ARINC 678
Thoughts on Distributed Radios

Tim Gibson, March 2021

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Functions for Architecture Comparison

For the sake of comparison, a fictional aircraft needs:

- Dual VHF COM with AM Voice and VDL Mode-2
- Dual MC/MF GNSS (SBAS, GBAS)
- Dual VHF NAV with VOR, ILS, GBAS
- An Audio System
- Marker Beacon Receiver
- Dual, Diversity Mode S Transponders with ADS-B Out
- ACAS Xa Active Surveillance with ADS-B In
- Dual, Scanning DME
- Radar Altimeter

- Means for these functions to communicate with the rest of the Aircraft including:
  - Control Inputs
  - Display Outputs
  - BITE and Health Outputs
  - Audio I/O and Alert Outputs
  - ADS-B Services Outputs
  - Software Loading, Data Loading, Config Loading
  - System Resource and Reversionary Mode Management

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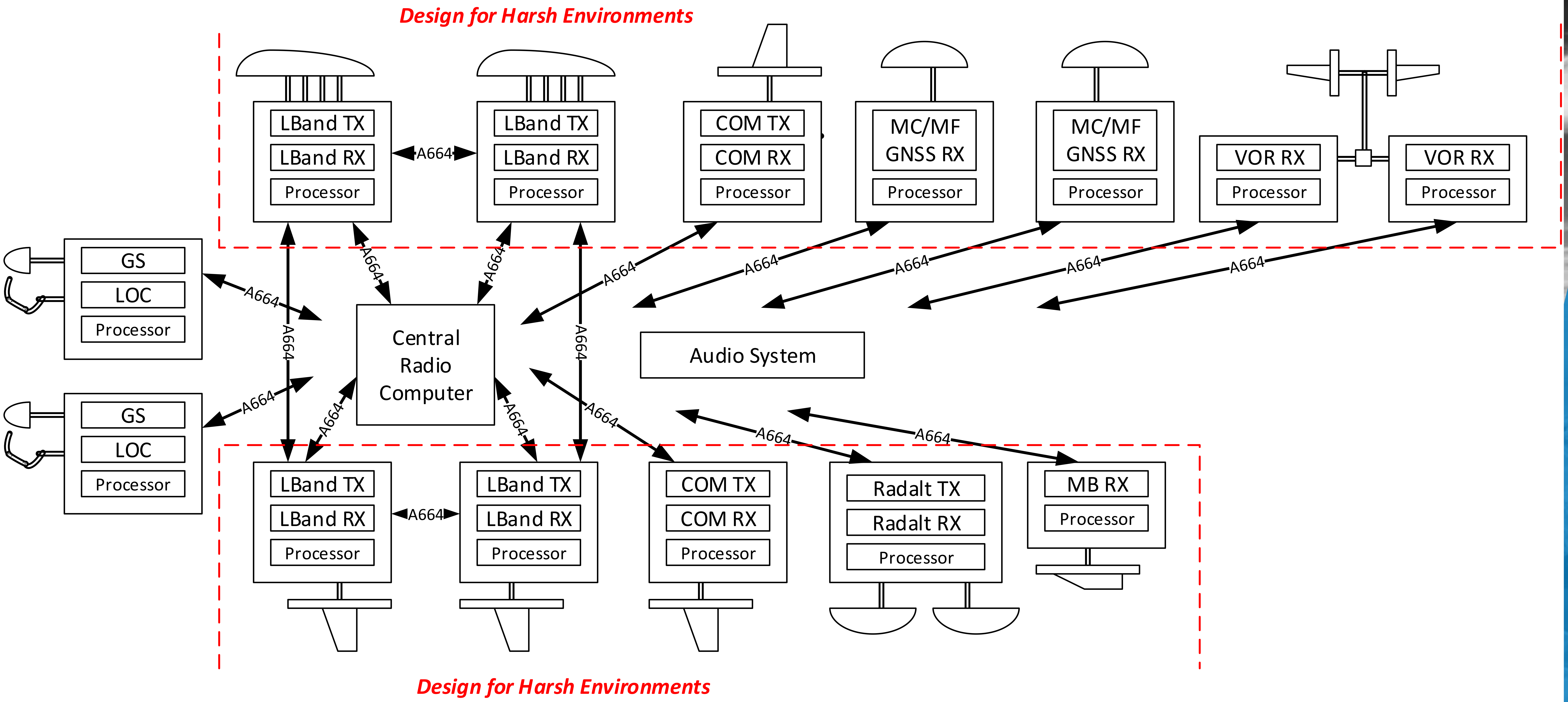
Distributed Radio Solution



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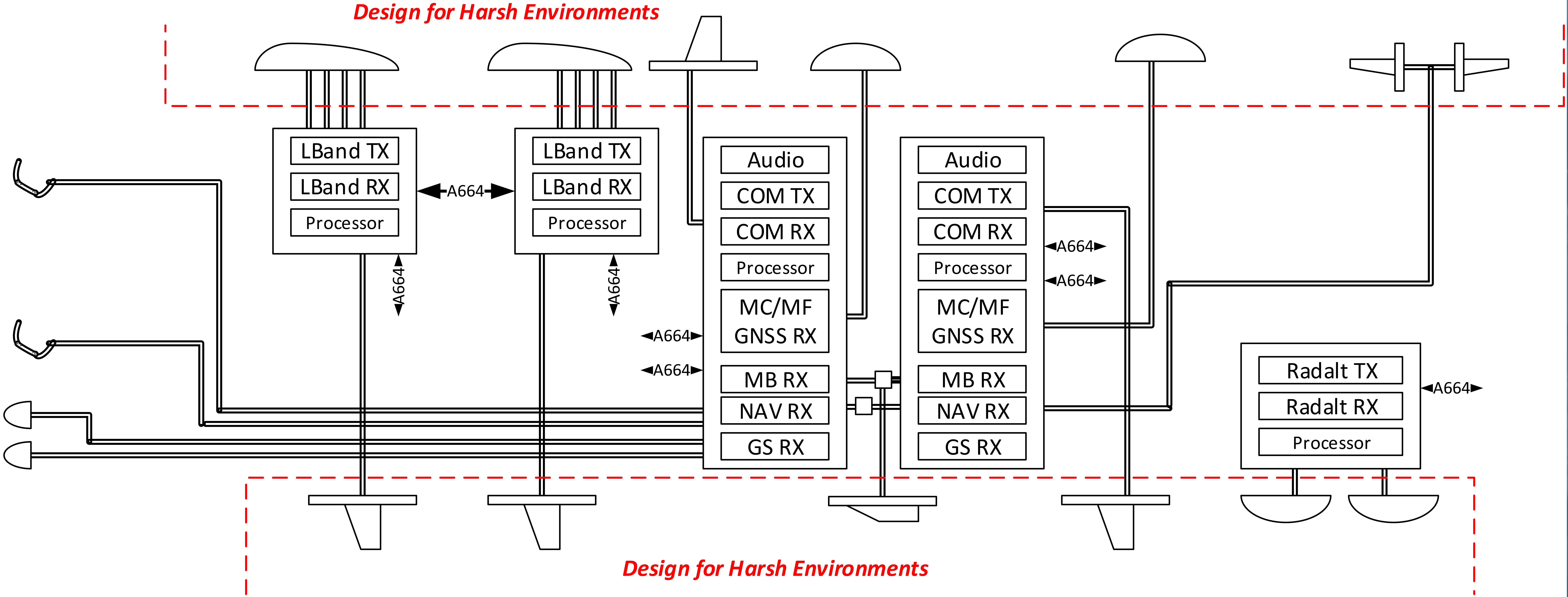
Integrated Avionics Solution



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Integrated Avionics Solution

These pieces are not theoretical. ARINC 768A is defining the L-Band system, the other systems shown already exist

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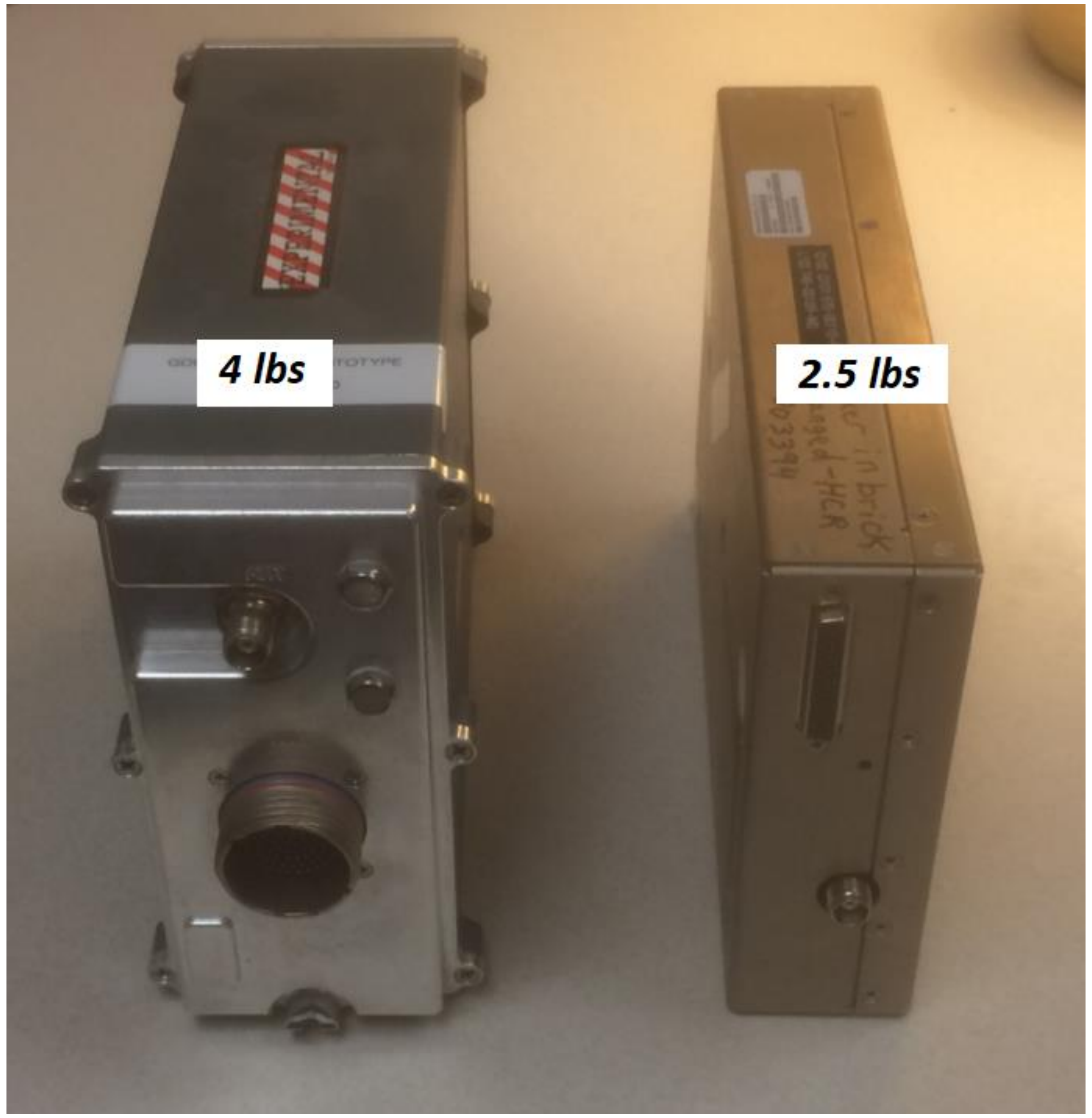
Harsh Environments= Larger and Heavier

Both the Harsh Environment and Standard Environment Units for Smaller Low-Power RF Avionics Transceiver



Moving single unit radio functions to areas with more demanding environmental requirements appears to necessitate a larger, heavier unit.

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Reliability

How do we take units that are most susceptible to marginal degradation due to environment, move them from the most benign environment to a harsh environment, and maintain (let alone improve) reliability?

If we currently prefer ARINC 600 units to sealed units in the ebay? How do we expect to get the reliability we want with sealed units in the crown of the aircraft?

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What about Hosted Applications?

In Garmin systems this unit already has a lot of spare cycles on the Main Board. We already have added functionality required at a system level to this unit because of availability.

Furthermore, There is a hot standby mainboard running all the time with an abundance of spare cycles that could be used depending on the criticality.
Also, the functions in this unit are already unique network entities that operate autonomously at a system level.
It's also the audio system, pulling a great deal of I/O and requirements out of the system ICD.

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Comparison of Complexity/Cost Drivers

Which one delivers on stated purpose: SWaP, Cost, Reliability, Serviceability?

Resource	Distributed Radios	Integrated Avionics
Number of Units	15 + Computer	5
Types of Units	9 + Computer	3
Harsh Environment Units in Difficult Service Locations	12	0
A664 Transceivers (Bidi Pairs)	36	16
Unit Weight	~88 lbs* + Computer	~56 lbs
Power	~254 W* + Computer	~220 W

** Assuming: 8 units at 4 lb / 8W (No high power TX, Harsh Env); 6 units at 8 lb / 30W units (High Power TX + Harsh Env); Audio system 8 lb / 10W*

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Does New Technology help Aviation Radios?

Yes and No

Yes!

Modern Avionics Radios are far superior to previous generations due to technologies like:

- Software defined basebands, DSP, non-linear functions in software
- Increased processing power; rich on-chip peripheral set
- Higher bandwidth communication
- Improved power supply architectures
- Better RF Power Devices; Commodity MMIC receive blocks
- Novel lightning solutions
- Reduced performance sensitivity to analog variation
- Better analog parts; accurate, cheap ADCs and DACs
- Functional integration

Will New Technology help us?

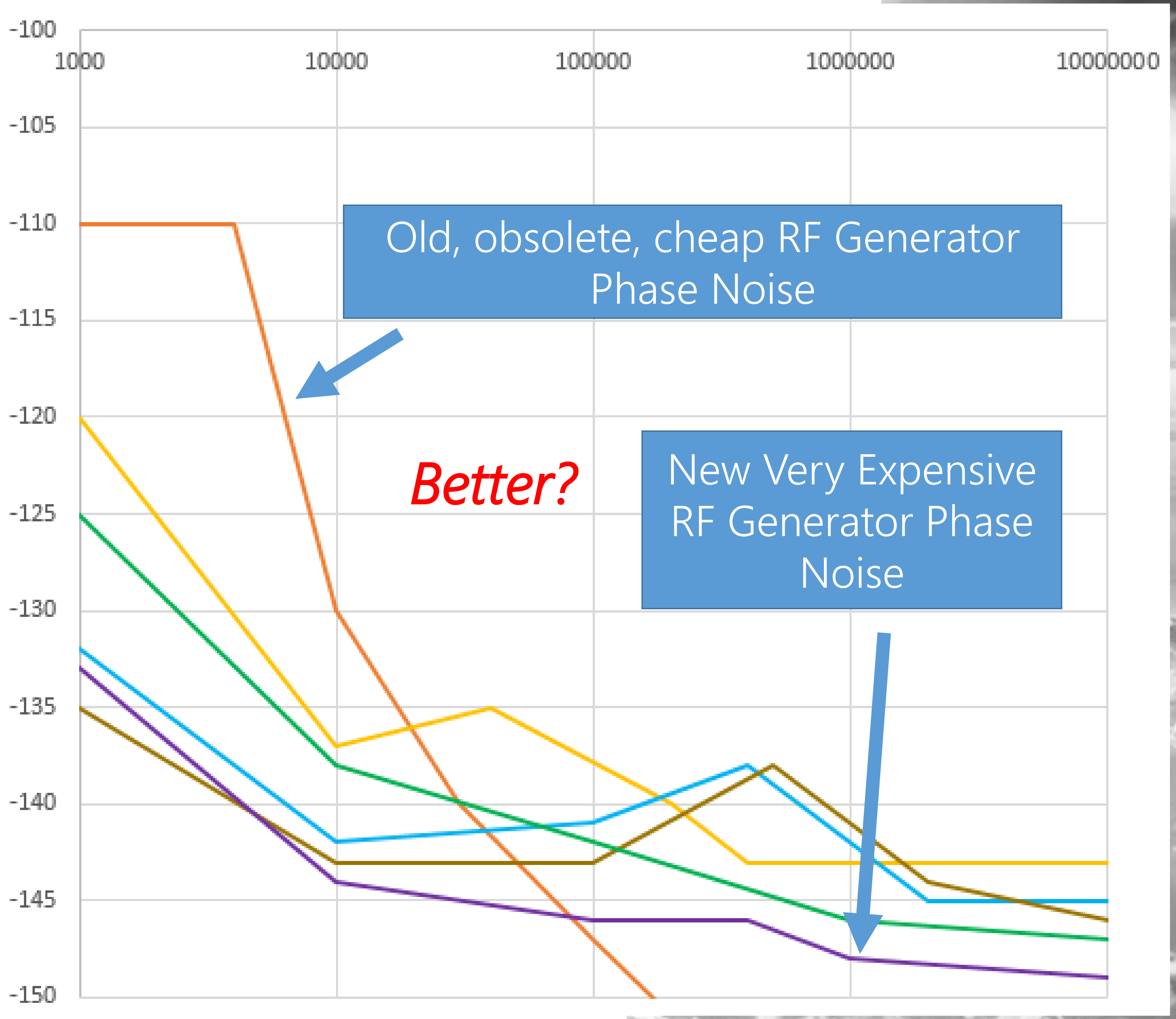
Yes and No

No?

Aviation adapts modern technologies to improve avionics solutions, but modern technologies are not being *driven* to produce better avionics solutions.

Equipment designed to improve mobile data devices and infrastructure doesn't always help us….

Also, digital solutions can be power-hungry compared to legacy analog solutions.



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What about Multi-Function Radios?

The existing radio functions have evolved together as an ecosystem over a century to give us the functional efficiency we expect today. This has created some unusual and challenging requirements not seen elsewhere. Just a couple examples:

- COM: Thermal noise audio reception separated 25kHz from +44 dBm transmission on a nearby antenna.
- NAV: Good old FM intermodulation and new GBAS COM-to-NAV interference
- SATCOM: These radios, and their interference requirements, are a moving target with lots of stakeholders
- XPDR: No relief for 3 uS reply processing. Phase Mod coming soon.
- ACAS: Tight control/monitor of four port RF amplitude and phase in real time; Long Range ADS-B In sensitivity increase
- WX RAD: Frequency, pulse compression, and range modes matched to a raindrop
- GNSS: Not aviation specific, but software defined radio is non-competitive with a 2-bit RF front end into correlators
- GS/Marker/RadAlt: Efficient solutions exist; generic solutions non-competitive
- ADF: Multi-port or Commutating antenna; not everywhere complies with ICAO Annex 10

One Software Defined Multi-Function Radio Platform to do all this? Smaller? Lighter? Less Power?

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ARINC 678 Distributed Radio Framework

Garmin recognizes its position as a newcomer in the Large Commercial Air Transport market segment; but sees the suggestions of the Distributed Radio Framework as inconsistent with the innovations that have allowed us to provide favorable solutions in the other markets we serve.

Garmin remains open to continued discussion of Distributed Radio solutions, but at the time of this writing perceives it as uncompetitive with Integrated Avionics solutions.

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