Develop Cloud Computing Capability at Streamgages using Amazon Web Services GreenGrass IoT Framework for Camera Image Velocity Gaging

CDI FY19 Statement of Interest

Lead PI Information

PI Name: Frank L. Engel
PI Email Address: fengel@usgs.gov
PI ORCID: 0000-0002-4253-2625
PI Organization: USGS Texas Water Science Center
PI Mission Area: Water Resources
PI City, State: San Antonio, TX

Financial Information

Total Requested Funds: 49706
In-Kind Matching Funds: 26926

Project Information

Project Description: In short, enact "smart" Internet of Things (IoT) infrastructure on our gaging network to enable camera image velocity gage archival and processing in the cloud. This project seeks funding to develop an IoT streamgage with a camera. Insights gained during the process will be used to build a framework toward leveraging IoT for other gages and sensors in the network.
List of Anticipated Deliverables: Deployable Amazon Web Services GreenGrass IoT framework for camera image velocity gage, presentations summarizing findings and next steps
SSF Element 1: Data Management
SSF Element 2: Web Services
SSF Element 3: Applications

Collaborators

	Name	City	State	Organization
Co-PI	John Parks	Guaynabo	PR	USGS, Office of Enterprise Information
Co-PI	Jennifer Erxleben	Bozeman	MT	USGS, Cloud Hosting Solutions
Co-PI	Jay Cedeberg	Tucson	AZ	USGS, Arizona WSC
Collaborator	David Donato	Reston	VA	USGS, Office of Enterprise Information
Collaborator	Antoine Patalano	Córdoba	Argentina	National University of Córdoba, CETA Institute
Collaborator	C. Marcelo Garcia	Córdoba	Argentina	National University of Córdoba, CETA Institute

Title: Develop Cloud Computing Capability at Streamgages using Amazon Web Services GreenGrass IoT Framework for Camera Image Velocity Gaging
USGS Lead PI: Frank L. Engel

Project Narrative

Background: USGS Water Mission Area has been developing and testing computerized video-based approaches to measuring river discharge from video-derived velocities (Image Velocimetry). We often can't safely capture flood flow data at gages due to dangerous and difficult site conditions, or event timing. Image velocimetry offers a promising solution to this critical need for measurement of flood flows because it allows technicians to measure river flow remotely. However, transmission, archival, and processing of video from cameras is a slow and costly process. New cloud computing technology and robust "smart" sensors (collectively termed the Internet of Things [IoT]), can process and archive camera-derived data.

What problem are we trying to solve? In short, enact "smart" Internet of Things (IoT) infrastructure on our gaging network to enable image gage archival and processing in the cloud. This project seeks funding to develop an IoT streamgage with a camera. Insights gained during the process will be used to build a framework toward leveraging IoT for other gages and sensors in the network. The first step is to use IoT to enable real-time gage image velocity processing which is connected to the cloud. We will use Amazon Web Services (AWS) Greengrass software, which allows IoT sensors and devices on a network to communicate and react, even when internet connectivity is down. The aim is to create a camera gage "IoT provisioned" device. IoT provisioned simply means that the computer and camera in the field is running Amazon Greengrass and has secure connectivity to the USGS virtual data center in AWS.

In addition, AWS Lambda functions for processing and archival of image velocity measurements will be developed. A Lambda function is an encapsulated program that can process information and data at the device. For example, Lambda functions for processing a video into flow velocities and river discharge would be executed by the camera device at the river site. The camera velocity gage built during this project will (1) process video into velocities and discharge, (2) provide secure and resilient data storage, and (3) provide back end analytics with visualization and reporting.

How is it done today, and what are the limits of current practice? Today, we do not have a real-time method of ingesting image velocimetry data into the AQUARIUS (AQ) database. We do have a real-time smart sensor platform (linux based, running on a Raspberry Pi) which is capable of auto triggering, recording, and storing video during events. Once video data are collected, a technician must retrieve the data either over 4g telemetry (slow and unreliable) or as part of a site visit. To process, the technician must use software products on a laptop and follow a relatively complex procedure to compute velocity and discharge. These results are then input into AQ manually.

What's new in your approach and why do you think it will be successful? Application of serverless cloud IoT to gaging is a different paradigm from the current approach. Now that IoT platforms support devices with intermittent connectivity and on-demand processing, a new world of possibilities for our gaging network exists.

Two key pieces to building a successful test case for the camera gage solution are (1) existing computing power at the gage—Amazon already supports the Raspberry Pi for this, and (2) porting of our existing processing codes into Lambda/Greengrass functions. Because AWS Lambda can natively ingest multiple scripting languages (Python included), we expect to accomplish our goals.

What are the risks and the payoffs? We may encounter unforeseen software, equipment, or telemetry challenges. Remote sites will still have connectivity issues. With more computing pushed to the field power supply requirements increase. However, the payoff is huge. Having a reactive network and highly scalable cloud analytics will improve sampling and data processing strategies. A "smart" gage network may save more lives and improve water resource management. In the long run, the deployment of a serverless platform on IoT devices will be significantly less expensive to maintain and provision than our current approach.

Estimated budget table
Use template provided below, 0.5 page.

Save the file (which should be 1.5 pages total) as a PDF document and submit it using the form on the [2019 Proposals Page](). Send questions to cdi@usgs.gov.

**Note: Travel must be included for at least one representative to attend the 2019 CDI Workshop, June 4-7, 2019 in Boulder, CO. Travel cannot include data field collection. See the budget justification section of the Evaluation Criteria for the Statement of Interest and Full Proposal in the CDI Request for Proposals Guidance for more information.*

Budget Category	Federal Funding "Requested"	Matching Funds "Proposed"
1. PERSONNEL (SALARIES including benefits):		
Federal Personnel Total:	$	$16,988
Contract/Collaborator Personnel Total:	$	$
Total Salaries:	$0	$16,988
2. TRAVEL EXPENSES:		
Travel Total (Per Diem, Airfare, Mileage/Shuttle) **x** # of Trips: 1. CDI Annual Workshop (5 days, 1 traveler) 2. Visiting Scholar / Coding intensive (31 days, 1 traveler)	$12,502	$
Other Expenses (e.g. Registration Fees):	$	$
Total Travel Expenses:	$12,502	$0
3. OTHER DIRECT COSTS: (itemize)		
Equipment (including software, hardware, purchases/rentals):	$	$
Publication Costs:	$	$
Office Supplies, Training, Other Expenses (specify):	$	$
Total Other Direct Costs:	$	$0
Total Direct Costs:	$12,502	$16,988
Indirect Costs (%):	$10,278	$9,938
GRAND TOTAL:	$22,780	$26,926