Emerging nanosatellite technology capabilities enabling resilience space solutions for the defense and security arena

NATO SPECIALIST MEETING
BUCHAREST 11-12TH OF JUNE, 2018

PRESENTER
ROBERT LINDEGREN

WHO WE ARE

GomSpace is a globally leading designer, integrator and manufacturer of high-end nanosatellites

Founded in 2007 and listed in Stockholm (GOMX)

We are headquartered in Denmark and with subsidiary in Sweden and Luxembourg and offices in the US and Singapore

Our positions of strength include systems integration, nanosatellite subsystems and advanced miniaturised radio technology

Our +200 strong international team is devoted to understanding our customer's requirements and deliver flawlessly

We serve customers in more than 50 countries within the academic, science, defence and commercial segments

DENMARK · SWEDEN · NORTH AMERICA · ASIA · LUXEMBOURG

NANOSATELLITE TECHNOLOGY

TECHNOLOGY PARADIGM SHIFTS

Mainframe computers was disrupted by personal computers

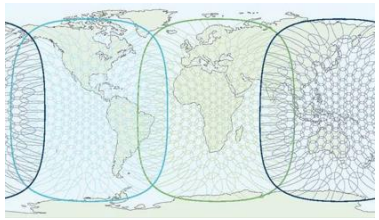
Telephones were first disrupted by mobile phones which then were disrupted by PDAs

Traditional production lines have been fully automatized with AI support to optimize throughput and quality assurance

Conventional million dollar satellites program will be replaced with low cost highly flexible nano-satellites constellations

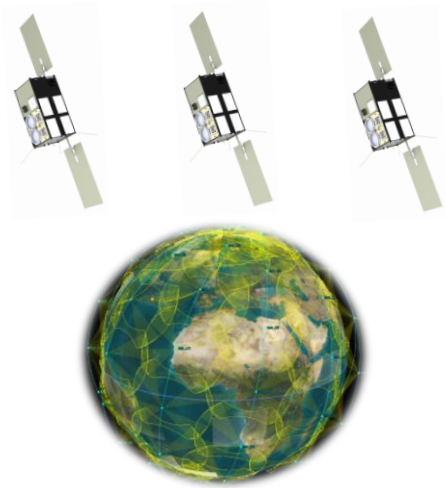
NEWSPACE – A PARADIGM SHIFT FOR SPACE

Traditional Space



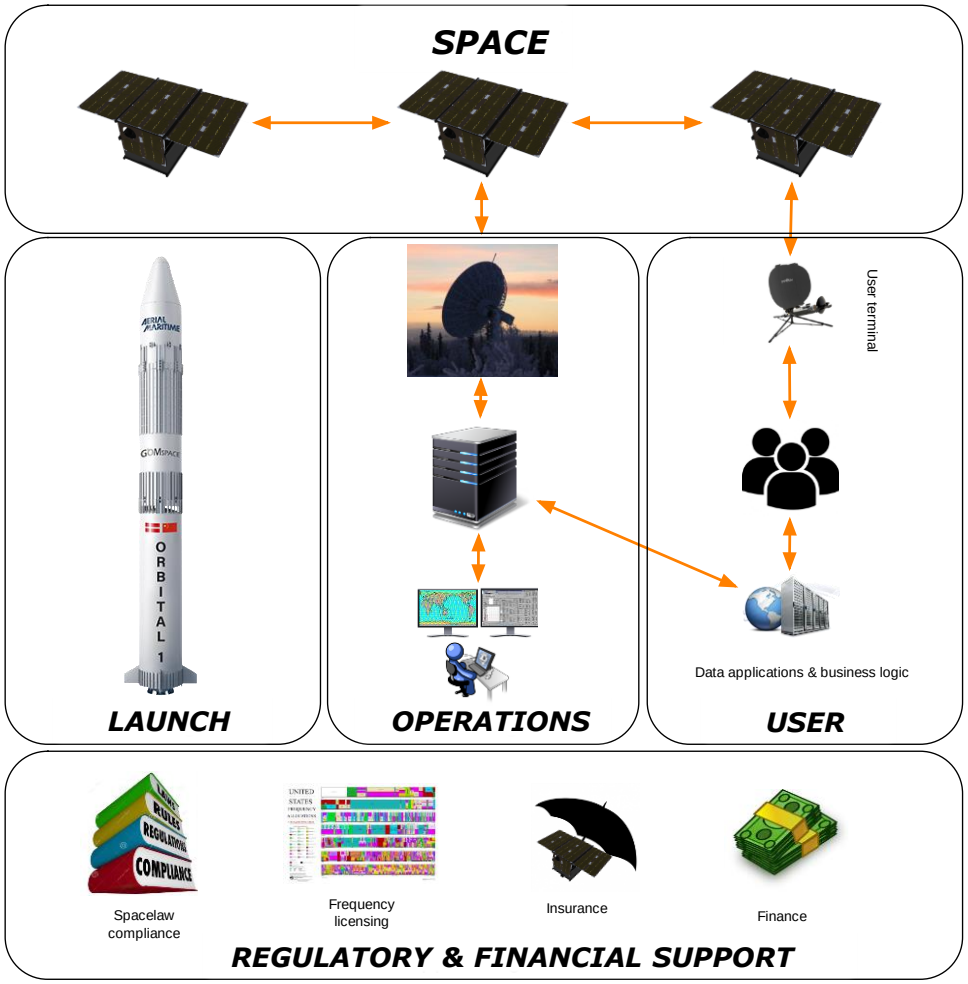
- Tailor-made designs
- Mass normally from 150kg to several tons
- Design mission lifetime is 10-20 years
- Extensive testing required
- Expensive RADHARD component required
- Project time to launch >3 years
- Launch cost as “prime"

SmallSat approach



- Standardized interfaces and form factor
- Utilization of industry graded COTS components
- Mass in the range of 10-20kg per satellite
- Design mission Life-time 5-7 years
- Pre-qualified platforms and deployments systems
- Enables rapid design -> 6-12 months
- Quick launch capability at affordable cost levels

WHAT IS NEEDED TO DEPLOY A SPACE SYSTEM

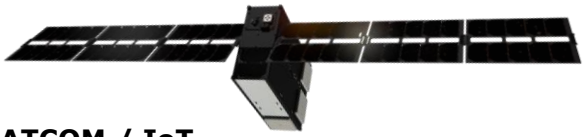


GOMSPACE

GOMSPACE SATELLITES

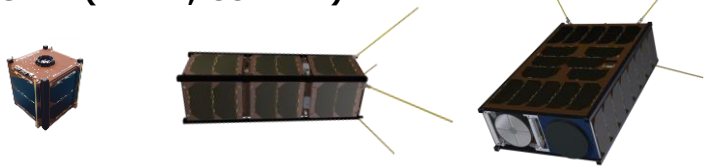
A GLIMPSE INSIDE

AIR / MARITIME SURVEILLANCE

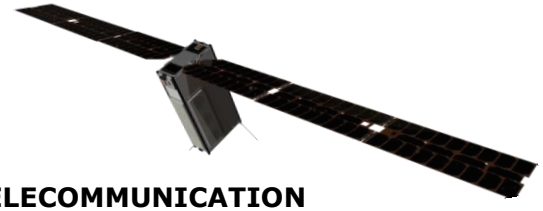


SATCOM / IoT

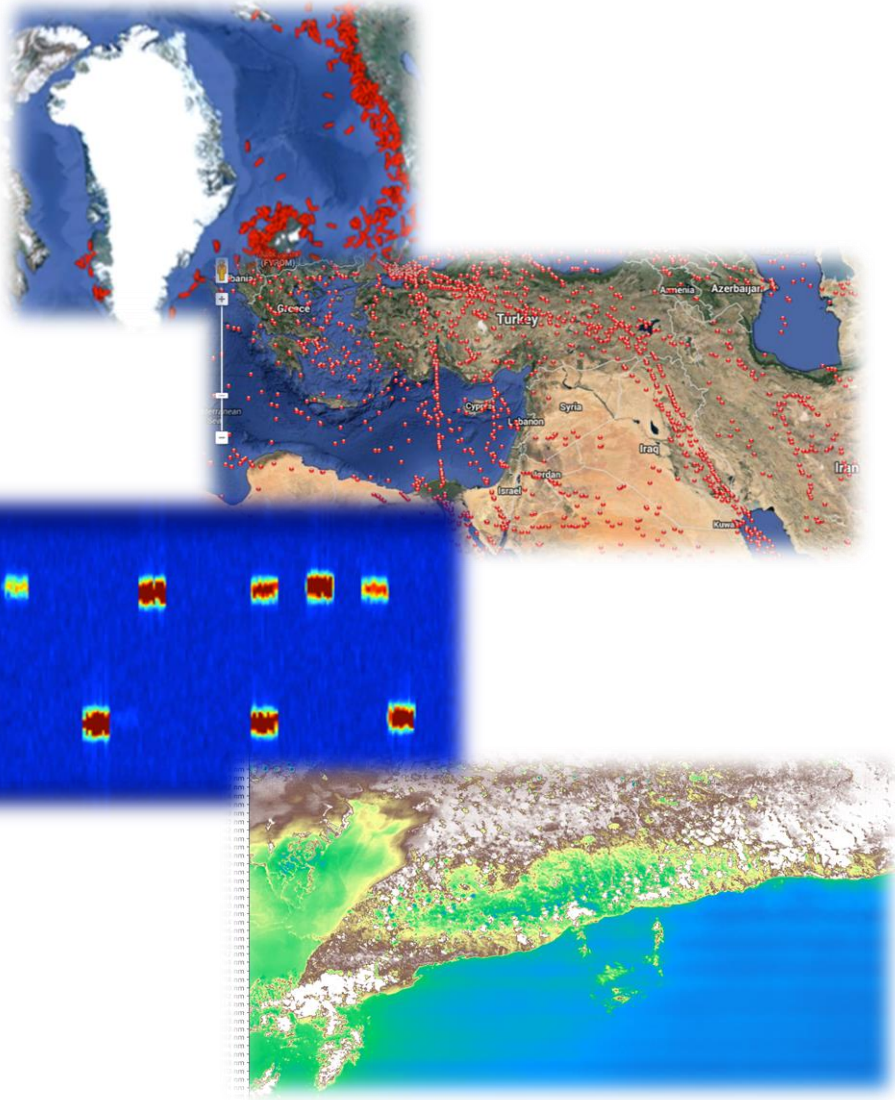
SIGINT (ELINT, COMINT)



EARTH OBSERVATION



TELECOMMUNICATION



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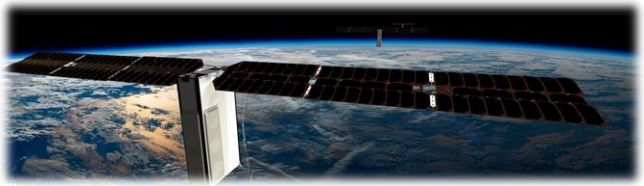
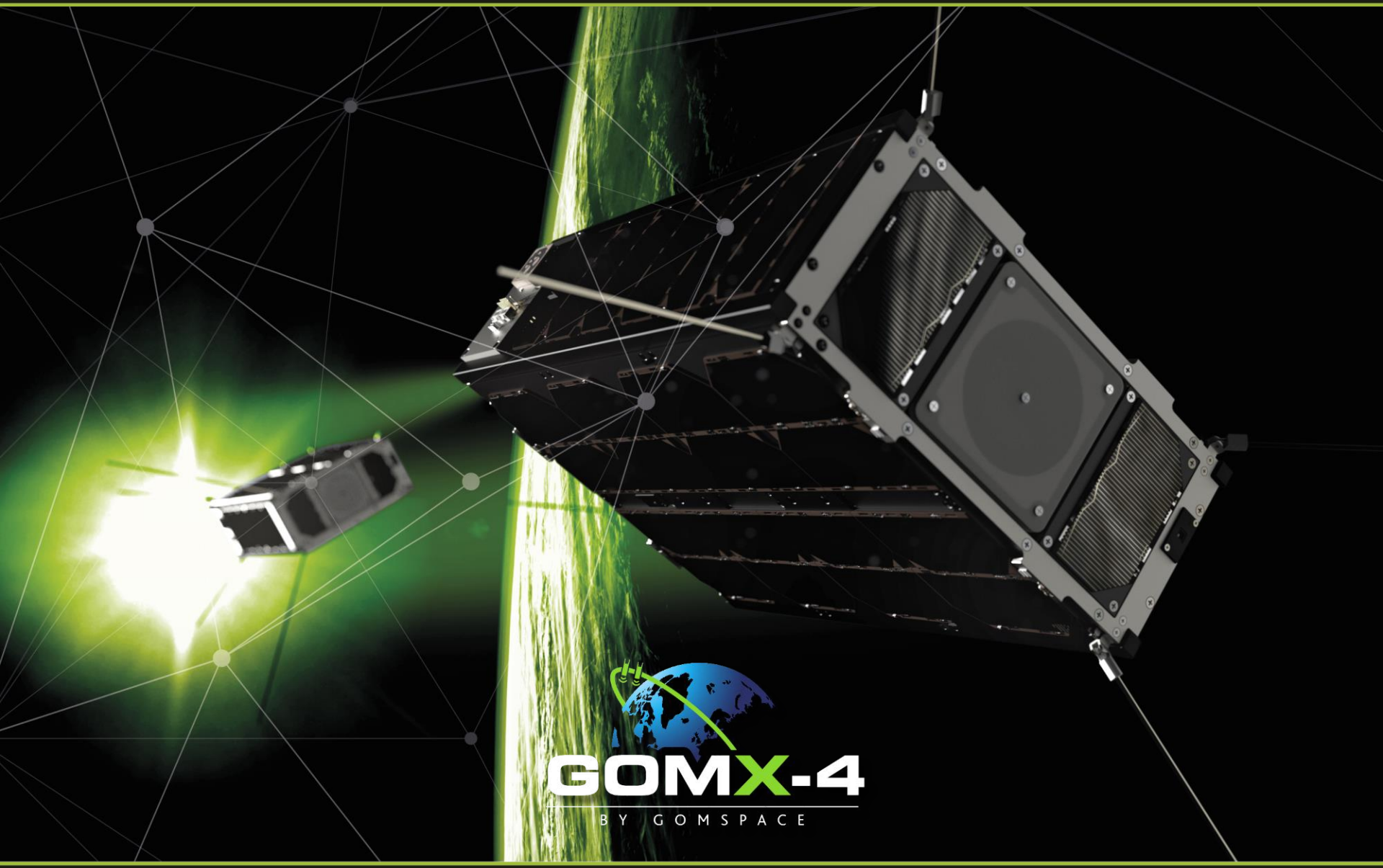
EXAMPLE OF ONGOING COMMERCIAL CONTRACTS

- Aerial & Maritime (A&M)
  - Satellite Constellation for Aircraft- and vessel tracking for situational awareness
  - Phase 1 consist of 8pcs 3U satellite
  - Launch scheduled Q1 2019 to 500 km near equatorial orbit
  - Next generation under evaluation to provide global coverage service

- Sky and Space Global
  - Nanosatellites constellation providing a global communication infrastructure
  - First 3 satellite (Three-diamonds) delivered and launched 2017
  - Delivery of 200+ high performance spacecraft of 14kg each form Q1 2019.
  - Powerful Software Defined Radio solution providing both Space-to-ground link and Inter Satellite Link (ISL)



GOMSPACE



GOMX-4 – A TWIN MISSION

Ulloriaq (GOMX-4A) PAYLOADS

GOMSPACE

Optic based image monitoring
Aerial monitoring (ADS-B)
Maritime monitoring (AIS)

Danish Defence
Acquisition and Logistics Organization

GOMSPACE

Inter-Sat link
Formation flying
Active orbit control

GOMX-4B PAYLOADS

NANOSPACE
A GOMSPACE COMPANY

Propulsion

cosine

Hyperspectral Imager

esa
European Space Agency

"Chimera"
Radiation Board

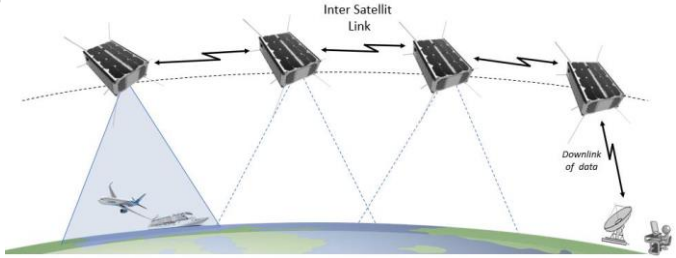
ISIS

Star Tracker

GOMX-4 – MISSION OBJECTIVES

Platform

- Inter-Satellite-Link capability
  - Data relay capacity for near real-time data and voice services
  - Constellation maintenance
- Delta-v maneuvers (orbit control)
  - Orbit corrections and maintenance
  - Rendezvous and proximity operation capability

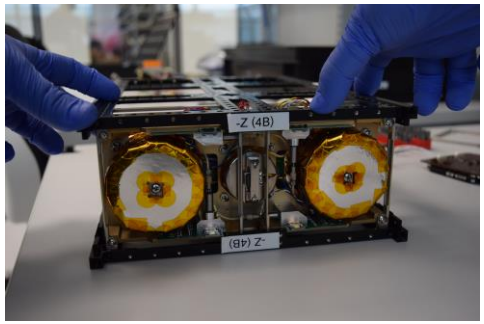


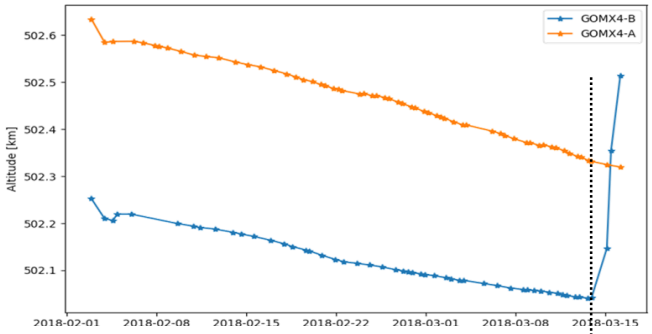
Hosted payload

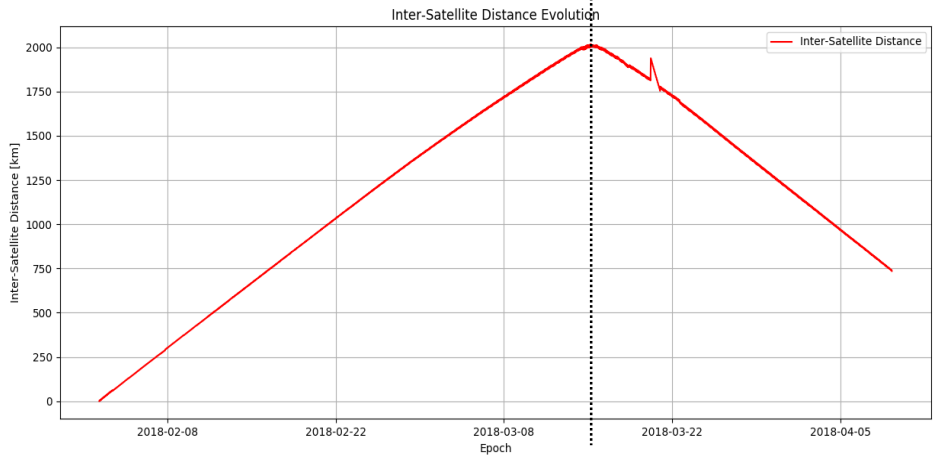
- Marine and Air Traffic monitoring
  - Space bases AIS and ADS-B remote sensing
  - Artic situation awareness
- Hyperspectral camera
  - Evaluation and optimization of filter algorithm for different applications
- Low resolution camera
  - Mission awareness and assessment of usability

GOMX-4 – FIRST ORBIT MANEUVER TEST RESULTS

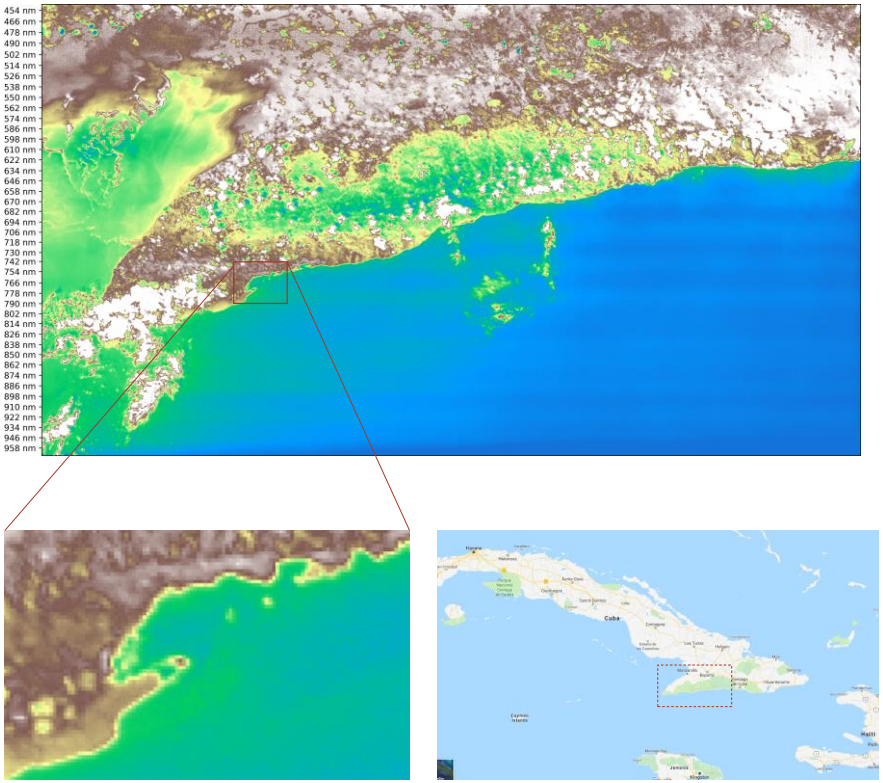
- Orbit maneuvers tested with the onboard cold gas propulsion system in April 2018
- Very successful demonstration
- State-of-the-art propulsion system provided by GomSpace Swedish subsidiary NanoSpace





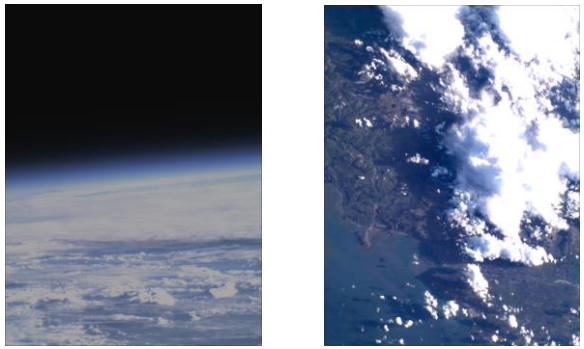


FIRST DATA CAPTURED BY GOMX-4



Multispectral image of Southern part of Cuba taken by the GOMX4A satellite

ADS-B data captured during a pass in a region around the equator. Here visualized on a map



RGB images taken with the NanoCam over over Funen and Zealand, Denmark

SECURITY AND DEFENSE APPLICATIONS

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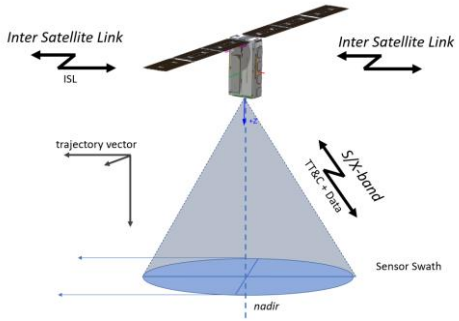
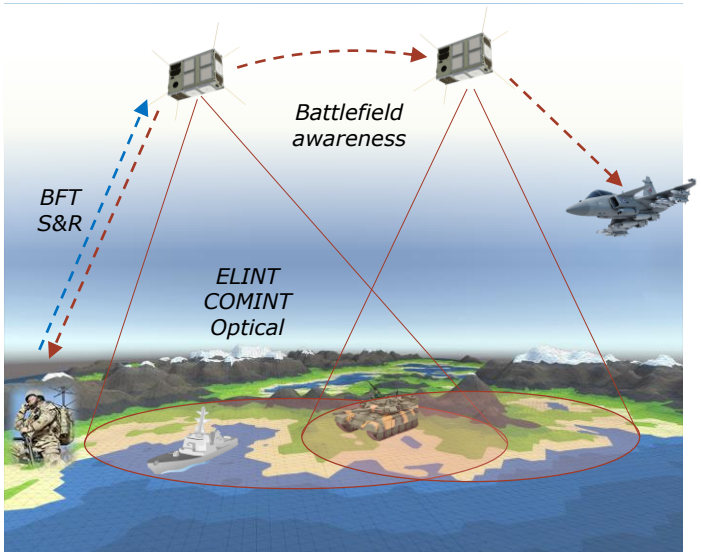
SECURE PROPRIETARY COMMUNICATION

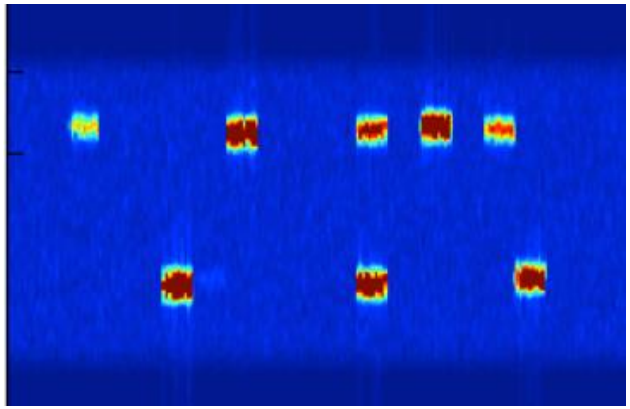
- Bespoke data communications systems for individual needs with customized encryption and features increasing resistance to jamming
- Supporting data and voice communication between different platforms and personal
- Multiple satellites with Inter-Satellite-Link capability
- Multiple satellites can provide geolocalization capability by using TDOA (time-difference-of-arrival) and time synchronization on platforms
- Complements existing communication means and provides resiliency – e.g. against cyber attacks





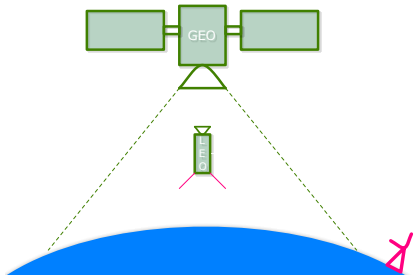
SIGNAL INTELLIGENCE - SIGNAL INTERCEPTION

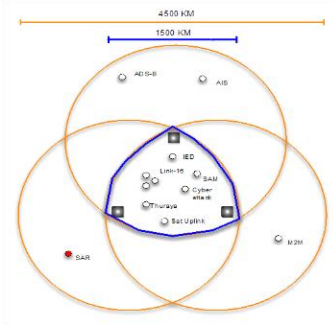
- SIGINT
  - Intercepting signals for extraction of voice or data content at the ground station
  - E.g. Monitoring and interception of hand held or mobile VHF and UHF radios, or SATCOM handsets
  - Can be combined with geolocation



VHF transmissions intercepted from space by GomSpace

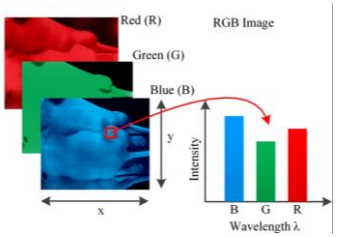
- SATCOM
  - Monitoring and intercept of adversary SATCOM traffic activity globally incl. over denied air spaces
  - A nanosatellite will daily pass under all beams from geostationary satellites
  - Capability assessment of adversary systems
  - Identification of usage patterns



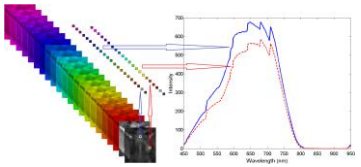


HYPERSPECTRAL IMAGING

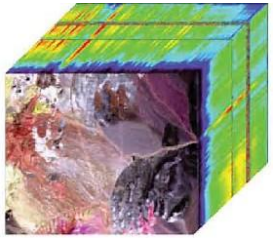
- detects multiple wavelengths in different bands beyond the visible spectrum
- Combining different bands and filtering enables detection of many different things (fire, oil, algae, ice, minerals etc.)
- Early alert warning system

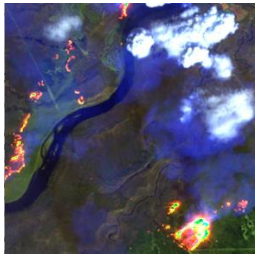


RGB with normal camera



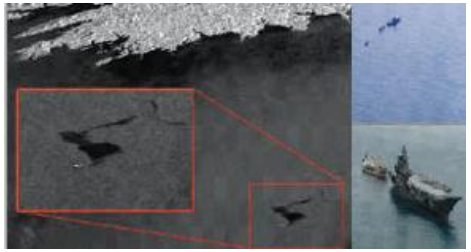
Multiband with hyperspectral camera





Fire Monitoring

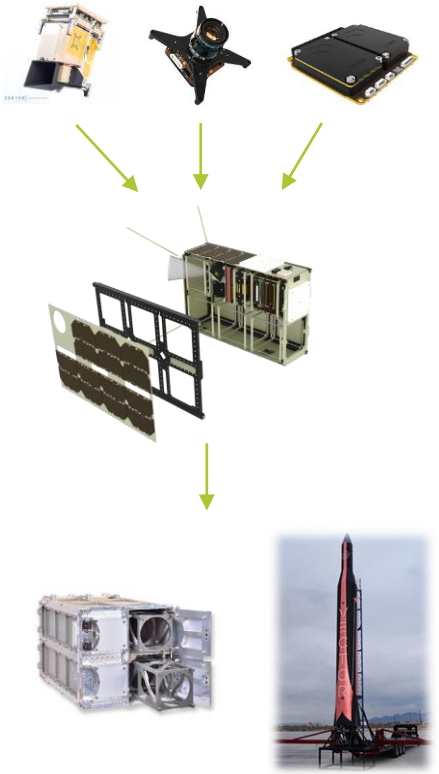
Algae monitoring



Oil Spill Detection (OSD)

RAPID MISSION DEPLOYMENT CAPABILITY

- Standard platforms with pre-designed payload alternatives
- Accessibility to rapid launch capability with new µ-launch alternatives and standard deployment system
- CONOPS development minimal
- Select requested sensor capability or communication solutions when needed



The challenge for enabling very rapid response capability is today related to regulatory aspects and not technology

PROVIDING RESILIENCY TO SPACE BASED CAPABILITY

- The modular design approached enables quick scalability between platform sizes
- Scalable missions - step from a single satellite mission to up to full constellation with same technology
  - Coverage and revisit time based on specific needs
  - Low latency data from other geographical regions
  - Better resistance to system degradation
- Deploy capability when needed and with right sensor/function
  - No operational cost allocation needed when no demand of capability
  - Ensure right capability at right time
- Reducing lifecycle time from 15 to 5 years enables opportunity to
  - Ensure latest sensor technology in operations
  - Reduced risk of sensor characteristic being revealed

SUMMARY - UTILIZATION OF NANOSAT TECHNOLOGY

- Nanosatellite technology is today mature enough to support high-end commercial business models
- 10x cost reduction for the complete space based infrastructure – both CAPEX and OPEX
- Shorter mission lifecycle brings opportunity to fly “the latest” sensor technology
- Standardized and pre-qualified components and interfaces entails option to cost efficient rapid response capability
- A new era is here - where new states will have the opportunity to invest in own space capability

CUSTOMERS

"A success in terms of planning, speed of development and technical achievements"
- Roger Walker, ESA, about the GOMX-3 project

"GomSpace is one of the best companies in the new space business. It is a great honor working with them."
- Meidad Pariente, CTO at Spacecialist, Israel

"A fantastic company not only in technical aspects also in customer care and help. Definitively, a team in which you can rely and trust for your space mission."
- Alex Becerra, CEO at Aurora Space, Chile

"WE HELP TEAMS ACROSS THE GLOBE ACHIEVE THEIR GOALS IN SPACE"

Robert Lindegren

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