



GLADIS: Global AIS & Data-X International Satellite Constellation

**Space-Based System for Sharing
Unclassified Maritime Domain Awareness
Among
International Partners**

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Briefing Agenda

- **Maritime & Technology Challenges**
- **GLADIS Mission Objective**
- **AIS & Data-X capabilities**
- **GLADIS Architecture**
- **International Strategy**
 - MSSIS as Model
- **Proposed Schedule**
- **Sustainment Option**
- **Benefits & Payoffs**



Maritime Challenges

- **Smuggling**
- **Fisheries violations**
- **Oil theft**
- **Illegal immigration**
- **Drug trafficking**
- **Human trafficking**
- **Environmental degradation**
- **Piracy**
- **Terrorism**
- **Criminal activity**



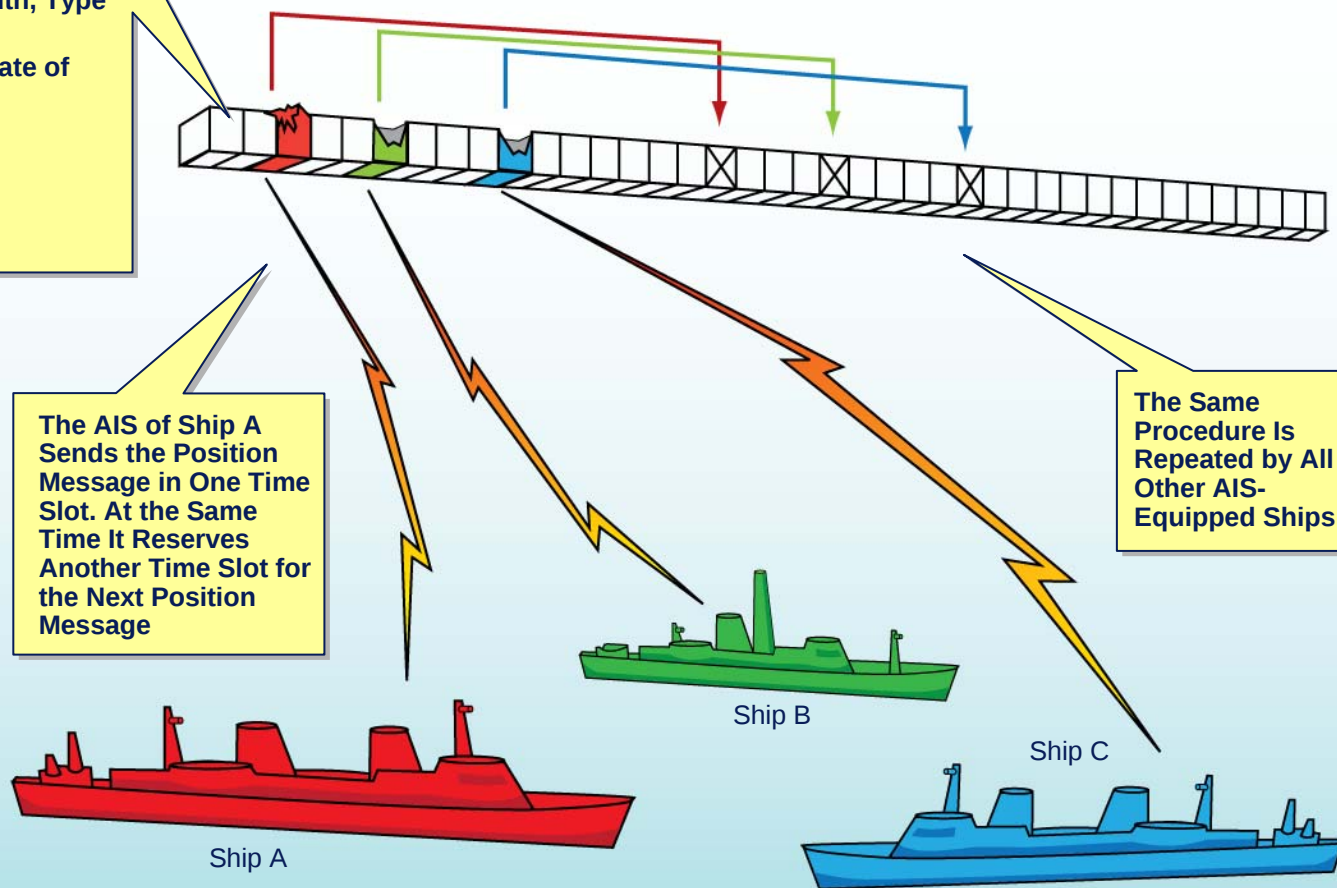


GLADIS Mission Objective

- Constellation of 30 nano-satellites (Global persistence) with two payloads providing enhanced Maritime Domain Awareness and Safety.
 - **Automated Identification System (AIS)** for ship tracking
 - **Data exfiltration (Data-X)** for widely dispersed sensors
- Flexible, Scalable, Standards-based architecture by U.S. provided design
 - Interdependent
 - Persistent Presence
 - Affordable
 - Partners control their information and satellites
- JCTD Proposed for FY10 for International effort to achieve
 - 30 Satellites Constellation
 - 5 Launches Polar Orbit
 - 5 Launch Dispensers
 - U.S. Proposal provides 1 launch, 1 dispenser and 6 satellites
 - The U.S. proposal is for 1 U.S. satellite on other 4 launch vehicles and provide room for 5 partner satellites on a U.S launch

AIS Messages: Self-organized Time Division Multiple Access

- An AIS Message Contains
 - Ship Identification (Name, Call Sign, etc.)
 - Length, Breadth, Type of Ship
 - Course and Rate of Turn
 - Draft, Cargo
 - Position
 - Speed
 - ETA



Data Exfiltration of Remote Sensors

- Data-X offers cost effective means for collecting data up to 9600 bps from:
 - Buoys
 - Moorings
 - In-Situ Floats
 - Unattended Ground Sensors
- Customizable Ground and Space Segments
 - FPGA Architecture Allows Customizing On-Orbit
 - Re-Programmable
- Two-Way Communication
 - Allows Acknowledgments, Error Correction/Sensor sleep modes
- UHF Frequency
 - Low Power / Good Foliage Penetration
 - Simple Antenna That Does Not Require Pointing





Business Case For Data Exfiltration? What Is Its Economic Value?

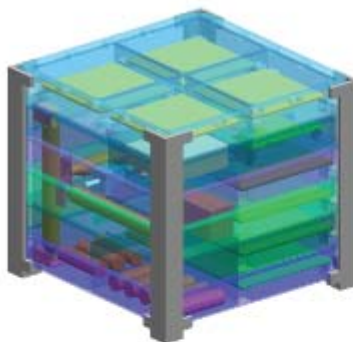
- **Sensors will proliferate as Data-X service increases**
 - **Think GPS, where spin off applications proliferated after initial constellation orbited**
 - **Partners can stimulate domestic industry**
- **Partners who cannot afford organic sensors, (airplanes, ships etc) to monitor their EEZ may find GLADIS to be significantly cheaper option to cover portions of their needs.**

Multi-source data (acoustic, EO/IR, RF) from distributed sensors can help fill current gaps in MDA picture

GLADIS: Point Design



Spacecraft



AIS Payload



Ground Terminal/Router



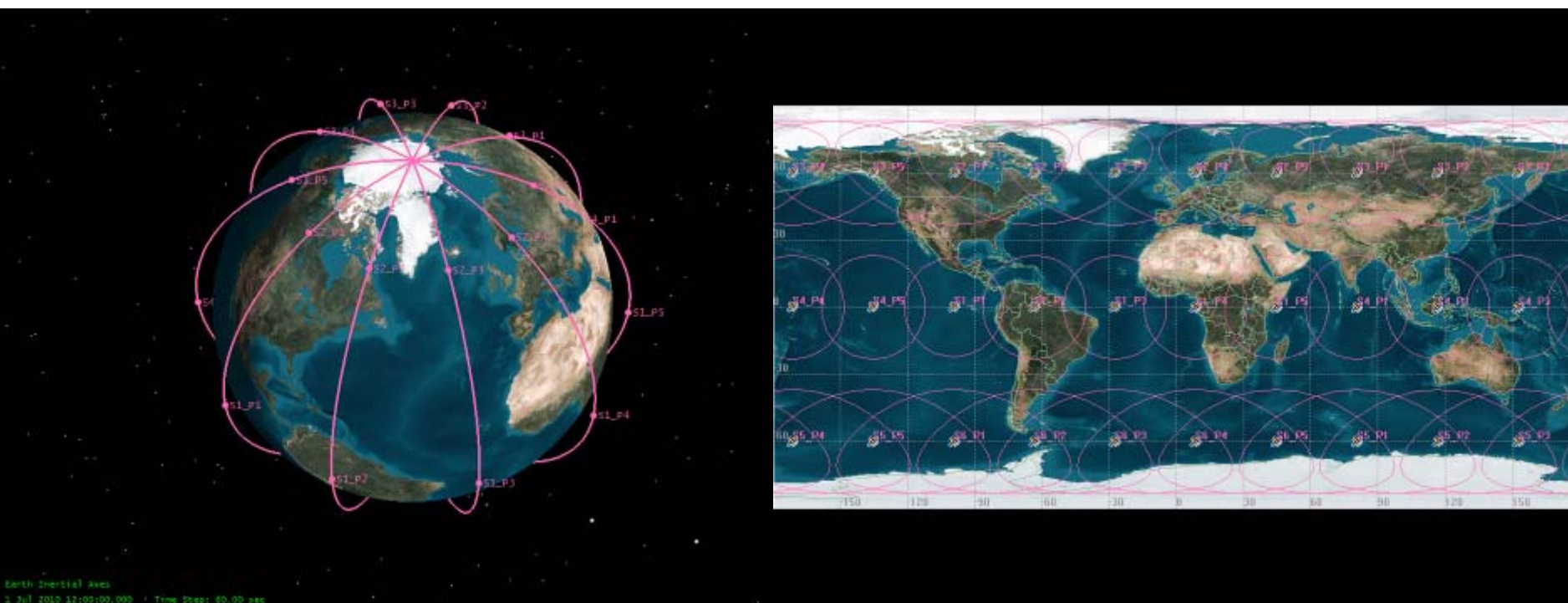
Minotaur

Launch Vehicle (Baseline)



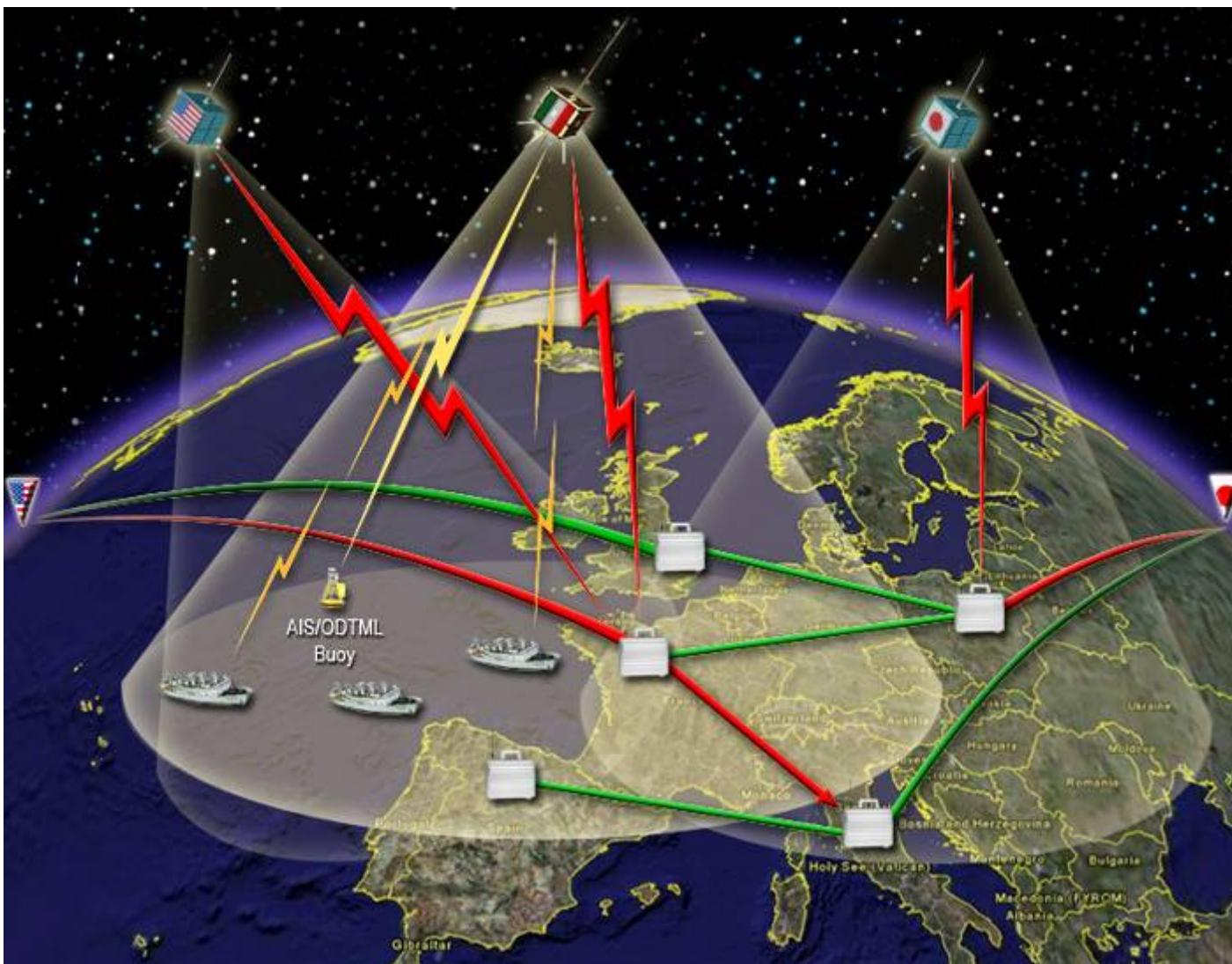
Launch Adaptor/Dispenser

GLADIS: AIS / Data-X NanoSat Constellation for Access to Any Point on the Globe in <10 Minutes



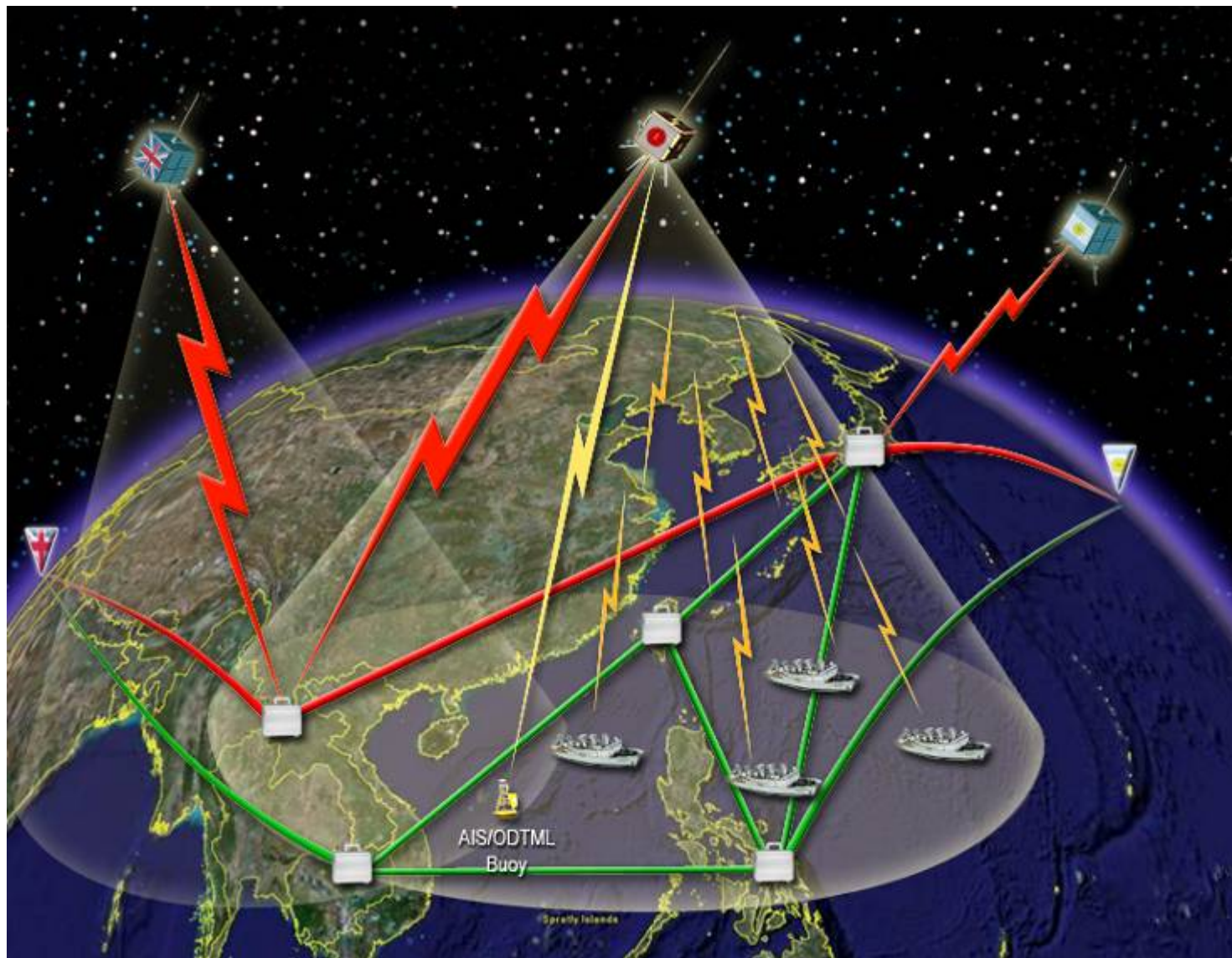
30 NanoSats in 5 Planes at 550 km, Polar Orbit

GLADIS Concept for Space-Based AIS & Data-X Collection and Data Sharing



- International Constellation Collects AIS Signals Globally via NanoSats
- Ground Terminal/Router Collects Downlinked Data bent pipe to satellite owner
- Data Processed/Posted via Internet, MSSIS used to Distro AIS
- Data is Global, Protected, Transparent, Frequent
- Each Nation provides their own crypto
- Encrypted
- SSL

GLADIS Concept for Space-Based AIS & Data-X Collection and Data Sharing





GLADIS: International Strategy

- **International partners Build or Buy their own GLADIS satellite or ground terminal**
 - Specifications/Designs provided by US Government as part of agreement
- **Only Government sponsored partners can participate**
 - Partners can acquire satellite and/or terminal to participate
 - Data may be provided to non-participating Nations in accordance with data sharing agreements
- **Specifications to build or buy hardware and software include:**
 - Tailored MIL-Standard documentation; interface control documentation; test plans.
 - Launch vehicle integration guides, orbital insertion guidance, etc.



Maritime Safety and Security Information System (MSSIS)



- **Genesis: US Department of Transportation (DoT)**
 - Network for US Coast Guard with data viewer (TV-32)
- **Simple, unclassified, freely shared, open architecture**
- **Uses Internet to share data**
 - Well-defined international data format (ITU-R M.1371-1)
- **Authorized users access through commercial security**
 - Navies, Coast Guards, agencies, ministries, Border Police, port authorities
 - Password protected with secure socket layer (SSL) encryption





MSSIS – Member Nations



Albania

Germany

Portugal

Australia

Ghana

Romania

Belgium

Greece

Sao Tome & Principe

Bulgaria

Israel

Singapore

Canada

Italy

Slovenia

Chile

Malta

Spain

Croatia

Mauritania

Tunisia

Denmark

Montenegro

Turkey

Estonia

Morocco

Ukraine

Finland

Norway

United Kingdom

France

Netherlands

United States

Iceland

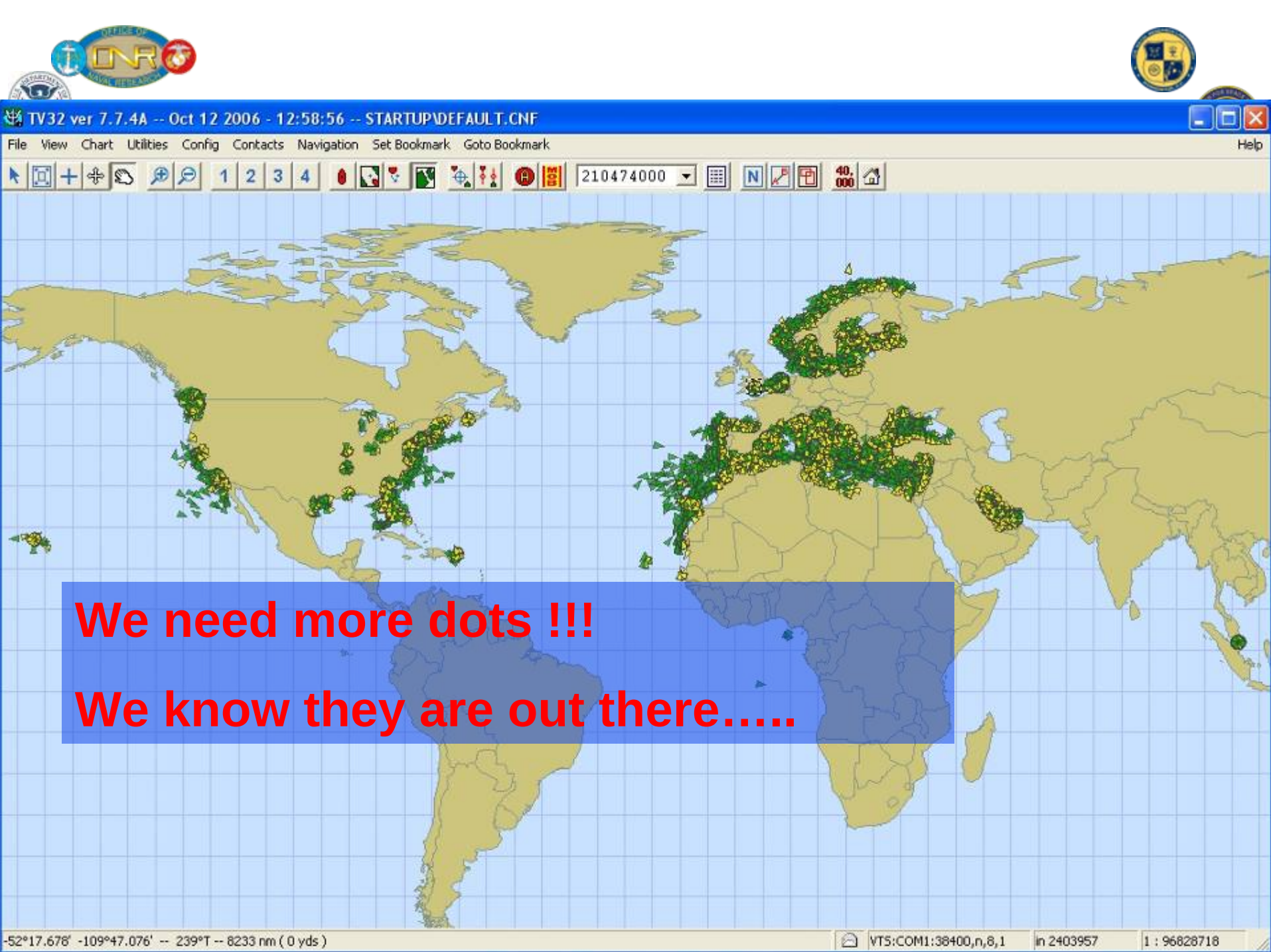
Poland

Jordan

**More being added
every day!**

**Gambia, Liberia,
Cape Verde,
Sierra Leone**

**South America
Coming Soon !**



We need more dots !!!

We know they are out there.....



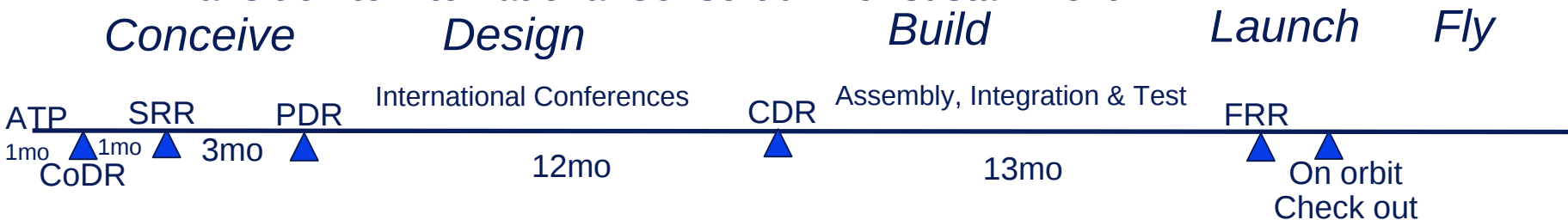
Proposed Schedule, with Scenario Options

30 Months from ATP* to ready for Launch

- U.S. Design, Build Dispenser and 6 satellites
- Pursue International Partners in Parallel
- Provide Interface specifications, satellite plans, software, plans for antennas and ground terminals

Possible Scenarios:

- Worst case - no or little interest, cancel program after PDR
- Next best - US build/launch six satellites, no other nation participates
- **Goal** - International Partners join at PDR, cost share on Dispensers, Rockets, and 24 more satellites as soon as possible. U.S. adds one satellite per plane
- Transition to International Consortium for sustainment



*ATP = Authorization to Proceed
CoDR = Concept Design Review
PDR = Preliminary Design Review
CDR = Critical Design Review
FRR = Flight Readiness Review



Possible Sustainment Option

- **Transfer of U.S. R&D designs/software to International Consortium**
 - Maritime NGOs already exist that maintain National, Industrial and Scientific membership that could coordinate and manage such a consortium (i.e. International Association of Lighthouse Authorities (IALA) or International Maritime Organization (IMO))
 - Combination of subscriptions and grants to maintain system
- **Internationally recognized Maritime organization assisted by space knowledgeable entity would reduce risk**
 - Commercial profit and/or non-profit U.S. and International space firms could form consortium and participate with Government Labs, Universities, Technical Institutes etc.



Benefits and Payoffs

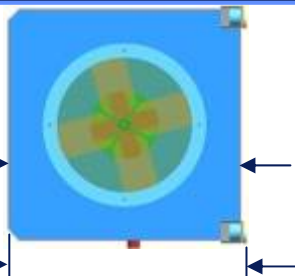
- **Persistence - Expand Nations Perspectives From Local to Global**
 - Partners Obtain Ocean Maritime Monitoring Tools
 - Monitor Own Shipping Beyond Line-of-Sight
 - Monitor International Shipping in Their Exclusive Economic Zones
 - Enforce Maritime Laws and Agreements (Piracy, Drugs, Terrorism, Ecology, Fisheries, and Mining)
- **Government-to-Government Sponsored, Vice full Commercial**
 - Information Controlled for Safety and Security.
 - Pure commercial capability lacks transparency for international partners.
 - Joint ownership breeds confidence in data fidelity/availability.
 - Unclassified/Non-Proprietary Data.
 - Expands opportunity to share information.
 - Nations determine cost benefit of commercial AIS/Data-X .

GLADIS S/C Configuration

Top View

10.31" SQ

10.56"



Front View

30.00"

10.25"



162 MHz Quadrifilar

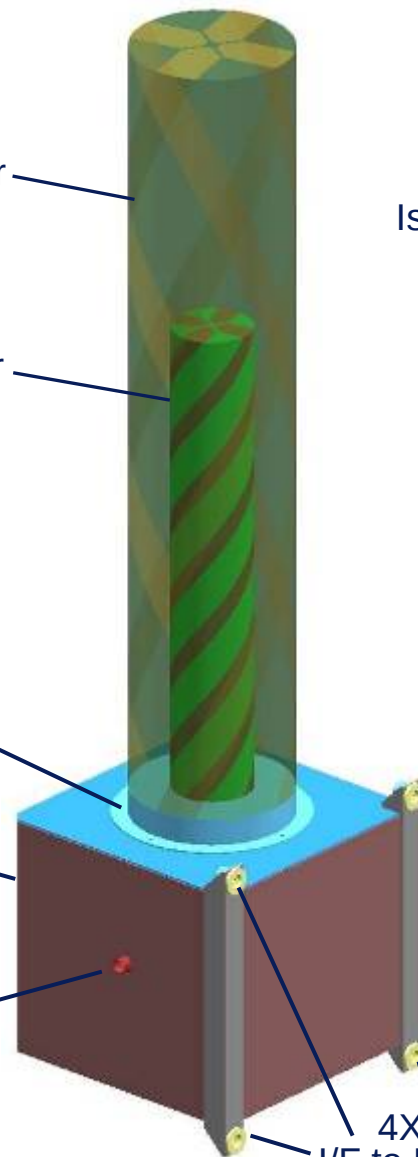
401 MHz Quadrifilar

Isometric View

Feed Network

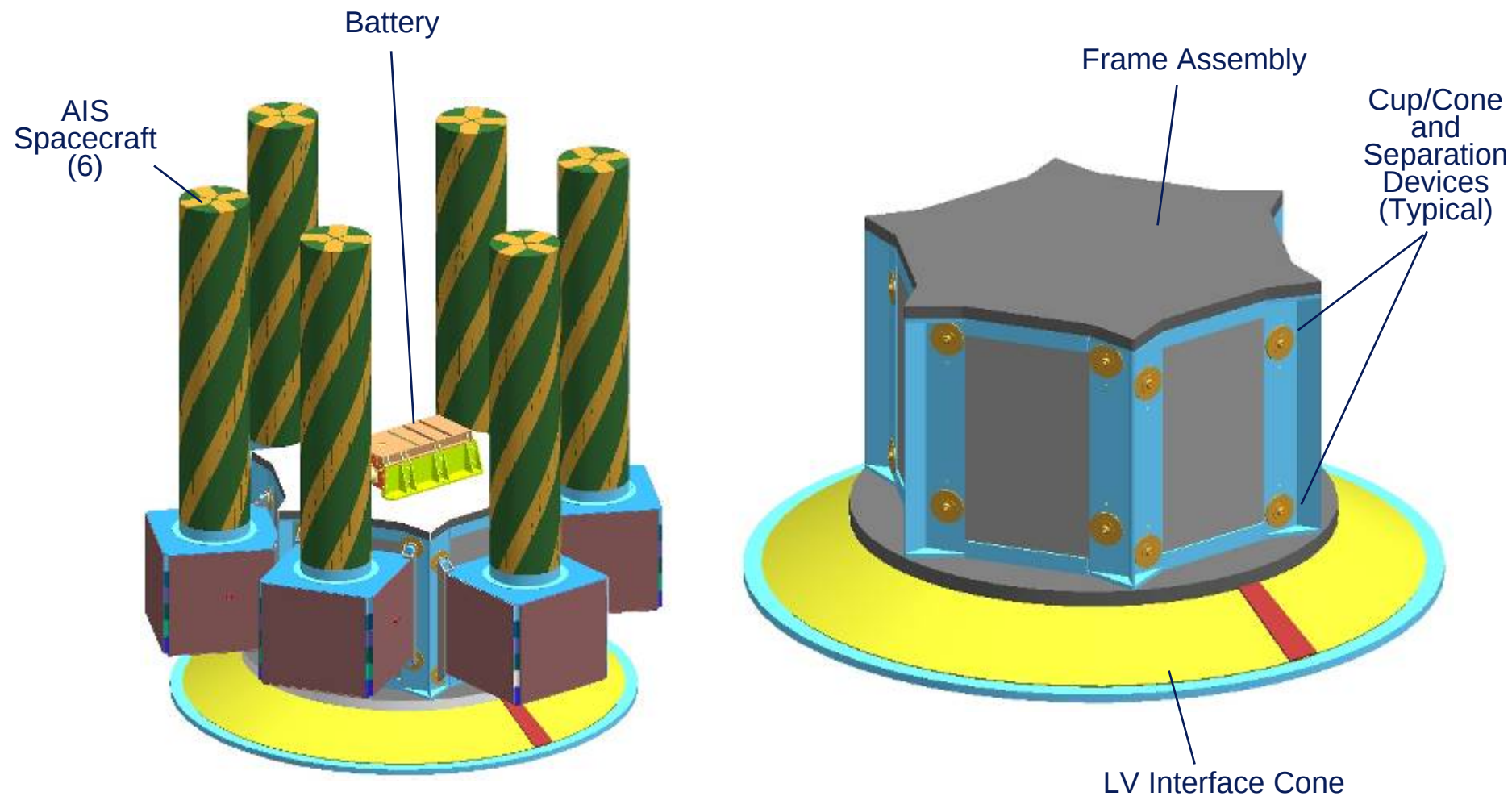
Electronics Enclosure

Thruster Exhaust



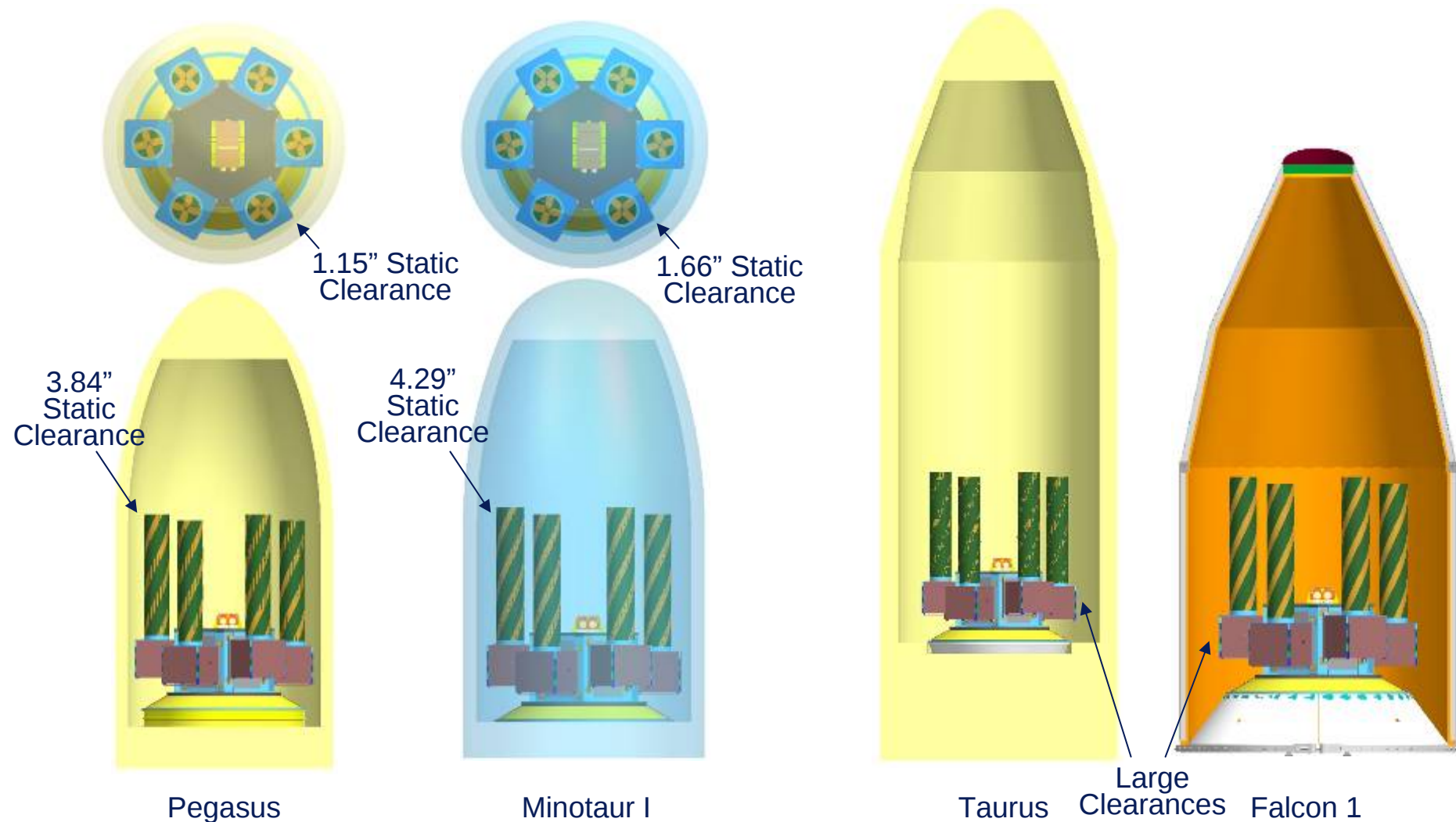
4X Cups
I/F to Dispenser

Launch Dispenser Configuration

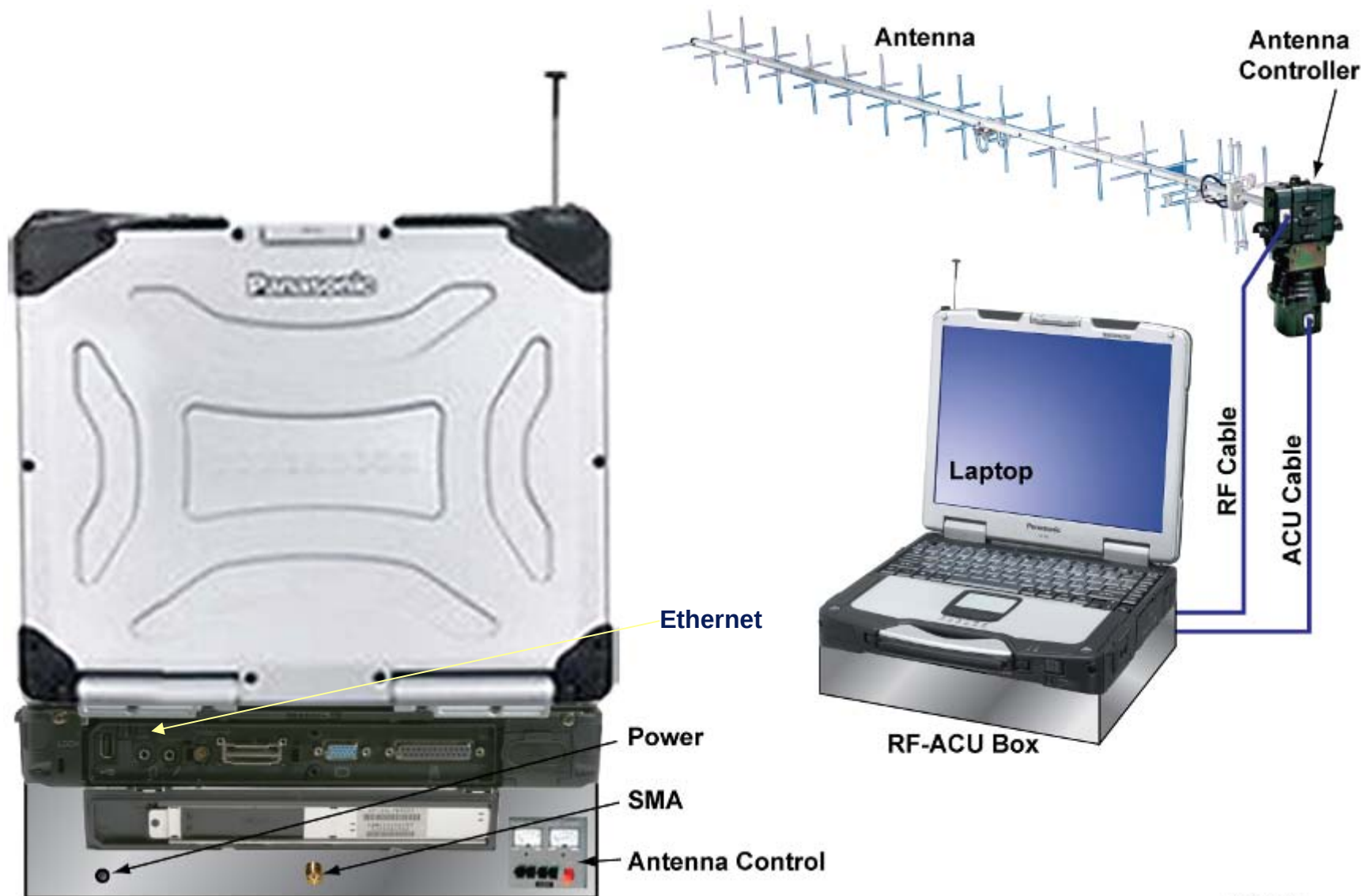


Isometric View

Launch Configuration in U.S. Fairings



GLADIS Ground Terminal





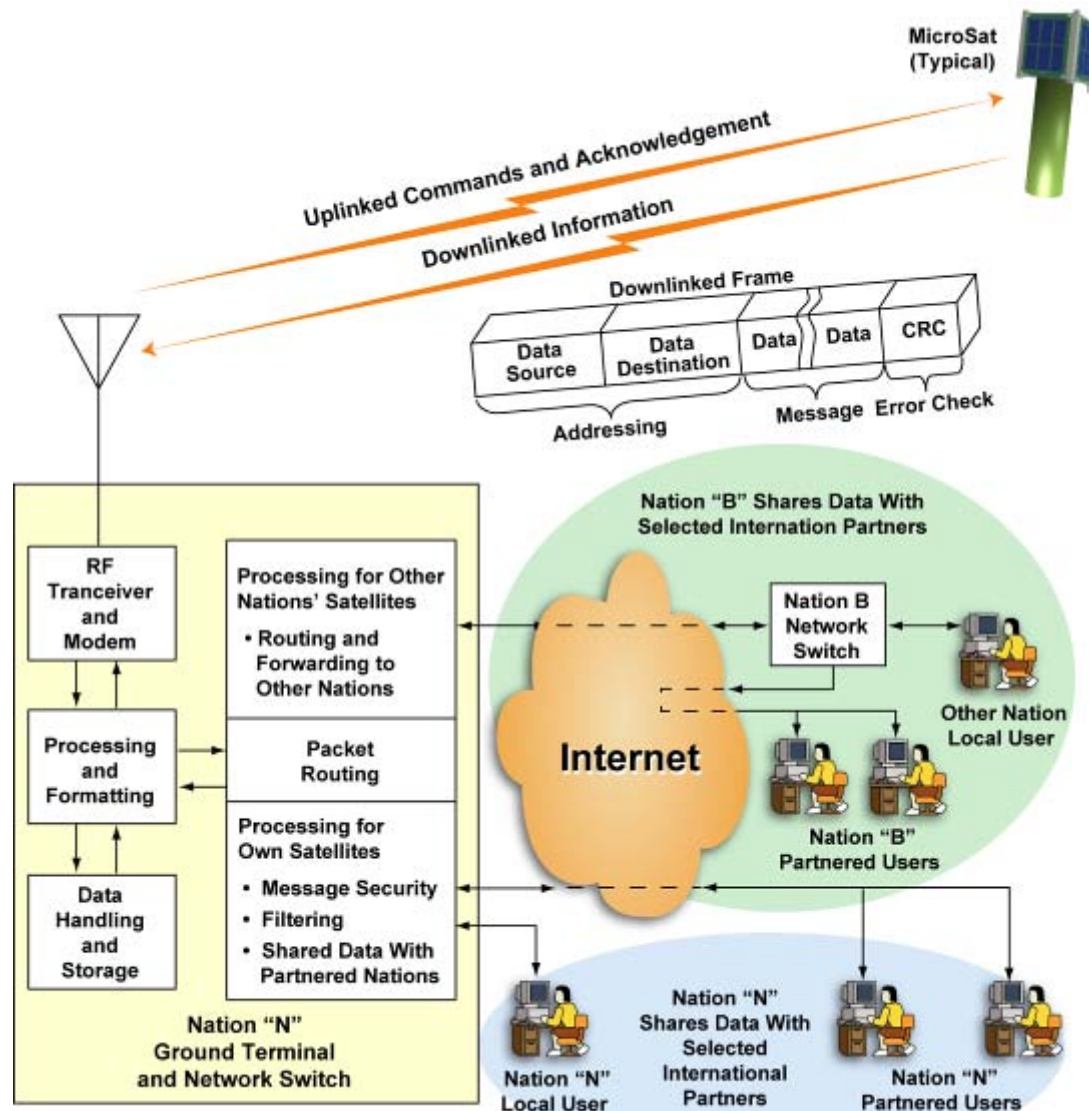
BACKUP SLIDES



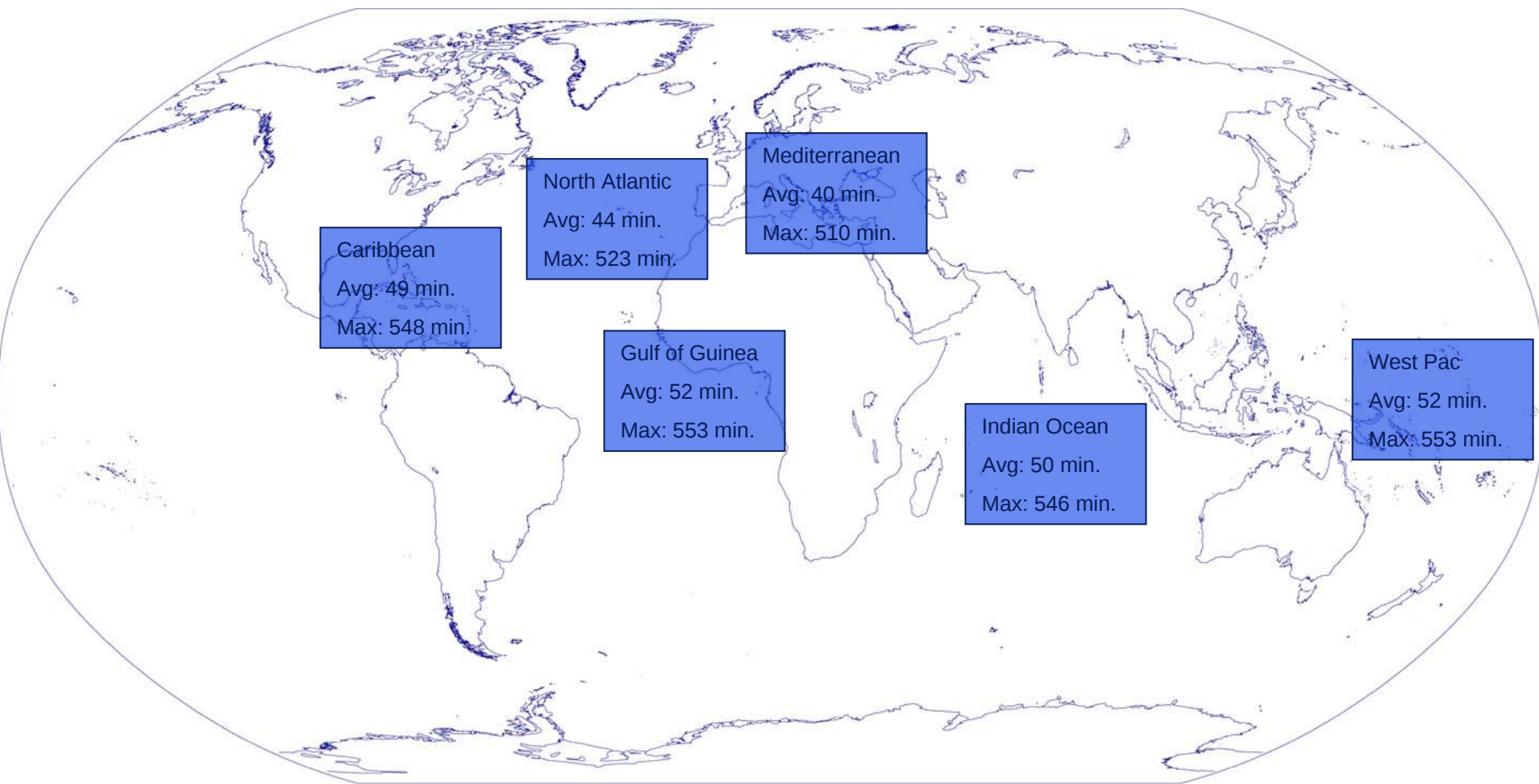
Separate Ground Terminal-to-Router Configuration for Data-X Distribution

- **Service Oriented Architecture (SOA) Enables Data-X Partners to Publish and Subscribe to Data-X info**

- Each Nation Posts Its Own Satellite's Information for Authorized Partnering Nations
- Handled differently from AIS as not inherently Safety and Security like AIS. Data can be provided to MSSIS as desired
- Defined Distribution Plan Lists Satellite (Source) and Nation's Routing Address (Destination)
- Satellite Data Receipt and Transmission Via Routing Function Determines Data Travel Between Different Nations' Networks Via the Internet
- Routing Function Sees Only the Message Envelope – Not the Information to Ensure Message Privacy



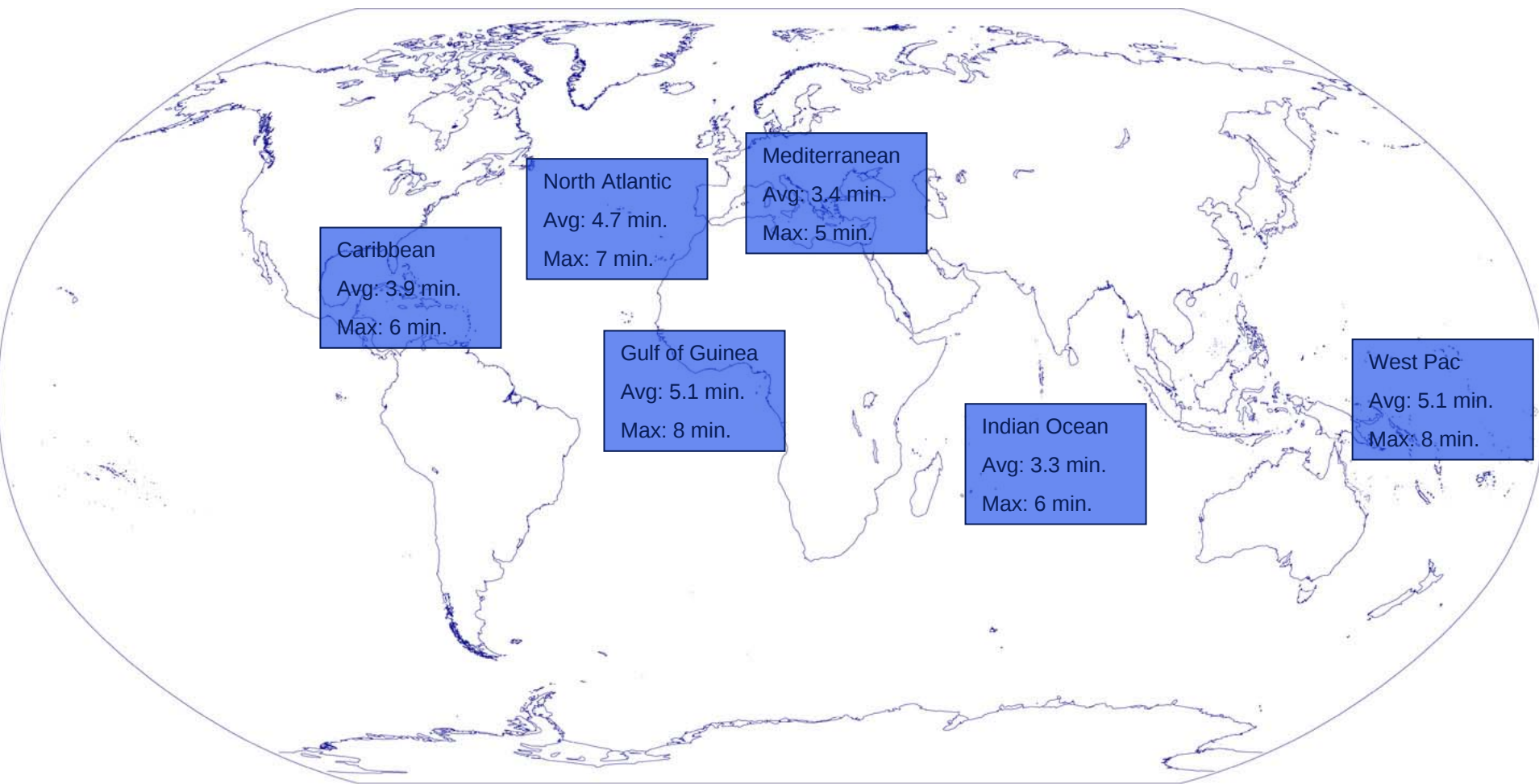
GLADIS Coverage Gaps w/ 6 satellites in one plane



6 Satellites in 1 Orbital Plane
Walker 6/1/0, $i = 90^\circ$, alt = 550km

Approved for public release; distribution is unlimited

GLADIS Coverage Gaps w/30 satellite Constellation



30 Satellites in 5 Orbital Planes
Walker 30/5/0, $i = 90$ deg, alt = 550km

Approved for public release; distribution is unlimited

Ground Terminal and Micro Satellite

