



“What’s Happening in the World of Spaceborne Platforms Impacting Photogrammetry and Remote Sensing”

NOVEMBER 1, 2019

ASPRS EGLR FALL MEETING

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- **Space Impacts on
Photogrammetry and Aerial
Systems**

Impact Of Spaceborne Platforms on Aerial Market

- 1. Photogrammetry more important**
- 2. High Resolution of Aerial more important**
- 3. Must move to Cloud and High Performance Compute Solutions**

Space

“Global **space** industry could generate revenue of more than \$1 trillion by 2040, up from \$350 billion, currently...”

Morgan Stanley

Gov't - Hypersonic Sensors



**A rendition of the SR-72 (Aurora)
hypersonic ramjet capable of 6,000 mph**

Unmanned Systems



HUMAN SENSORS

- ***CELL PHONE Imaging***
- ***CELL PHONE GPS Coordinates
-LOCATION Based Intelligence***
- ***ACTIVITY Based Intelligence***
- ***SINGLE Largest Sensor Collection
Device The “Human Sensor”***



New Space SmallSats / Others

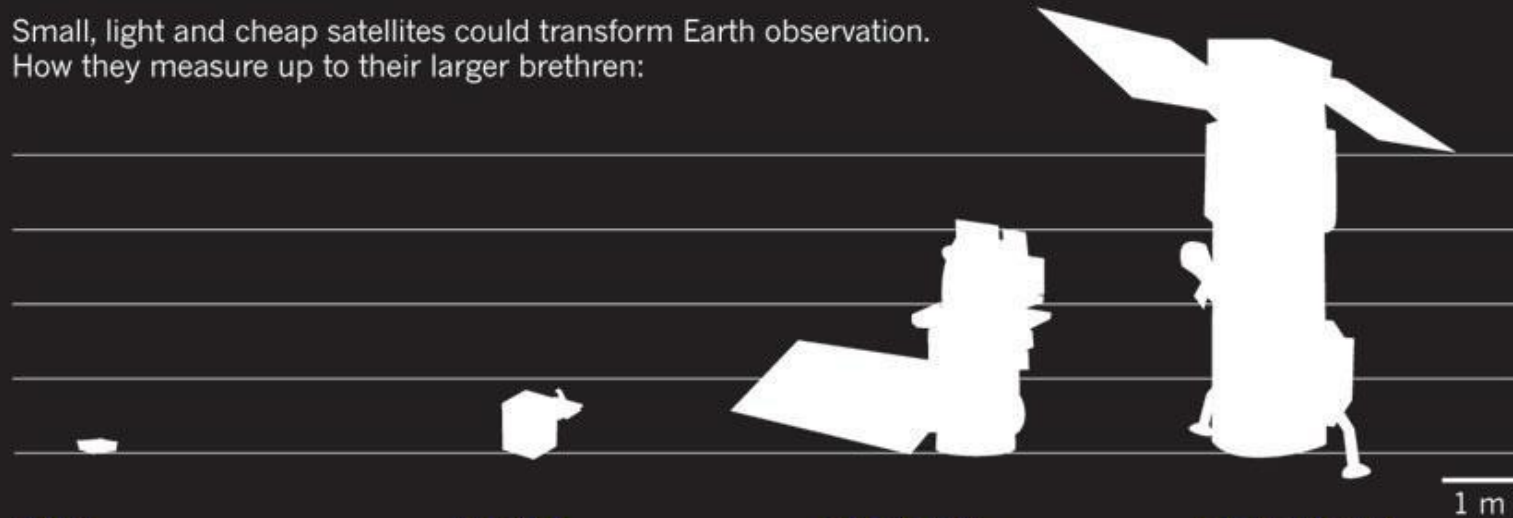
To SMALLSATS



Satellite Size

THE SWARM COMETH

Small, light and cheap satellites could transform Earth observation. How they measure up to their larger brethren:



DOVE

Operator: Planet Labs
Number of satellites*: 32
Weight: ~5 kg
Instruments: Optical and near-infrared spectral bands
Spatial resolution: 3–5 m

SKYSAT

Operator: Skybox Imaging
Number of satellites*: 24
Weight: ~100 kg
Instruments: Optical and near-infrared spectral bands
Spatial resolution: ~1 m

LANDSAT 8

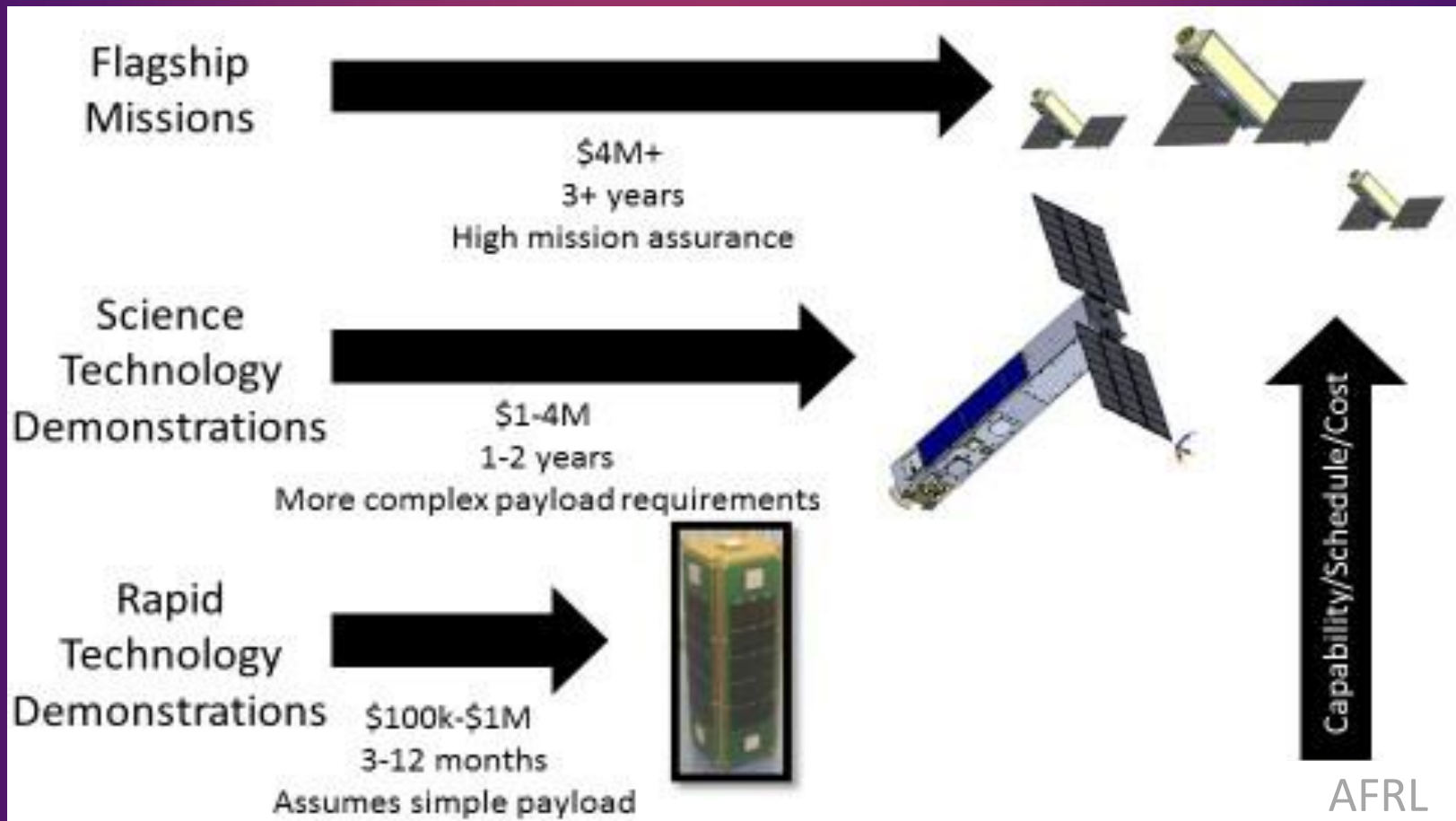
Operator: NASA
Number of satellites*: N/A
Weight: 2,071 kg[†]
Instruments: Multiple spectral bands
Spatial resolution: 15–100 m[‡]

WORLDVIEW-3

Operator: DigitalGlobe
Number of satellites*: N/A
Weight: 2,800 kg
Instruments: Multiple spectral bands
Spatial resolution: 0.3–30 m[‡]

*When fully operational † Without instruments ‡ Depending on spectral frequency

Typical CubeSat Mission Types/Costs



Satellite Size - Image Comparison

WorldView-3 (2,800 kg)
1.2 Gbps 8PSK in X-band





30 cm/pixel

High Speed Down Link is required for huge amount of observed Data

© Terra Bella

SkySat-2 (100 kg)
300Mbps 8PSK in X-band



85 cm/pixel

High Speed Down Link is required for huge amount of observed Data

© Terra Bella



Sensors Requested By Markets

- Multispectral – Planet
- SAR – Capella Space
- Hyperspectral – Wyvern Space
- RF – AIS – OrbComm, Exact Earth, SPIRE, others
- LiDAR – LITE, NASA

Current Status Space Investments

\$\$\$\$- SPACE THE NEW FRONTIER

Global Space Value:

- 2019 - \$400B
 - 2040- \$3-4 Trillion
 - 2001-2019 - \$18B in Space
- Start-Ups**
- 

\$\$\$\$- SPACE THE NEW FRONTIER

WHO:

- Governments
- VC's
- Banks
- Private/Industry Wealth

\$\$\$\$- SPACE THE NEW FRONTIER

WHY:

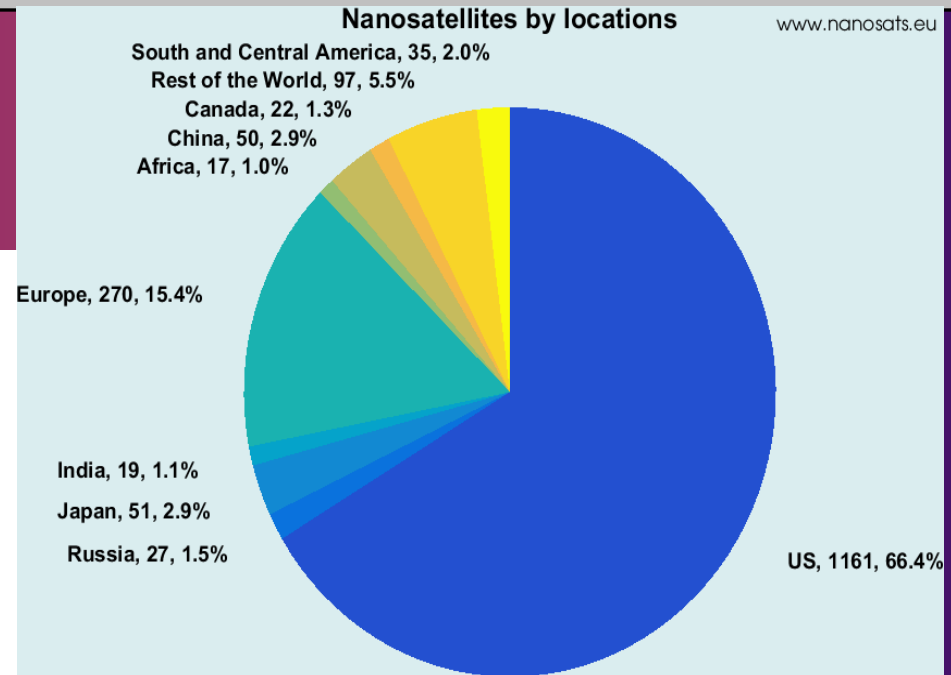
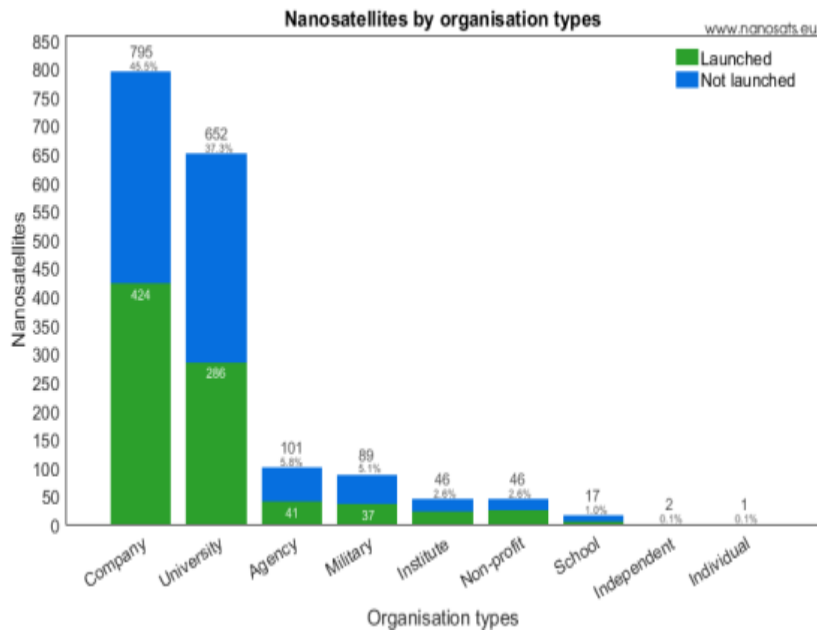
- National Security
- Maritime
- Environment – Food Energy –
SUPPLY CHAIN ADVANTAGE

–\$\$\$\$ and Exit Strategies

Democratization and Commoditization In Low Earth Orbit

Commercial Investment Growth

- 2016 - \$990 million
to
- 2020 - \$2.52 billion



Outstripped the government's ability to lead this industry, the commercial world pushes the space proposition to commercial markets such as agriculture, finance and energy with Business Intelligence Products.

Space Disruptive Forces

Global Disruptive Forces to EO

5 “global disruptive forces” altering the world landscape and impacting the Global Commercial Geospatial Industry and include:

(1) Global Aging Workforce

(2) Focus

(3) Pace

(4) Flow

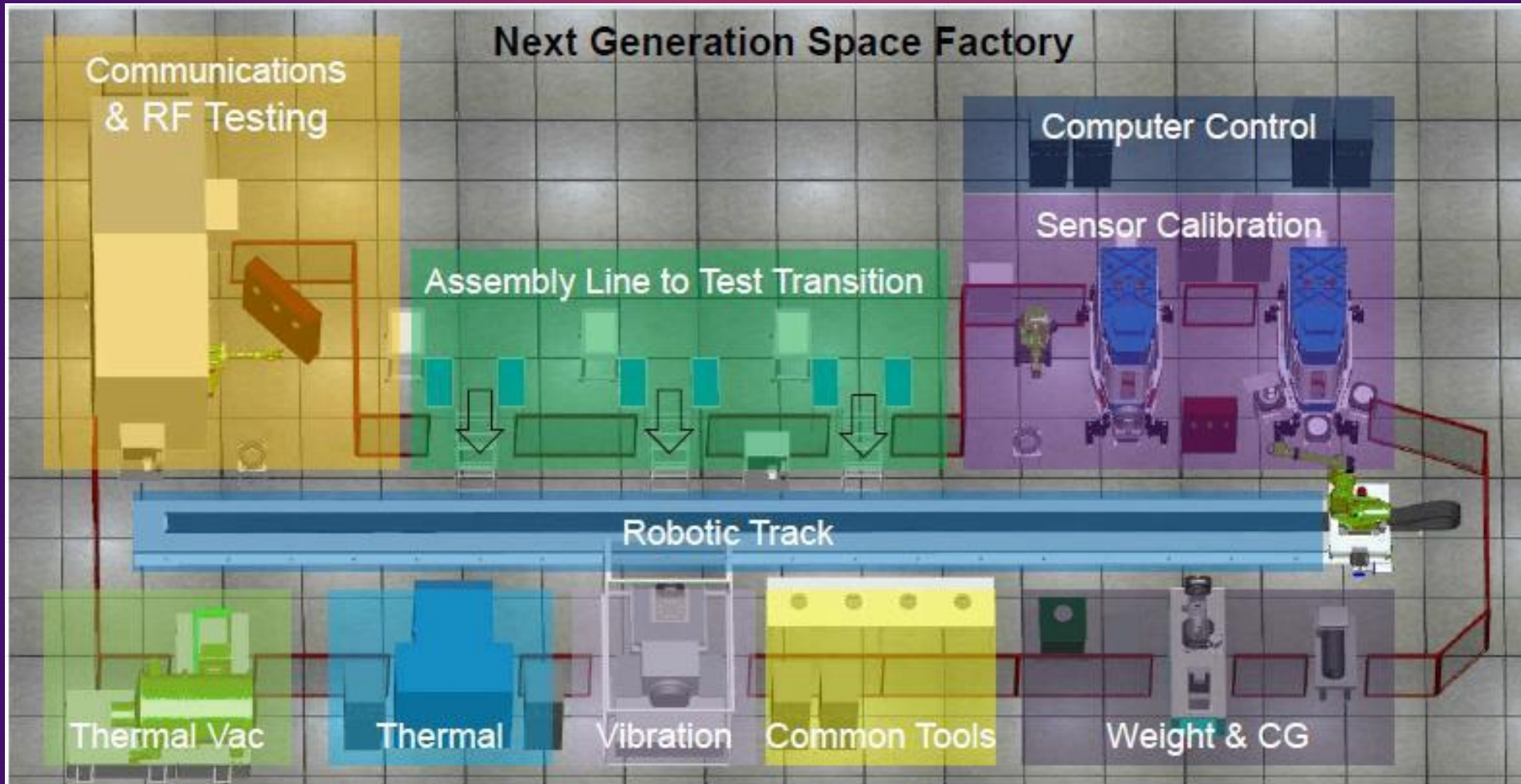
(5) Business Behaviors – Exit is the

Goal not Growth



New Space Enables:

Advanced Robotics so More to Come



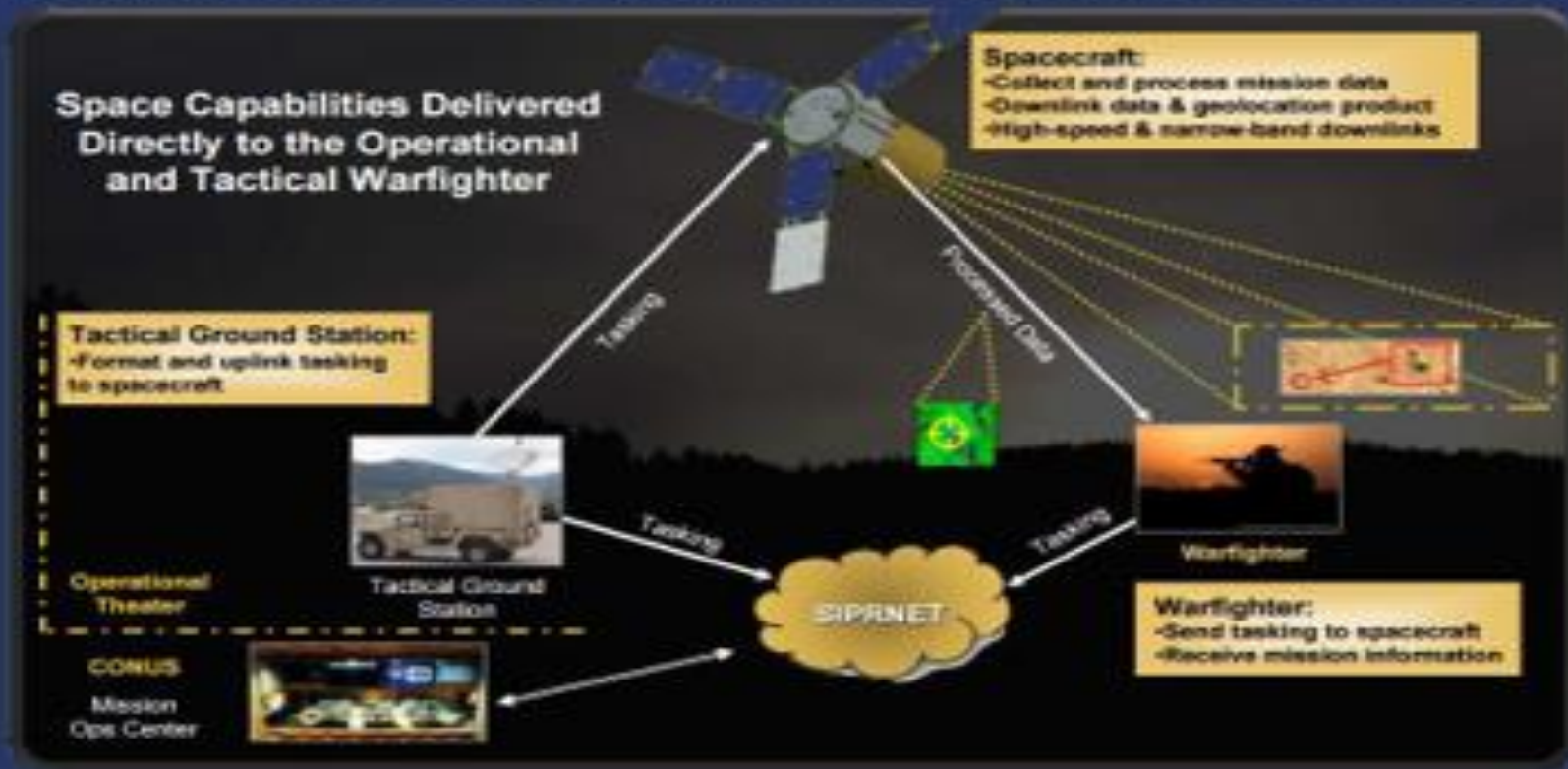
New Space Enables:

Operationally Responsive Space

Enabling Operationally Responsive Space



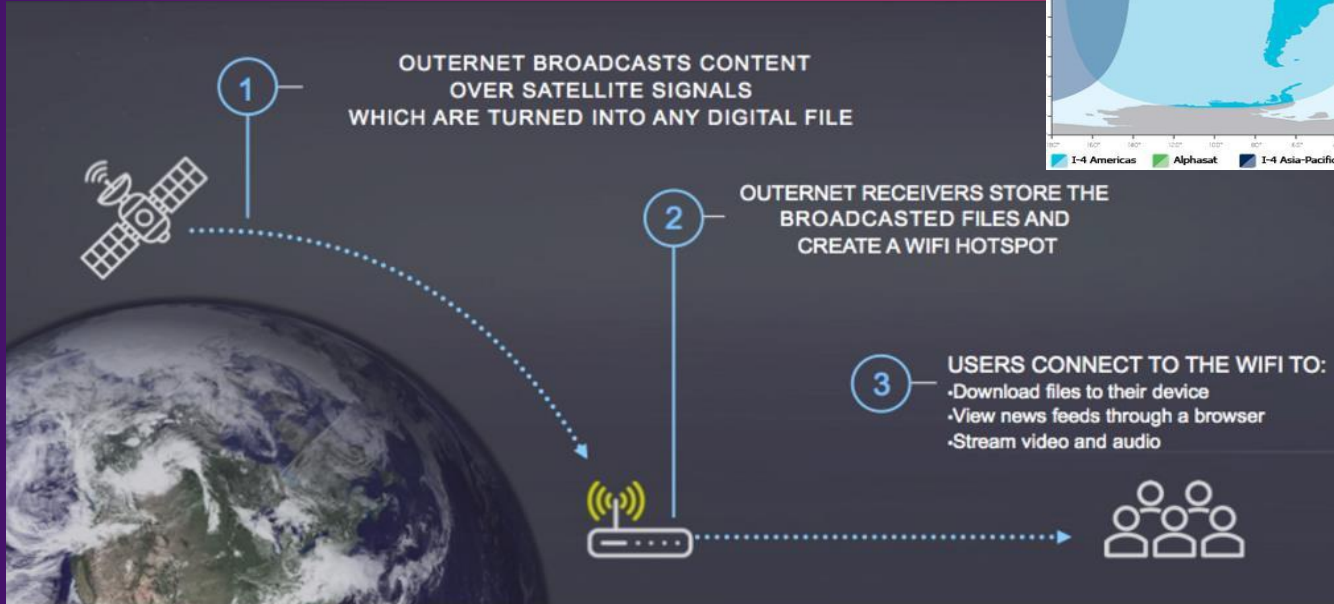
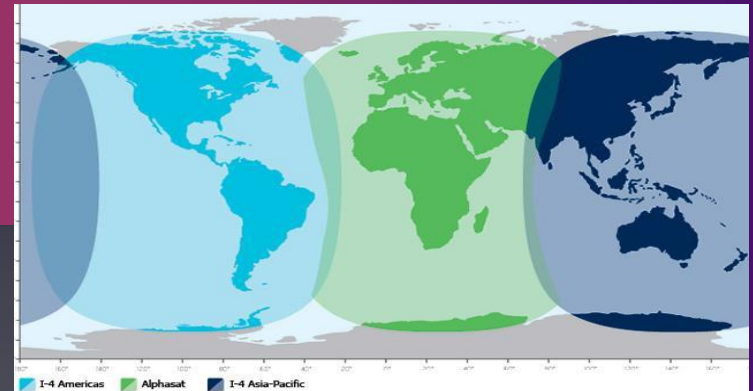
Breaking Old Paradigms and Giving JFCCs the First Realistic Opportunity for Responsive, Dedicated Space Capabilities at the Operational and Tactical Level



New Space Enables: 5G & Global Internet Greater Connectivity



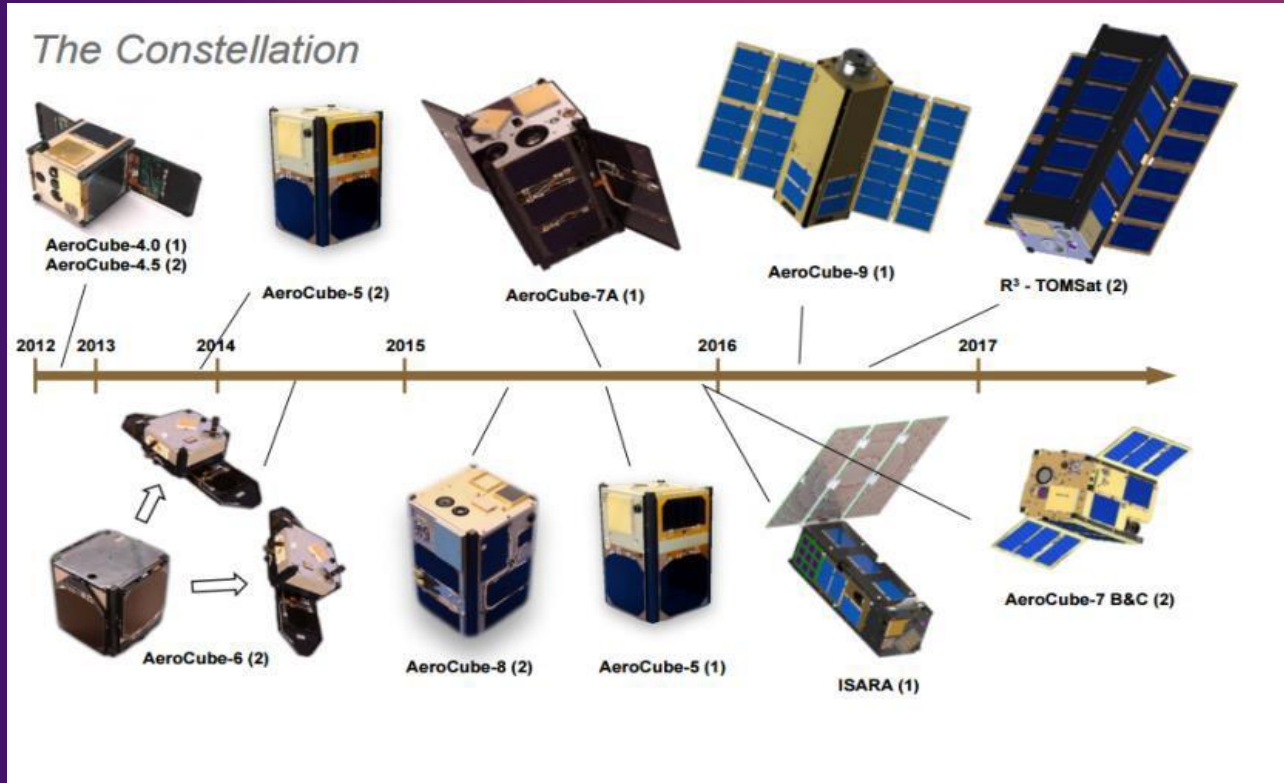
Outernet's goal is to provide global free access to the internet through geostationary and Low Earth Orbit satellites



New Space Enable: New Ground Stations



Evolution of an Automated Ground Segment for Operation of the Aerospace CubeSat Constellation



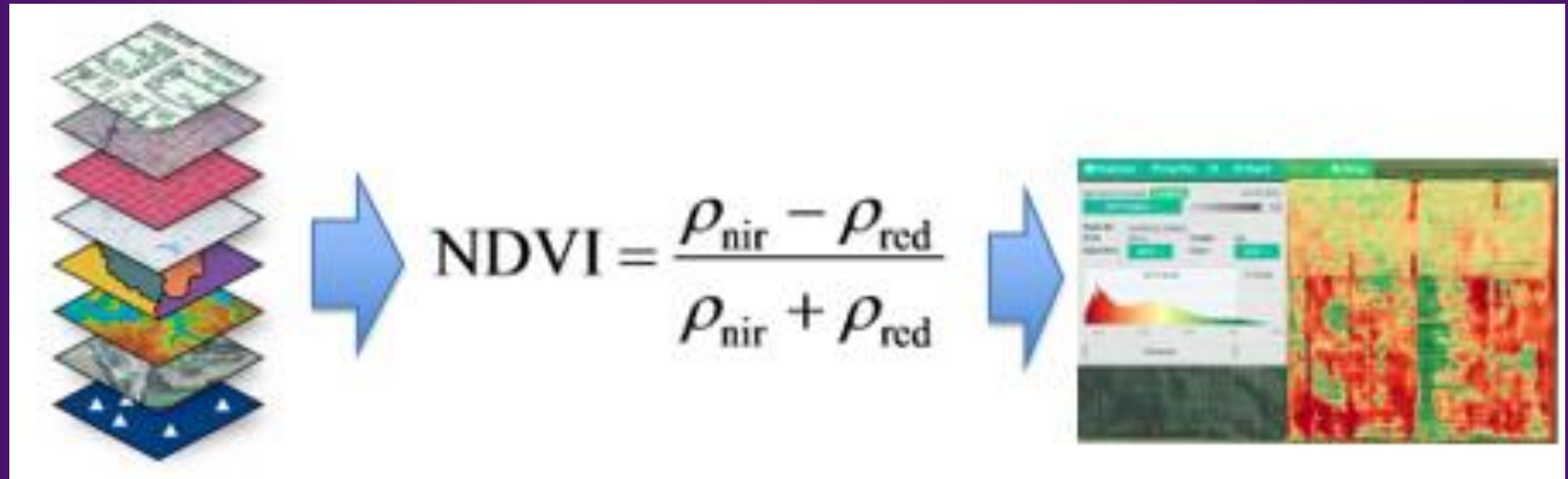
System Evolution

The Goal

- Driving Goal
 - Reduce The Required Labor to Maintain the Constellation
- How
 - Automate Ground Stations
 - Simplify Coordination
 - Automate Telemetry Collection and Aggregation
 - Automate Basic Fault Detection
- Requirements
 - Do not interfere with user planned missions
 - Interact with existing software

Democratization and Commoditization of Data with

Big Data Analytics for Multi-Source, Persistent Observations



Imagery &
Data

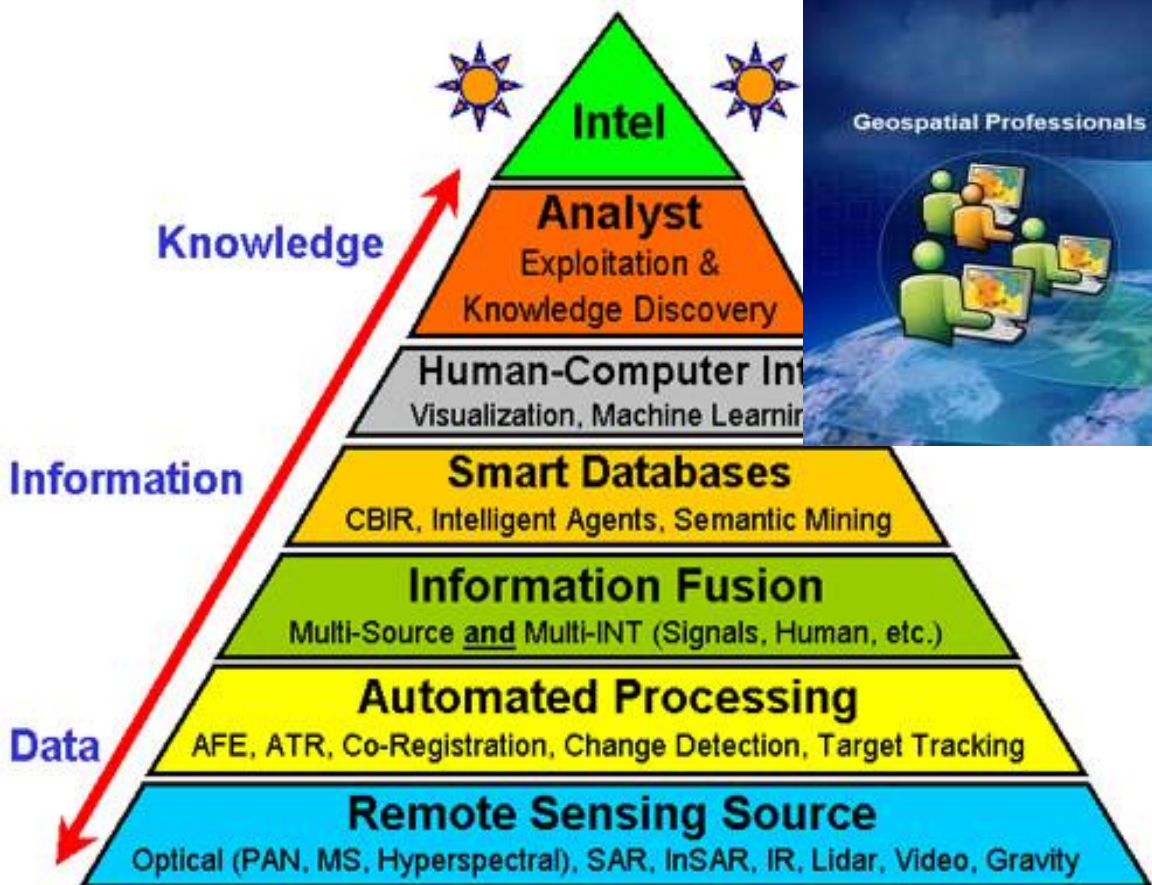
Model or
Algorithm

Geospatial
Visualization

Streaming Data from Space – Persistent Coverage – Big Data Analytics – Analysis-as-a-Service – Knowledge and Answers!

New Space Impacts on Photogrammetry and Aerial Remote Sensing

Markets/User Wants : Detections NOT Pixels



Impacts

- **Multiple data inputs raster and vector**
- **Downward pricing pressure**
- **New opportunities for Projects with Clients who are Solutions Driven**

Business Model Disruption

Past



Main Frame Computer

Present



*Cloud
Computing*



*Mobile
Devices*



High Performance Computing

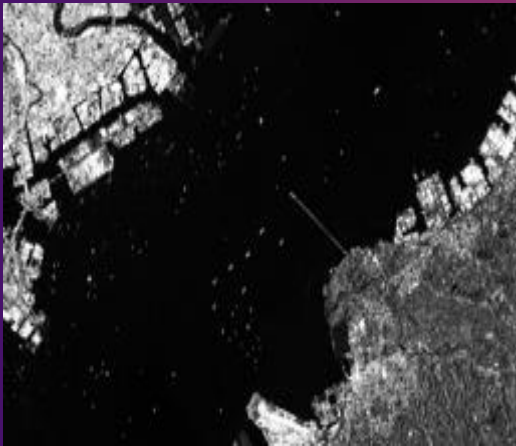
Impacts - Public Safety, National Security, Oil and Gas, Infrastructure, Industry

Photogrammetry Needed now more than ever Computer Vision Searches & Data Science

Raw pixels are not enough. Value lies in information, decisions.

- ❑ Abstract away details of data access and processing
- ❑ Uniform interface to many types of data
- ❑ Fast analysis / model development
- ❑ Deploy models on a global scale

Multi-modal data



SAR over Tokyo

Temporal information



Crop Fields in Nebraska

Machine Learning



Buildings detected in LA

Results & Verification

Identify sources of confusion for re-training, specifically to understand sources of bias and confusers that may not be eliminated without adversely impacting model performance



Segmentation results overlaid on Airbus SPOT



Source imagery: Airbus SPOT (1.5m)



Verification imagery: Airbus Pleiades (0.5m)

A map of Northeast China, showing provinces like Liaoning, Jilin, and Heilongjiang. A green grid is overlaid on the map, with a denser grid in the eastern coastal region. The number '33' is visible in the top right corner of the map area.

**Iterate modeling at scale – Then
Obtain a Closer View**

-ALL IN ONE CAPABILITY

-SPEED and SCALE of OPERATIONS

LiDAR

LiDAR Data

Highly Accurate And Provides:

- Base For 3-D Model Object Recognition Data
- Can Generate Object To within 15 cm of Ground Truth
- Works In Conjunction with 3-D Ground Laser Scans



Fused LiDAR And Color Imagery
Presenting A “Real World” View Of The Scene provided by Woolpert 34

Hyperspectral Imaging

1. Oil and Gas
2. Environmental Monitoring
3. Food Security
4. Seed Viability
5. Biological threats
6. Water Management



IMPACTS

- Unlimited Applications to Global Users
- Photogrammetry now part of Data Science
- Low cost of compute make all data available for Advanced Analysis
- Aerial Becomes MORE Important
- Aerial Data MUST be Accessible

Thank You!

Geospatial Business Intelligence Experts™

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