



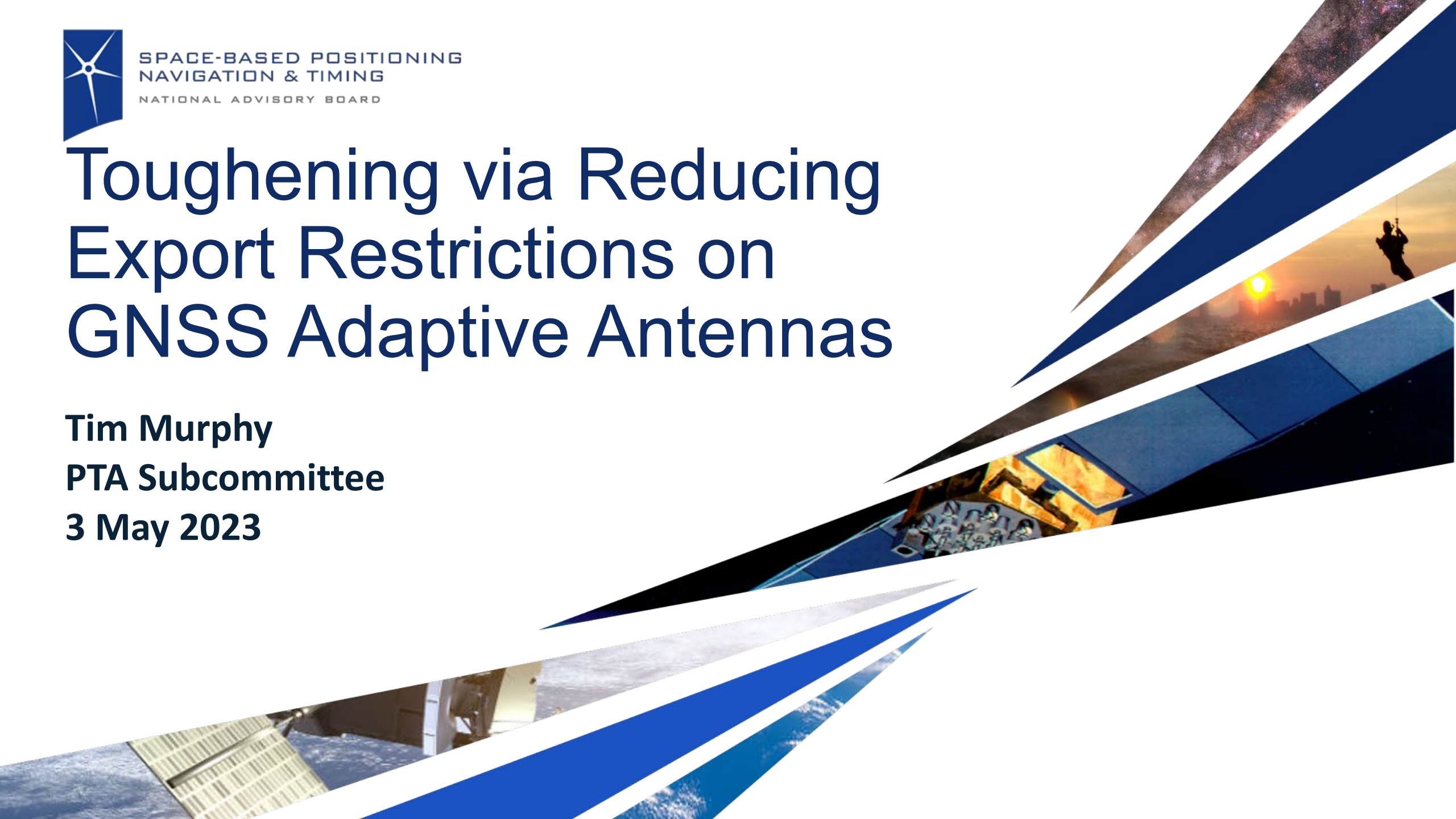
SPACE-BASED POSITIONING  
NAVIGATION & TIMING  
NATIONAL ADVISORY BOARD

# Toughening via Reducing Export Restrictions on GNSS Adaptive Antennas

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PTA Subcommittee

3 May 2023



# Toughening GNSS Receivers

**Techniques for toughening GPS receivers are well known, have been demonstrated and to some extent deployed for 40+ years**

Major Techniques:

1. New signals and signal processing.
  - New signals take a long time to implement (e.g. L5 – 20+ years and counting)
  - Improvements in signal processing have produced gains, but there is only so much that can be done once interference is received
2. Deep integration with inertial sensors
  - Can be effective. Mostly deployed in military applications so far. Can be expensive.
3. Use of Adaptive Antennas
  - Very effective strategy – prevents the interference/spoofing signals from getting into the receiver
  - Potentially very effective for spoofing detection (through DOA techniques)
  - Arguably the shortest path to significant toughening of civil user equipment
  - However, this technology has had very limited use in civil applications



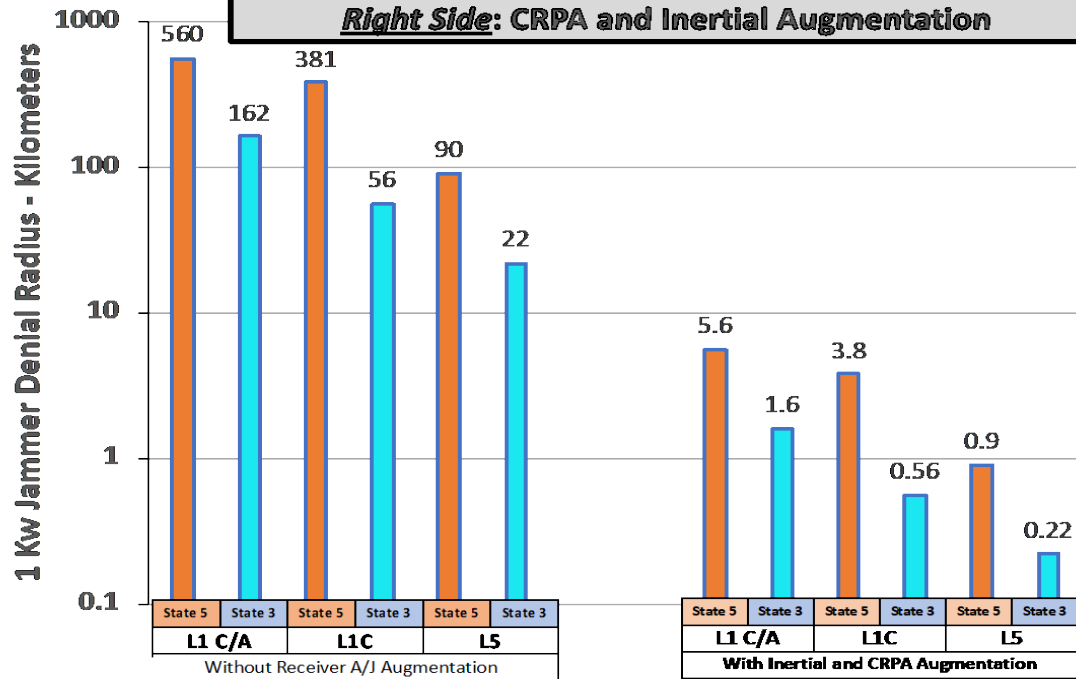
# Operational Benefits of Toughening GNSS Receivers

## Denial Radius of 1Kw Jammer (Kilometers)

*Three GPS signals: L1 C/A, L1C, and L5*

*Left side: No Receiver Augmentation,*

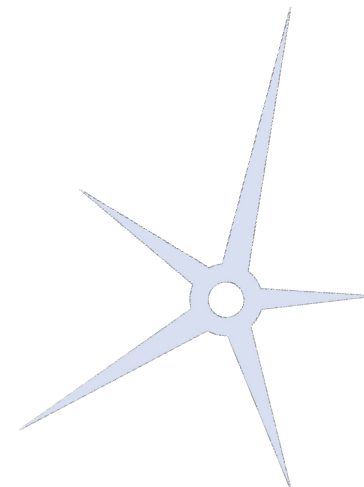
*Right Side: CRPA and Inertial Augmentation*



For each 20 dB of anti-jam performance, the effective radius of a given jammer is reduced by a factor of 10.

- Affected area is reduced by a factor of 100
- Affected volume by a factor of 1000

Heat Map showing GNSS Jamming Europe and Asia



# Impediments to Civil Use of Adaptive Antennas for GNSS

## Perceived costs –

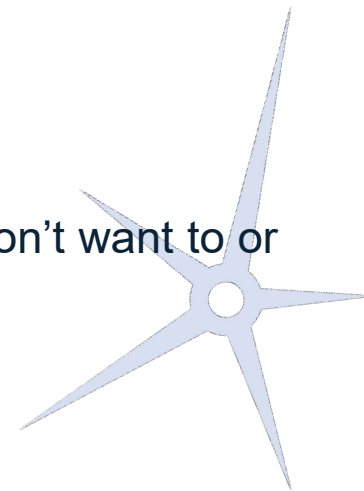
- Until recently hardware was expensive and often bulky -

## Lack of Motivation

- Interference to GNSS has been increasing with little reason to believe the trend will stop

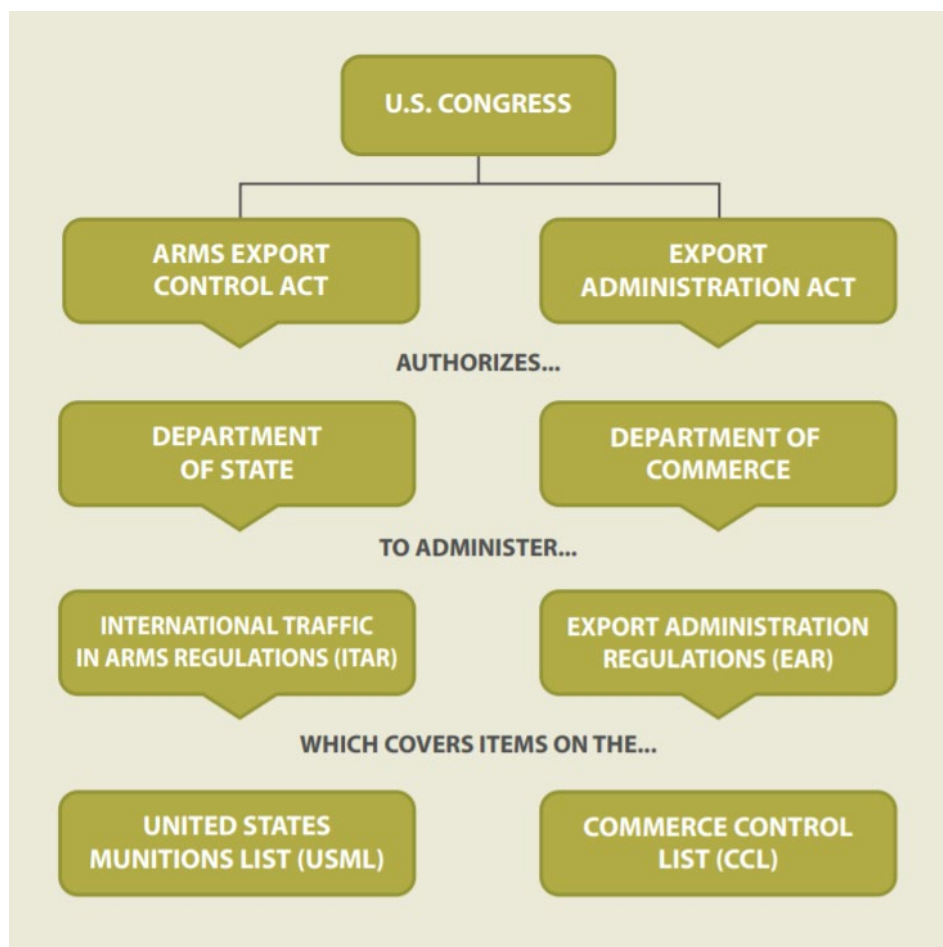
## Export Controls

- **There is a perception (only partially justified) that Adaptive Antennas for GNSS can't be exported**
  - They can in some cases be exported but adaptive antennas (or receivers specially designed to use them) which violate certain controls are under control of ITAR
  - Exporting ITAR controlled items is difficult at best and impossible for certain countries
  - ITAR restrictions impact both the manufacturer and the end user
- Many companies have been hesitant to develop commercial products as it is believed civil users don't want to or simply can't deal with ITAR Restrictions

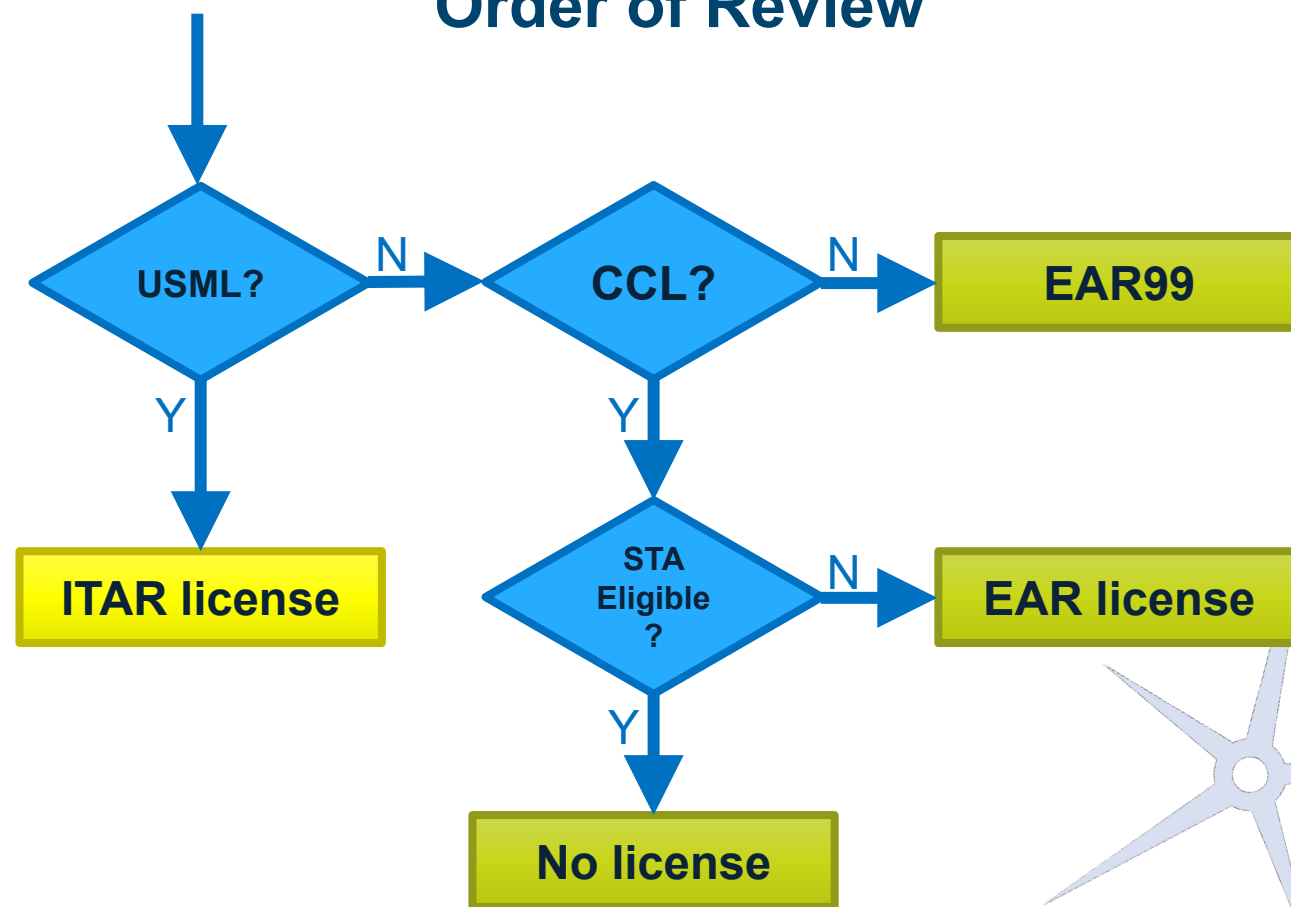


# What is ITAR Anyway?

## U.S. Authorization Hierarchy



## Order of Review



# ITAR vs. EAR Licensing

## ITAR – Controlling Defense Items

### Must Register with Directorate of Defense Trade Controls

- DDTC provides guidelines on the type of controls to implement within the organization. The guidelines include information on the **creation of a compliance manual, recordkeeping, audits, and management commitment.**
- Registration alone does not grant the registrant authority to export.

### Must obtain a license

- Several types of licenses - all include restrictions on which individuals in which countries can have access to the items or data.
- Substantial liability and responsibility for tracking and showing compliance

### ITAR components included in systems results in the entire system being controlled by ITAR

- The product inherits all the restrictions of the components

### Restrictions on retransfer

- Recipients of items or data are restricted from re-exporting without DDTC approval
- Restrictions on retransfer to dual nationals and third country nationals

### Substantial Penalties for Violations

- **Up to \$500,000 per event**
- **Potential for inadvertent or “deemed” exports**

## EAR – Controlling Dual Use Items

### EAR essentially controls everything not ITAR

- Commerce Control List (CCL) - is a limited list of items which could potentially have a military use in addition to commercial use. (i.e. "dual use.")
- The overwhelming majority of things that fall within the scope of the EAR are not listed on the CCL; instead, they are given the designation "EAR99." – marked NLR (No License Required)

### EAR export restrictions depend on the ECCN (Export Control Classification Number)

- ECCN designates that an item, which can be a tangible or intangible (i.e., software or technology), is controlled because of its specific performance characteristics, qualities, or designed-end use.

### Bureau of Industry and Security (BIS) is the regulating authority

- Recordkeeping and reporting may be required for some licenses.
- Some licenses do not require reporting of reexporting

### GNSS Adaptive antennas

- Covered under - ECCN - 7A005.b and 7A105.b.3

### Licensing under EAR is less onerous than ITAR

- Some improvements in EAR licensing criteria would also be beneficial



# Toughen Working Group Update

- Activity

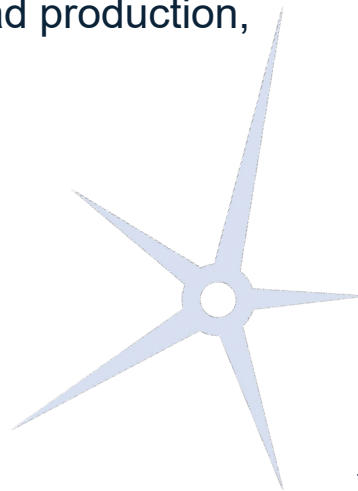
- Investigation of effect of export restrictions on civil applications of adaptive antennas for GNSS
- Five fact finding meetings held over the last year – involving government and industry stakeholders
- Developed a white paper

- Outcomes

- White paper completed
  - Documents the investigation and information discovered
  - Includes a proposed general recommendation for deliberation by PNT Advisory Board:
    - “... recommends that the U.S. and its allies modify current export controls to enable widespread production, use, and export of civil, commercial, GNSS adaptive arrays and associated receivers. ”
    - Three suggested approaches for modification for USML limitations

## Way Ahead

- Next steps depend on the outcome of the PNT Advisory Board deliberations



# Toughen Working Group - findings

- Presentations from manufacturers foreign and domestic
  - Presentations by 9 companies
  - Many of the leading companies in this technology space are non-US companies
    - Impacted differently by export restrictions
  - Limited offerings in the commercial space at this time
  - Several companies validated the perception that ITAR restrictions have kept them out of the commercial market
- Investigation of proliferation of AA technology
  - Searches of publicly available information on AA technology for GNSS
    - AA been deployed on drones manufactured by Iran and deployed in Ukraine
    - Significant manufacturing base in China – technology well understood and applied practically
    - Compared publications and patent applications in China vs. the US
  - Current export restrictions have apparently been ineffective at limiting proliferation of the technology
- **Consensus** – Best option would be to get adaptive antenna technology for GNSS off of ITAR
  - Retain controls under EAR as dual use technology





# Non-US Applications of Adaptive Antenna Technology



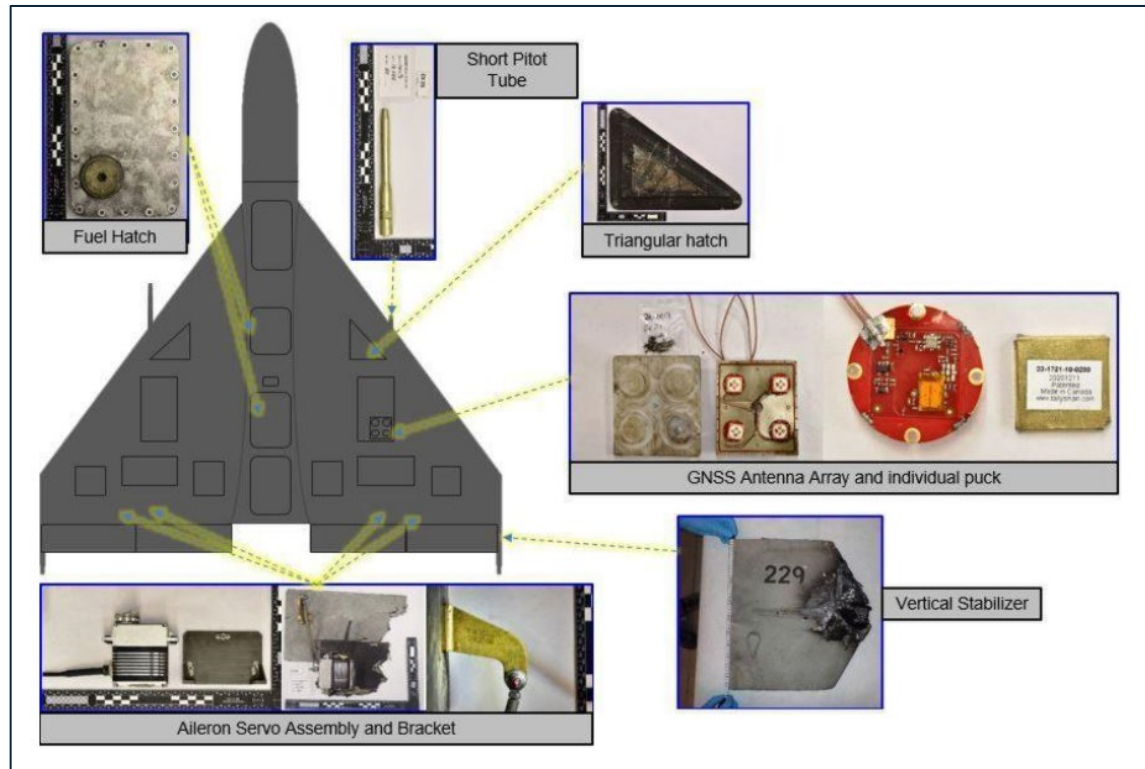
Novatel  
GAJT-710ML  
anti-jam antenna



Infinidome  
GPSdome 2  
4 element



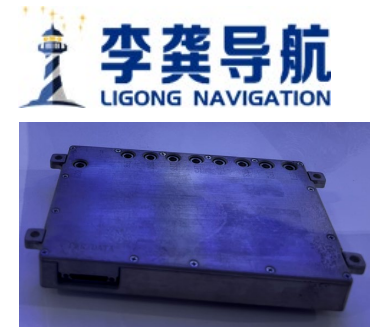
Tualcom  
TUALAJ 16300-D  
16 – Element CRPA



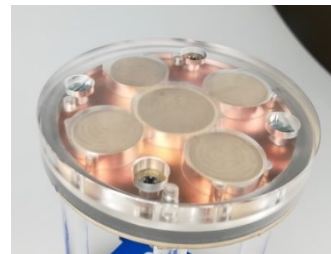
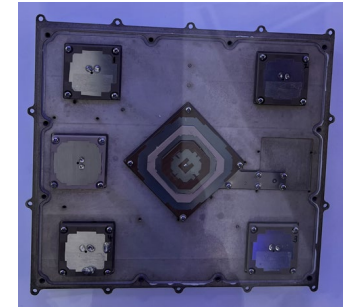
CRPA Antenna on Iranian Built Shahed-131 UAV



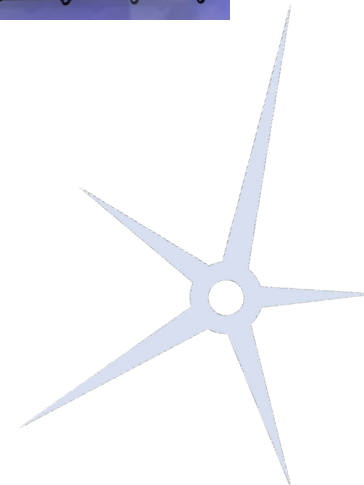
XD-KGT113-T100  
型特种卫星导航抗干扰天线



8 element BFN



DLR  
9 cm - L1+E5/L2/E6  
2018 (Patented)



# National PNT Advisory Board Protect, Toughen, Augment Subcommittee Recommendation 2 May 2023

## **Title of Recommendation: Modify Export Controls for GNSS Adaptive Antennas (AA)**

### **Finding:**

Current export control regimes are outdated, ineffective at limiting availability of AA technology inside and outside the US, and are unduly hampering development of AA products of potentially great benefit in toughening GNSS.

### **Recommendation:**

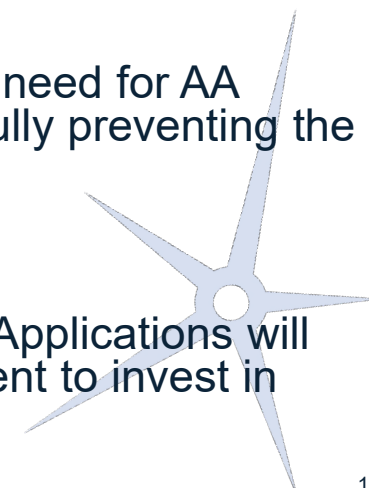
Recommend through ExCom to Departments of State and Commerce: Modify or eliminate some current export controls to enable civil, commercial applications of adaptive antenna technology for interference protection/suppression and signal manipulation protection while maintaining national security critical GPS anti-jam/anti-spoofing controls.

### **Reasons for Recommendation:**

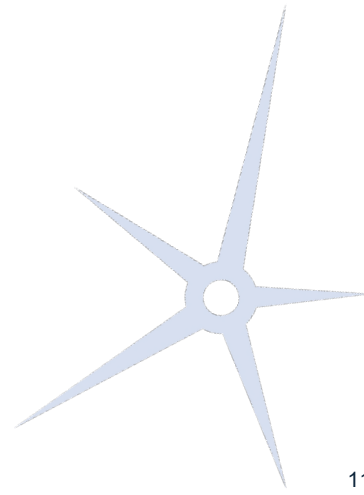
Manifold: 1) Current controls are hampering civil applications of the technology. 2) Civil community has a need for AA technology to protect Critical Infrastructure and Safety applications. 3) Current controls are not meaningfully preventing the proliferation of the technology outside the US. (See white paper)

### **Consequences of No Action on the Recommendation:**

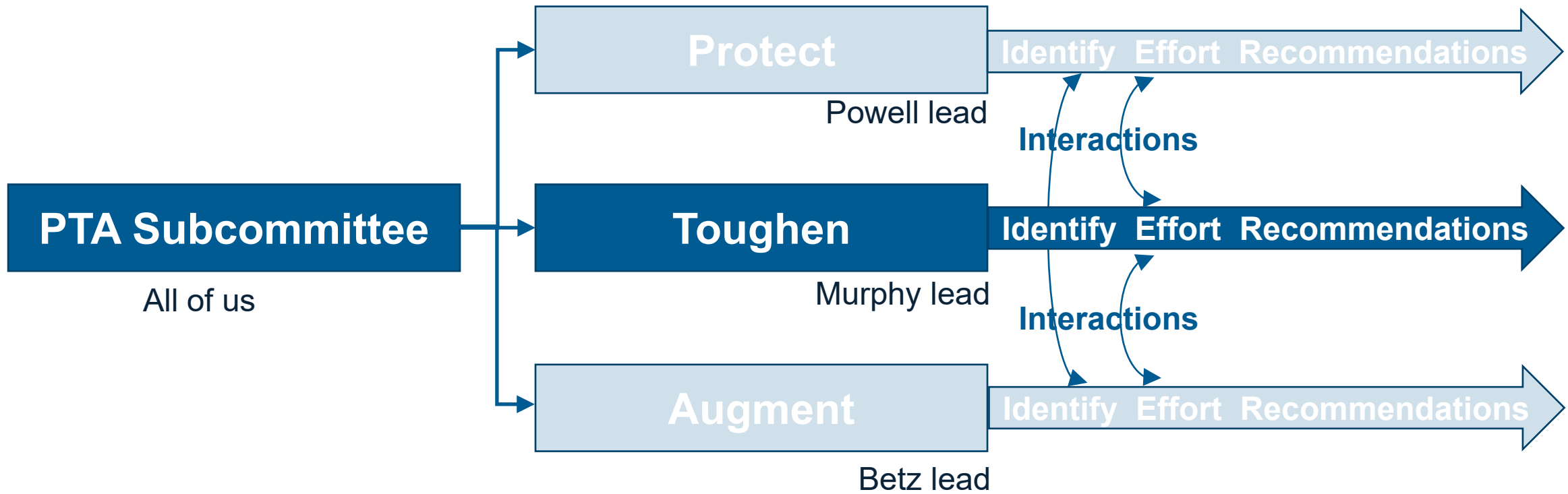
Currently, the U.S. risks losing any lead we had in this technology. Civil Critical Infrastructure and Safety Applications will remain vulnerable. US companies will continue to be disadvantaged in the market and hence will be reticent to invest in needed product developments.



# Backup Slides



# PTA Subcommittee Parallel Focus



**Identify and work with key implementers of our recommendations—  
not just the EXCOM**

