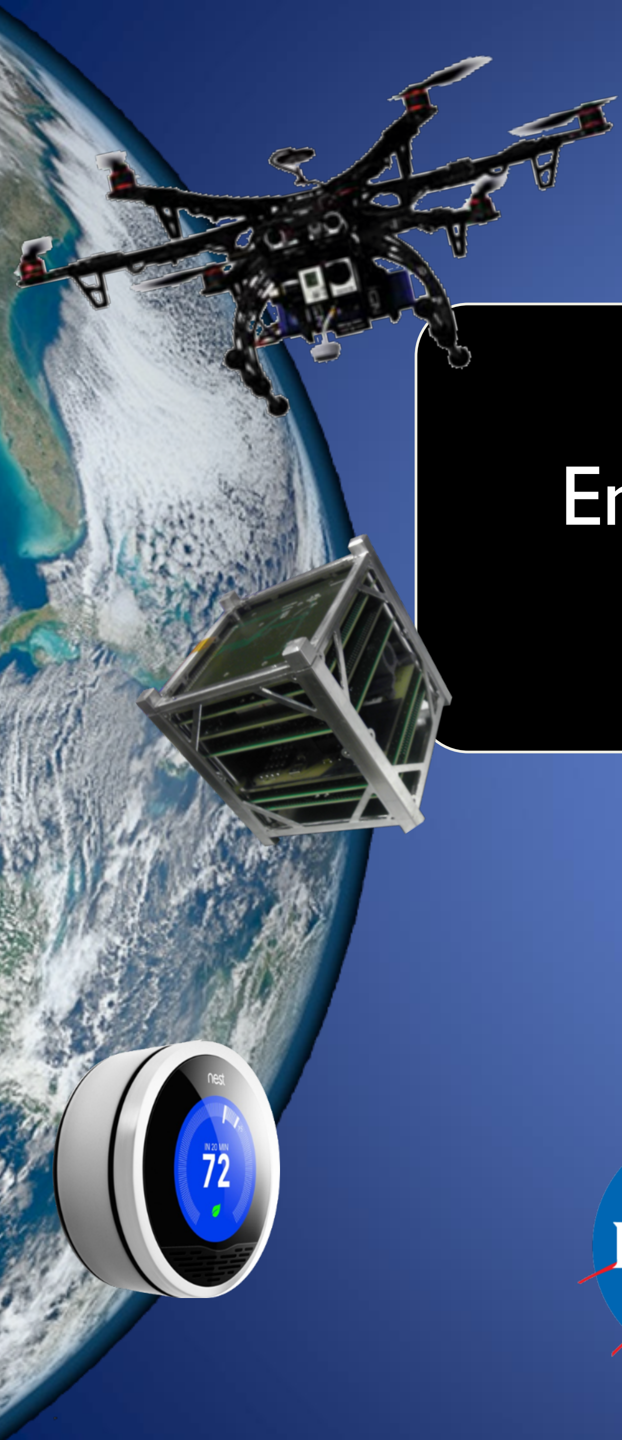


Emerging Earth Science Technologies in Disaster Risk Management

John D. Evans

Global Science & Technology, Inc. (GST)
Greenbelt, Maryland

NASA

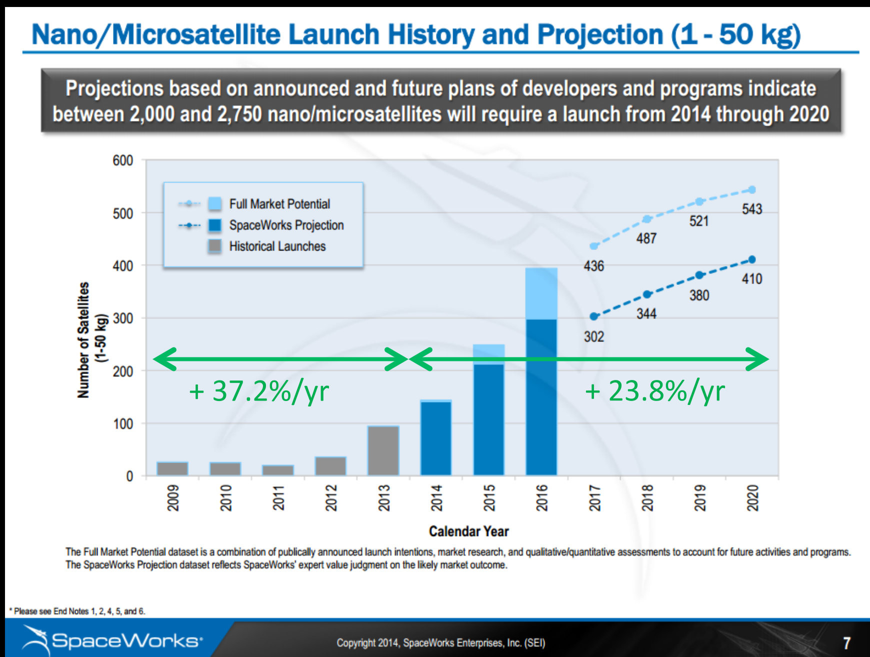
ESTO
Earth Science Technology Office

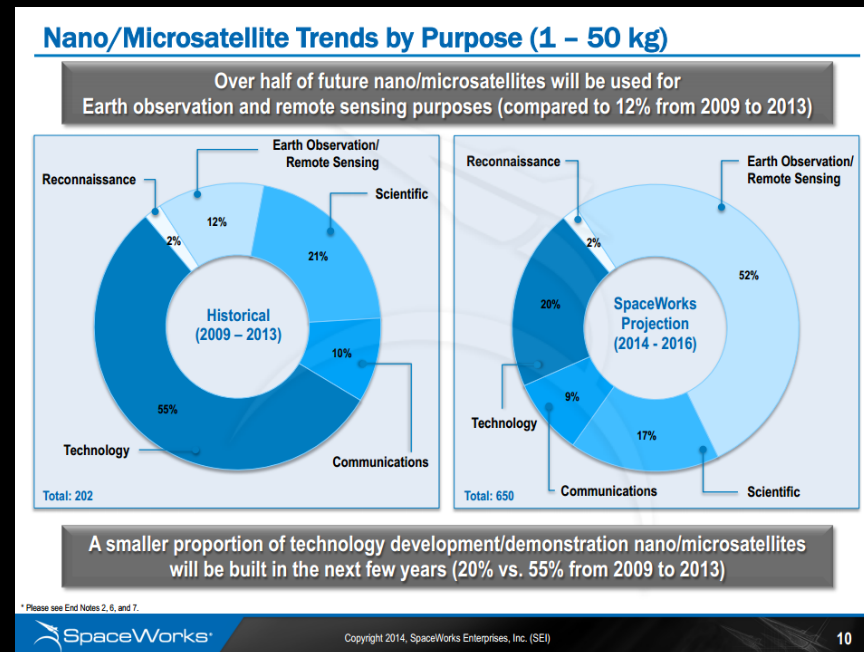
Global Science & Technology, Inc.

Overview

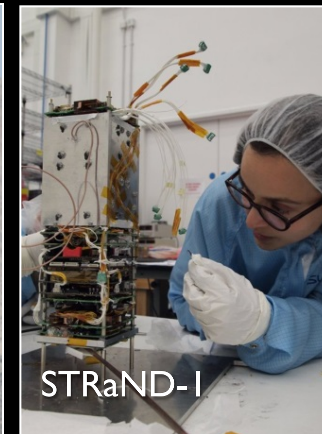
- Review emerging earth science technologies
  - Small Satellites; Drones
  - Crowdsourcing; Location-Based Services
  - Direct Broadcast; Sensor Web; Internet of Things
  - Big Data Analytics; Model Webs; Cloud Computing
  - Collaboration & Semantic Services
- Analyze their roles in Disaster Risk Management
  - Using GEOSS Architecture for Disasters / GA.4.D
  - Ingredients of streamlined integration
  - Working towards technology roadmaps

Small Satellites



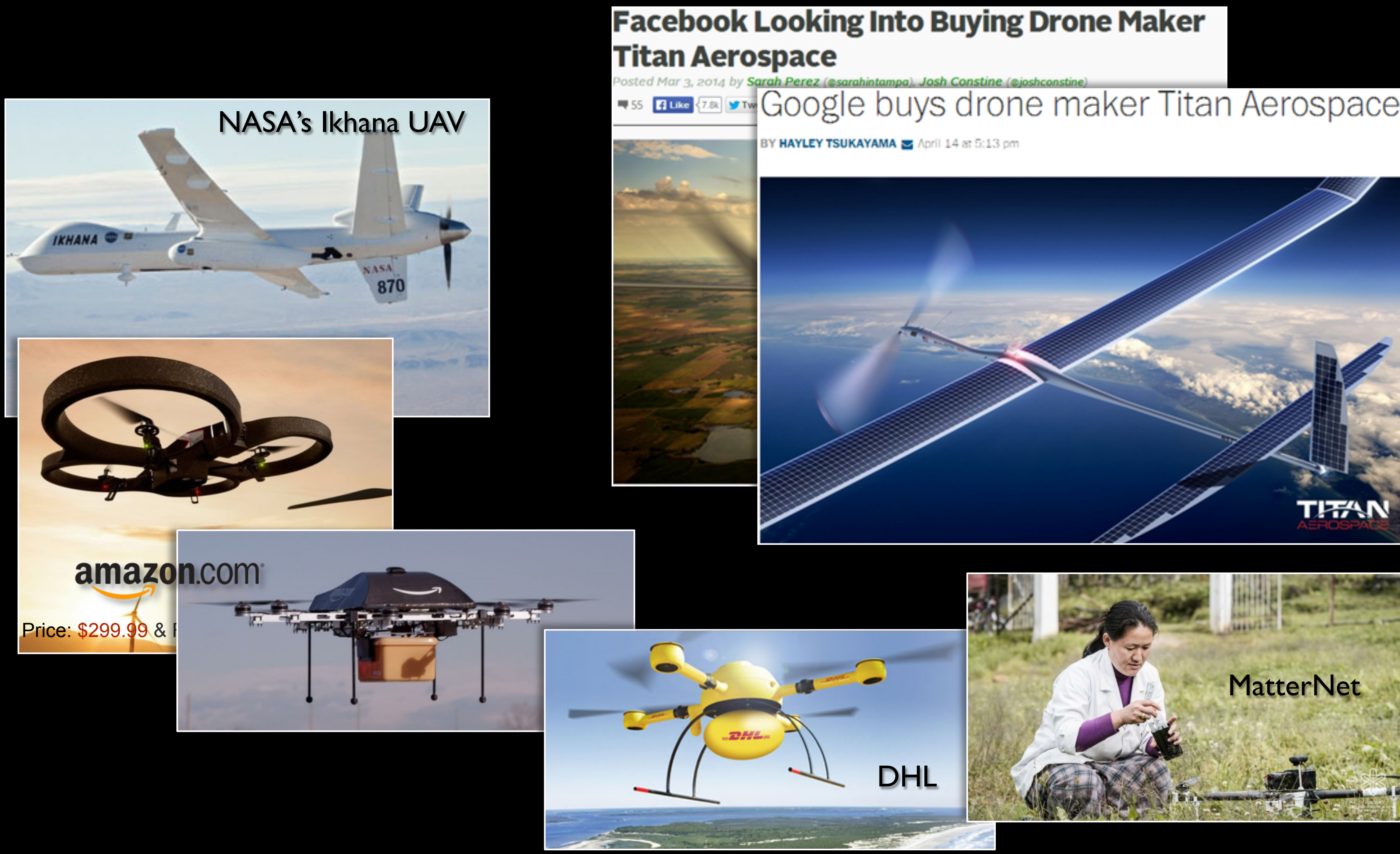


CubeSats

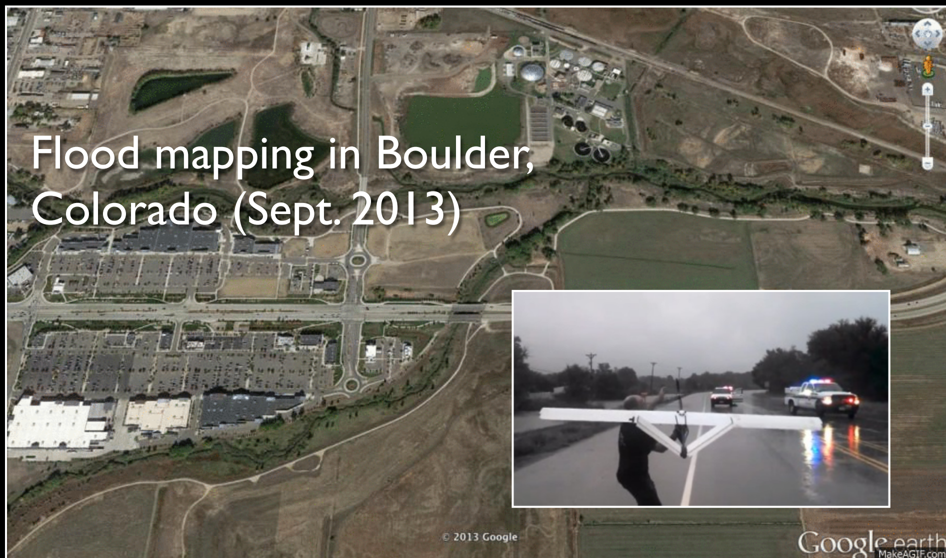


- Cheap to develop & launch
- Tolerate higher risk, shorter lifecycles
- Small form factors; limited power budgets
  - Deployable optics; Nanolayer synthetics

Unmanned Aerial Vehicles (drones)



Unmanned Aerial Vehicles (drones)



UNEP

UNEP Global Environmental Alert Service (GEAS)

Taking the pulse of the planet; connecting science with policy

Website: www.unep.org/geas E-mail: geas@unep.org

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Thematic focus: Climate change, Ecosystem management, Environmental governance

A new eye in the sky: Eco-drones

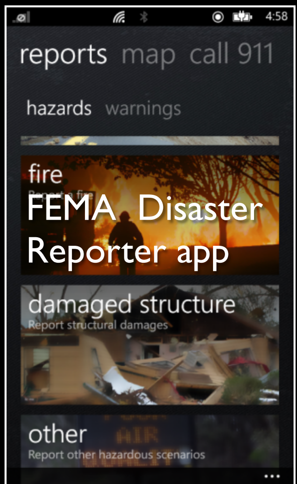
A drone is generally thought of as a military weapon or surveillance tool. Commonly referred to as an unmanned aerial vehicle (UAV), unmanned aerial system (UAS) or remotely piloted aircraft (RPA), a drone can also provide a low-cost and low-impact solution to environmental managers working in a variety of ecosystems. Drones used for these purposes are referred to as 'eco-drones' or 'conservation drones.' Their agility and quality imaging abilities make them advantageous as a mapping tool for environmental monitoring, but there are still several challenges and concerns to be surmounted.

Imprezа54 /Wikimedia Commons/ CC-BY-SA-3.0

Change Mapping	Disaster Risk Management	Disaster Risk Mitigation	Illegal Activity	Monitoring
River erosion	Flooding risk	Map impacted areas	Poaching	Migration patterns
Deforestation	Landslide risk	Broadcast messages	Illegal fishing	Endangered species status
Urban expansion	Volcano eruption risk	Monitor forest fire spread	Illegal trade	Agriculture

"Eco-drone" applications (per UNEP Global Alert Service, May 2013)

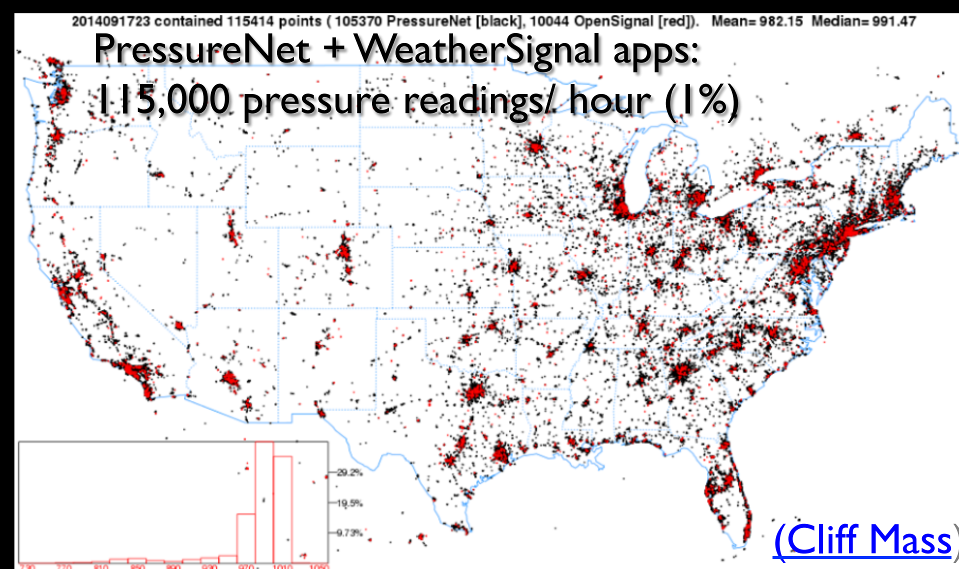
Crowdsourcing via mobile devices



FEMA Disaster Reporter app

SMS in 2010 Haiti earthquake

Ebola e-tracking in Sierra Leone, Liberia, Guinea (C. Moro)

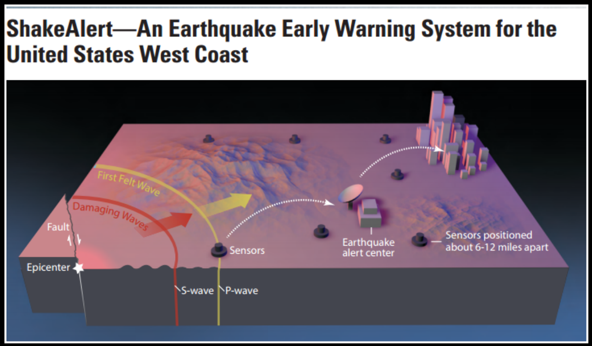


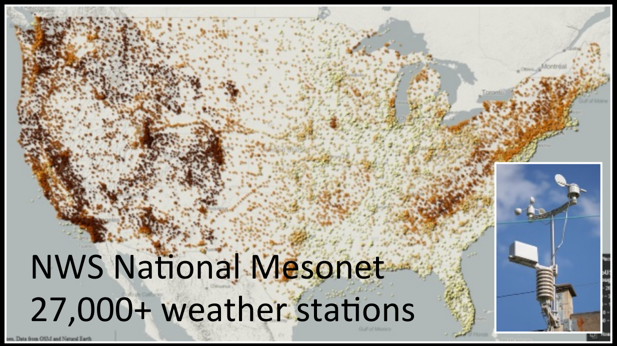
PressureNet + WeatherSignal apps:
115,000 pressure readings/ hour (1%)

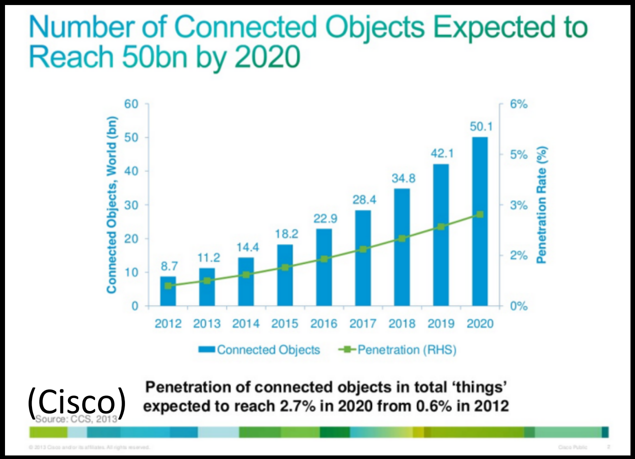
(Cliff Mass)

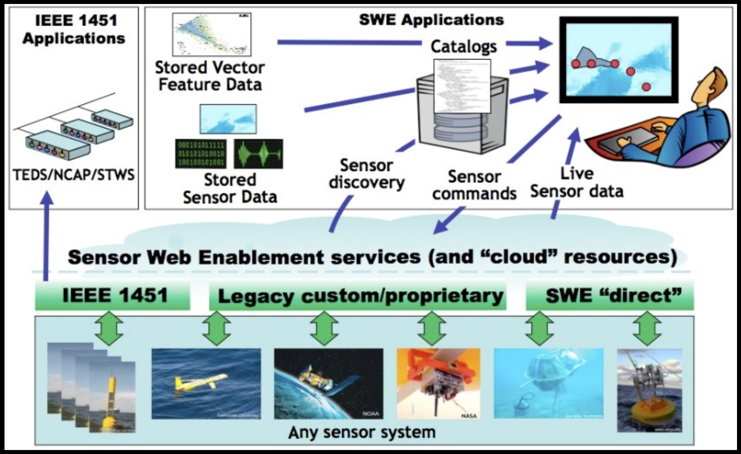
Sensor Web & "Internet of Things"

- Sensor-based detection of earthquakes, severe weather, forest fires, oil spills, volcanic gas plumes, drought



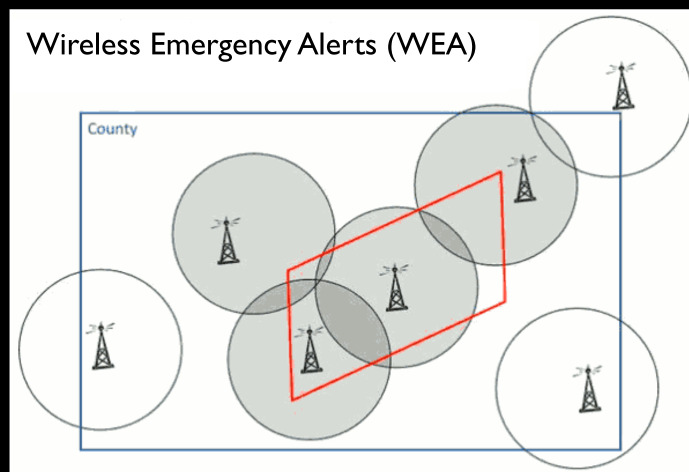


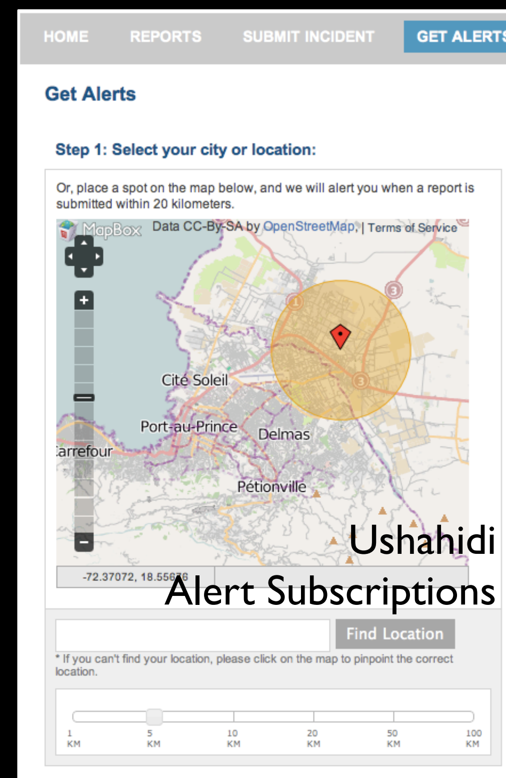




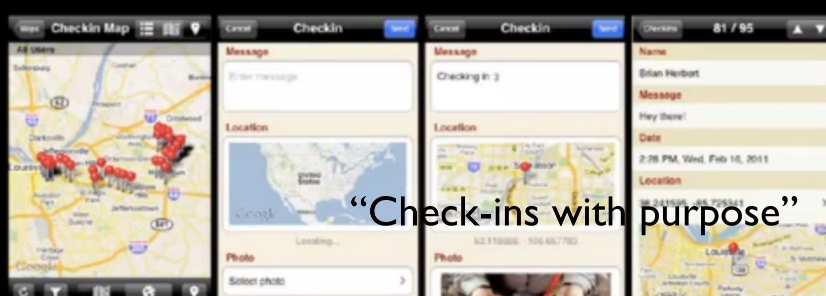
Location-based services

- Geographically targeted advisories
- Location-specific information access / subscriptions
- Check-ins → real-time maps





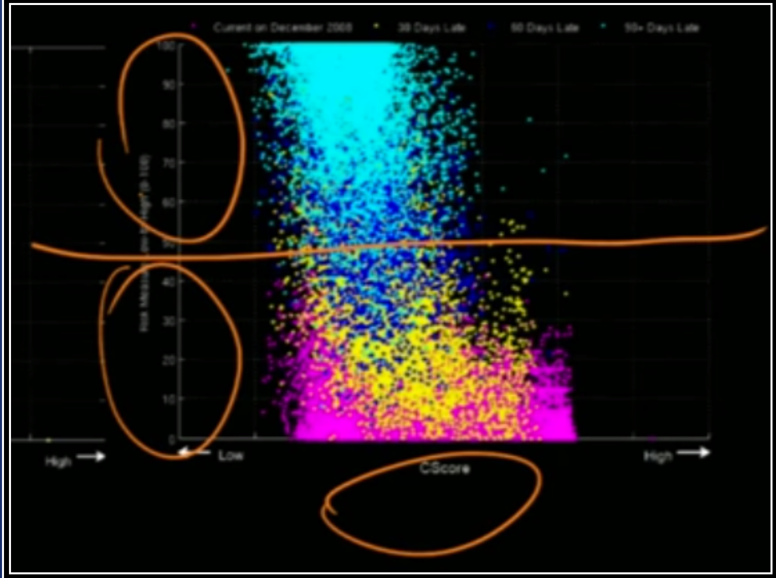
Ushahidi Alert Subscriptions

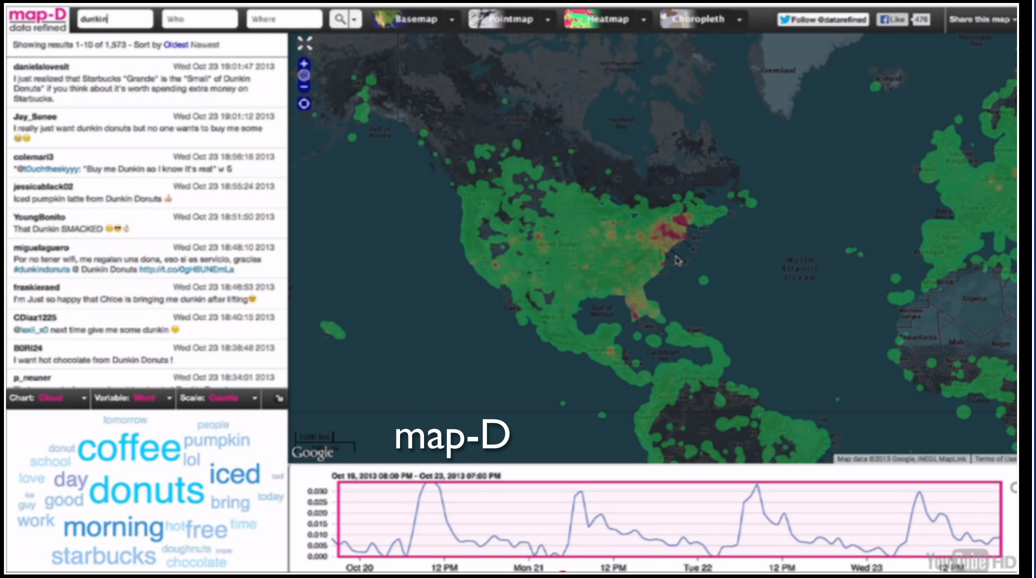


“Check-ins with purpose”

Big Data analytics

- Patterns & correlations
- Ensemble simulations → Risk envelopes
- Machine learning



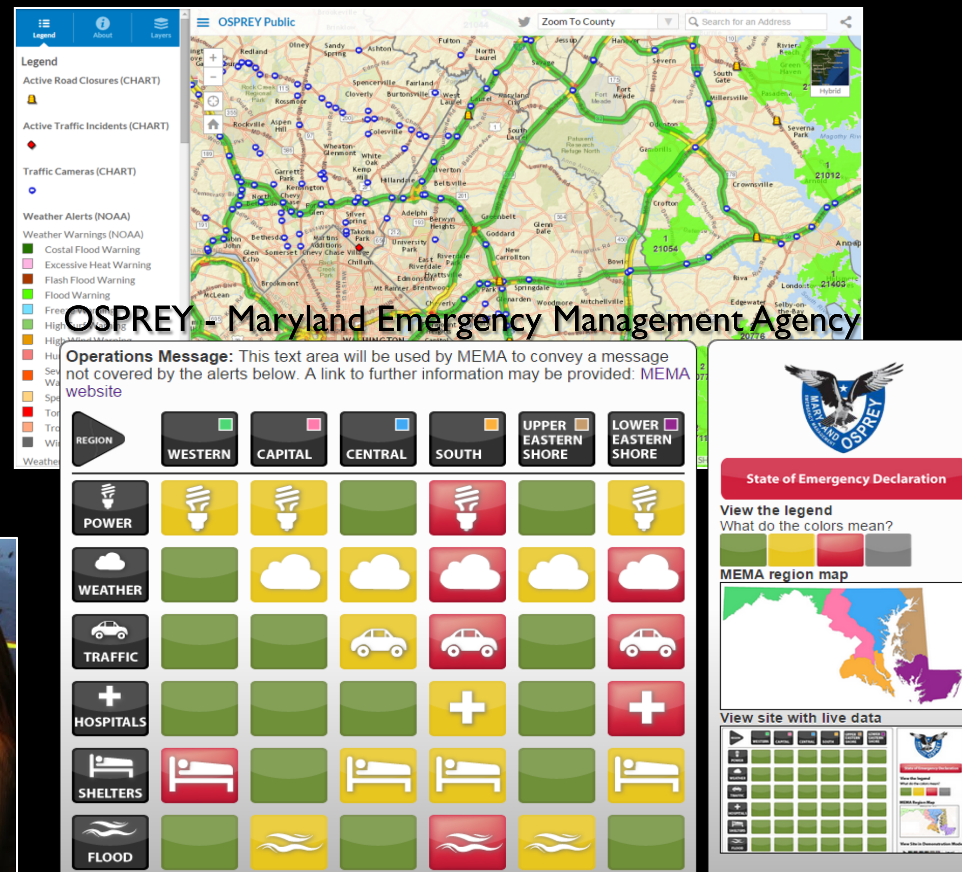


Collaboration Services

- Centralized *or* distributed

Fairfax Co. Emergency Operations Center

StormCenter Communications Envirocast® Vision™ Collaboration Module



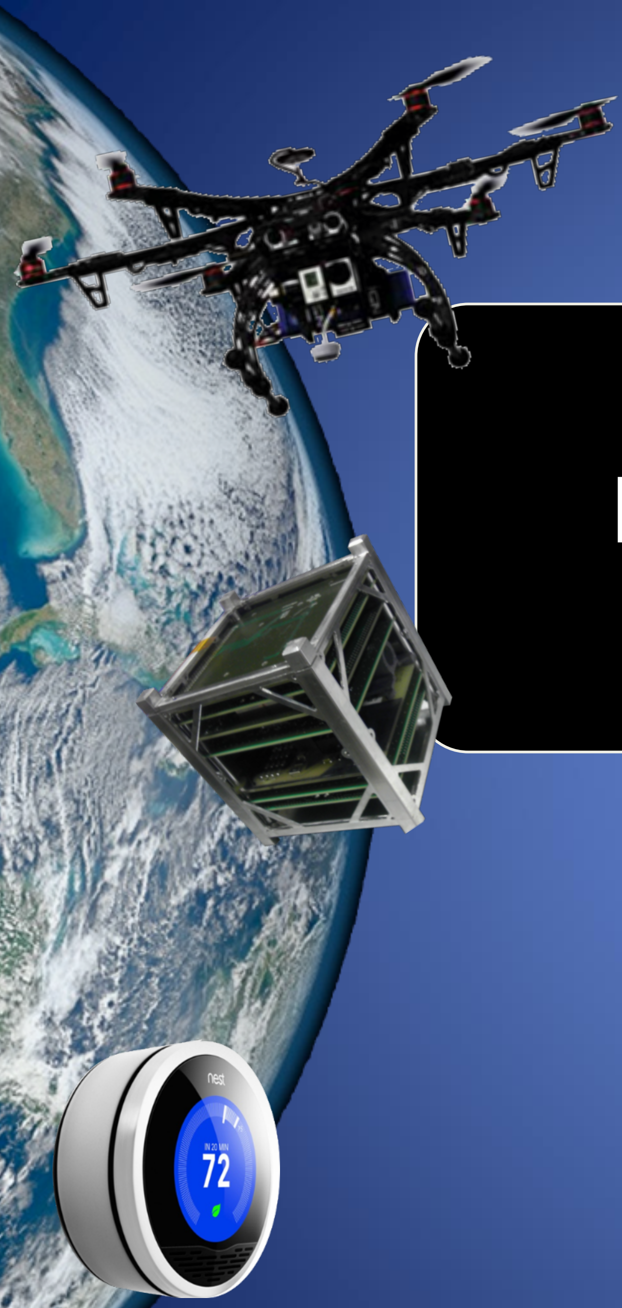
OSPREY - Maryland Emergency Management Agency

Semantic Services

- Disaster-specific ontologies:
  - Disaster Response Ontology (E.U. "Disaster 2.0" project)
  - Management of a Crisis (MOAC) Vocabulary
  - Humanitarian Exchange Language (UN OCHA)
  - SoKNOS (German public safety agencies)
  - Others *(See also: UNISDR Terminology)*
- Standards for expressing and using semantics:
  - SPARQL Protocol and RDF Query Language (SPARQL, GeoSPARQL)
  - Web Ontology Language (OWL)
  - Web Service Modeling Ontology (WSMO)
  - Simple Knowledge Organization System (SKOS)

Other potential game-changers

- Model Web / Modeling as a Service
- Cloud Computing
- Satellite Direct Broadcast / Direct Readout
- Gigabit networking?
- …



How to make sense of it all?

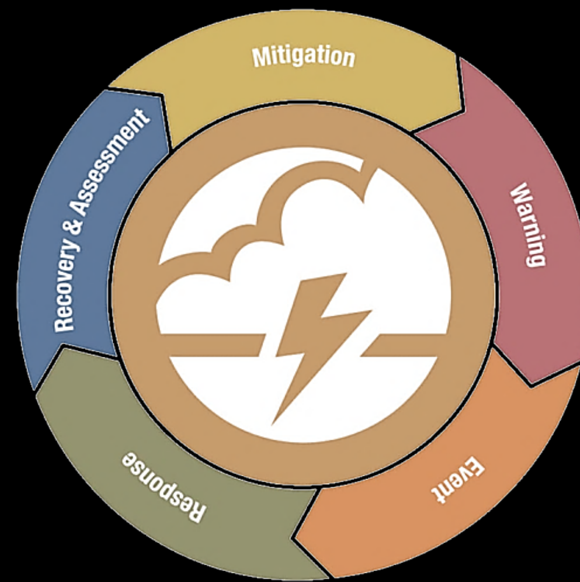
CEOS / GEOSS Architecture for the use of Remote Sensing Products in Disaster Management and Risk Assessment (GA.4.D)

GEOSS Architecture for the Use of Remote Sensing Products in Disaster Management and Risk Assessment

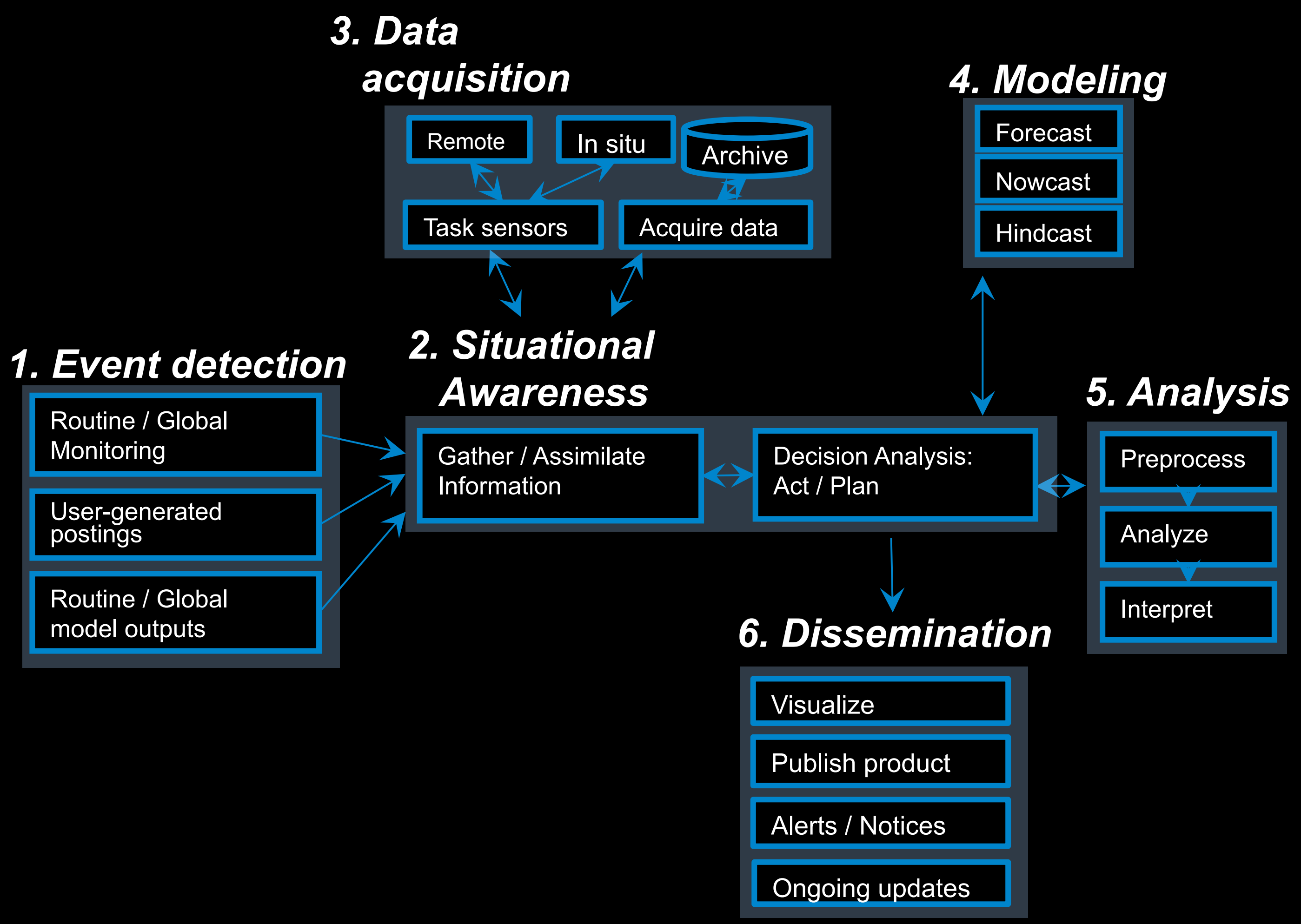
CEOS
Working Group on Information Systems and Services

Scope, purpose, structure

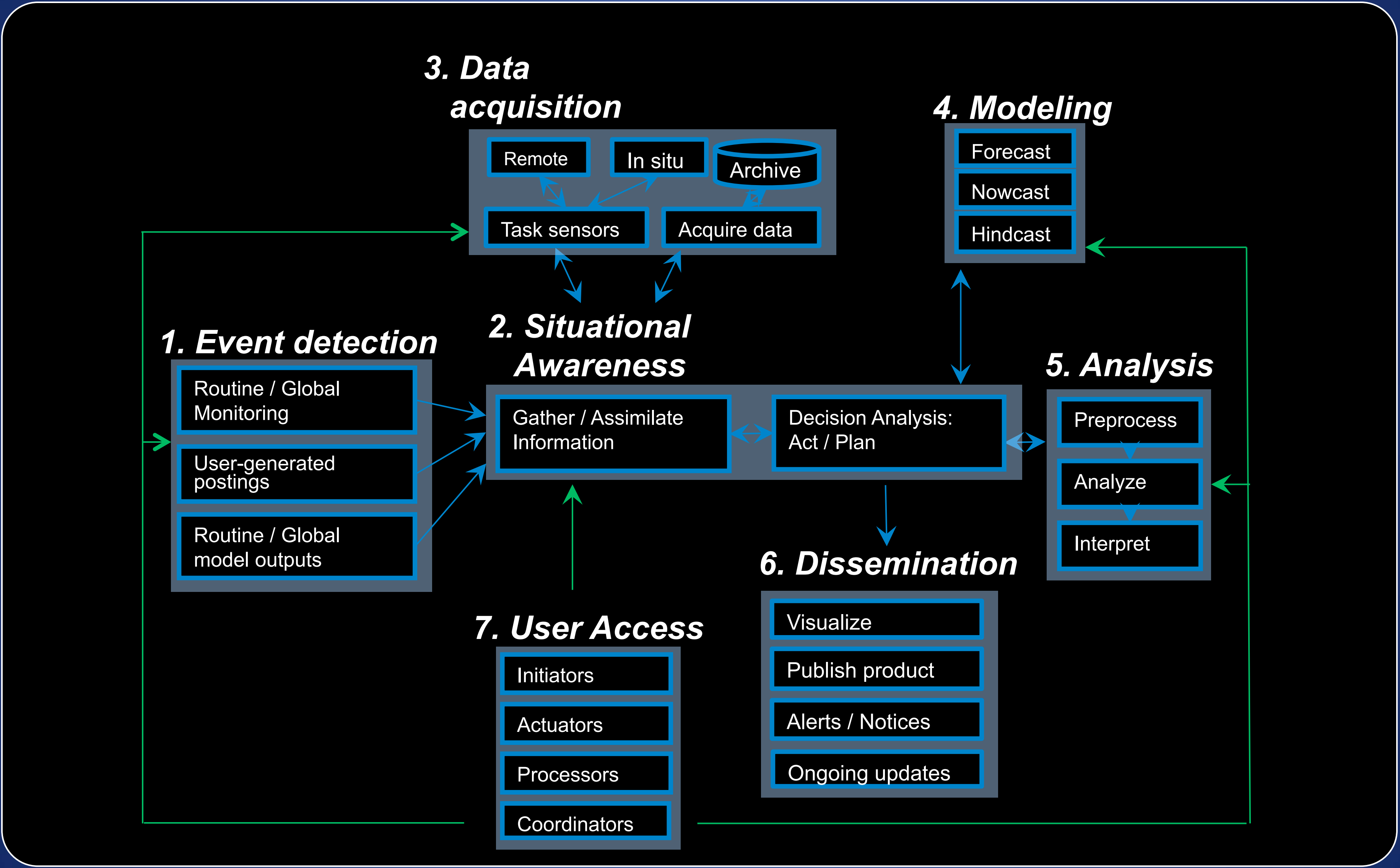
- Lifecycle phases
  - Mitigation
  - Warning
  - Response
  - Recovery
- Hazard types
  - Flooding
  - Earthquakes
  - Volcanoes
  - Drought
  - Windstorms
  - Landslides
  - Wildfires
  - Tsunamis
- Values and priorities (GEOSS, CEOS)
  - System of Systems
  - Data Sharing Principles
  - Interoperability Arrangements



Activities (business processes)



Activities (business processes)



Emerging technologies and architecture viewpoints

Information viewpoint

- Small Satellites
- UAVs (drones)
- Direct Broadcast
- Semantic Services
- Mobile devices
- Internet of Things
- Crowdsourcing

Computation viewpoint

- Big Data analytics
- Model Webs
- Cloud Computing
- Semantic services
- Mobile devices
- Location-based services
- Collaborative services

Emerging Technologies and Disaster Lifecycle Phases

	Warning	Response	Recovery	Mitigation
Unmanned Aerial Vehicles (Drones)	•	•		
Small Satellites (incl. CubeSats)	•	•		
Satellite Direct Broadcast / Direct Readout	•	•		
Internet of Things / Sensor Web	•		•	•
Crowdsourcing	•	•	•	•
Big Data Analytics	•	•		•
Model Webs / Modeling as a Service	•		•	•
Cloud Computing		•	•	
Location Based Services	•	•		
Semantic Services		•	•	•
Collaboration Services	•	•		

Emerging Technologies and Natural Hazard types

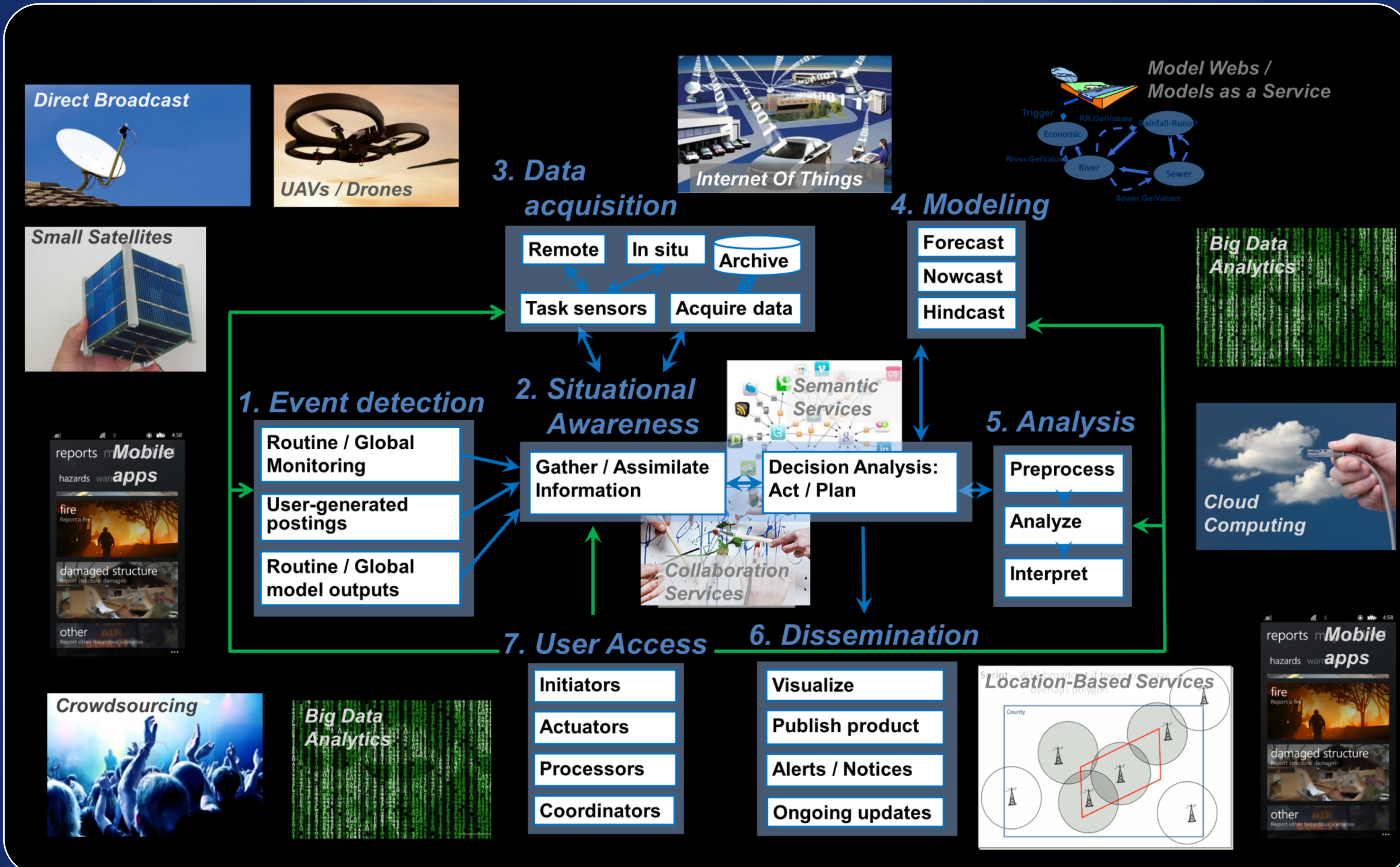
	Floods	Earthquakes	Volcanoes	Droughts	Windstorms	Landslides	Wildfires	Tsunamis	*(Any)*
Unmanned Aerial Vehicles (Drones)	•	•			•	•	•		•
Small Satellites (incl. CubeSats)	•			•	•		•	•	
Satellite Direct Broadcast / Direct Readout	•		•	•	•		•	•	
Internet of Things / Sensor Web	•	•		•	•		•		•
Crowdsourcing	•	•			•	•			
Big Data Analytics	•	•			•				•
Model Webs / Modeling as a Service									•
Cloud Computing									•
Location Based Services	•	•			•				•
Semantic Services									•
Collaboration Services									•

Emerging Technologies and Disaster Mgmt. Activities

	Event detection	Situational awareness	Data Acquisition	Modeling	Analysis	Dissemina-tion	User Access
Unmanned Aerial Vehicles (Drones)	• (red)	•	•				
Small Satellites (incl. CubeSats)	•	•	•				
Satellite Direct Broadcast / Direct Readout	•	•	•				
Internet of Things / Sensor Web	•	• (red)	•				
Crowdsourcing	•	•	•			•	•
Big Data Analytics	•	•	•	•	•		
Model Webs / Modeling as a Service	• (red)	• (red)		• (red)	• (red)	• (red)	• (red)
Cloud Computing				•	•		
Location Based Services						•	•
Semantic Services	• (red)	•	• (red)		•		• (red)
Collaboration Services		•					• (red)

• = Documented *• (red) = Plausible / Anticipated*

Emerging Technologies and Disaster Mgmt. Activities



Integrating new technologies: Architecture

- Clarify data / analysis / communication needs
  - Semantic content; formats of files and data streams
  - Behavior & services; system interactions; component interfaces
- Articulate broadly-defined goals and practices
  - Get beyond current practice and *ad hoc* arrangements
  - Adopt new tools based on anticipated roles / benefits
  - Facilitate building flexible, sustainable capability
- Envision new capabilities enabled
  - Technologies may enable new goals (not just new methods)

Integrating new technologies: Standards

- Alleviate vendor lock-in; Allow creative repurposing
- Widely-adopted, consensus-based standards for
  - Information semantics
  - Data formats
  - Service definitions
  - Software interfaces
- Examples:
  - OGC SensorML (StarFL?), SOS, W*S; OPeNDAP; IOOS; SPARQL; *etc.*
  - OpenMI, Eucalyptus, OpenStack, MapReduce, …?
- Challenge: pace of technology adoption
  vs. pace of consensus processes

Towards technology roadmaps

- Mature *(integrate)*
  - Cloud Computing
  - Direct Broadcast
- Near term *[2014-2016] (accelerate, focus)*
  - Smallsats, CubeSats
  - Drones
  - Big Data analytics
  - Location Based Services
  - Crowdsourcing
  - Collaboration Services
- Medium term *[2017-2020] (support, shape)*
  - Sensor Web, Internet of Things
- Future *[2020-] (investigate)*
  - Models as a Service
  - Semantic services

This is only a sketch

- Currently seeking input
  - From technology users, developers, experts
  - From practitioners in Disaster Risk Management
- Clarify and envision roles and impacts of these technologies in Disaster Risk Management
- Identify technology gaps or opportunities
- Roadmap, priorities for NASA, GEOSS, *et al.*

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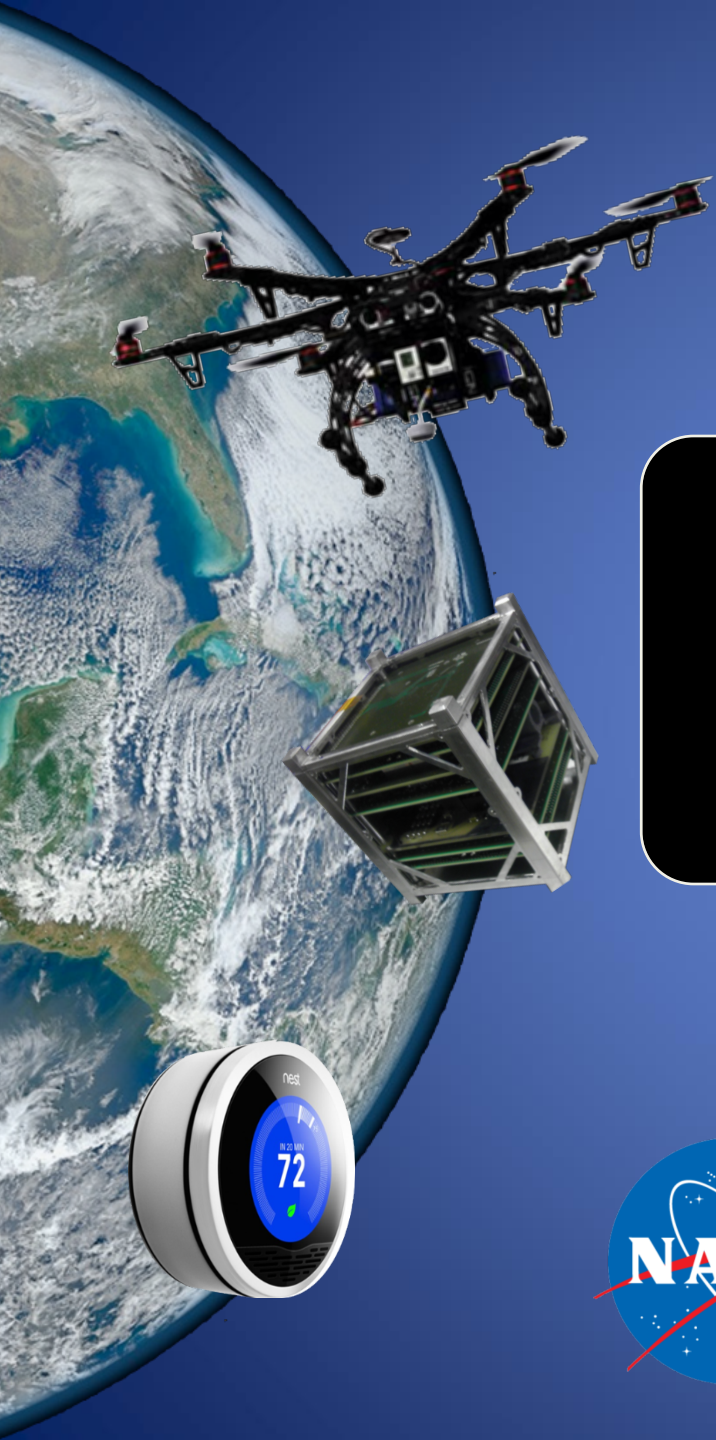

Your input is invited

john.evans@gst.com

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