CubeSat-driven ISR – Will It Fulfill Its Promise?

DSEI - 2019

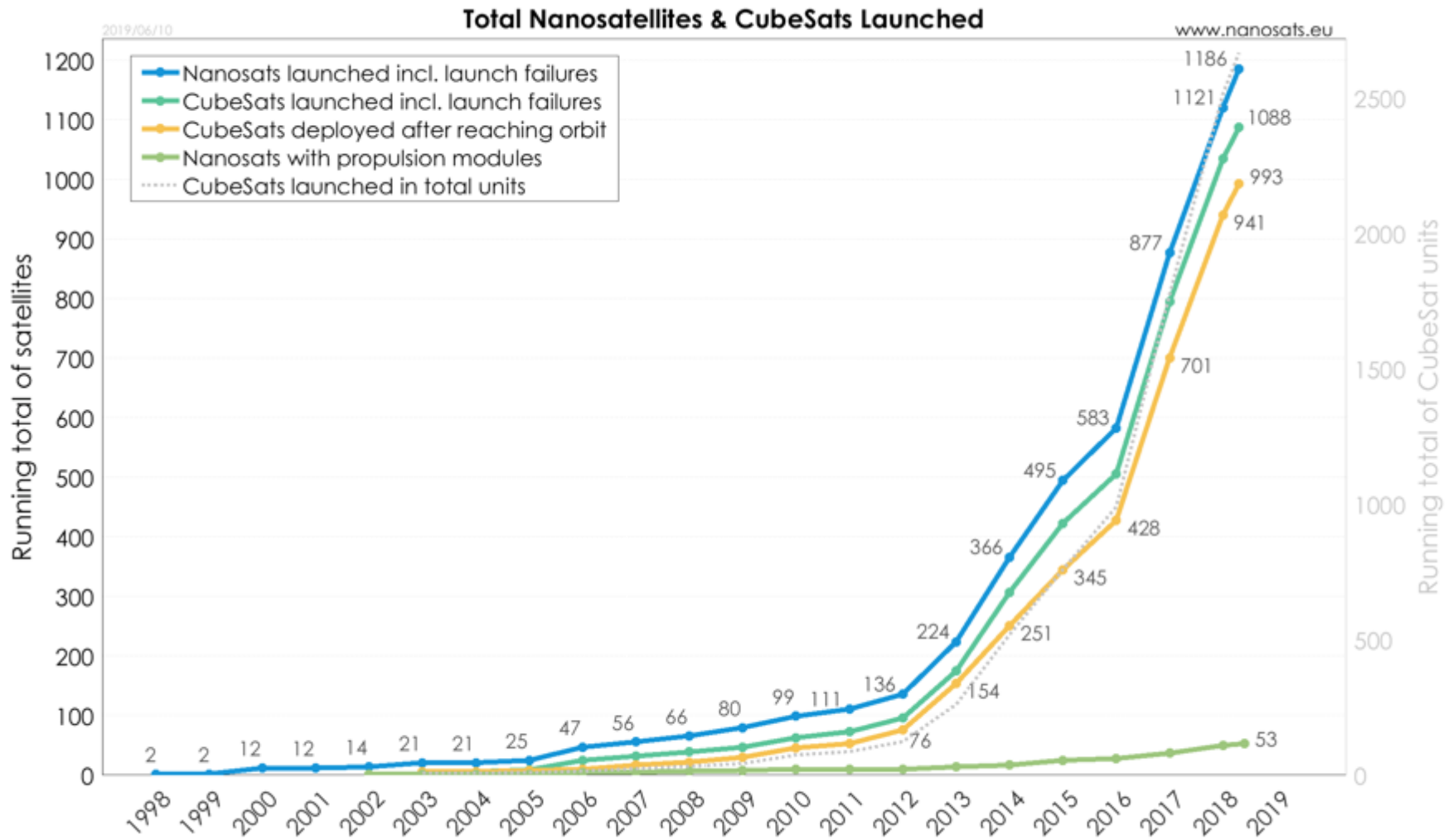
Western ISR – Current Systems

- **Today, ISR is provided via various manned and unmanned systems as well as space-based assets**
  - ***Rivet Joint*/*Air Seeker*/P-8**
  - ***Global Hawk***
  - ***Reaper***
  - **Tactical ISR**
  - **Space-based systems**

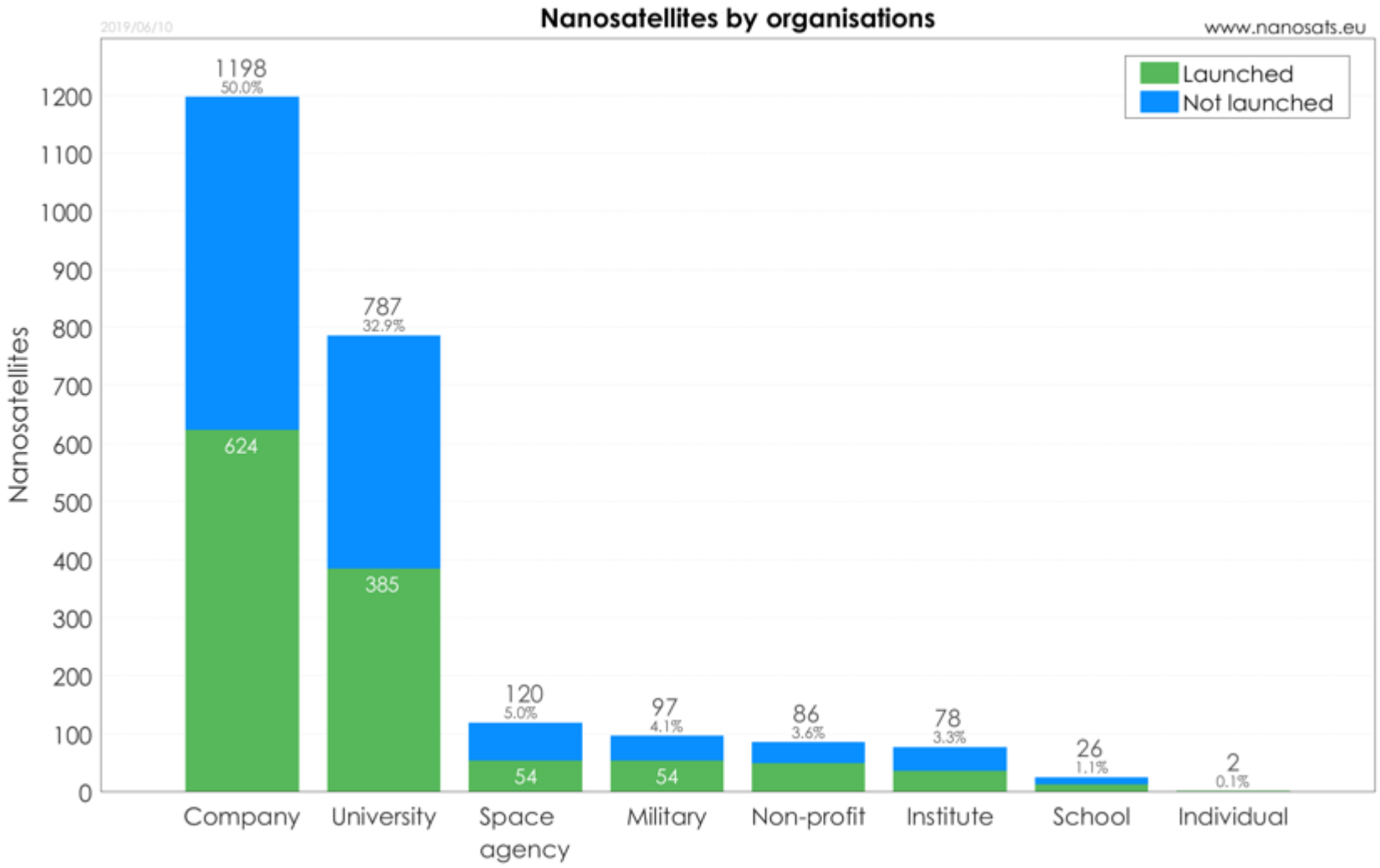
CubeSats – New Technology

- The first “CubeSats” were launched in 2003 based on a concept published by researchers at Stanford and Cal Poly in California
- Small satellites which “de-orbit” after 18-24 months – ensures latest technology
- 2014, Planet Labs (founded by ex-NASA engineers) launches 33 CubeSats from the ISS
- According to estimates, between 2018-2027, it is estimated 6,500-7,000 small satellites will be launched
- By mid-2019, $3 Billion has been invested in “new space” companies worldwide. Total investment since 2009 in 476 “new space” companies totals $22.2 Billion (

CubeSats – Total Launches



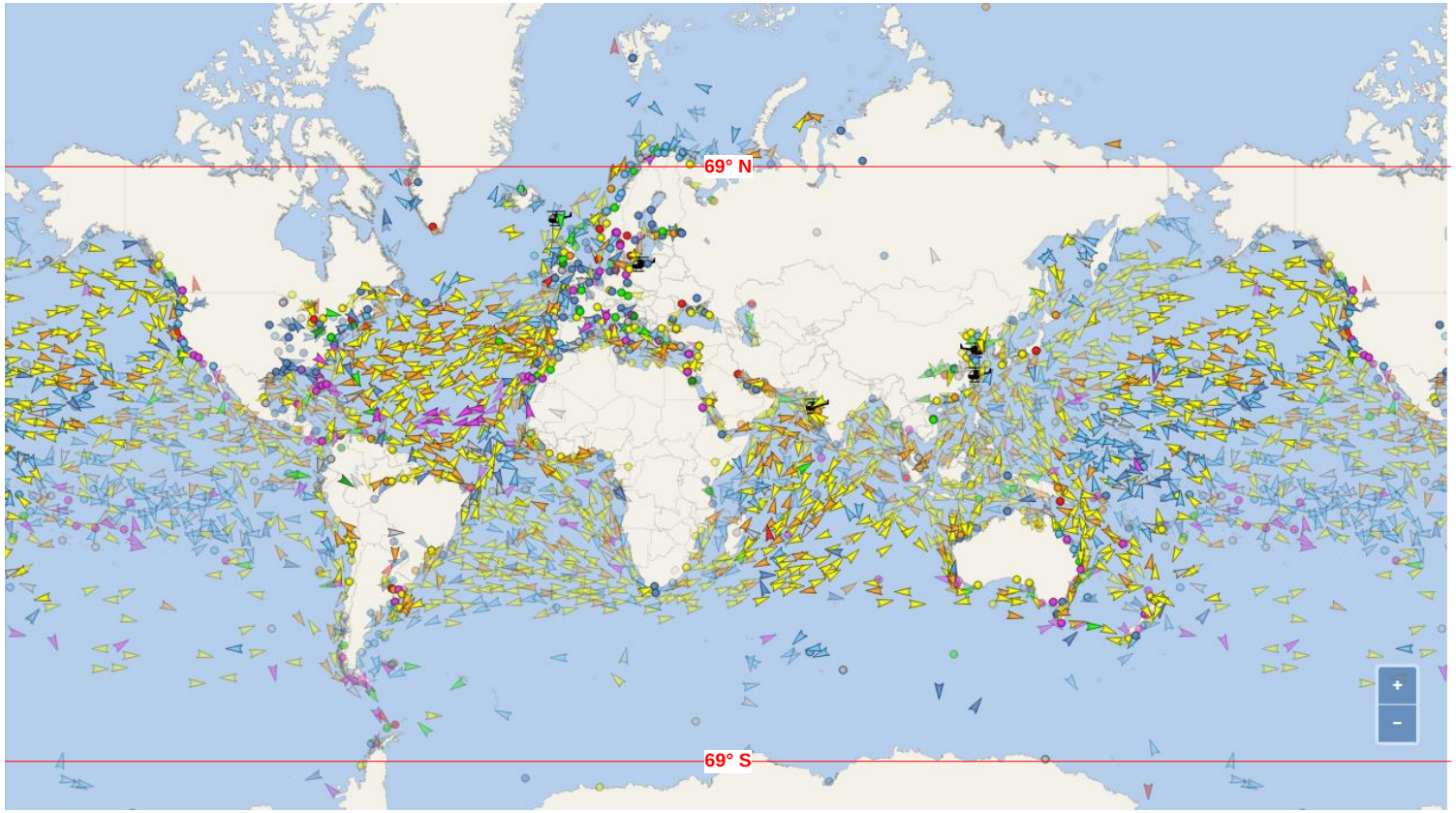
CubeSats – By User



The Pioneers – Spire and AIS tracking/analytics

- **Spire Global founded in 2012, and first launch was in 2014**
- **Goal was to transform the space-based AIS tracking business**
- **US/Lux based**
- **VC funded. $140+ Million**
- **80+ 3U Lemur CubeSats in orbit**
- **“Eight Figure” revenue**

spire



The Pioneers – Planet and Electro Optical (EO)

- **Planet was founded in 2010**
- **Acquisition of RapidEye (5 sats) from BlackBridge (Germany)**
- **$183M in VC Funding**
- **Complete image of the Earth at 3-5m optical resolution**
- **Largest constellation ever put in orbit; 200 active CubeSats (of 300 launched)**

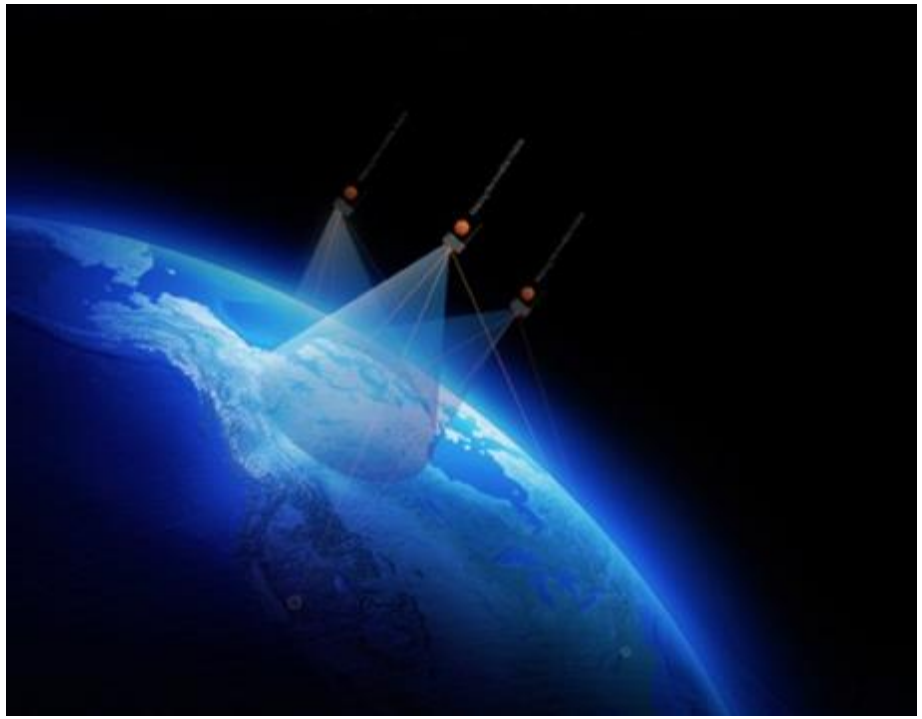
The Pioneers – ICEYE, NovaSAR: SAR Imaging

- **ICEYE is a Finnish company founded in 2014. $53 Million in VC funding**
- **Originally designed to monitor ice features**
- **Two (2) sats in orbit of a future constellation of eighteen (18) sats**
- **NovaSAR – SSTL (Airbus): first satellite launched in 2018**
- **Capella Space founded in 2016 with goal of 36 Sat with a resolution of 50 cm and revisit**

ICEYE

The Pioneers – Hawkeye 360: RF Collection

- **HE360 was founded in 2015**
- **Venture Capital and industry (Raytheon and Airbus) funded. $99 Million to date**
- **RF signals collection from a constellation of three (3) 12U small sats**
- **First launch in Dec. 2018. No launches in 2019**
- **Goal: 6 Clusters / 18 Sats**
- **USG is key customer**



Newcomers

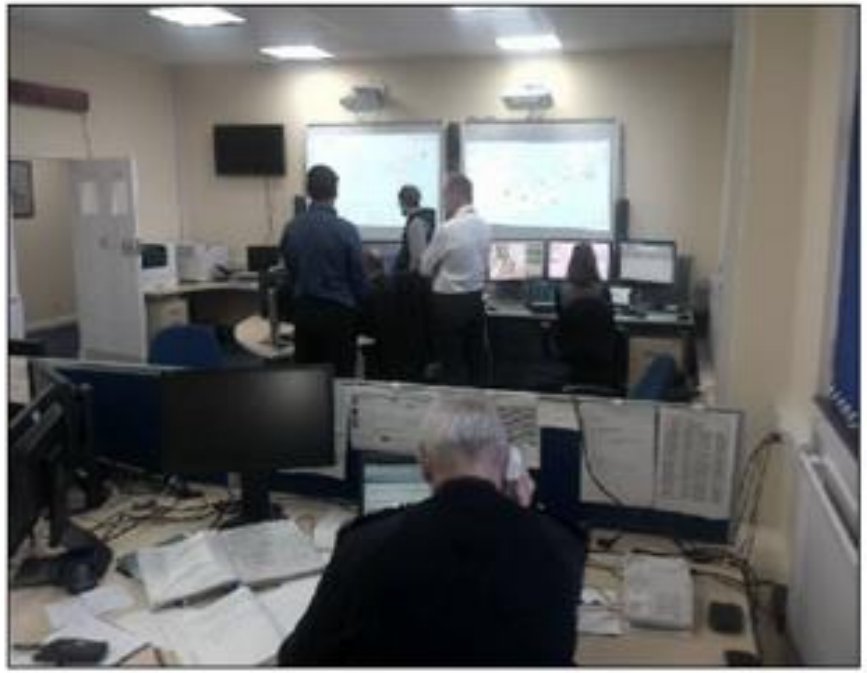
- **Horizon Technologies**
  - **UK SME already in the SIGINT/ISR business**
  - **Small constellation with innovative technology**
  - **Radar/Sat Phone Geolocation, Intercept, and ESM functionality**
  - **UK Gov investment/funding**
  - **MOU with UK Gov/NMIC – Sept. 2019**
- **Kleos (Lux/Australia)**
  - **RF (VHF Detection) via 4 sats in formation**
  - **No launches to date**
- **Unseen Labs (FR)**
- **DEWC (Australia)**

AMBER

NMIC

AMBER

National Maritime Information Centre



ROYAL NAVY
Border Force
Maritime and Coastguard Agency
Marine Management Organisation
HM Revenue & Customs
Department for Transport
Foreign & Commonwealth Office
POLICE
NCA National Crime Agency
Joint Maritime Operations Coordination Centre

Markets: Who is buying this data?

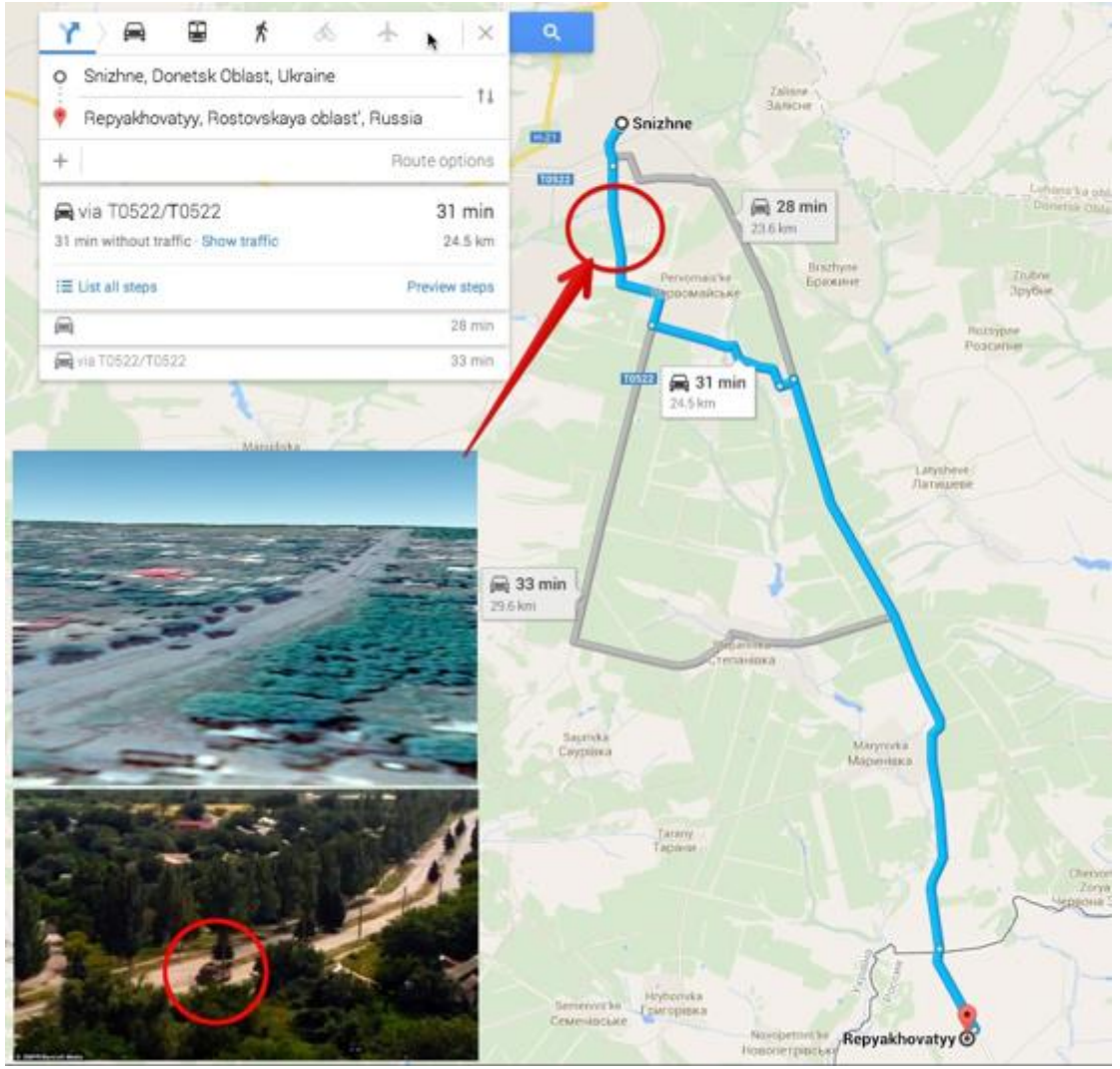
- **Earth Observation is growing market; from environmental, agricultural monitoring, micro-weather to maritime**
- **Operators sell data; DaaS (Data as a Service)**
- **The maritime market:**
  - **Space-based AIS data market**
    - **Governments**
    - **Fleet operators**
    - **Insurance companies**
    - **Aggregators**
  - **Imagery (SAR/EO)**
    - **Governments**
    - **Aggregators**

Military ISR Requirements

- **Various NATO militaries are looking to see if CubeSat-driven ISR can have a role in supplanting current ISR systems; manned, unmanned, and space-based**
- **Requirements are more stringent than for the commercial market**
  - **Higher resolution imagery**
  - **Geolocation under 500m**
  - **Fingerprinting of emitters**
  - **High latency**
- **Governments already by geospatial data**
- **US DARPA *Blackjack* Program, *ARTEMIS* (RAF), etc.**

Example: BUK Missile Launcher MH17 2014

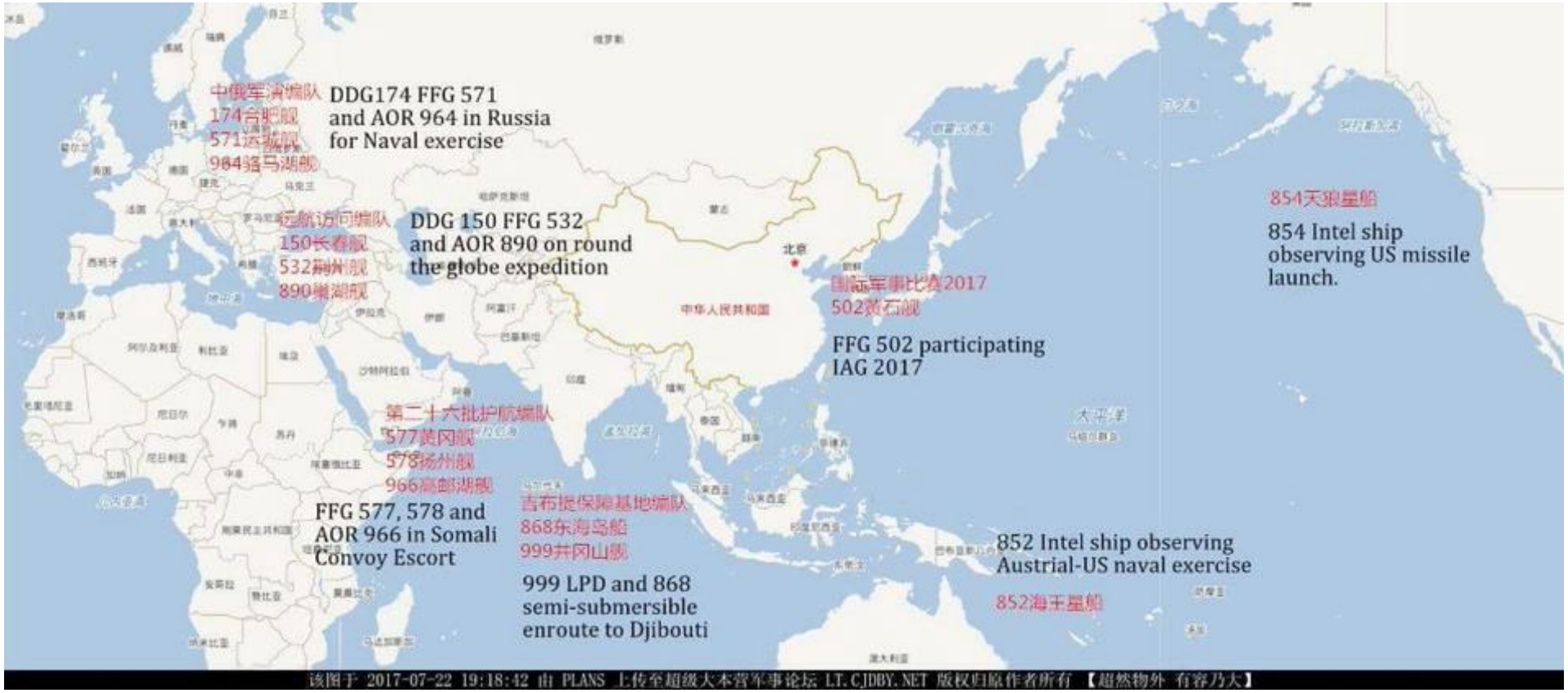
- The Russian BUK SAM systems (SA-11) could have been tracked; before or after the shoot down
- None of the international guesswork would have been necessary
- Or, if it “didn’t turn on its radar,” the MH 777 aircraft would still be flying today



Example: Targets

- **Warships which emit via their navigation or air defense radars will located, fingerprinted and tracked**
- **Countries will be able track warships (including emitting submarines) in their territorial waters or in other areas of interest**
- **Ability to determine enemy warship order of battle (EOOB) and location/movements**

Example: Chinese Navy Order of Battle / Locations



- **Estimated Chinese Navy deployment October, 2017**
- **CubeSats will geo-locate, and track all of these vessels**

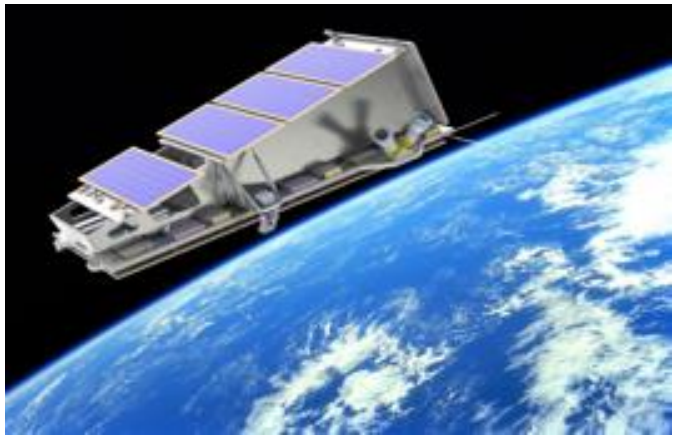
Example: Ground-based Emitters / Locations

- **Mobile SAM systems which emit via their air defense radars will located, fingerprinted and tracked**
- **Countries will be able track mobile SAM systems (which accompany most ground force units at Brigade and higher level) areas of interest**
- **Ability to determine enemy ground forces electronic order of battle (EOOB) and location/movements**

Example: Russian OOB Ukraine 2018

Where Will We Be in 2020 and Beyond?

- **By the early 2020s, the building blocks will be in place (and in orbit). Constellations with the following capabilities:**
  - **EO**
  - **SAR**
  - **RF/SIGINT**
- **The market will expand far beyond today's maritime-centric domain**
- **International organizations like EMSA, Frontex, etc. and governments already changing procurement rules to speed up purchase of data**



First Use of Military Balloons for Aerial Reconnaissance

Battle of Fleurus, June 26. 1794. French troops led by Gen. Jourdan beat back the Imperial Austrian army.

First use of aerial reconnaissance balloons in combat

Will CubeSats be as transformational?