Space Weather Services, Science and Supporting Infrastructure -- Building the Partnership

Space Weather Enterprise Forum
Washington, DC
June 27, 2017

Conrad C Lautenbacher, Jr
CEO, GeoOptics, Inc

Agenda

- Space Weather Enterprise
  - Strategy
  - Components
  - Partnership
  - Progress
- Budget Situation
  - Solution
- Commercial Contributions
  - ACSWA
  - Specific capabilities
- Summary

National Space Weather Strategy*

Introduction

"The Strategy and Action Plan builds on recent efforts to **reduce risks** associated with natural hazards and **improve resilience** of essential facilities and systems, aiming to foster a **collaborative environment** in which **government, industry,** and the **American people** can better understand and prepare for the effects of space weather."

.

"The Nation must continue to **leverage existing public and private network of expertise and capabilities** and pursue targeted enhancements to improve the ability to manage risks associated with space weather."

*http://www.sdr.gov/docs/final_nationalspaceweatherstrategy_20151028.pdf

The Space Weather Enterprise

Products and Services

Maximizing Value

Analogy:
"Weather Enterprise"

Government

- **Public Safety**
- Economic Health
- National Defense
- Regulation

Academia

- Science
- **Research**

Commercial

- Services
- **Efficiency**
- Competition
- **Robust Economy**
- Communication

Space Weather Enterprise

Connections

$
Grant
CRADA

Government

$
BAA
Contract
SBIR
CRADA

- Public Safety
- Economic Health
- National Defense
- **Regulation**

Academia

Commercial

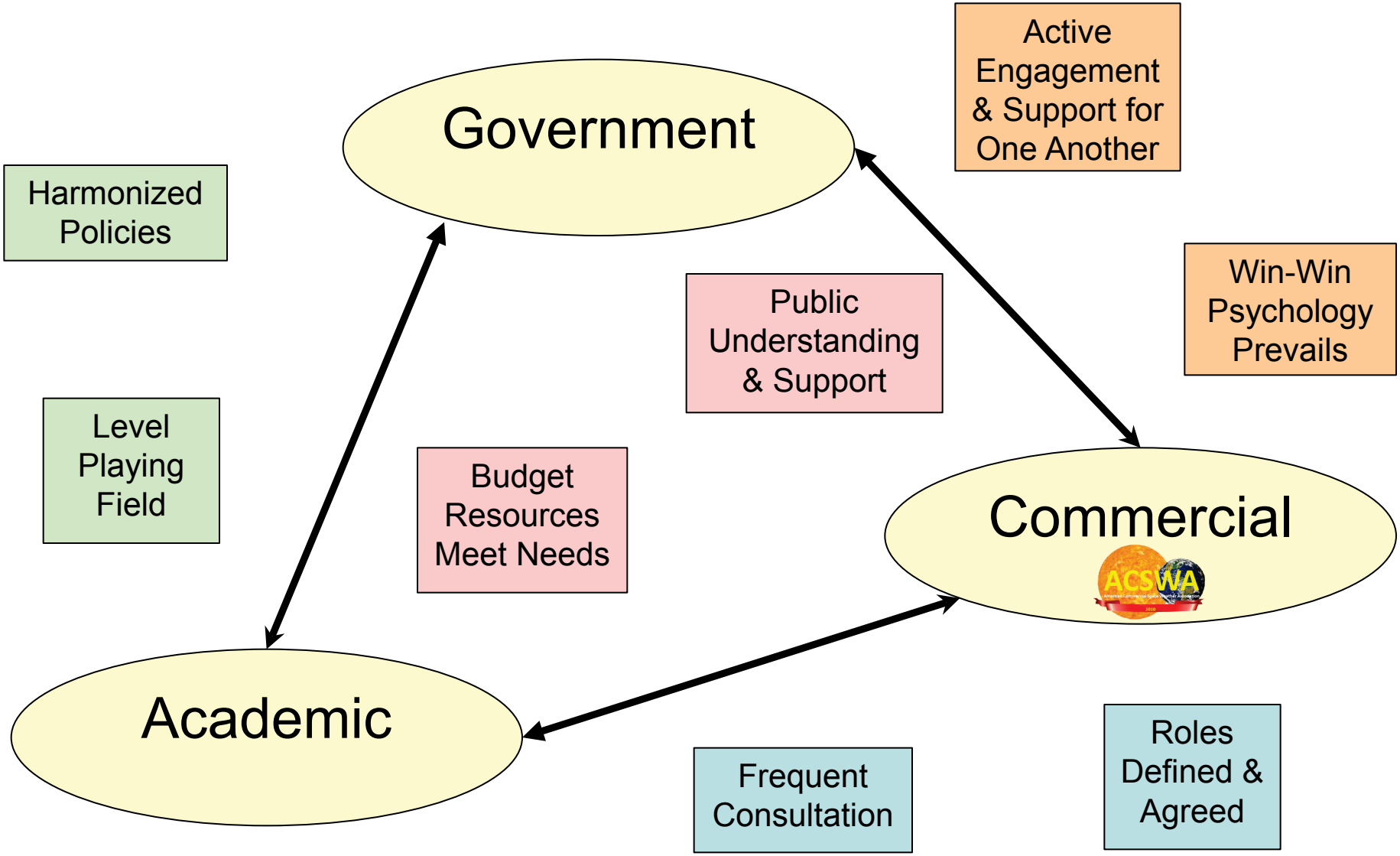
- Science
- Research

$
Contract
STTR

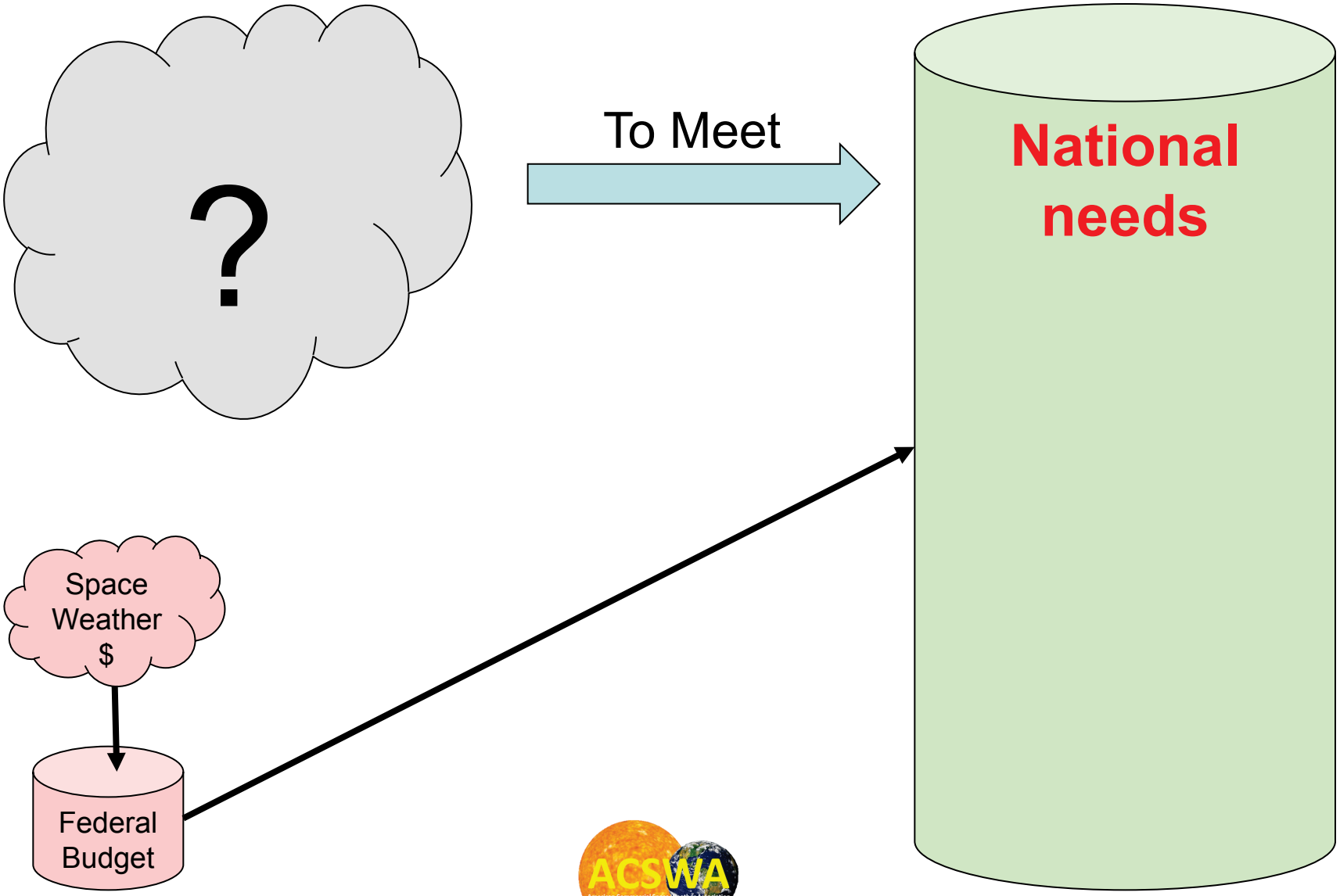
- Services
- Efficiency
- Competition
- Robust Economy
- Communication

SBIR – Small Business Innovation Research
STTR -- Small Business Technology Transfer
CRADA – Cooperative R&D Agreement

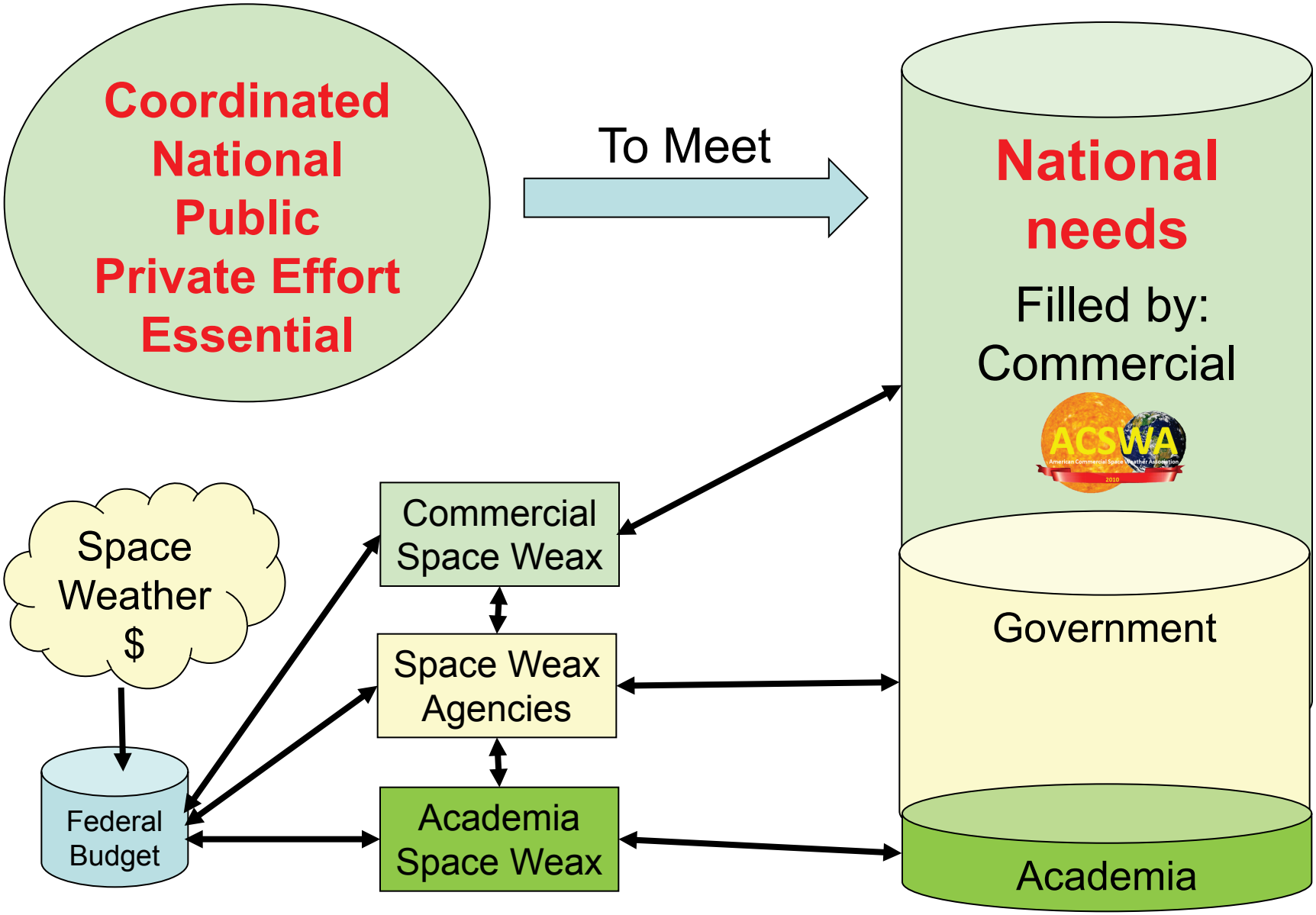
Toward A Successful Partnership!



Federal Budget Dilemma



Partnership Solution



Enterprise Efficiency

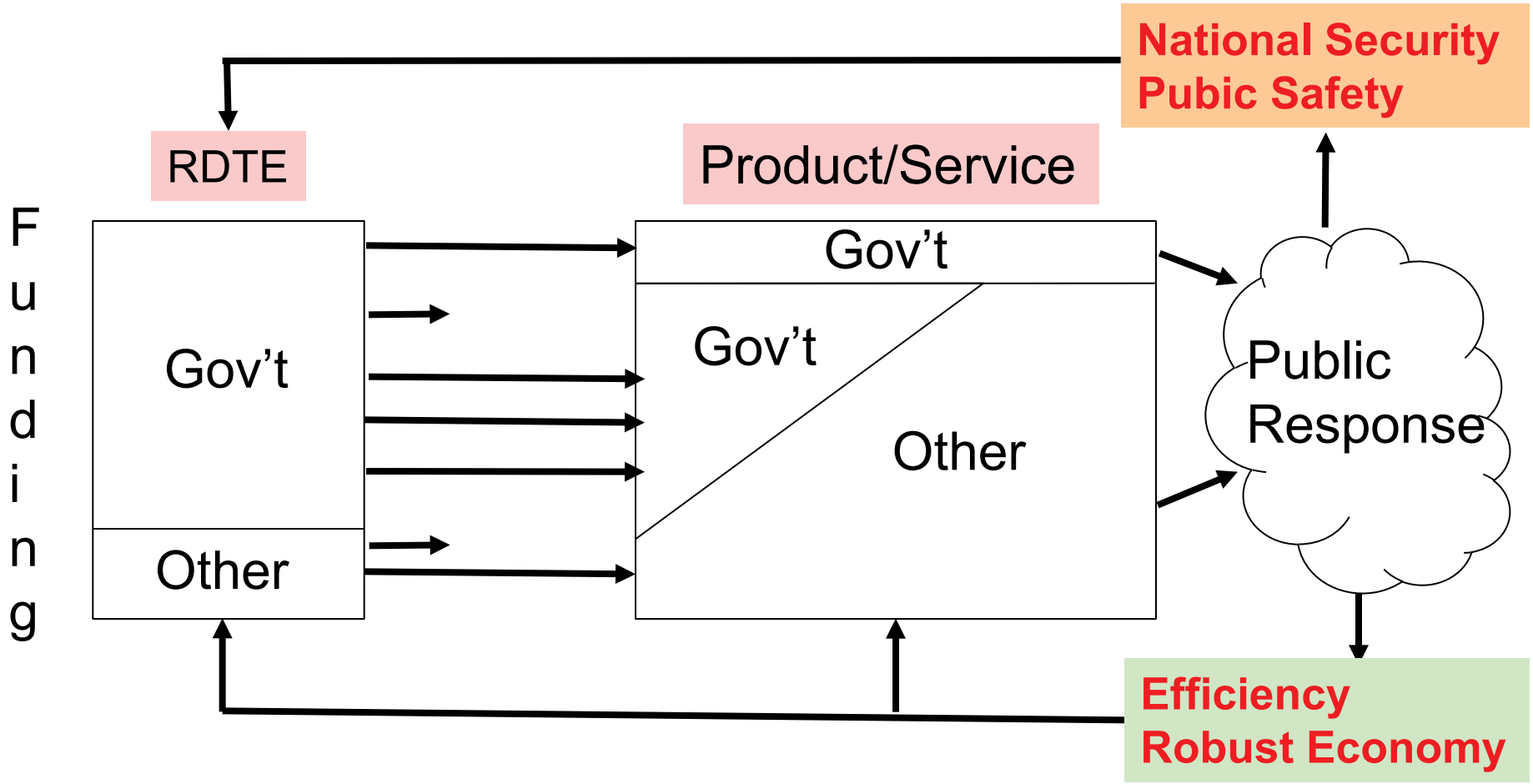
Which system architecture is the most efficient?

Swim Lanes?

Free for All?

*NOAA's Policy on Partnership; Edward Johnson, Dir Strategic Planning & Policy NWS 1/22/ 2015

"Swim Lanes" for National Needs



Other = NGO, Free Enterprise

American Commercial Space Weather Association

- **Formed in 2010, 5 Members;**
- **2017, 19 Members:**

AER, ASTRA, CPI, CRC, FF, GO, IS, PiQ, PRA,PSI, Q-up, SAC, SEC, SET, SSI, SSH, SA, SWFTT, NGF

www.acswa.us

Executive Committee:

G. Crowley (ASTRA)
A. Engell (NGF)
D. Intriligator (CRC)
C. Lautenbacher (GO)
R. Robinson (IS)
R. Schunk (SEC)
K. Tobiska (SET)

Commercial Space Weather Industry

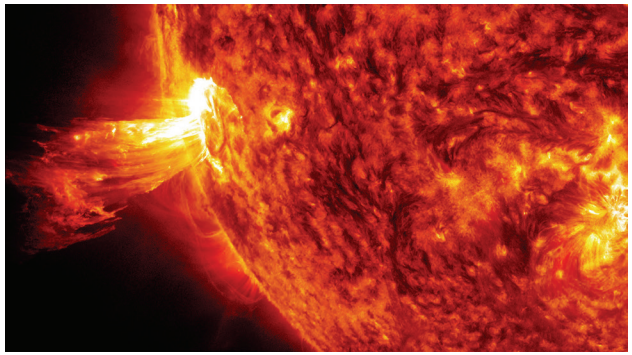
Products and Services

Value Chain

American Commercial Space Weather Association

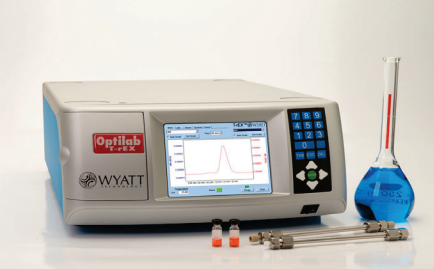
Upstream

- Research
- Observations
- Instrumentation
- Data



Mid-Stream

- Data Processing
- Computation
- Algorithms
- Models



Downstream

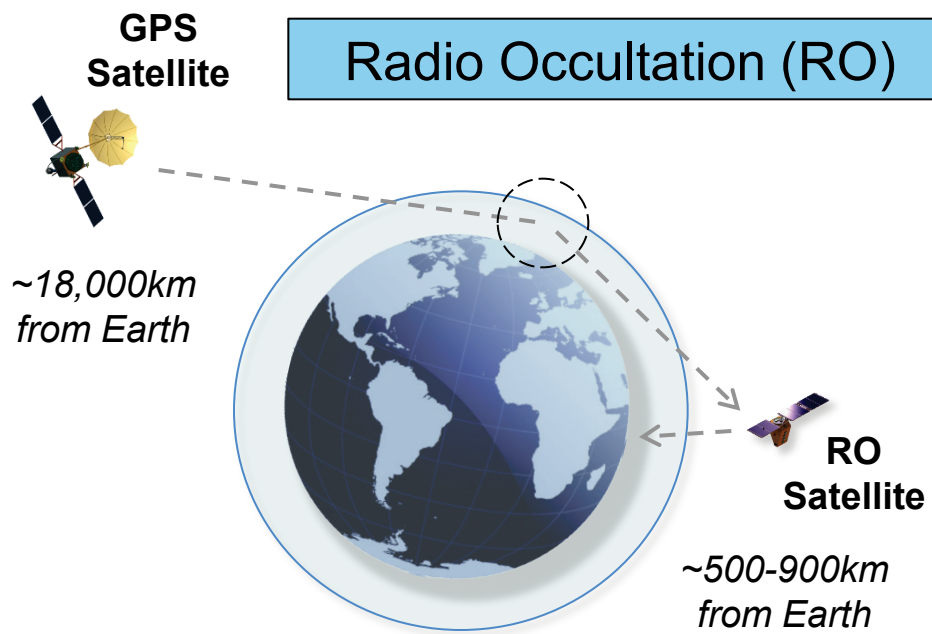
- Forecasts
- Warnings
- Services
- Emergency Mgt

"Community Initiative for Continuing Earth Radio Occultation"

CICERO

- Nano Satellites
- 6 ~~12~~ ~~34~~ ~~48~~ ~~?~~
- Cion Receiver
- Ground Command & Control
- Data Processing
- Products
  - High Resolution Atmospheric Profiles
    - Bending Angle
    - Refractivity
    - Density
    - Pressure
    - Temperature/Moisture
    - Absolute Measurement Heights
  - Ionospheric Electron Density
  - Global Temporal & Spatial avgs
  - Global pressure contours, gradients & geostrophic winds
- Replenishment & Updating

Radio Occultation (RO)



COSMIC I

- Fully Successful RO Test
- Rapidly Reaching End of Life

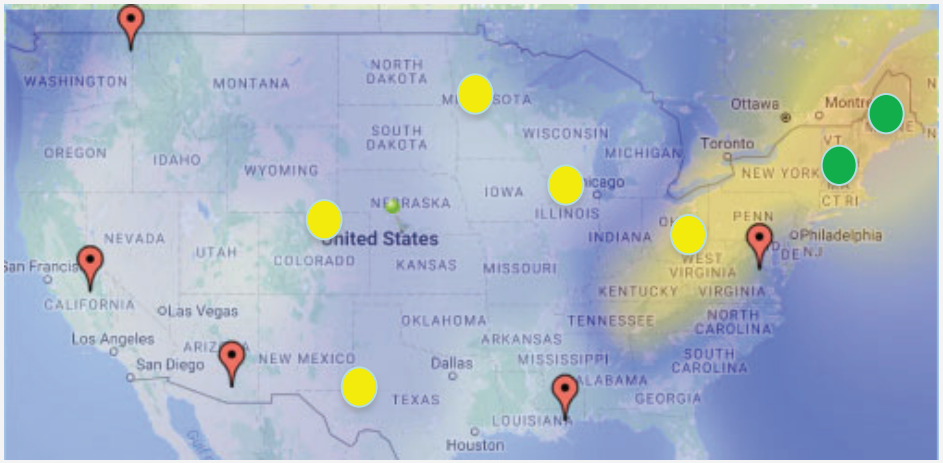
COSMIC II

- Limited Satellite Number (12)
- Specified Lifetime
- CICERO data Interchangeable
  - Ground Processing
  - Distribution
  - NWP Use

COMPUTATIONAL PHYSICS, INC.

Local situational awareness of GIC - "Geomagnetically Induced Current"- for power utility planning and ops

AVERT real-time induced electric field hazard map: GIC hazard analysis for power utility research, planning and operations

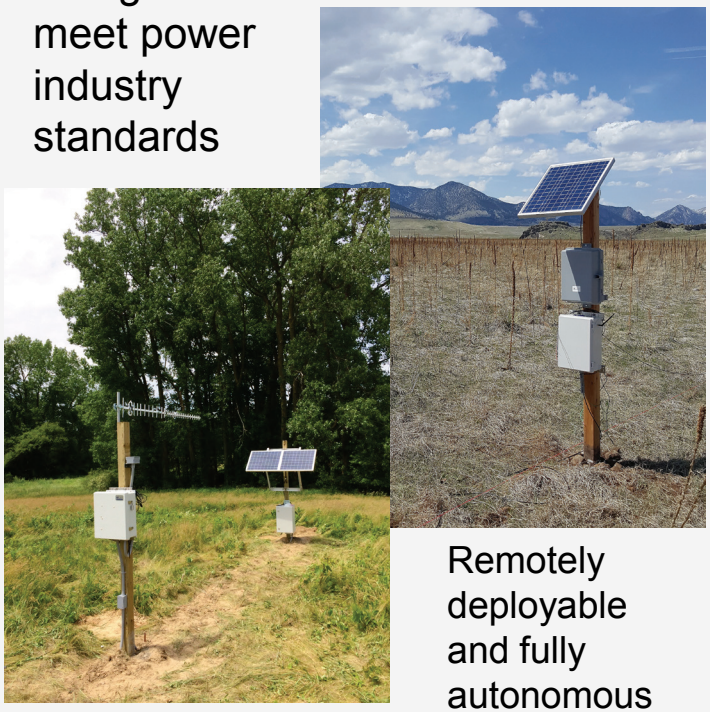


Above: AVERT with SHM sites (existing ; planned 2017)

Space Hazard Monitors (SHM)

Magnetometer installations for monitoring GIC hazard

Designed to meet power industry standards



Remotely deployable and fully autonomous

CONTACT INFORMATION

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COMPUTATIONAL PHYSICS, INC.

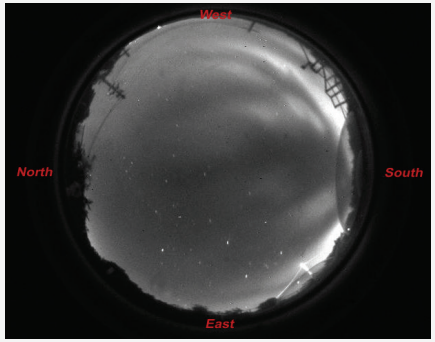
Modeling and monitoring the near earth space environment from the ground and space.

DATA PRODUCTS:

Thermospheric neutral temperatures and Doppler winds at the Arecibo and Millstone Hill Observatories.

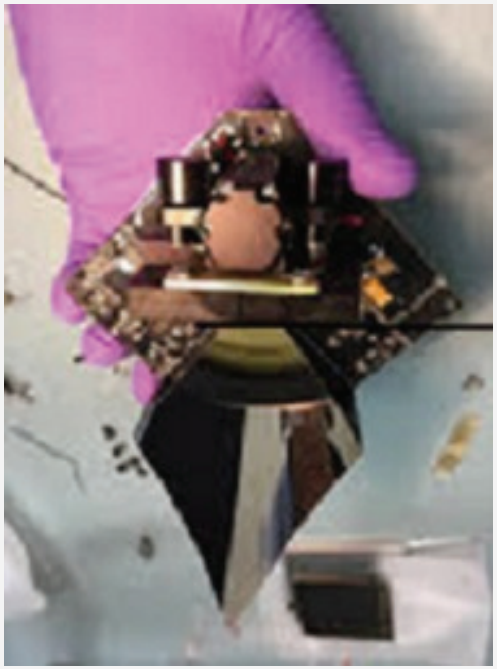
MODELS:

AURIC atmospheric radiance model; **B3C** auroral model.



ESF plume imaged at 630 nm over the Arecibo Observatory. Image taken 20 Nov 2014 at 10:30 PM local time. ESF plumes started at about 8:20 PM.

SENSORS &



Small form factor high luminosity optics for space based remote sensing.

Ground based neutral atmosphere sensors, including imagers, spectrographs and Doppler imagers.

Remote, autonomous ground based sensing stations for monitoring TEC and the neutral thermosphere.

CONTACT INFORMATION

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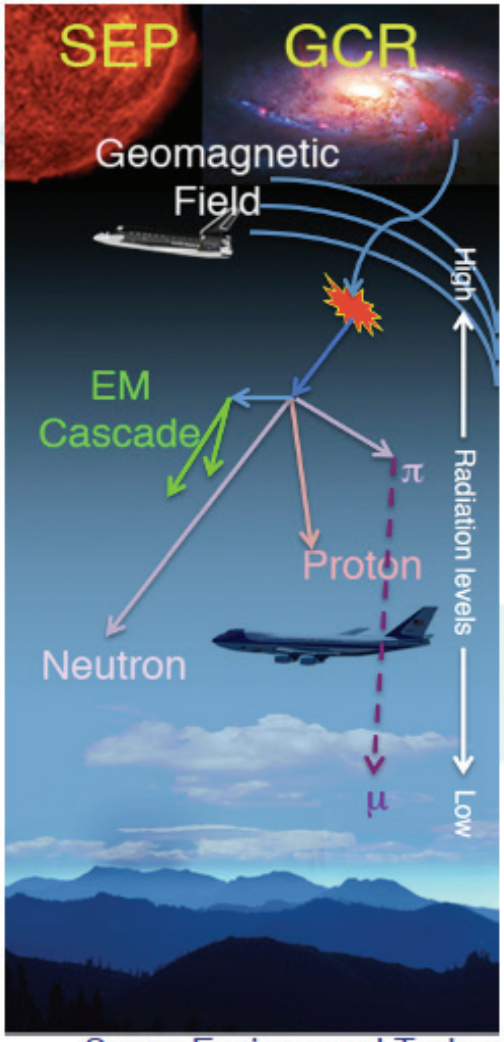
noto@cpi.com
http://www.cpi.com
http://www.neutralwinds.com

ACSWA American Commercial Space Weather Association 2010

SPACE ENVIRONMENT TECHNOLOGIES
Space Weather Division

ARMAS



Space weather creates a dynamic radiation environment at aviation altitudes

Aviation radiation exposure can come from

- ✓ **global phenomenon** GCRs (career health issue)
- ✓ **high latitude phenomenon**
  - ✓ **Extended major events** SEPs (fleet operations and aircrew/passenger safety issue)
  - ○ **Possible short-term minor events** precipitating outer radiation belt energetic electrons (career health issue)?

Space Environment Technologies

http://spacewx.com

SEP – Solar Energetic Particles CME – Coronal Mass Ejection GCR – Galactic Cosmic Radiation

SPACE ENVIRONMENT TECHNOLOGIES
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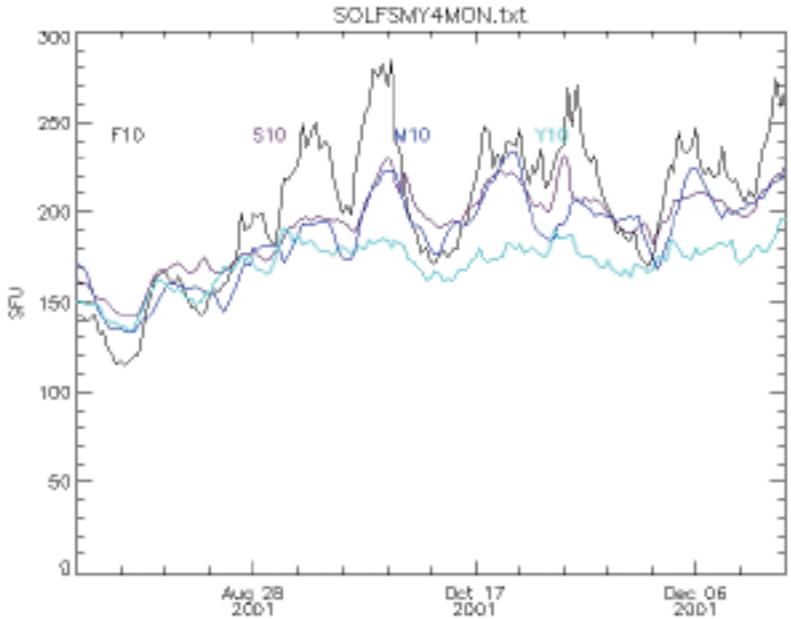
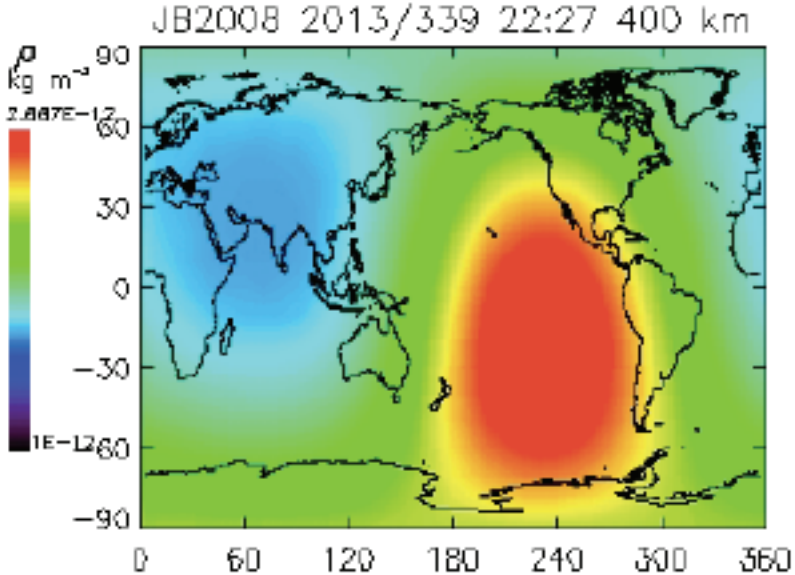
ARMAS

SET manufactures the ARMAS FM6

- FM6 has a micro dosimeter, GPS, micro SD data logger, Bluetooth and external in a size similar to a smart phone; app link to phone or tablet
- Measures all altitude ranges and all sources of radiation
- **Personal dose exposure reported around the world** providing situational awareness with NAIRAS model data inclusion
- **Provides management options for rad flight events**
- FAA compliant (stand-alone – no attachment to plane)

JB2008 solar indices provide most accurate specification of Low Earth Orbit neutral densities





The Environmental Data Services Company

The End