APPLIED DEFENSE SOLUTIONS

A Broad Based Community Approach to Space Situational Awareness

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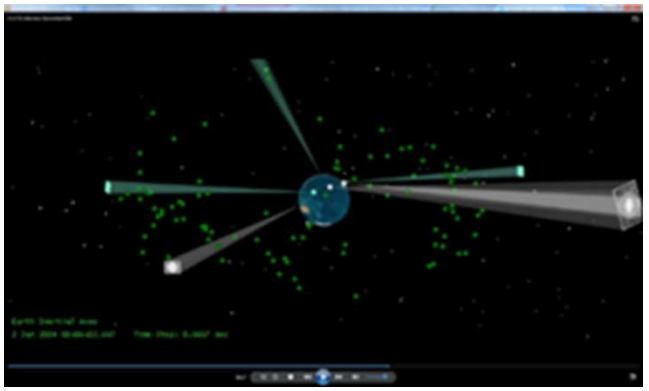
Presentation overview

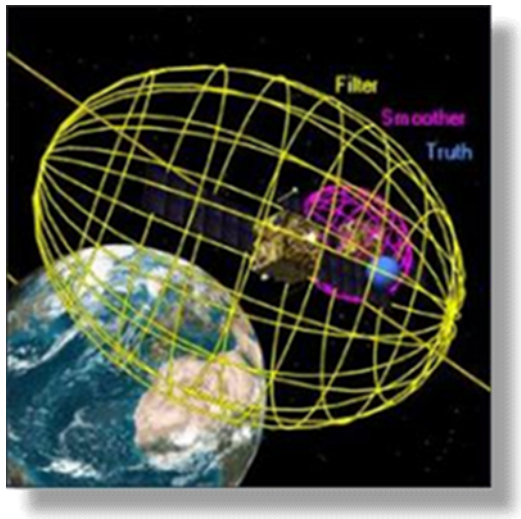
- Motivation for a community approach to SSA
- Why a community approach
- Technical enablers for community involvement
- SSA/STM/BMC2
- Model communities of Interest



Motivation for Global SSA

- Why:

It is simply *too expensive and complicate*d to build and maintain a government exclusive SSA capability-- when the global commercial market can meet the majority of the requirements more cost effectively



A Global Interest in SSA

- The big sky axiom no longer applies
  - Space is big and the probability of collision low is no longer true.
  - Space is congested and competitive; over 500,000 objects of interest, thousands are active and maneuverable
- We have long enjoyed an asymmetrical advantage over adversaries based upon our modern space capabilities.
- Asymmetric advantage has become asymmetric vulnerability
  - Non peer states and foreign terrorist organizations can spend much less to affect and counteract space based capabilities.
- Global participation discourages adversaries from having a financial or strategic advantage to denying our space based capabilities.
- Encourage good behavior with an open and highly visible space environment

Five Eye Nations depend on a space economy

- Earth Observation, Geo-location, and Communication services provided by sovereign and commercial systems.
  - In 2014 global space activity accounted for $330B,
  - A day without space would be a day without global commerce

Country Organization	Spacecraft Deployed	LEO SpaceCraft	MEO SpaceCraft	GEO SpaceCraft
World	7142	5232	383	880
Russia/USSR	3488	3057	187	154
UNITED STATES	2137	1345	142	187
CHINA	244	176	7	55
JAPAN	197	109	4	53
Globalstar	84	82	2	0
INTELSAT	81	1	2	72
EUROPEAN SPACE AGENCY	71	31	18	8
INDIA	71	36	2	31
FRANCE	69	46	1	11
GERMANY	64	50	1	6

Research Community Role

- The market is rapidly evolving away from the exclusive domain of military and intelligence domination
  - SSA evolved out of missile warning and nuclear deterrence
  - Trusted special purpose sensors and military architectures evolved as increments on the original mission capability
  - The entire system has become unwieldy if not borderline unreliable to protect all of our national space interests

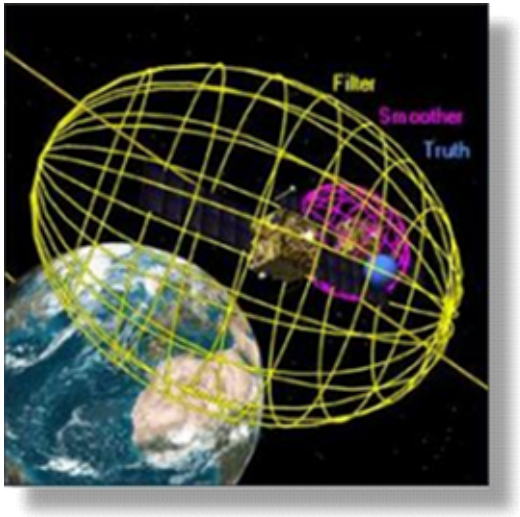
- The research community is uniquely positioned to lead the way in open global approach to space protection.

- Global collaboration must be baked in FROM THE START, not bolted on in the end.

A community approach to SSA relies on:

- Shared interest in a positive end state
- Some standardization
  - Common shared references –time, position, and uncertainty
- Reliable networks to communicate
- TRUST built and reinforced through joint activities

- Enablers
  - Commercial off the shelf technology has lowered the cost for entry
  - Sensors deployed around the globe
  - Community open source software
    - Astrodynamics processing and data fusion
    - Error estimation algorithms for quality rating
    - Trust metrics and consistency checking
  - Effective examples of community models exist
  - An effective TRUST and REWARD Mechanism



A look at Space Situational Awareness

Commercial Space Traffic Management (CSTM)

- Foundation Piece is the AFRL D2P2 Geo Catalog Project
- Support the civilian non-military role in Space Situational Awareness and Space Operations Control
  - Military role diminishing as focus shifts to BMC2
- Space equivalent to Air Traffic Control
  - Launch and early orbit
  - Relocation
  - Maneuver planning and screening
  - Disposal and reentry
  - Permitting and flight plan management and verification
  - Dispute resolution
    - Radio frequency interference
    - Proximity monitoring
  - No one Global system but global standards of interaction

Commercial Space Situational Awareness (CSSA)

- Foundation piece is the 50th CONS Commercial SSA services contract

- Commercially capabilities to augment national systems
  - Global Network of Optical, Radar, and RF sensors
  - Processing based on integration of COTS, GOTS, and Open source
  - Data Sourced from around the globe
    - Coordinated with host foreign nation

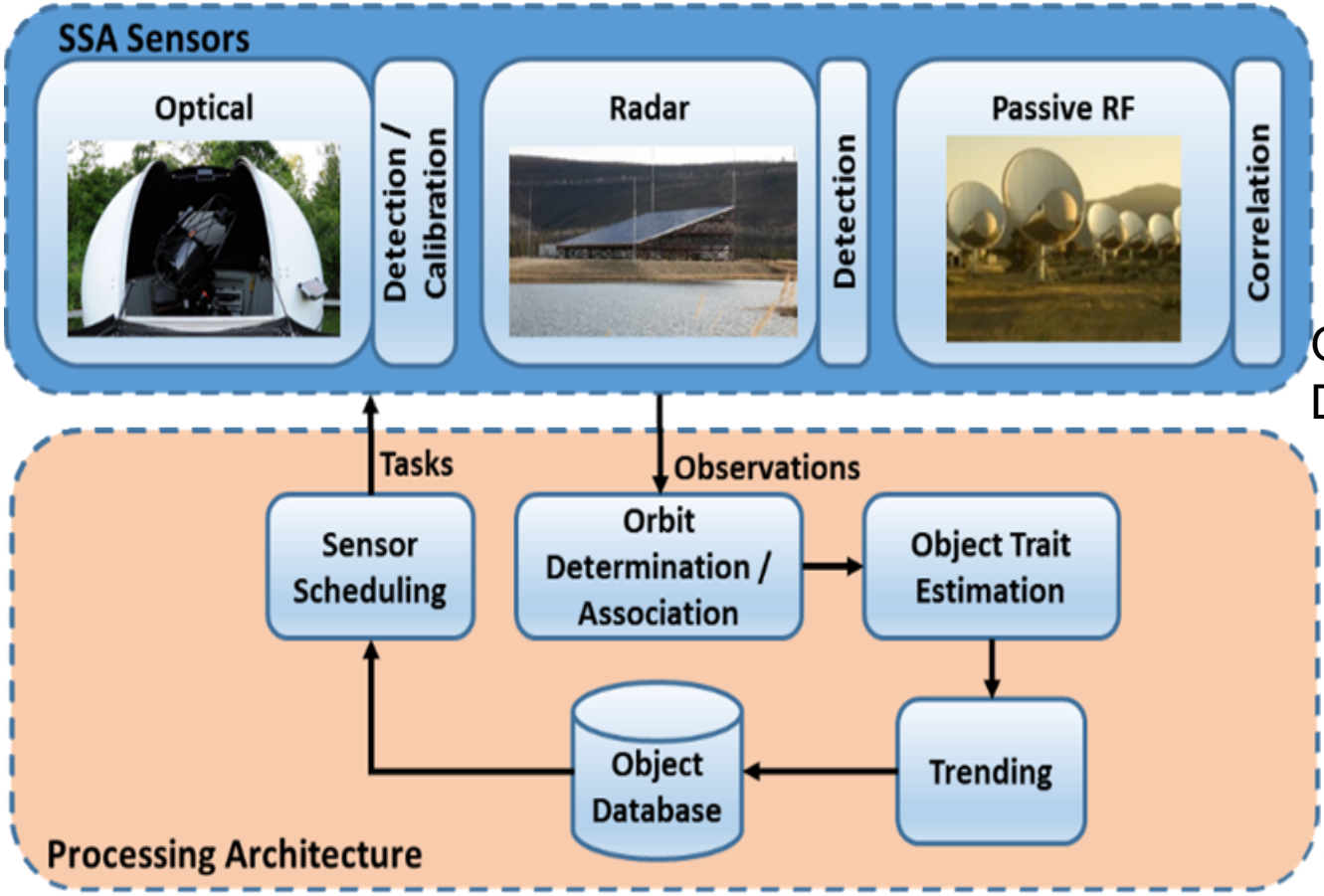
- Broad usage including civilian and military centers, commercial consortiums, and international partnerships.
  - Data and analysis derived from commercial sources can naturally be shared and used more easily
  - Starting point for NATO, 5-EYE, and new national SSA Operations centers solutions.

BMC2

- Foundation Piece is the DARPA Hallmark ISE and Toolsets
- The military component to SSA focusing on the protection and operations on the space enterprise and the ability to operate through and survive military conflicts.
- Goal is to manage the entirety of the USG space enterprise as a coordinated and controlled system.
  - Protect and fight as one
  - Timely and focused decision making
  - Extend to allies
  - Cooperate with commercial space systems
  - Discourage adversaries from taking up the fight
  - Protect our advantage

Processing and Data Fusion

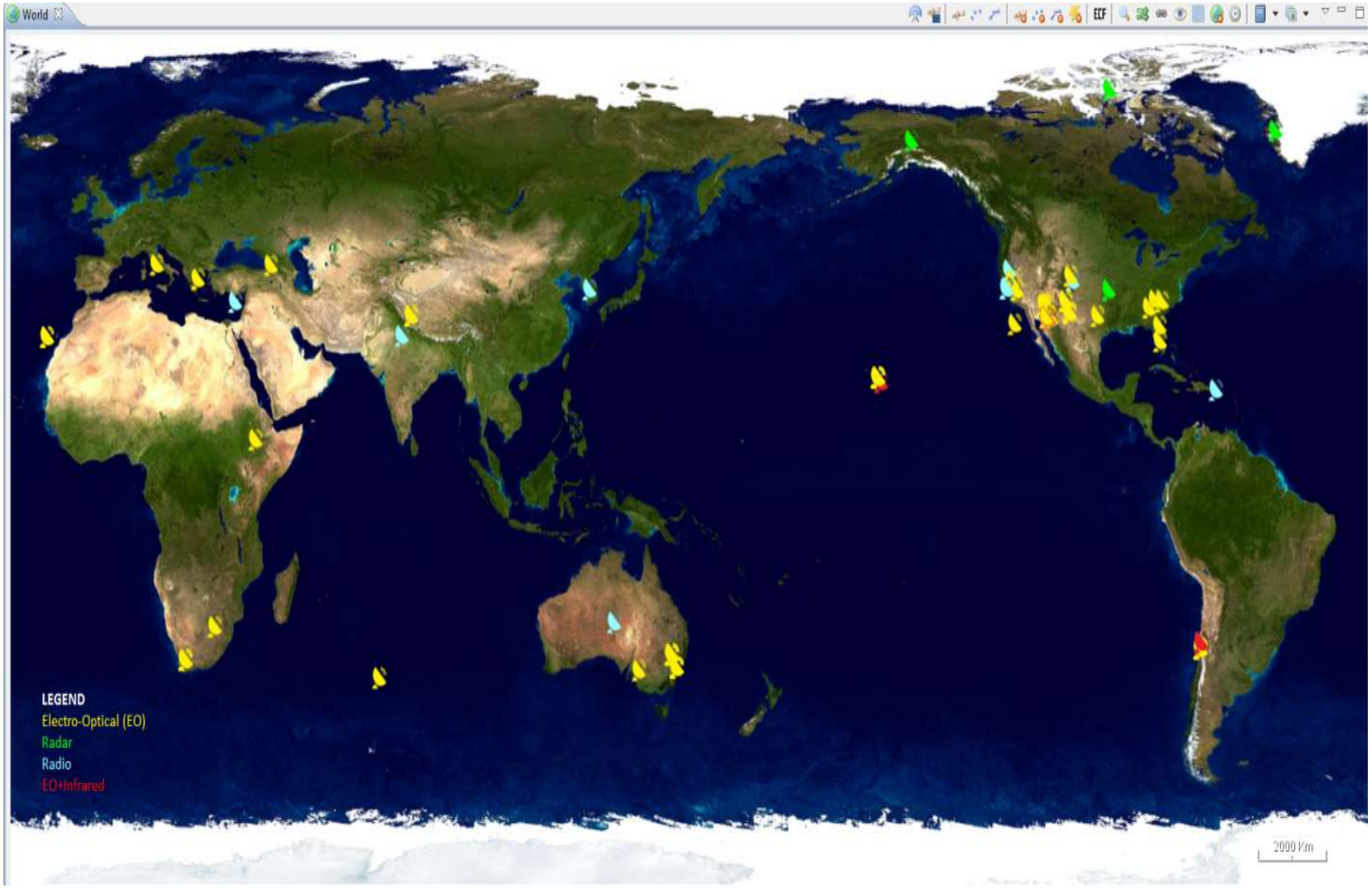
- An integrated system of user supplied data and centralized processing



Geographically Distributed

Centralized Processing

Global Coverage for all Orbit Regimes is Commercially Available

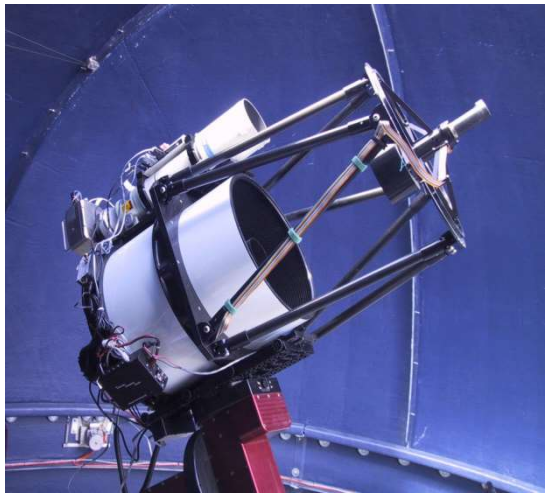


--- not just the unwashed masses.

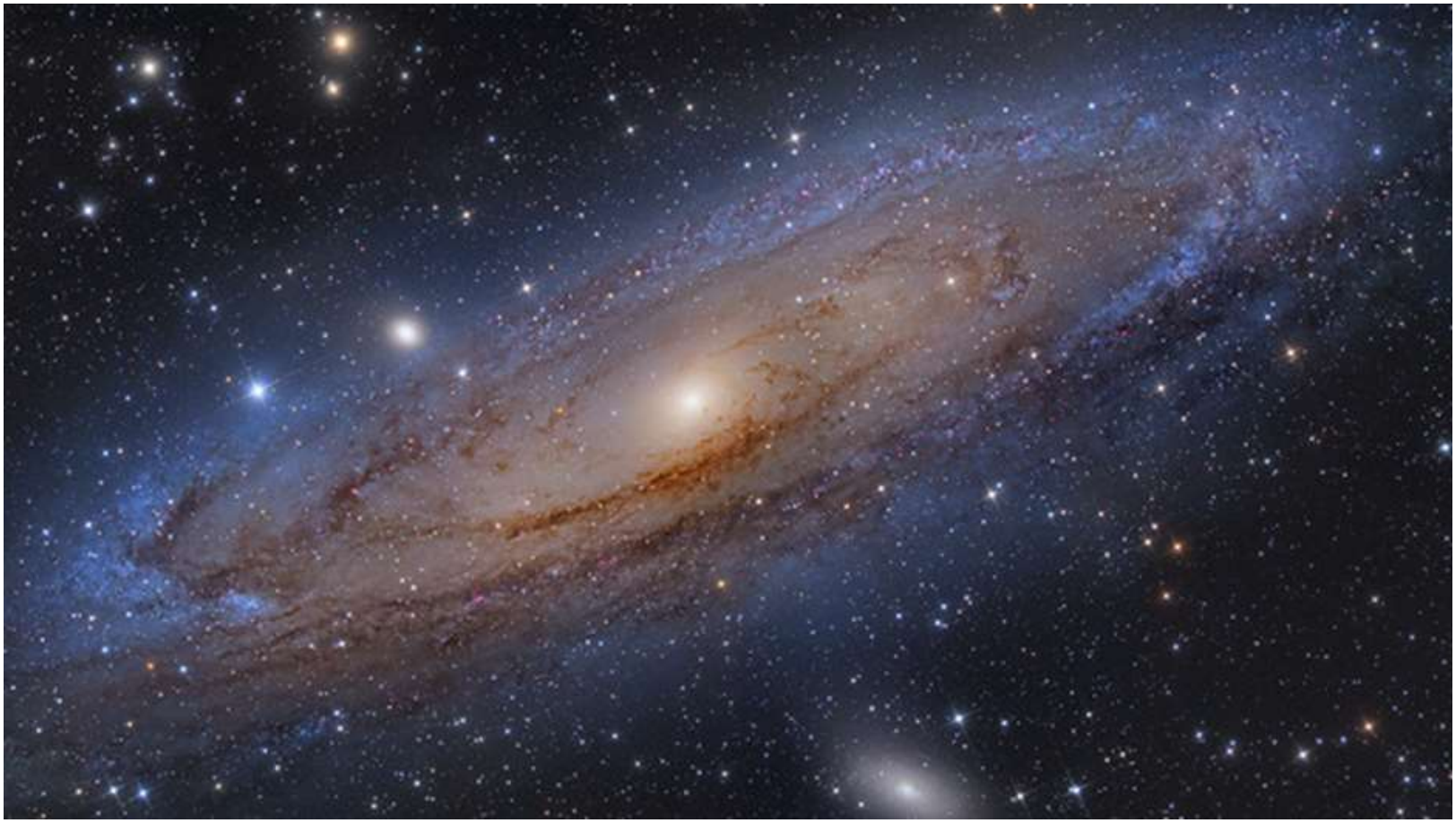
Mark Dahmke

Backyard astronomers have fantastic capability

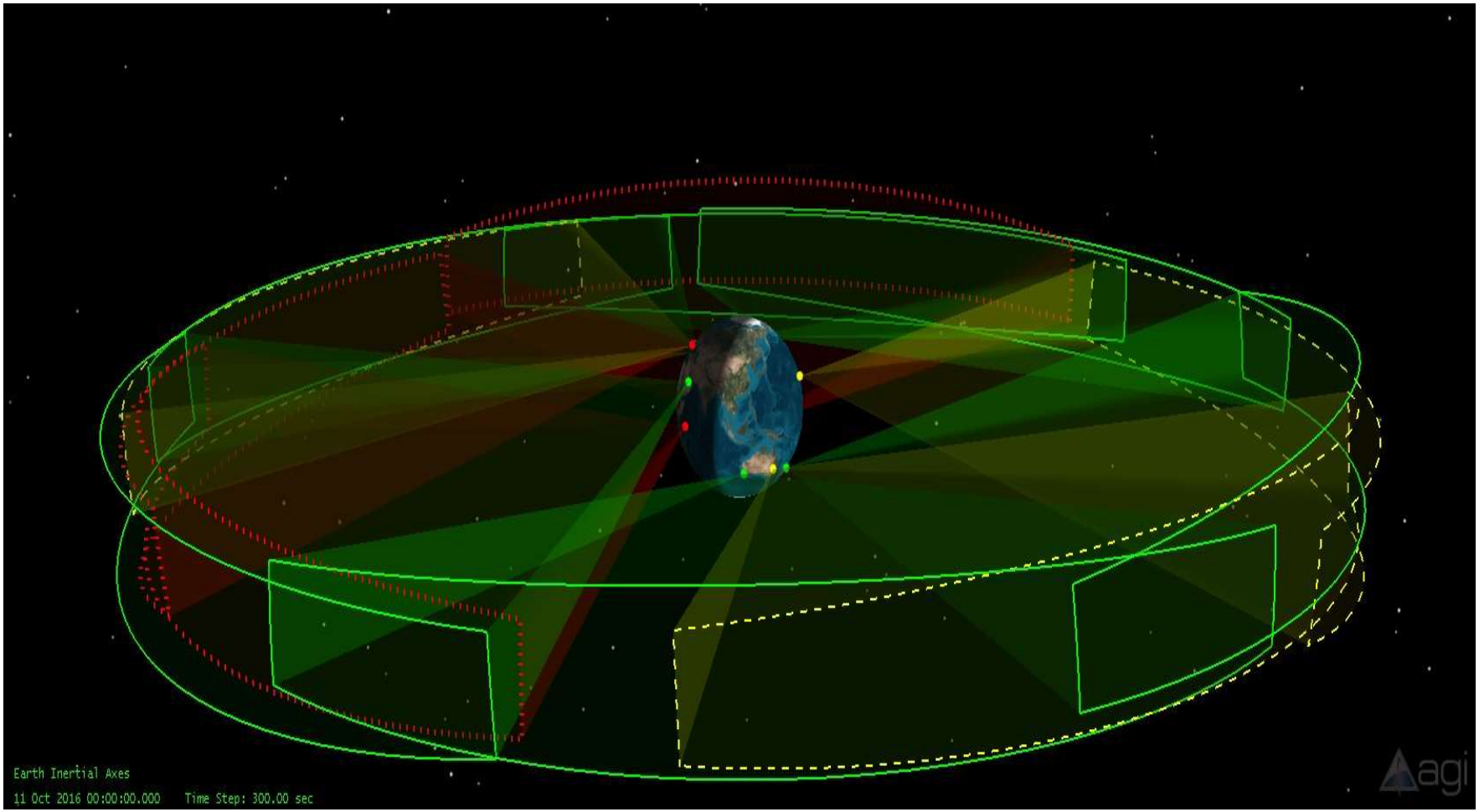
- 1000's of backyard astronomers look skyward every night with telescopes capable of seeing space objects in all orbit regimes.
  - Highly stable highly automated mounts
  - Apertures greater that 10"- hundreds greater than 14"
  - Computer controlled and networked
  - Six sixteen" telescopes placed properly can cover GEO



Backyard astronomers have excellent capabilities



Global Geo Coverage



Discussion on models for community SSA

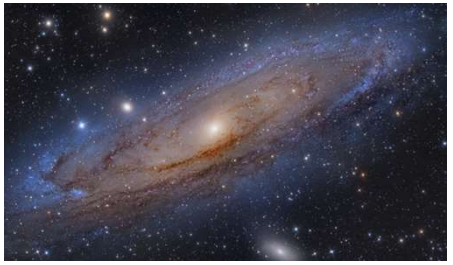
- Research Collaborations and Open Data Foundations
  - Opt in community of interest where contributors serve the interests of the community
  - Study, Create, Distribute, Modify the shared data with shared intellectual property
  - Rules set by governing body
  - Shared property within the organization limits general public access.
  - Transition of capability to open source as Foundation decides
  - Foundation can set up and operate secondary supply and cooperative models.

  - UBER Model
  - Use own assets to provide fee based services
  - Scheduling and payments provided in easy to use application
  - Consistent pricing
  - Voluntary
  - Standards of quality and behavior
  - Assistance in financing
  - Incremental cost is low and scaling is high

- Google Earth Data Provider- Test Model
  - Collection Assets are provided to operators
  - Operators agree to a level of service
  - Asset can be used for non competitive services.
  - If level of service is reached assets ownership transfers to the operator
  - Incremental cost of operations goes to near zero.

Model Open Communities of Interest

- Astronomy Picture of the Day (APOD)
  - The APOD archive contains the largest collection of annotated astronomical images on the internet.
  - All the images on the APOD page are credited to the owner or institution where they originated.
  - Amateur Astronomers compete daily for the glory.
  - Terabytes of data daily



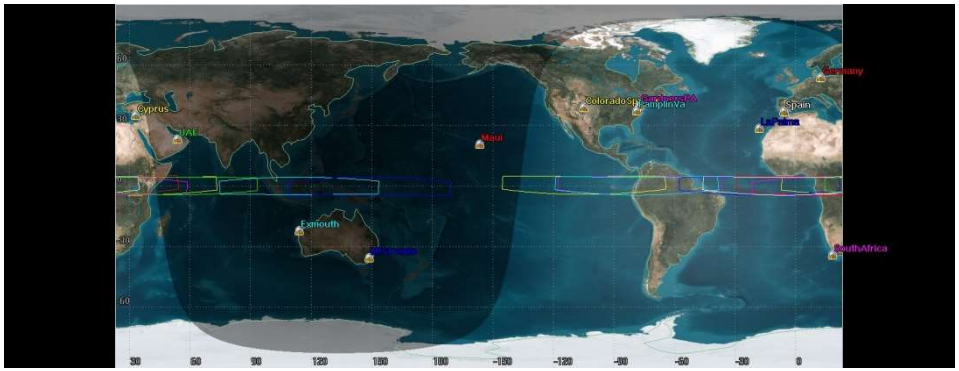
- SETI – Search for Extraterrestrials Intelligence
  - Processing of large amounts of electromagnetic data
  - Cooperative model for distributed data processing creating a virtual supercomputer composed of large numbers of Internet-connected home systems.
  - Open Source software for volunteer computing

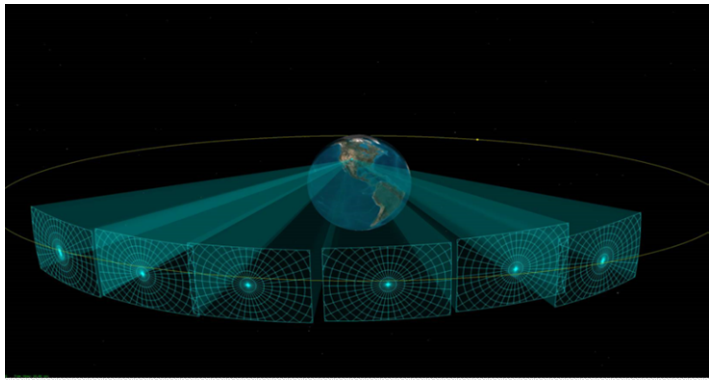
SETI INSTITUTE

- LINUX Open Source Software
  - Free and open-source software collaboration
  - The underlying source code may be used, modified and distributed by anyone under the terms of its licenses
  - Value add layered on top of community supported code base.

A Path Forward

- Establish a research relationship to encourage cooperation between UK and US in Space Situational Awareness and Space Traffic Management
- Co-location of commercially available cameras and telescopes to collect measurements to locate objects near the Geo Synchronous belt.
- Data sharing and joint research
- Coordinated AFOSR outreach with local researchers to enhance capabilities.





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