazards. This should include alerts from the China Tsunami Early Warning Center and the China Earthquake Networks. China is also implementing an Asia regional segment of the Global Multi-hazard Alerting System (GMAS) based on FAH technology.

Copernicus Atmospheric Monitoring Service (CAMS) --Aerosols, ozone and other reactive gases such as nitrogen dioxide determine the quality of the air around us, affecting human health and life expectancy, the health of ecosystems and the fabric of the built environment. Dust, sand, smoke and volcanic aerosols affect the safe operation of transport systems and the formation of clouds and rainfall. These conditions can prompt the issuance of CAP alerts that can be disseminated by FAH and other alert hubs.

Earth Observations for Disaster Risk Management - FAH is relevant to the stated objective to: Promote timely and reliable access to in situ data required in emergency

events; Coordinate efforts towards a more timely dissemination of information for monitoring, predicting, early warning, and responding to hazards at local, national, regional, and global levels; and, Demonstrate the validity of regional end-to-end systems through pilot demonstrators with an initial focus on Floods, Seismic Hazards, Volcanoes and Landslides.

Earth Observations for Geohazards, Land Degradation and Environmental Monitoring .- This activity focuses on EO technologies to map and monitor geological and anthropogenic hazards, such as: landslide and subsidence dynamics, soil degradation and contamination due to anthropogenic activities, and glacier monitoring. It asserts that the generation of up-to-date terrestrial surface potential hazard maps will allow building early warning and monitoring systems improving risk management and disaster resilience. Any resulting alerts can be issued in CAP format and disseminated by FAH and other alert hubs.

Earth Observations for Health (EO4HEALTH) - The activity seeks to foster the development of integrated information systems that improve the capacity to predict, respond to and reduce environment-related health risks. Any resulting alerts can be issued in CAP format and disseminated by FAH and other alert hubs.

Earth Observations for Managing Mineral Resources - Monitoring of illegal and uncontrolled mining activities can prompt the issuance of CAP alerts, which can be disseminated by FAH and other alert hubs.

Global Flood Awareness System (GloFAS) - GloFAS is supported by the Copernicus Emergency Management Service - Early Warning Systems to produce daily flood forecasts and thereby improve preparedness and response for floods. These forecasts can be used in the issuance of flood alerts in CAP format that can be disseminated by FAH and other alert hubs.

Global Flood Risk Monitoring - This activity aspires to provide early prediction and characterization of flood inundation in near real time. Such characterization can be useful in the analysis that leads to flood alerts in CAP format which can then be disseminated by FAH and other alert hubs.

Harmful Algal Bloom (HAB) Early Warning System - A Harmful Algal Bloom warning system with a 24-hour lead-time would be a critical element. Any resulting alerts can be issued in CAP format and disseminated by FAH and other alert hubs.