GLU-2100

Land Globally

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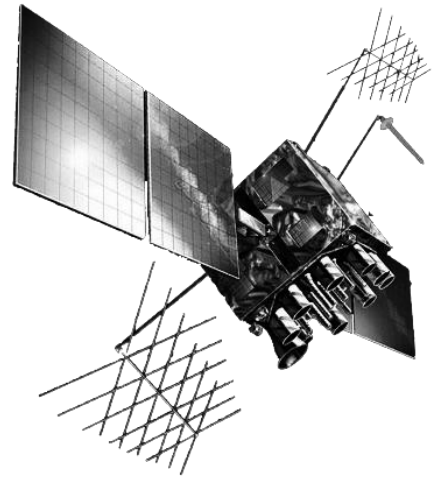
Stuart Deathridge
GLU-2100 Capabilities

DATE: October 2025

EVOLUTION OF GNSS NAVIGATION

ENHANCED NAVIGATION PERFORMANCE

July 1977
First GNSS signal received and decoded in Cedar Rapids, at Collins



1998
- GPS approved for sole means of navigation

2000
- Selective availability turned off

2003
- First SBAS LPV approach

2005
- GBAS Cat I implemented

2015
- Implementation of RNP/RNAV in global aerospace

2020
- RFI Threats
- US ADS-B GNSS req.
- GLS Cat II/III

2023
- RF Robustness
- Dual-frequency/ Multi-constellation

2025+
- Geo-political mandates
- PBN Mandates

GLU-920

GLU-925

GPS-4000A **GPS-4000S**

GLU-2100

ORE EFFICIENT AIRSPACE

MANDATED PERFORM S

VED GLOBAL APABILITIES

Rollout

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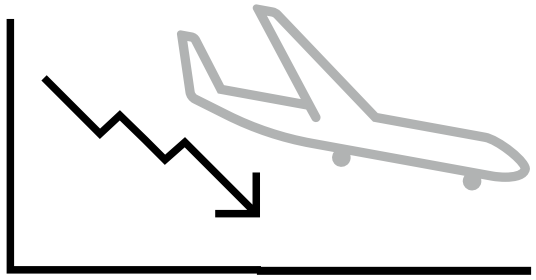
Navigation Challenges Being Faced

Evolving Airspace

- The challenges being solved today are different than what we'll face tomorrow



Aging Ground Infrastructure and Regional Changes

- Legacy solutions are aging and being phased out in favor of PBN requirements

Increased Jamming & Spoofing

- Intentional RFI has expanded at exponential rates in recent years

Landing globally is non-optional

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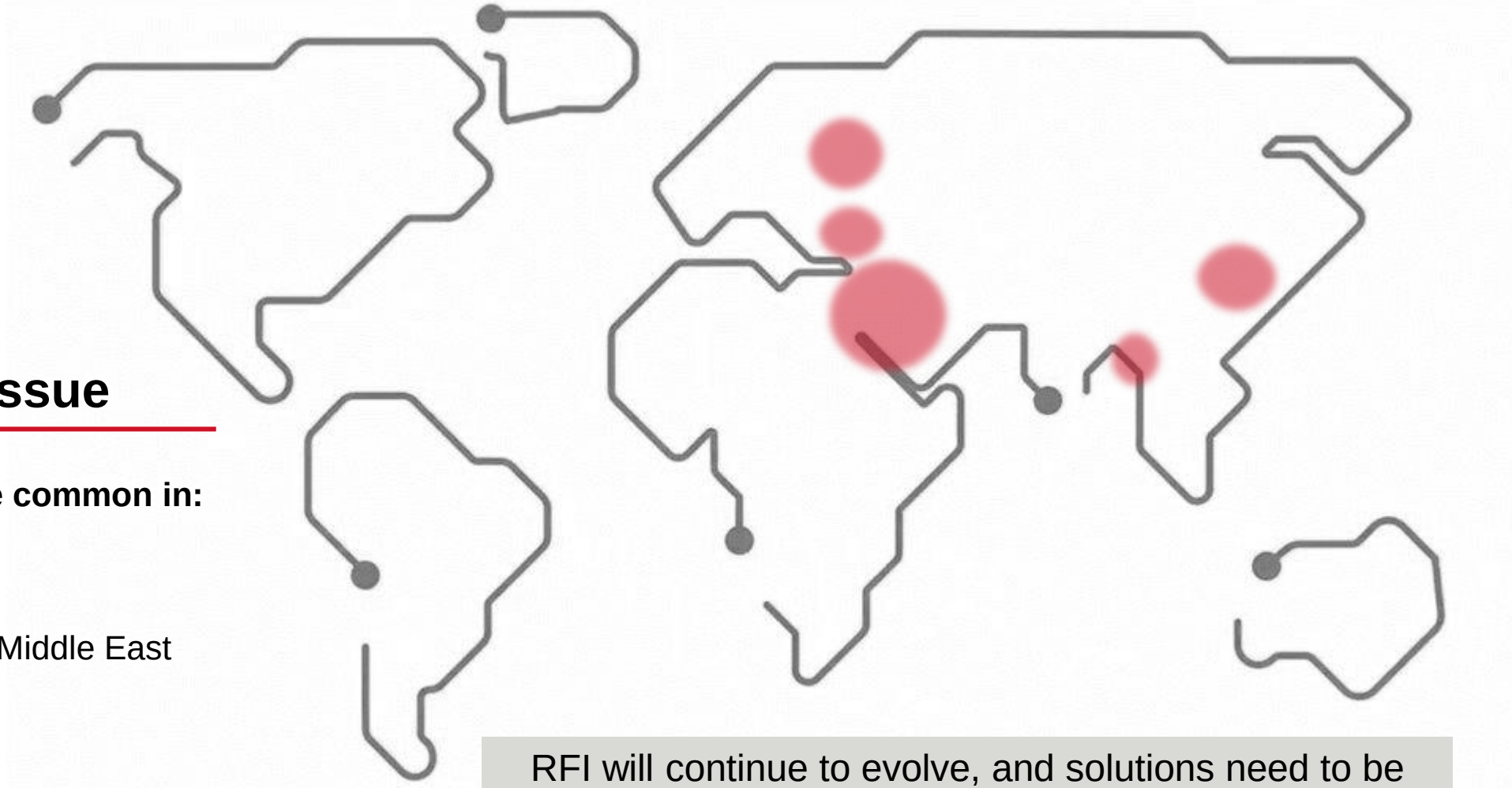
RFI and GPS



RFI is a global issue

Intentional events more common in:

Baltic Region
Black Sea
Eastern Mediterranean / Middle East
China

RFI will continue to evolve, and solutions need to be flexible for new capabilities

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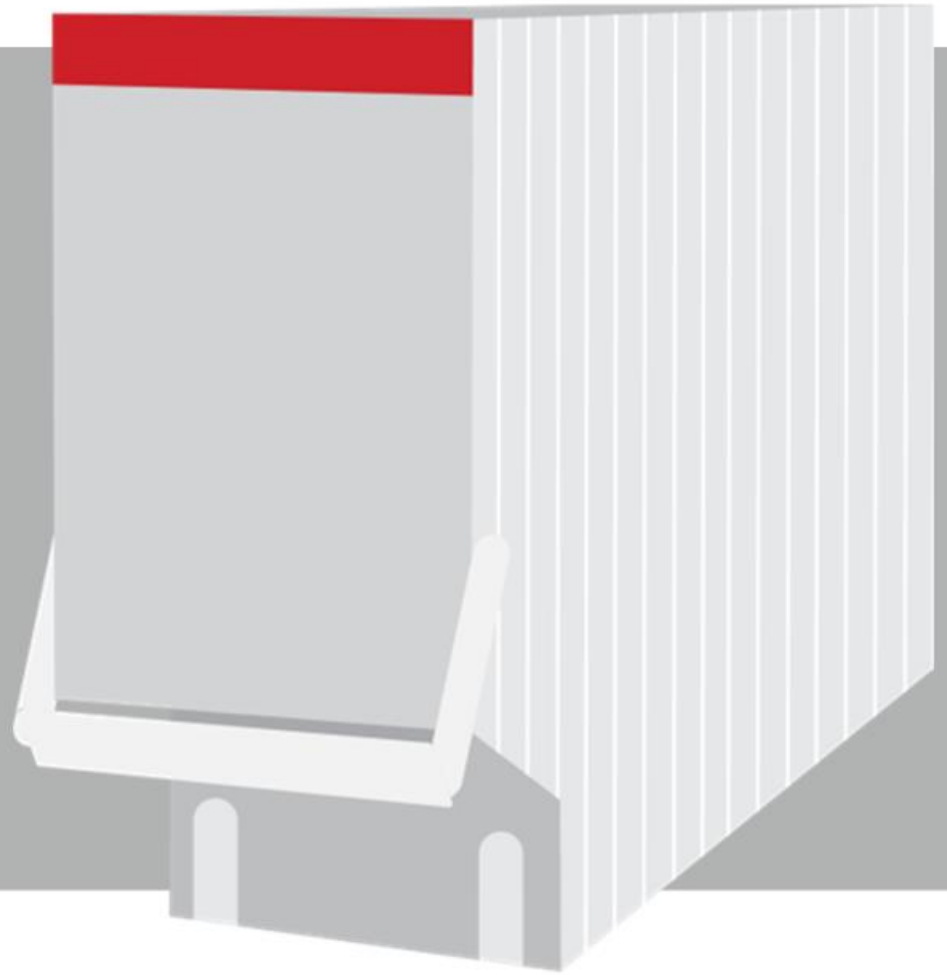
Collins GLU-2100 Multi-Mode Receiver (MMR)



- Growth Focused
  - Field-loadable, software-configurable packages
  - Adaptable to meet today and future needs: SBAS, LPV/SLS, RFI, DFMC, etc.
  - Future Development Capability Proven
    - Flew on B777 Eco Demonstrator
    - GLAD Global ARAIM for Dual Constellation
    - MUGG Multi-Mode GPS and Galileo Project
- Drop-in replacement for most existing MMRs
- Robust, DAL A hardware
- Reduced size, weight, & power requirements

Built for today – designed for tomorrow

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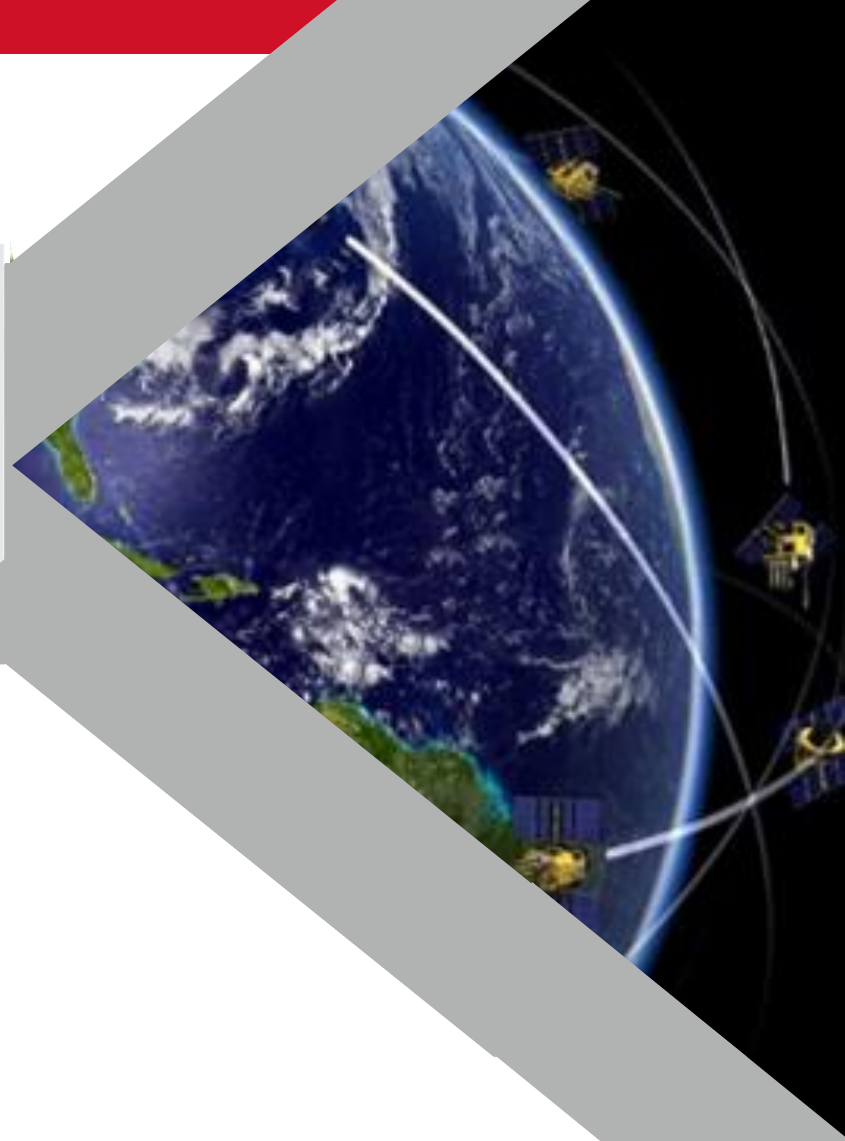
Setting Precedence

Over 30 Years of industry-leading experience



Our GLUs are on more than 15 Commercial Platforms

- 12,000 Systems Sold
- 12M Flight Hours in Service
- Prototyping DFMC MOPS ED-259B via B777 Eco Demonstrator, GLAD, MUGG, multiple committee chairs on RTCA/EUROCAE Groups, representation on GNSS Spoofing OPSGROUP

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GLU Capability Progression

Current Software

	GLU-925	GLU-2100 Initial Version	GLU-2100 V2.6 (Boeing) L4.2 (Airbus)	GLU-2100 **Next SW** With Optional Detection and Mitigation feature	GLU-2100 Planned Future SW
Field Loadable SW	No	Yes	Yes	Yes	Yes
SBAS	No	Yes*	Yes*	Yes*	Yes*
GLS CAT 1	No	Option Enabled	Option Enabled	Option Enabled	Option Enabled
VOR and Marker Beacon	No	Yes*	Yes*	Yes*	Yes*
GLS CAT 2/3	No	No	Option Supported*	Option Supported*	Option Supported*
LPV	No	No	Option Enabled	Option Enabled	Option Enabled
DO-229E	No	No	Yes	Yes	Yes
RFI Improvement Robustness Improvements	No	No	✓	✓✓	✓✓✓
RFI Detection and Mitigation SENTRI & RASA	No	No	No	Option Enabled	Option Enabled
DFMC	No	No	No	No	Option Enabled

*Options may vary by OEM and platform

An evolving solution for evolving needs

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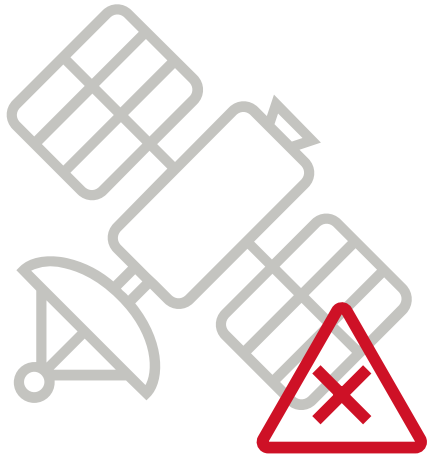
Future Focused

Intentional RFI

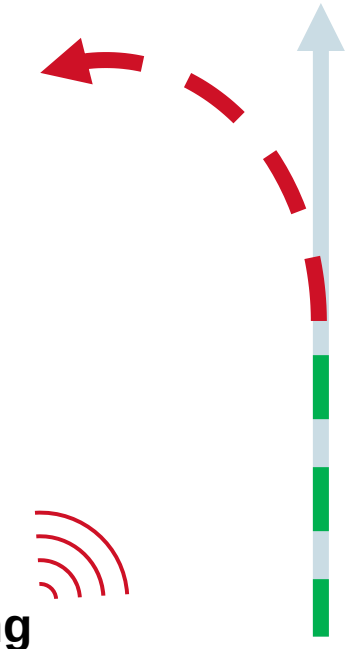
JAMMING AND SPOOFING



Jamming

- Malicious signals emitted overpowering the satellite signals
  - Stops location data from reaching the receiver or renders it unusable
- Result is loss of PVT data

RFI Mitigation Software Focus



Spoofing

- Malicious signals inserted to suggest the aircraft is somewhere else.
  - False location data is received causing false positioning without warning
- Result is misleading PVT data

Two separate RFI issues that need to be solved

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Research & Development: Jamming

Coasting

- Coasting uses the last known PVT data and inertial input to estimate an accurate PVT while encountering RFI
  - Initialized when PVT data is lost in the event of jamming
  - Could also be initialized when SENTRI detects a spoofer

Anti-Jam Antenna

- R&D is underway at Collins
  - We are analyzing a few different solutions
  - We will be soliciting VOC in the near future

Solutions for jamming are on the way

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GLU-2100 Future Potential Options

Evaluating & Prototyping

- Dual Frequency / Multi-Constellation Option (DFMC)
  - Upgradable via software and dual-frequency antenna
  - Additional navigation modes
  - Further RFI improvements
- MUGG Project
  - Extensive DFMC work being done by Collins in support of the European Union Agency for the Space Programme (EUSPA)

Exploration

- Alternate Position Navigation and Timing (APNT)
  - Use of non-GNSS APNT sources
  - Dependent on industry alignment, regulatory acceptance, and OEM Integration

GLU-2100 designed to grow for continued future flexibility

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Why Dual Frequency Multi Constellation (DFMC)?

- Current Legacy SFSC (Single Frequency Single Constellation) limitations and vulnerabilities
- Obvious increased availability with much more satellites/signals in view + redundancies
- Improvement of the integrity of the GNSS solution, more trust can be placed in the accuracy of navigation solution PVT (Position Velocity and Time)
- Accuracy is improved thanks to less noisy measurements and the ability to remove some error sources such as ionospheric delay
- Specifically in aviation, there is a possibility to operate at more airports in locations with limited or no ground-based landing systems or SBAS (Satellite Based Augmentation System) coverage
- Increased resilience and in case of a single frequency outage (jamming, meaconing, spoofing, …)
- Access to new operations (low RNP, LPV 200 in equatorial regions, …)
- Access to new protections against feared events: authentication, cross checks, natural signals robustness, etc.

Why DFMC for civil aviation?

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MUGG Project: GLU-2100

- The GLU-2100 is an ARINC 755-4 compliant digital Multi Mode Receiver that supports the following TSO functions:
  - VOR receiver compliant to DO-196 and ED-22B
  - MB receiver functionality compliant to DO-143 and 1/WG7
  - ILS Localizer receiver functionality compliant to DO-195 and ED-46B
  - ILS Glideslope receiver functionality compliant to DO-192 and ED-47B (up to Cat IIIb installation supported)
  - GNSS*:
    - L1 GPS – used for navigation
    - SBAS Navigation & Landing compliant to DO-229E – Satellite Based Augmentation System, wide area or regional (EGNOS, GAGAN, MSAS etc.) augmentation to the GPS navigation system enables higher precision and integrity data to be used.
    - GBAS Navigation & Landing (Cat I) compliant to DO-253C – Ground Based Augmentation Systems that supports local area augmentation from a ground station that enables very high precision and integrity data to be used.

* TSO-C145d Class Beta-3, TSO-C146d Class Delta-4, ETSO-C145c Class Beta-3, ETSO-C146c Class Delta-4

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MUGG Project: GLU-2100 –> DFMC Prototype

- The MUGG DFMC Prototype is built from Collins GLU-2100 Product and includes:
  - New navigation modes: DFMC SBAS PA/NPA, DFMC H-ARAIM, L5 H-ARAIM
  - Implementation of ED-259A MOPS acquisition and tracking requirements
  - Optimizations to DSP functions and resource re-allocations
  - Specific forced modes for test purposes…
- Why DFMC?
  - GPS L1/L5 and Galileo E1/E5a
  - Integrity of the GNSS solution is increased, meaning more trust can be placed in the accuracy of the PVT
  - Accuracy is improved thanks to less noisy measurements and the ability to remove some error sources such as ionospheric delay
  - Specifically in aviation, there is the possibility to operate at more airports in locations with limited or no ground-based landing systems or SBAS coverage
  - Increased resilience in case of an L1/E1 outage

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Project main achievements

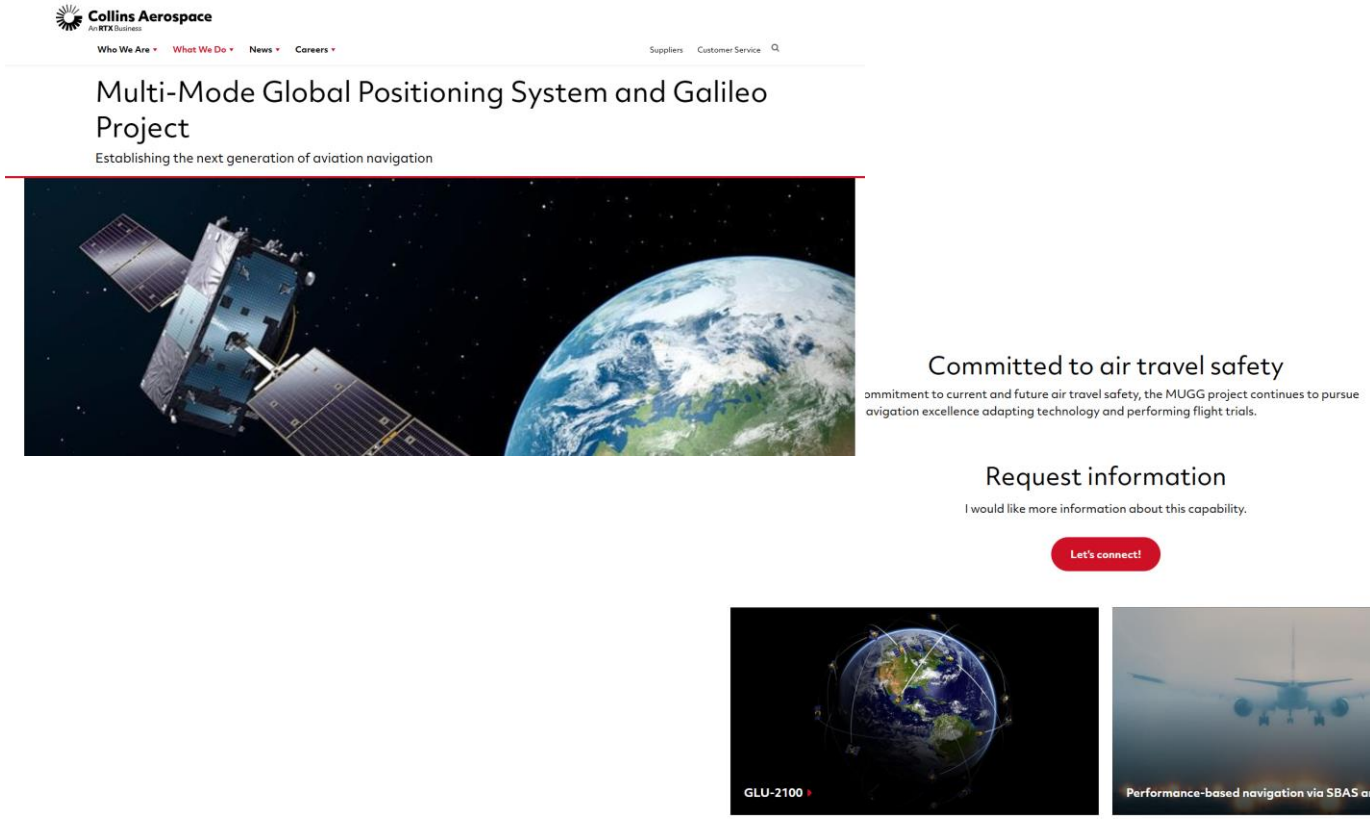
- HARAIM
  - For the first time on the certified platform GLU-2100, H-ARAIM developed in the scope of MUGG have been demonstrated in a representative operational conditions
  - With improved Pconst for the Galileo constellation, a significant improvement for the Protection Levels performance would be achieved: down to 20 meters
- SBAS DFMC
  - MUGG project demonstrated the implementation of DFMC SBAS capability on an Avionics certified hardware platform
  - Comparison of L1 SBAS, GPS L1L5 SBAS and DFMC SBAS shows significant improvement for LPV and CAT1 coverage
- Implementation of MOPS in a representative avionics receiver is key to mature/consolidate MOPS requirements

For further information…

Any question is welcome!

- MUGG project website:

[Multi-Mode Global Positioning System and Galileo Project | Collins Aerospace]



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Contact and website

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Thank You!

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