A New User Interface for On-Demand Customizable Data Products for Sensors in a SensorWeb

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Overview

• A SensorWeb is a set of sensors (land, marine, air, space) and processing that interoperate in an automated collaborative manner.

• The SensorWeb Toolbox is a set of software modules that have been created to enable users to create various SensorWebs

• The Web Coverage Processing Service (WCPS) is one of the components created in the SensorWeb Toolbox which is the subject of this presentation
  – WCPS enables a user to rapidly define an algorithm which can then be uploaded and run within a sensor system
  – WCPS shown in next diagram relative to other SensorWeb components
NASA Decadal Survey HyspIRI
Architecture of Intelligent Payload Module to be Used for HyspIRI
WCPS Quick Load/Quick Look Ops Con

Web Coverage Processing Service (WCPS)-Client
Uploads to Various Environments

Create Custom Algorithm

Machine Learning Supervised Classifier (Regression Tree) Refined Offline

WEKA to WCPS Translator

Custom Algorithm Parse tree

Cloud

Quick algorithm upload

HyspIRI

GlobalHawk, Ikhana, ER-2 …

NASA Cloud Infrastructure As A Service

WCPS-Runtime Executes Algorithm Against Selected Sensor Data

Notification to user

Quick look data products

Custom Data Product (KMZ, PNG…)

Quick algorithm upload
Example of WCPS Product

background = black
opaque clouds = white
cloud shadow = black
haze and thin clouds = grey
clear water = blue
turbid water = brown
dry land = green
Another Example of WCPS Product

EO-1 ALI False Color Enhanced for Oil Sheen

Oil Classification Output Product
Cloud SCIENCE USER

Select algorithm to run

Parse tree

Onboard Algorithm Buffer

Run

Algorithm Builder Service

Create algorithm

High speed instrument data source

Run

WCPS-Flight Testbed Ops Con (Summer 2011)
User Interface for Access to WCPS-Client and WCPS-Runtime
Sample Concurrent Processing for Web Coverage Processing Service (WCPS)

Workers Running on separate Cores/Tiles

EXECUTE ALGORITHM

WCPS Runtime

Tile #1
WCPS Runtime Worker

Tile #2
WCPS Runtime Worker

Tile #N
WCPS Runtime Worker

Algorithm Pan-sharpening
concurrence
resample red band
resample green band
resample blue band
end…
Pursuing Flight Opportunity To Test Operations Concept

Phase 1:
- eMAS on ER-2 (Summer/Fall 2012)
Phase 2:
- eMAS on Global Hawk (2013)

PRE-Processing

L0
L1R
L1G
L2
ZIP

Post-Processing

VNIR
Thermal
GPS/INS

Atmospheric Correction
Digital Elevation Model

ODTHL UHF

Normal Mode Bypass To Ground

TLM DATA
INMARSAT CMD

Ground SensorWeb

GlobalHawk

ER-2

eMAS – Enhanced MODIS Airborne Simulator
Details of First Use of Cloud with WCPS

• First experiments using WCPS with Cloud occurred in collaboration with Open Cloud Consortium which provided a Cloud rack of equipment and personnel for system administration, funded by National Science Foundation
  ➢ Next slide shows connectivity of cloud
• Cloud integrated into Earth Observing 1 operations and WCPS used for ground data products
• User interface, along with WCPS-C and WCPS-R are all hosted on cloud
  ➢ For other missions each of these components can reside in different places.
Astronomical data

Biological data (Bionimbus)

Earth science data (& disaster relief)

Open Science Data Cloud

NSF-PIRE OSDC Data Challenge
Cloud Integration on EO-1 - Overview

Hyperion and ALI Level 0 Processed data from GSFC, building 3 server

External users, especially international (e.g. disaster workers)

NASA Investigators

Technologists

Level 1R and Level 1G Processing for ALI & Hyperion
Atmospheric Correction for ALI & Hyperion
Web Coverage Processing Service (WCPS) to enable users to customize Level 2 products

Eucalyptus-based Elastic Cloud SW
300+ core processors
40 x 2 Tbytes of storage
10 Gbps connection to GSFC
- being upgraded to 80 Gbps (Part of OCC)
At Univ of Illinois at Chicago
Supplied by Open Cloud Consortium
Open Science Data Cloud Virtual Machines & HTTP server to VM’s

Nambia Flood Dashboard
2 year data product archive

OCC = Open Cloud Consortium

Added Elastic Cloud to EO-1 Operations April 2011
Transformation to On-Demand Product Cloud Part 1
EO-1 Data Product Pipeline

- EO-1 Level 0 Processor Server
- EO-1 Level 1 Processor Service
  - EO-1 Level 1 Geospatially Corrected Service
  - EO-1 ALI Atmospheric Correction – FLAASH Service
- Hyperion Level 1R
  - Hyperion Level 1R
- ALI Level 1R
  - Hyperion Level 1G
  - ALI Level 1G
- Storage – 1 year
  - Hyperion & ALI Level 1R
  - Hyperion & ALI Level 1G
  - Storage – 1 year
  - Hyperion & ALI Level 1R and Level 1G AC
- Storage – Available Algorithms
  - WCPS Algorithm Generation Service
  - WCPS Runtime Service
- Storage – 1 year
  - User Defined L2 Products
- Select algorithm & data to run against
- Generate a new product with this new algorithm

Added Elastic Cloud to EO-1 Operations April 2011
On-Demand Product Cloud Part 2
Flood Dashboard (Matsu)

- CREST Hydrological Model
- TRMM based Global Rainfall Estimates
- Radarsat Images
- MODIS Daily Flood Extent Map
- Global Disaster and Alert and Coordination System (GDACS)

- Storage – 1 year
  Hyperion & ALI Level 1R
- Storage – 1 year
  Hyperion & ALI Level 1G
- Storage – 1 years
  Hyperion & ALI Level 1R and Level 1G AC
- Storage – 1 year
  User Defined L2 Products
  e.g. EO-1 Flood Mask

- Flood Dashboard Display Service
  - Mashup
  - Google Maps Inset
  - Plot Package

- Namibia River Gauge Data base

- 5 Namibian River Gauge Stations - Daily Measurements

- http server

Added Elastic Cloud to EO-1 Operations April 2011
Conclusion

• WCPS provide a unique capability to control in near realtime the method by which raw sensor data is processed onboard or on the ground

• The WCPS software is flexible and can be set up in a variety of ways
  – Distributed or centralized

• Largest impact of WCPS will in airborne and satellite sensor based communities because it is a paradigm shift on how onboard algorithms get updated versus traditional methods
  – More flexibility
  – Faster
  – Less expensive