Expanding the Global Sensor Web with Cubesats

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A Networked Web of Sensors

• An increasing number of ever-more-capable Cubesats are being deployed on Earth observation missions
• Our diverse, open and supportive Cubesat community is uniquely positioned to embrace and benefit from large-scale sharing
• What do we need to do to make that happen?
This is not a new idea!

- Scott Delin, Charles Norton, Karen Moe, and many others have described the possibilities of a sensor web...
Some example Sensorweb benefits:
- Increased understanding of geophysical processes
- Disaster early-warning and response
- Measurement of phenomena at global scale

Tropical Cyclone Ita Just Off-Shore Near Cape Flattery, Queensland, Australia

Credit: NOAA Environmental Visualization Laboratory, http://www.nnvl.noaa.gov/
Motivation

- Science, data, disasters
- Recent developments
  - Moore’s Law progression of capabilities
  - Comm links becoming robust and continuous
  - Number of cubesats in (or going to) orbit

*Image credit: Fairchild Camera & Instrument Corp, 1964*
Concept of sensorweb

- Conflation with “internet of things” (IoT) and “Smart Grid” e.g. sensor networks
- Often: A system in which sensor readings in one system are used to modify the behavior of another system
- Distinct from a network of sensors, in which data is simply collected
Key Properties

- It is a distributed system,
- interconnected through communications links,
- that functions as a larger instrument than the individual nodes of which it is comprised.
• May have higher-level autonomy
  – Dynamic response to emerging phenomena
• Need and opportunity exists for simpler sensorwebs too
  – E.g. Virtual Instruments
  – “I have a ____ sensor, but I need ____ measurements to complement it...”
Potential Benefits

• New architectures
  – CYGNSS
  – EDSN
  – Fractionated
  – Dynamic

• Now vs. the Future
  – What can we do today, with the assets and capabilities at hand?
Some Examples

• JPL Volcano Sensorweb
  – Low-res MODIS imagery → MODVOLC → volcanic activity of interest → EO-1 tasking → higher-res hyperspectral imagery
• Intelligent Mission Management + Wildfire Research Applications Partnership
  – Low-res MODIS thermal/fire products → UAS mission planning → high-res multi-spectral UAS on-board-products delivered in real time to ground forces
Image credit: NASA/MODIS Rapid Response
Standards

• As we know from the Cubesat standard, standards enable and allow communities to form!
• Open Geospatial Consortium’s Sensor Web Enablement (SWE) initiative
  (http://www.opengeospatial.org/domain/swe)
  – Defines a set of services and standards
  – Some have a reference implementation
• 52 North (http://52north.org/) has an active development community and implementations
Implementation

• This is a good topic for community discussion!
  – Public vs. Private?
  – Open, Community-driven vs. Closed?

• Advantages and disadvantages to each approach

• They’re not mutually exclusive

• Really, someone just needs to go first, so we can all learn from the experience
What is needed?

• Key enabling piece is a catalog or repository of spacecraft sensor capabilities
  – Enables discovery of what’s available, and how to contact / interact / make requests
  – Part of the OGC SWE initiative
Path Forward

• We need to bring together a group of like-minded Cubesat developers/operators,
• Then implement a shared registry,
• And start testing!
Conclusion

- While the concept of many spacecraft participating in a sensorweb is not new, the capabilities and number of Cubesats now make it an exciting proposition.
- The Cubesat community stands to collectively benefit from participation in such a sensorweb.
- Use of standards, and instantiation of a sensor repository/catalog, are the key steps forward.
Thank you – Questions?