Wireless Avionics Intra-Communications (WAIC) for Commercial Aircraft

Passive Wireless Sensor Technology Workshop 2016

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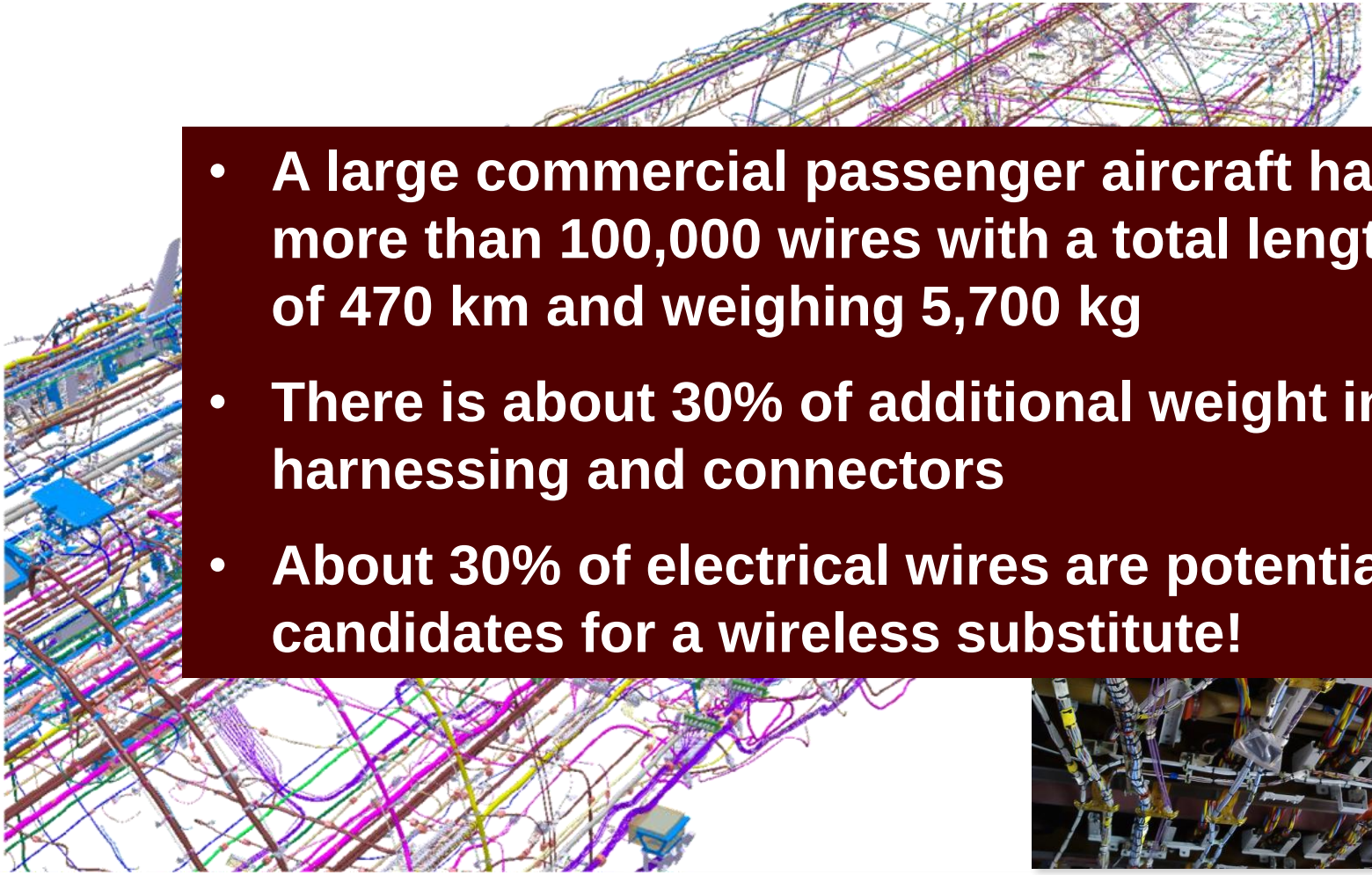
28 September 2016

Outline

- Why WAIC?
- What is WAIC?
- How WAIC? - AVSI WAIC Projects
- Status / Next Steps

WAIC
WIRELESS AVIONICS
INTRA-COMMUNICATIONS

The Problem



- A large commercial passenger aircraft has more than 100,000 wires with a total length of 470 km and weighing 5,700 kg
- There is about 30% of additional weight in harnessing and connectors
- About 30% of electrical wires are potential candidates for a wireless substitute!

Motivation: Why WAIC?

WAIC and Next Generation of Aircraft

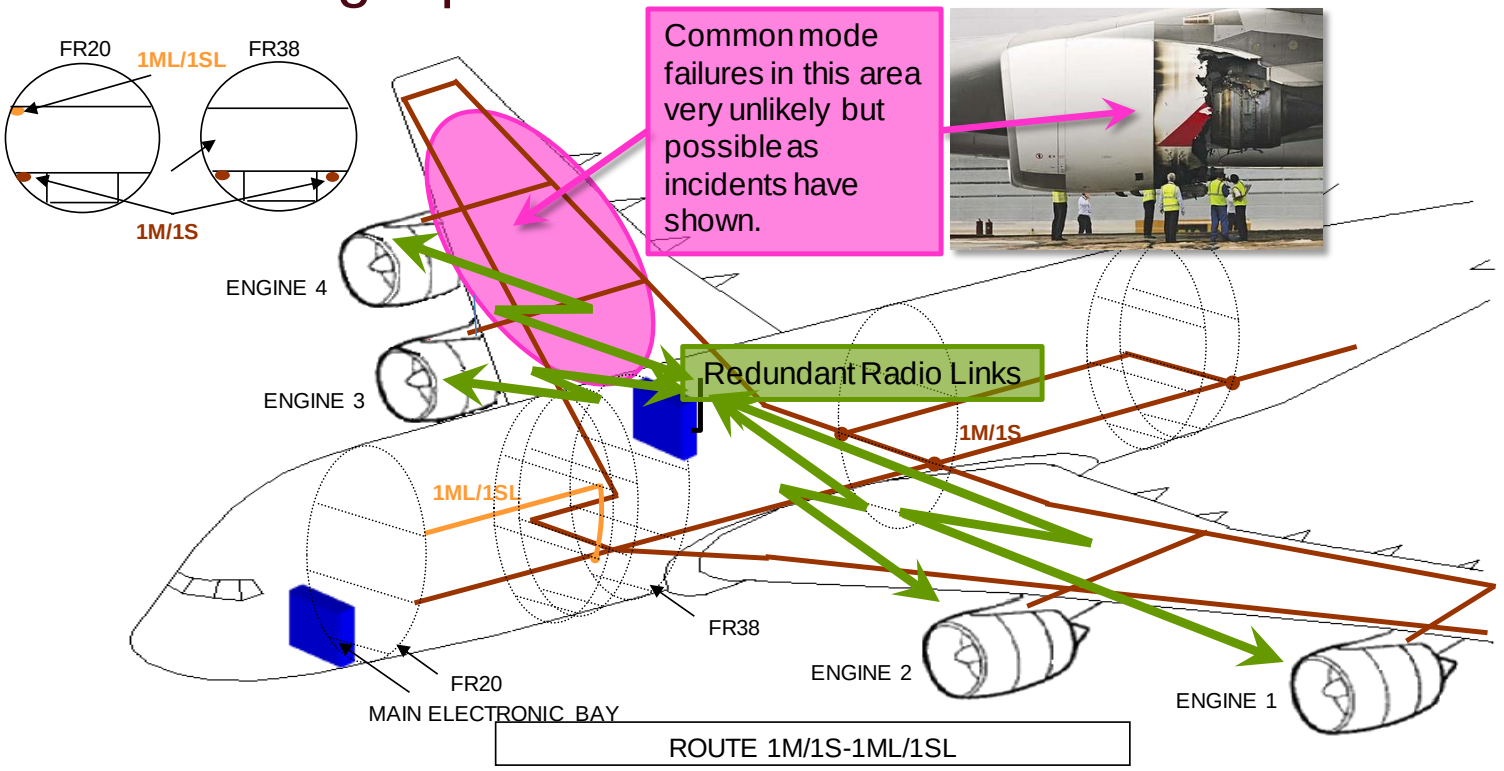
- Aircraft and the RF environment in which they operate are evolving.
- **Goal is to add operational efficiencies and reduce the overall weight of systems; and include the ability to obtain more data from the aircraft systems and surfaces during all phases of flight.**
- **The objective is to enhance efficiency and reliability while maintaining or improving current required levels of safety.**
- The intent is to NOT mandate equipage changes or to require additional costs to airlines.

Importance of WAIC to Airlines

- **Safety Improvements:**
  - Provide dissimilar redundancy
  - Fewer wires means a reduction in connector pin failures, lower risk of cracked insulation & broken conductors.
  - Mesh networking could provide redundancy in emergencies.
- **Environmental Benefits:**
  - Reduced wiring and associated aircraft weight enables less fuel burn.
- **Increased Reliability**
  - Reduce amount of aging wiring
  - Simplify and reduce life-cycle cost of airplane wiring
  - Ability to obtain more data from aircraft systems and surfaces
  - Add new sensors and controls without additional wire routing
- **Provide operational efficiencies and associated cost savings.**
  - To monitor systems and surfaces that currently cannot be monitored without taking the aircraft out of service.
  - Enhance reconfigurability

Need for WAIC - Dissimilar Redundancy

- **Example: Redundant communication paths**
  - Route segregation, combined with redundant radio links, provides dissimilar redundancy and mitigates risk of single points of failure

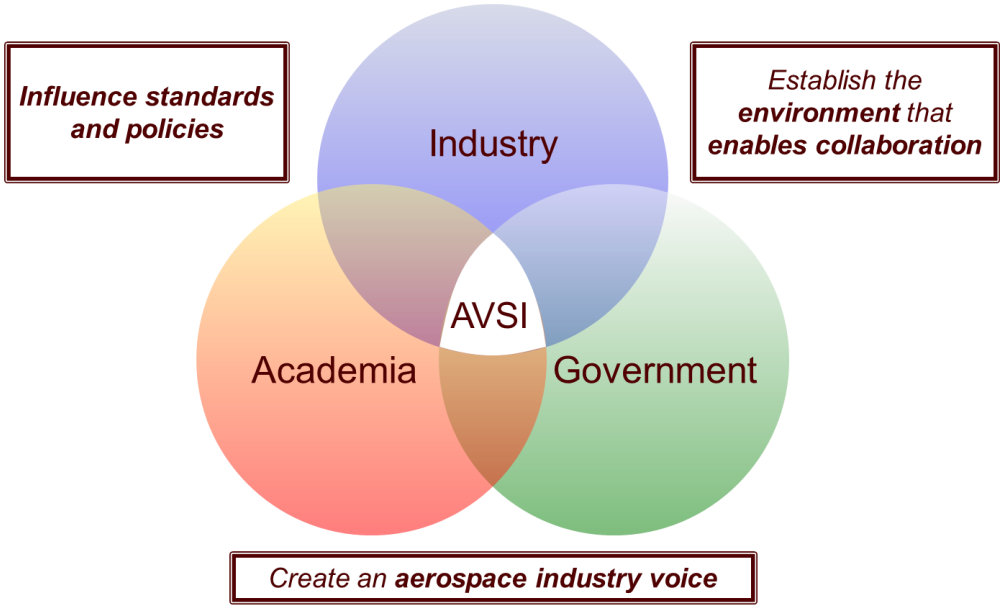


Questions

- Can existing wireless technologies be applied in a certified aircraft?
- What are the risks and requirements for implementing wireless technologies onboard?

- **Common industry stand is vital**
- **Wireless necessitates cooperation**
- **Stakeholders already addressing these questions through the Aerospace Vehicle Systems Institute**

The Aerospace Vehicle Systems Institute



TEXAS A&M UNIVERSITY

AVSI is an industry-centric applied research cooperative founded in 1998 at Texas A&M University that facilitates pre-competitive collaborative research projects ("AFE's").

AVSI Membership Represents the Industry

Full Members

- Airbus
- Boeing
- DoD
- Airbus Group
- Embraer
- GE Aviation
- Honeywell
- Rockwell Collins
- Rolls Royce
- Saab
- Thales
- United Technologies

Liaison Members

- FAA
- NASA
- Aerospace Valley
- SEI

Associate Members

- ATI Wah-Chang
- HarcoSemco
- Rafael D. S.
- SAES-Getters

Current membership includes a cross-section of aerospace industry stakeholders, including aircraft producers, system suppliers, regulatory bodies, government and trade organizations, and academia.

Wireless Prehistory at AVSI

AFE 14 – completed 2001

- Wireless Communication for Aircraft Systems
- Focus on:
  - Generic characterization of future on-board wireless systems: throughput, latency, data losses, etc
  - Prospective suitability of COTS components
- Conclusion: "*Wireless communication in one form or another may be suitable at least for some aircraft applications*"

AFE 14 Members
Boeing
Goodrich
Honeywell
Rockwell Collins
TRW
Cessna

AFE 23 – completed 2003

- Certification Guideline for Wireless Communication in Aircraft
- Focus on:
  - Installed systems communicating with PEDs but also with other installed wireless
  - Non-essential applications, but not excluding higher criticality
- Overview of certification processes and issues to be addressed

AFE 23 Members
Boeing
Cessna
Goodrich
Honeywell
Smiths

These two foundational studies prepared the ground for WAIC

AFE 56: Search for "Quiet Band"

Feasibility of Intra Aircraft Wireless Sensors

- Focus on installed systems of higher criticality
- Initial recognition that coexistence and spectrum sharing will be an issue – "quiet band" needed
- Issues impacting certification of wireless
  - Contractors: Ferrell and Associates Consulting
  - Interviewed multiple FCC, FAA, military officials
  - Introduced AVSI team to basic regulatory terminology, ITU-R frequency allocations, types of radio services, role of ICAO etc.
- Report ready May 2007, just in time for WRC-07

AFE 56 Members
:BAE Systems,
Boeing,
FAA (observer),
Goodrich,
Honeywell
NAVAIR (observer)

Main Findings:

- ***"certification of intra-aircraft wireless sensors is possible within the existing certification framework"***
- ***"there are no inherent barriers imposed in any of the existing civil certification approaches"***
- ***"use of the ISM bands for such sensors would be problematic"***
- ***"need to develop Minimum Operational Performance Standards (MOPS) for wireless sensor networks"***
- **preference to use an already existing primary allocation to an Aeronautical Service**

First AVSI Spectrum Workshop

- Motivated by AFE 56 findings
- Invited industry participants outside of AVSI
- Hosted by RTCA, Washington, DC, Oct 10-11
- Thorough review of ITU processes by Boeing regulatory team
- Confirmed strong case for wireless in essential, safety-related application
- Hope to introduce an agenda item for "dedicated aviation spectrum" at WRC-07, for an allocation at WRC-11
- Informal spectrum working group was formed out of the workshop

Workshop Participants

Airbus	NASA
Boeing	NAVAIR
Bombardier	Cessna
Continental	MITRE
Embraer	L-3 Comm.
Goodrich	Rockwell Collins
Gulfstream	Securaplane
Honeywell	Thales
Sikorsky	

Creation of AFE 73

- Bad news at out of WRC'07
  - Agenda Item for new spectrum may be established only at WRC'11 (eventually WRC'12)
  - Intensive preparatory work needed to support creation of a new Agenda Item
  - New allocation may be approved at WRC'15 at the earliest
- Informal group set to work with ITU
  - First submission in winter 2008 – Working Document Towards PDNQ (see next slide)
- Spectrum group formalized under AVSI
  - Non-AVSI members needed convincing
  - Tentative decision at the second spectrum workshop Oct 2008
  - AFE 76 kicked-off: initially planned for 2 years: Jan 2009-Dec 2010
- **Initial Goal:** ITU Report or Recommendation to substantiate new Agenda Item request at WRC-11

Original AFE 73 members

Airbus
BAE Systems
Boeing
Bombardier
Embraer
GE Aviation
Goodrich
Gulfstream
Honeywell
Sikorsky
Continental (observer)
NASA (observer)

Project name:
- Wireless Intra-Aircraft Communications (WIAC) was proposed
- Wireless Avionics Intra-Communications (WAIC) was already in use at ITU
- WAIC was kept as the official name of the effort to avoid confusion

What is Wireless Avionics Intra-Communications (WAIC)?

- **WAIC is:**
  - Radiocommunication between two or more points on a single aircraft.
  - Integrated wireless and/or installed components to the aircraft.
  - Part of a closed, exclusive network required for operation of the aircraft.
  - Only for safety-related applications.
  - Based on short range radio technology (< 100m).
  - Low maximum transmit power levels of 10mW for low rate and 50mW for high rate applications
  - Mostly internal - within fuselage/cabin.
- **WAIC does not:**
  - Provide off-board air-to-ground, air-to-satellite, or air-to-air service.
  - Provide communications for passengers or in-flight entertainment.

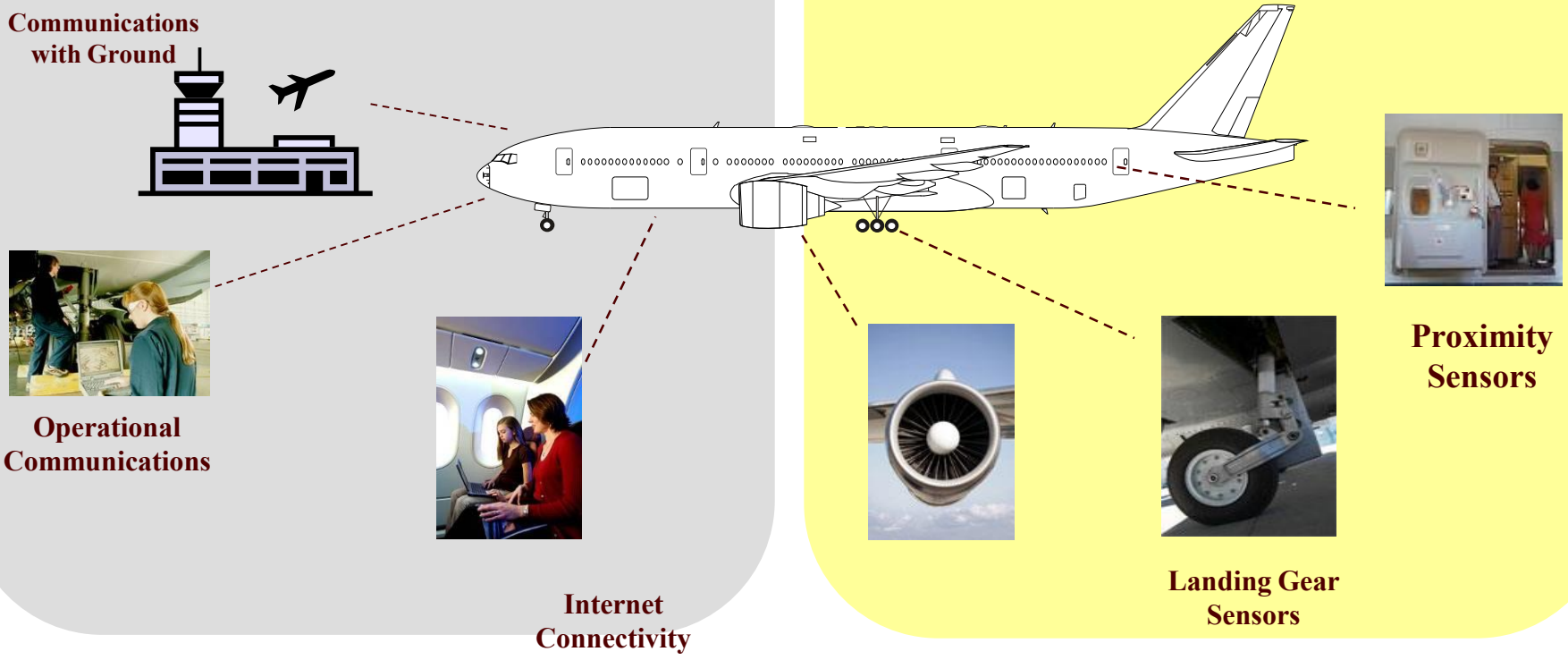
Examples of Aircraft Wireless Applications – Traditional systems vs. WAIC systems

Current Aircraft Communications:

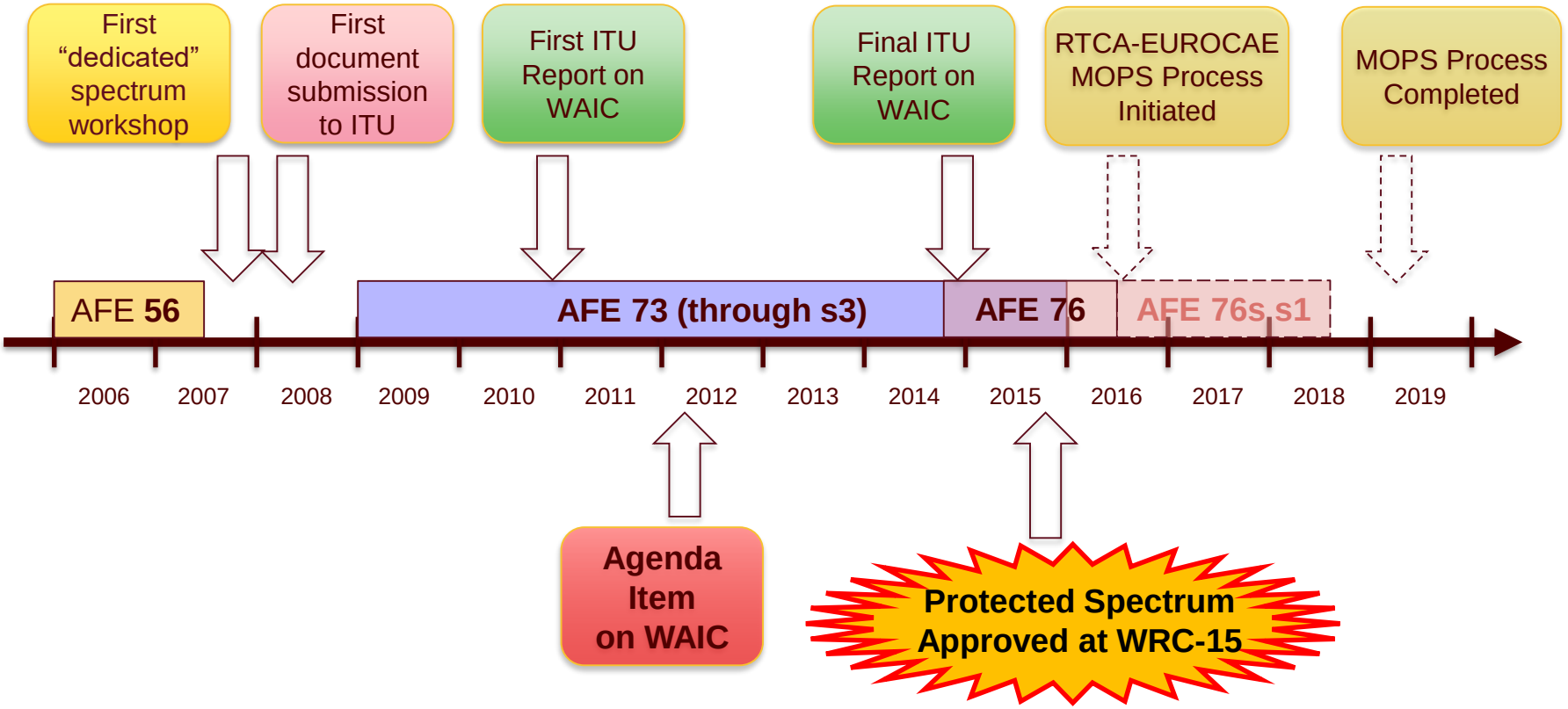
- Safety-related communications
  - HF/VHF/Satellite communications
- Non-safety related communications
  - Passenger connectivity

WAIC Systems:

- Safety-related applications, e.g.
  - Sensors/Actuators
  - Additional wireless redundancy for wired communications



WAIC Journey



Learning About ITU

ITU-T
Standardization Sector

ITU-D
Telecommunication Development Sector

ITU-R
Radiocommunication Sector

ITU-R holds WRC
approx. every 4 years

SG 1
Spectrum Management

SG 3
Radiowave Propgatation

SG 4
Satellite Services

SG 5
Terrestrial Services

SG 6
Broadcast Service

SG 7
Science Services

Study Groups
meet semi-annually

Working Parties
meet semi-annually

WP 5A
land mobile, and amateur

WP 5B
maritime and aeronautical

WP 5C
fixed wireless

WP 5C
IMT

Lifecycle of ITU documents

Working Document Towards PDNQ → Preliminary Draft New Question (PDNQ) → Draft New Question (DNQ) → Question

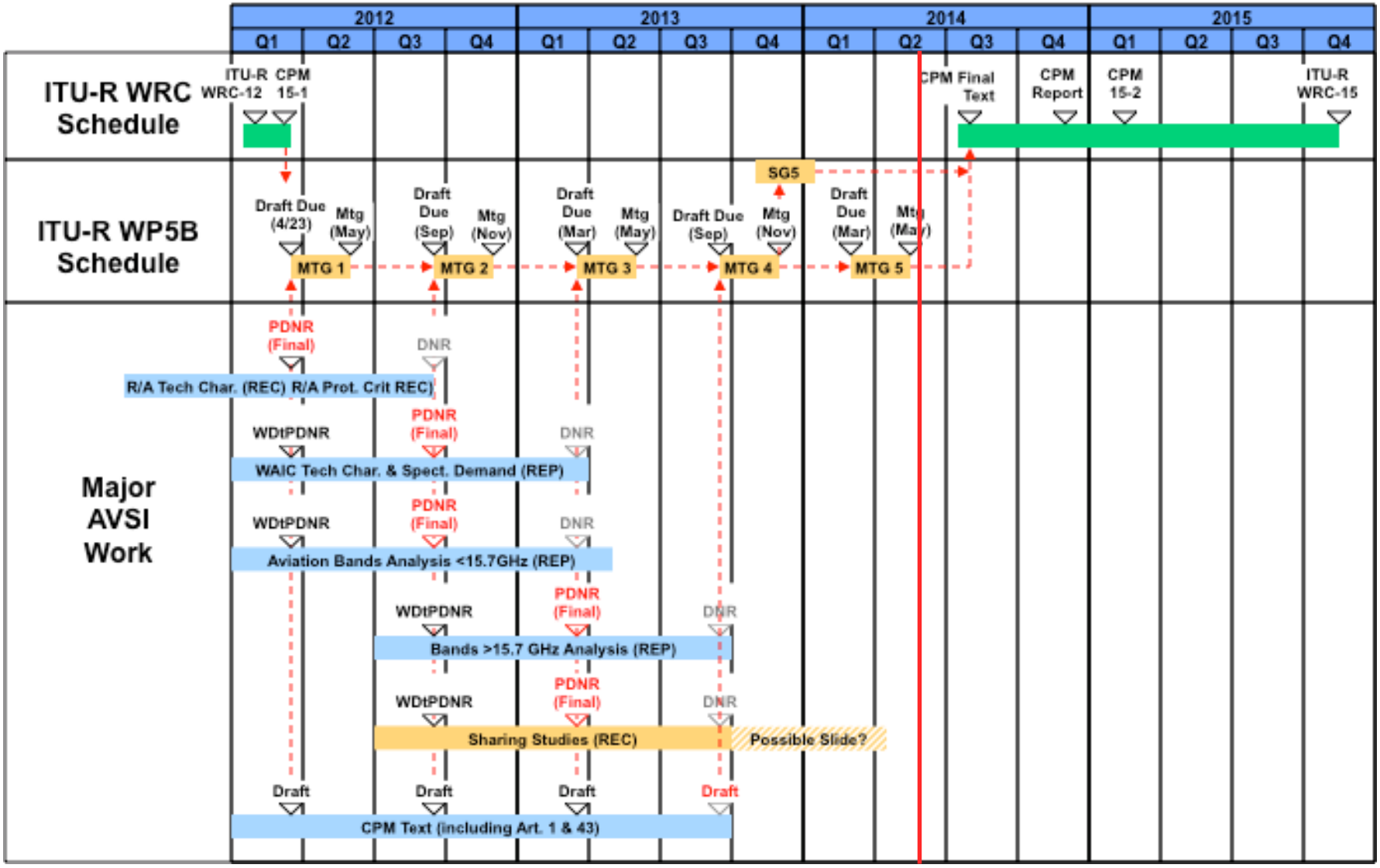
Working Document Towards PDNR → Preliminary Draft New Report (PDNR) → Draft New Report → Report

Approved at Working Party level

Approved at SG level

- Generally at least 6 months between document stages
- Shortcuts happen, but delays happen more often
- Official Question needed only once to jumpstart the process
- To support WRC, documents need to make it to Conference Preparatory Meeting (CPM), at least 6 months prior to WRC
- All submissions must come through national delegations, adding more delays
- **The process is very long**

ITU-R Radio Regulations Process



More about ITU Process

Radio Frequency Management is done by experts who meld years of experience with a curious blend of regulations, electronics, politics, and not a little bit of larceny. They justify requirements, horse-trade, coerce, bluff and gamble with an intuition that cannot be taught other than by long experience.

Dr. Jon L. Boyes (1921-2004)
Vice Admiral, United States Navy

As quoted in a Naval Postgraduate School thesis

- All spectrum is already allocated, sometimes multiple times
- New requests generally are opposed as a matter of course
- Most resistance in the beginning of the process, when target spectrum unknown
- Procedural tricks frequently used to keep documents in Working Parties
- A handful of well respected individuals wields a lot of Informal power

Non-ITU players

ICAO

- Typically deferred to in aeronautical matters.

Regional bodies

- CEPT – may issue European positions
- CITEL – may issue Inter American Proposals
- APT (Asian Pacific Telecommunity)
- *Others*

A lot overlap in personnel between these groups

All eventually feed into ITU

AVSI team attempted to participate in most of these

Bandwidth requirements were developed by considering potential WAIC applications

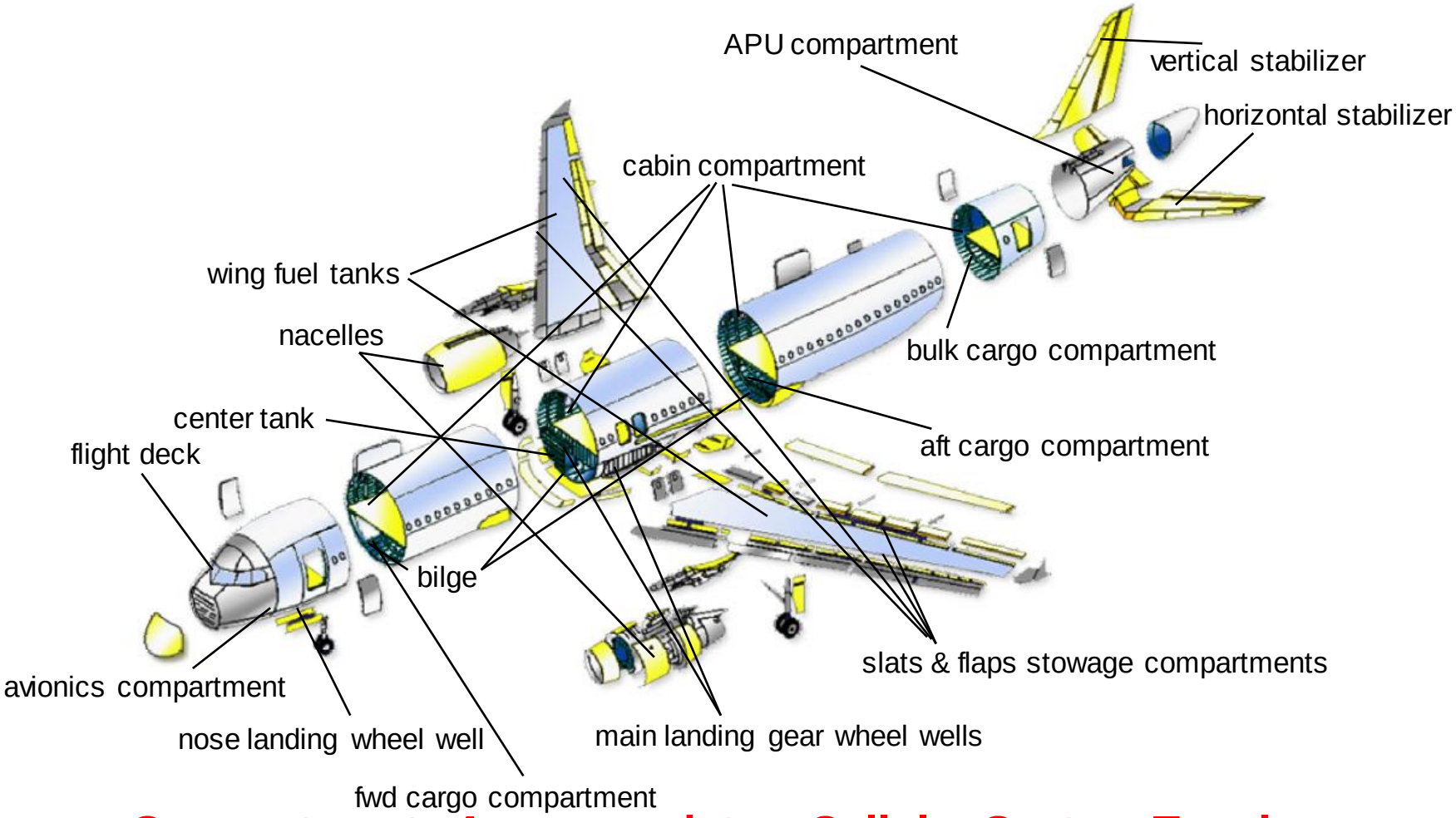
- **Low Data Rate, Interior Applications (LI):**
  - Sensors: Cabin Pressure - Smoke Detection - Fuel Tank/Line – Proximity Temperature - EMI Incident Detection – Structural Health Monitoring - Humidity/Corrosion Detection
  - Controls: Emergency Lighting - Cabin Functions
- **Low Data Rate, Outside Applications (LO):**
  - Sensors: Ice Detection - Landing Gear Position Feedback - Brake Temperature - Tire Pressure - Wheel Speed - Steering Feedback - Flight Controls Position Feedback - Door Sensors Engine Sensors - Structural Sensors
- **High Data Rate, Interior Applications (HI):**
  - Sensors: Air Data - Engine Prognostic - Flight Deck/Cabin Crew Images/Video
  - Comm.: Avionics Communications Bus - FADEC Aircraft Interface - Flight Deck/Cabin Crew Audio / Video (safety-related)
- **High Data Rate, Outside Applications (HO):**
  - Sensors: Structural Health Monitoring
  - Controls: Active Vibration Control

WAIC spectrum requirements for all application categories

WAIC application category	Application data rate in kbps (P_{eff})	Protocol overhead factor (α)	Channelization overhead factor (β)	Multiple-aircraft factor (m)	Modulation efficiency in bps per Hz (η)	WAIC Spectrum requirements *MHz* (F)
Low data rate Inside (LI)	394	1.38	1.92	1.0	0.096	**11**
Low data rate Outside (LO)	856	1.38	1.92	1.7	0.096	**40**
High data rate Inside (HI)	18385	1.04	1.20	1.0	0.723	**32**
High data rate Outside (HO)	12300	1.04	1.20	2.9	0.723	**62**

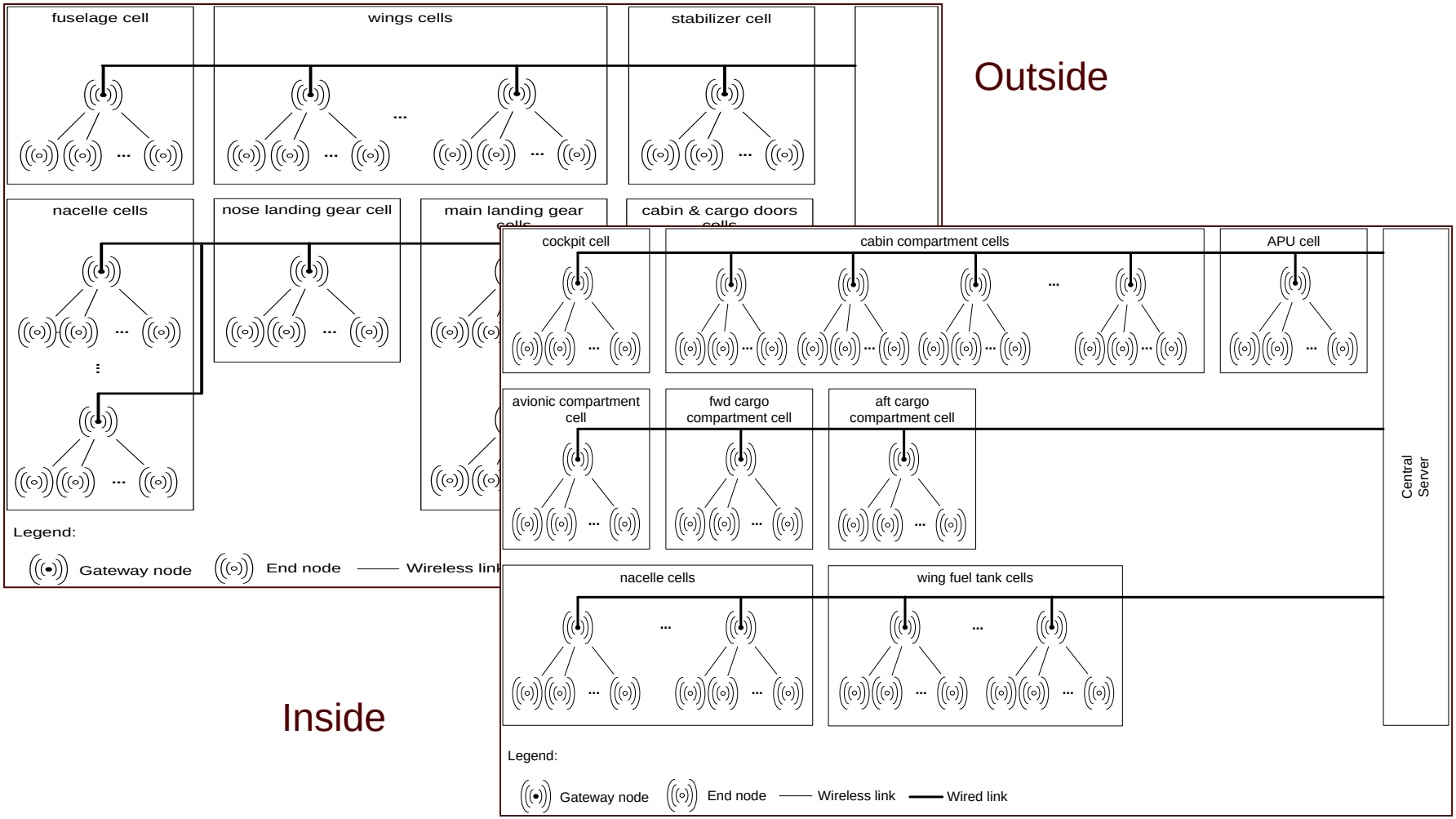
Estimated that 145 MHz Total Spectrum Allocation Needed

Major components of a typical passenger aircraft and location of compartments



Compartments Accommodate a Cellular System Topology

The WAIC model consider different network topologies



First Major Milestone at ITU: WAIC Characteristics Report

- <u>Full status report in November 2010</u>
  - Took only six WP/SG cycles: two cycles for Question and four cycles for Report
  - Lightning speed at ITU
- Completed one year before WRC-11
  - In time to support new agenda item proposal
- Report did not define spectrum need, but gave enough detail to placate at least some likely opponents
  - Defined classes of inside vs. outside and high vs. low data rate wireless applications
  - Parametric analysis of power vs bandwidth for four classes of systems
  - Need for low data rate systems estimated between 60MHz and 200 MHz
  - Need for high data rate systems estimated between 200MHz and 2000 MHz
  - Bandwidth numbers still unrealistic, but not completely so
  - Target bands still undefined
- By approving the Report, SG 5 legitimized the need for WAIC spectrum

WRC'12: WAIC Agenda Item

RESOLUTION 423 (WRC-12)

Consideration of regulatory actions, including allocations, to support Wireless Avionics Intra-Communications

The World Radiocommunication Conference (Geneva, 2012),

considering

a) that the future generation of aircraft is being designed to enhance efficiency, reliability and safety, as well as to be more environmentally friendly;

b) that Wireless Avionics Intra-Communications (WAIC) systems are restricted to radiocommunications between two or more points integrated into or installed on a single aircraft;

c) that WAIC systems do not include communications between an aircraft and the ground, another aircraft or a satellite;

d) that WAIC systems have to ensure the safe operation of an aircraft and have to operate with an appropriate level of protection to comply with the safety and regularity of flight;

e) that WAIC systems will be operated on the ground and during all phases of flight;

f) that aircraft equipped with WAIC systems will be operated globally and will cross national borders,

recognizing

a) that WAIC systems are being developed to operate safely and efficiently in one or more non-contiguous radio-frequency bands, emphasizing those currently allocated to the aeronautical mobile service and aeronautical radionavigation service;

b) that WAIC systems operating inside an aircraft will benefit from fuselage attenuation and other aircraft surface attenuation in order to facilitate sharing with other services;

c) that Report ITU-R M.2197 provides technical characteristics and operational objectives for WAIC systems,

resolves

that WRC-15 consider, based on the results of ITU-R studies, possible regulatory actions, including appropriate aeronautical allocations, to support the implementation of WAIC systems, while taking into account spectrum requirements for WAIC and protection requirements for systems operating in accordance with existing allocations,

invites ITU-R

1 to conduct, in time for WRC-15, the necessary studies to determine the spectrum requirements needed to support WAIC systems;

2 to conduct sharing and compatibility studies, based on the results of *invites ITU-R* 1, to determine appropriate frequency bands and regulatory actions;

3 when conducting studies in accordance with *invites ITU-R* 2, to consider

i) frequency bands within existing worldwide aeronautical mobile service, aeronautical mobile (R) service and aeronautical radionavigation service allocations;

ii) additional frequency bands above 15.7 GHz for aeronautical services if spectrum requirements cannot be met in frequency bands studied under *invites ITU-R* 3 i),

invites

the International Civil Aviation Organization (ICAO) to contribute to these studies,

instructs the Secretary-General

to bring this Resolution to the attention of ICAO.

Key points of the Resolution

1. WAIC tacitly defined as safety-related installed on-board systems
2. **WRC-15 instructed to consider (a) new allocation(s) for WAIC**
3. Preference for sharing existing aeronautical allocations
4. Sharing and compatibility studies mandated

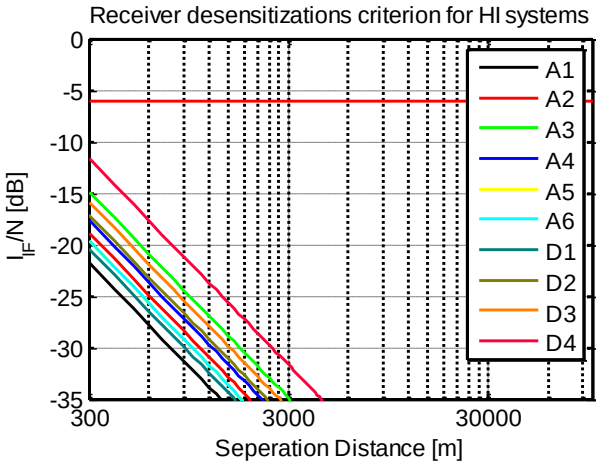
At this point key PMC experts were 80% sure there would be some allocation

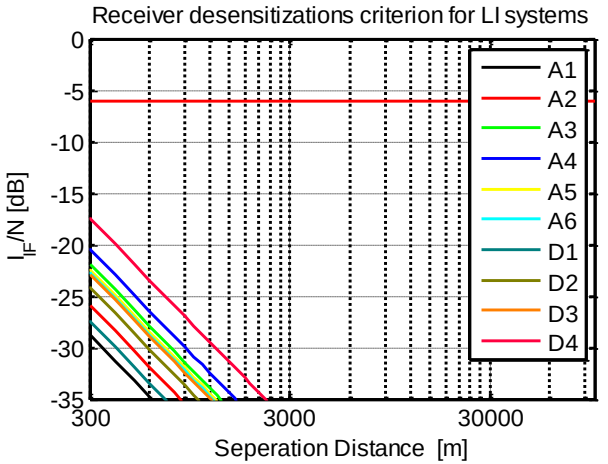
Spectrum requirements and practical considerations led to radar altimeter band

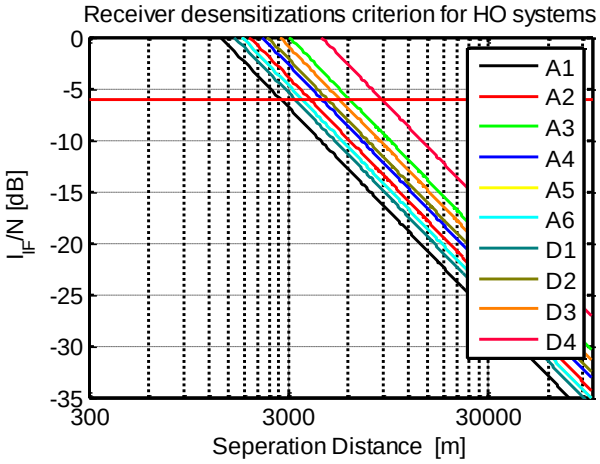
- Considered only Aeronautical allocated bands
- The radar altimeter (RA) band 4.2 – 4.4 GHz was promising since there was only one incumbent service
- Two of three major RA manufacturers are AVSI Members
- AVSI team helped defined RA protection criteria
- AVSI team performed band sharing studies to demonstrate WAIC compatibility with incumbent service
- Considered HI, LI, HO, LO application compatibility with both FMCW and Pulsed radar altimeters

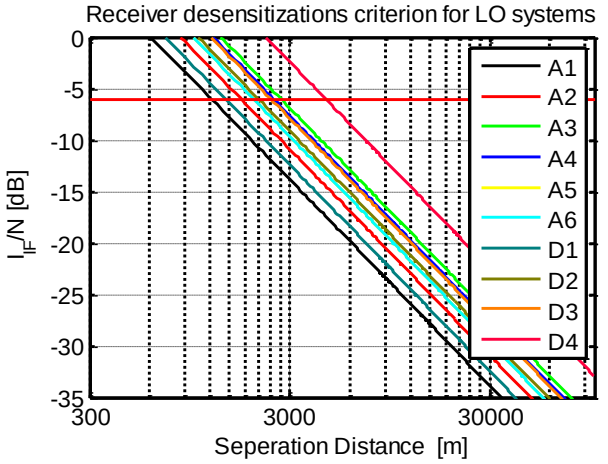
WAIC Desensitization of RadAlt is harshest factor

Internal WAIC systems meet -6 dB I/N non-interference criteria



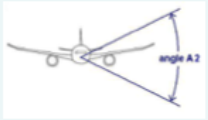


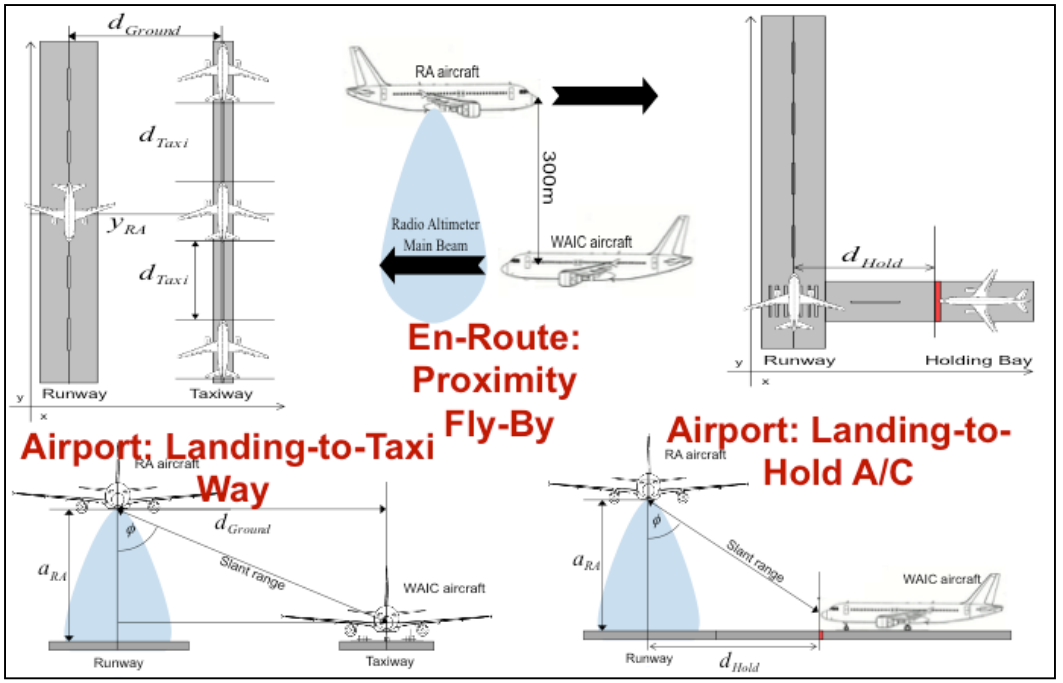




Aircraft Shielding & Geometry Considerations

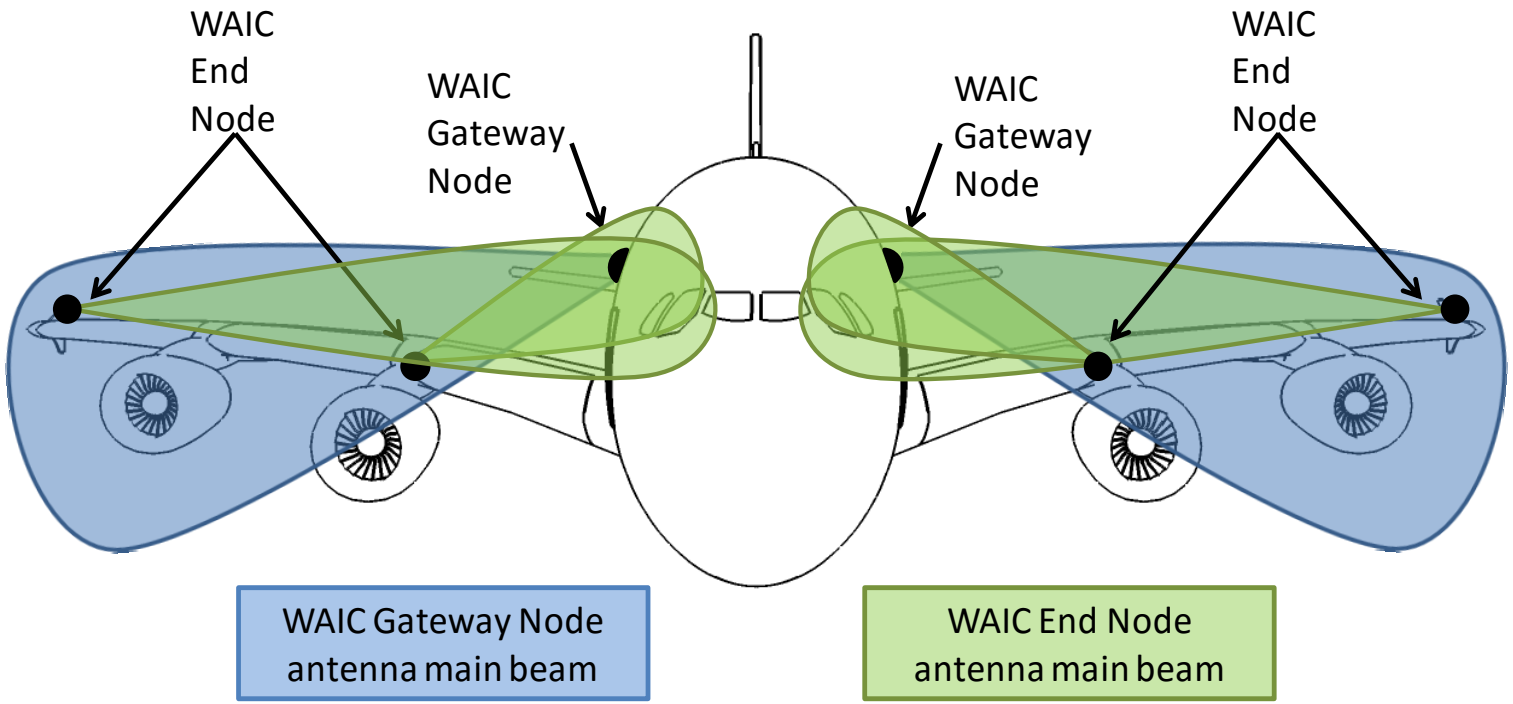
- Additional Path Loss due to Aircraft Shielding crucial to isolating WAIC Internal Systems from the Radio Altimeter without requiring additional mitigation techniques

Case	Viewing Angle	Configuration	Typical attenuation
1	viewed from A1 	a) transmitters within cabin	25dB
		b) transmitters installed in lower lobe of aircraft fuselage	35dB
2	viewed from A2 	a) transmitters within cabin	10dB
		b) transmitters installed in lower lobe of aircraft fuselage	30dB
3	All angles	Enclosed compartments or aircraft fitted with shielded windows	35dB
4	n/a	Partly shielded external aircraft areas	5dB

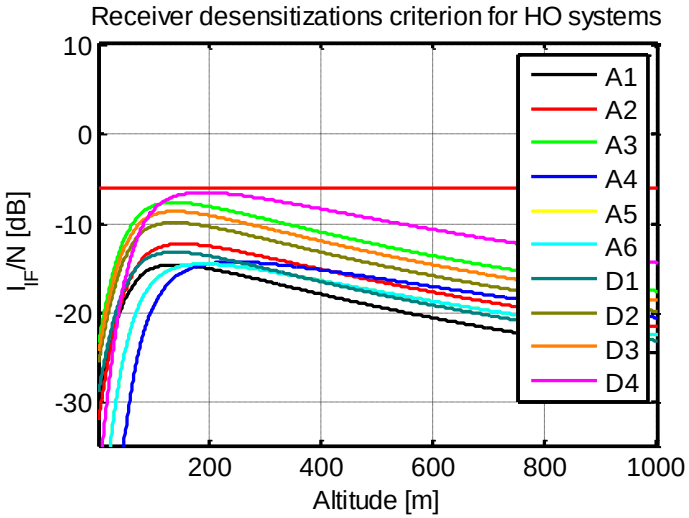


Using Directional Antennas to Reduce Interference Effects

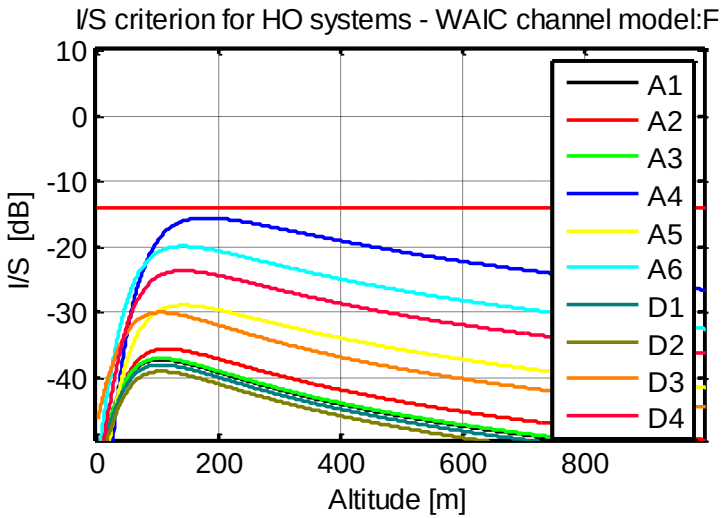
- WAIC External Systems can shape the radiation pattern using directional antenna pattern controls as one potential mitigation technique for external WAIC systems



WAIC External Systems do not Interfere with RadAlts after Directional Pattern Control



Results of radio altimeter receiver desensitization for the “airport taxiway” scenario



Results for I/S protection criteria for WAIC HO systems for the “airport taxiway” scenario

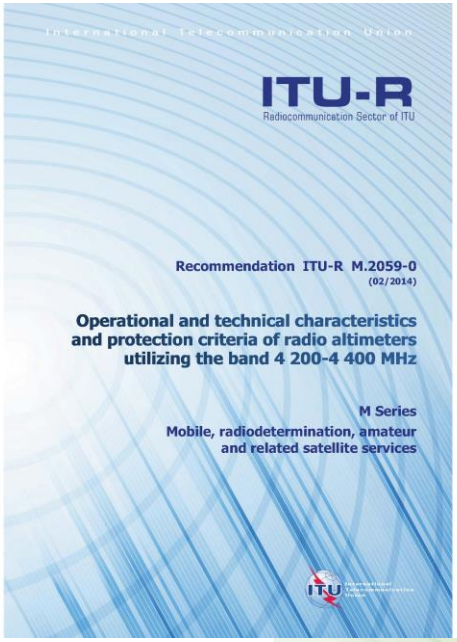
ITU-R Documents and Studies Completed by AVSI WAIC Team

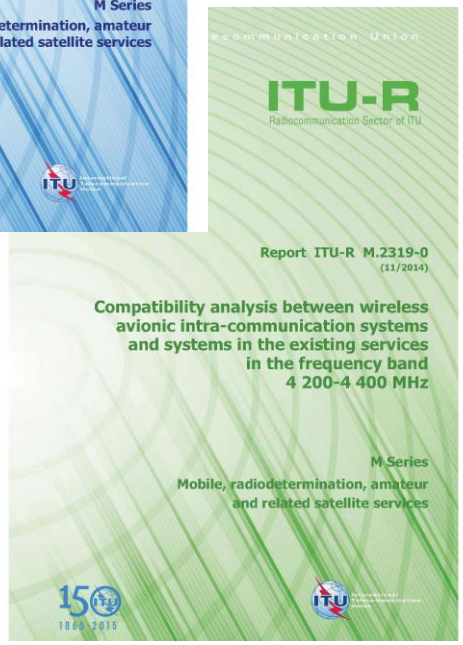
- ITU-R Documents Finalized by Study Group 5
  - Generated for Agenda Item 1.17 in Working Party 5B
- Relevant ITU-R Recommendations and Reports:
  - Recommendation ITU-R M.2059
    - Radio Altimeter Protection Criteria, for non-interference analyses
  - Report ITU-R M.2283 – WAIC Technical Characteristics (replaces M.2197)
  - Recommendation ITU-R M.2067 – WAIC Characteristics (new)
  - Recommendation ITU-R M.[WAIC Conditions] –
    - recommends transmitter PSD limits – but not incorporated in Radio Regs
  - Report ITU-R M.2319 - WAIC_SHARING at 4 200-4 400 MHz
  - Report ITU-R M.2318 – WAIC Bands Studied below 15.7 GHz
  - Report ITU-R M.[WAIC_SHARING_22/23 GHz]
  - *Recommendation ITU-R P.525-2 – free space attenuation (ref)*

Second WAIC Characteristics Report

- Brought to full report status in December 2013
  - More than one year before the 2015 CPM
  - Well In-time to substantiate allocation proposal
- Largely a modification of the first report
  - On ground (airport) multi-aircraft scenario added
  - Airframe compartmentalization model for spectrum reuse
  - On-board RF propagation model used – AVSI measurement campaign and TAMU data analysis
  - Out of aircraft emissions characterized – needed for coexistence studies
- Specific spectrum needs calculated
  - Total of 145 MHz now needed for all classes of WAIC systems
  - Less than the 200 MHz available in radio altimeter band
  - By this time, the team had already abandoned hope for an additional allocation for high data rate systems above 15.7 GHz

Two additional crucial documents





- Protection criteria for radio altimeters
  - Finalized in February 2014
  - Needed to perform compatibility studies
  - Define interference levels that altimeters may tolerate
  - Motivated by WAIC and also by IMT's attempts to get more spectrum
  - Non AVSI radio altimeter data compiled from Rockwell Collins and Thales
- Compatibility study for WAIC operating in 4.2-4.4 GHz
  - Finalized November 2014
  - Mandated by the Agenda Item
  - Interference from WAIC to Radio Altimeters – to demonstrate that altimeter protection criteria may be satisfied by fully functional WAIC
  - Interference from Radio Altimeter to WAIC – to demonstrate that WAIC has a chance to fully function while installed in presence of altimeters
- Once compatibility study was completed, the PMC expert's confidence in new allocation was nearing 99%

WRC-15: New Allocation Approved

MOD

2 700-4 800 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
4 200-4 400	AERONAUTICAL MOBILE (R) ADD 5.A117 AERONAUTICAL RADIONAVIGATION MOD 5.438 5.439 5.440 ADD 5.B117	

ADD

5.A117 Use of the frequency band 4 200-4 400 MHz by stations in the aeronautical mobile (R) service is reserved exclusively for wireless avionics intra-communication systems that operate in accordance with recognized international aeronautical standards. Such use shall be in accordance with Resolution **COM4/1 (WRC-15)**. (WRC-15)

- One of the two Agenda Items completed first – in less than a week
- Controversy and frantic last-minute negotiations about Resolution wording did happen
- AVSI team held a celebratory reception for WAIC supporters

- Aeronautical Mobile Route Service – AM(R)S – was added to 4200-4400 MHz band, in addition to the previously existing Aeronautical Radionavigation Service used by Radio Altimeters
- Only WAIC can use the new AM(R)S allocation
- The new use must be in accordance with internationally recognized aeronautical standards

Resolution COM4/1 (WRC-15)

RESOLUTION COM4/1 (WRC-15)

Use of Wireless Avionics Intra-Communications in the frequency band 4 200-4 400 MHz

The World Radiocommunication Conference (Geneva, 2015),

considering

a) that aircraft are designed to enhance their efficiency, reliability and safety, as well as to be more environmentally friendly;

b) that Wireless Avionics Intra-Communications (WAIC) systems provide radiocommunications between two or more aircraft stations integrated into or installed on a single aircraft, supporting the safe operation of the aircraft;

c) that WAIC systems do not provide radiocommunications between an aircraft and the ground, another aircraft or a satellite;

d) that WAIC systems operate in a manner that ensures the safe operation of an aircraft;

e) that WAIC systems operate during all phases of flight, including on the ground;

f) that aircraft equipped with WAIC systems operate globally;

g) that WAIC systems operating inside an aircraft receive the benefits of fuselage attenuation to facilitate sharing with other services;

h) that Recommendation ITU-R M.2067 provides technical characteristics and operational objectives for WAIC systems,

recognizing

that Annex 10 to the International Civil Aviation Organization (ICAO) Convention on International Civil Aviation contains Standards and Recommended Practices (SARPs) for safety aeronautical radionavigation and radiocommunication systems used by international civil aviation,

resolves

1 that WAIC is defined as radiocommunication between two or more aircraft stations located on board a single aircraft, supporting the safe operation of the aircraft;

2 that WAIC systems operating in the frequency band 4 200-4 400 MHz shall not cause harmful interference to, nor claim protection from, systems of the aeronautical radionavigation service operating in this frequency band;

3 that WAIC systems operating in the frequency band 4 200-4 400 MHz shall comply with the Standards and Recommended Practices published in Annex 10 to the Convention on International Civil Aviation;

4 that No. **43.1** shall not apply for WAIC systems,

instructs the Secretary-General

to bring this resolution to the attention of ICAO,

invites the International Civil Aviation Organization

to take into account Recommendation ITU-R M.2085 in the course of development of SARPs for WAIC systems.

Key points of the Resolution

1. WAIC is defined as stations on-board a single aircraft and supporting safe operation of aircraft
2. WAIC must give protection and precedence to radio altimeters
3. WAIC must comply with ICAO SARPS – hence SARPS must be first developed

AFE 76: Preparing WAIC Standard

- New AFE to define protocol requirements was proposed by Goodrich as early as June 2008
  - Other members hesitant to commit resources
  - Prefer to waiting until new allocation is quite certain
  - Proposal revisited regularly every year
- AFE 76 kicked-off in August 2014
  - Key PMC experts 99% sure there would be an allocation for WAIC
  - Membership largely overlapping with AFE 73
  - Joint AFE 73/76 telecons and workshops as a matter of convenience
- Goals
  - Define a set of protocol requirements for WAIC
  - Enable future development of "internationally recognized international aeronautical standards"

Final AFE 73 membership

Airbus
Boeing
BAE Systems
Embraer
Honeywell
UTC

AFE 76 members

Airbus
Boeing
Embraer
Honeywell
UTC
GE Aviation
HARCO
Rockwell Collins
NASA

- Current AFE 76 period of performance is through 12/31/2016
- Supplement 1 will be requested to support ICAO, RTCA, EUROCAE processes and to define more detailed protocol requirements

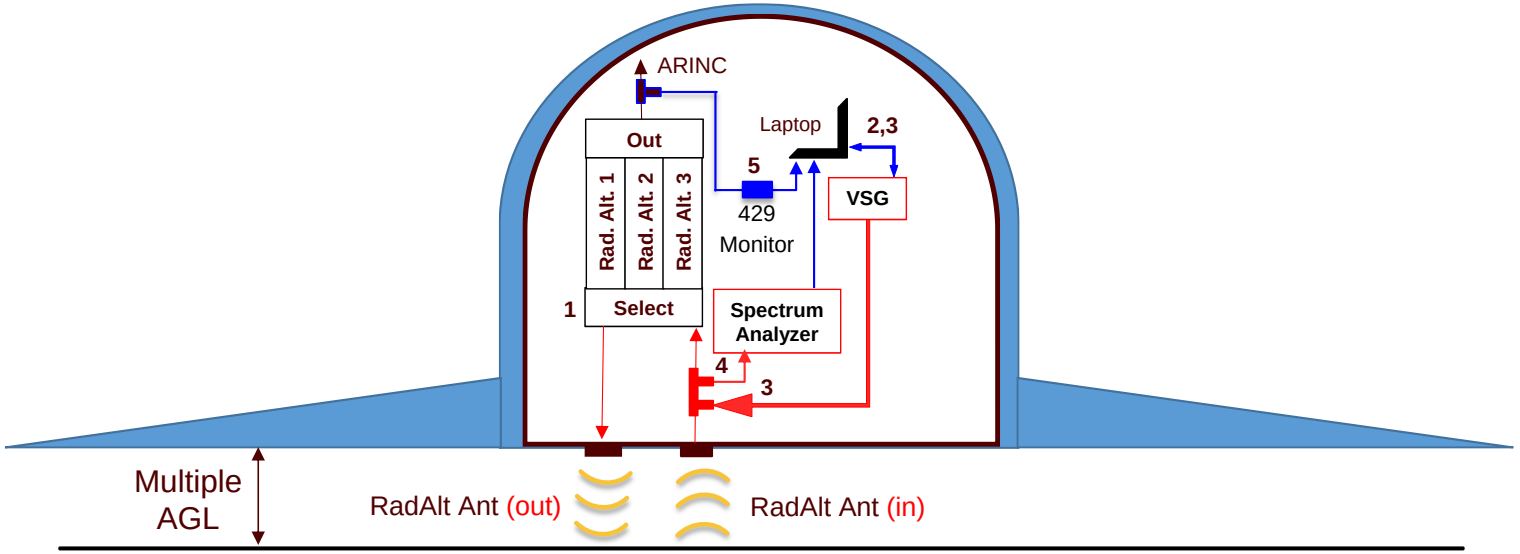
AFE 76: Current Status

- Initial versions of a Concept of Operations and Protocol Requirements documents completed, with updates planned.
- Continued modeling and analysis to develop the characteristics and requirements on WAIC nodes and networks
- Radio altimeter interference testing planned to begin this month. Laboratory testing will be conducted at Texas A&M and flight testing at NASA in November to characterize mutual interference of radio altimeters and candidate WAIC protocols.
- Simultaneous promotion and support of regulatory framework that will enable certification through ICAO, EUROCAE, and RTCA as directed by the ITU.

Design Evolution of WAIC Systems

- Extensive Laboratory Testing of Radio Altimeter Sensitivity to Interference
  - Concludes that accuracy remains within required limits
  - Directional antenna controls are not necessary
- MATLAB modeling and simulation of WAIC and Altimeter interactions for protocol development
- Identify hardware implementation approaches
  - Consider COTS chipsets, SDR availability in band
  - Consider passive (reflective) designs for low power
    - Goal is to get to energy harvested power, long-life battery
- Develop PHY/MAC/net protocols on prototypes
- Include security protections, safety issues

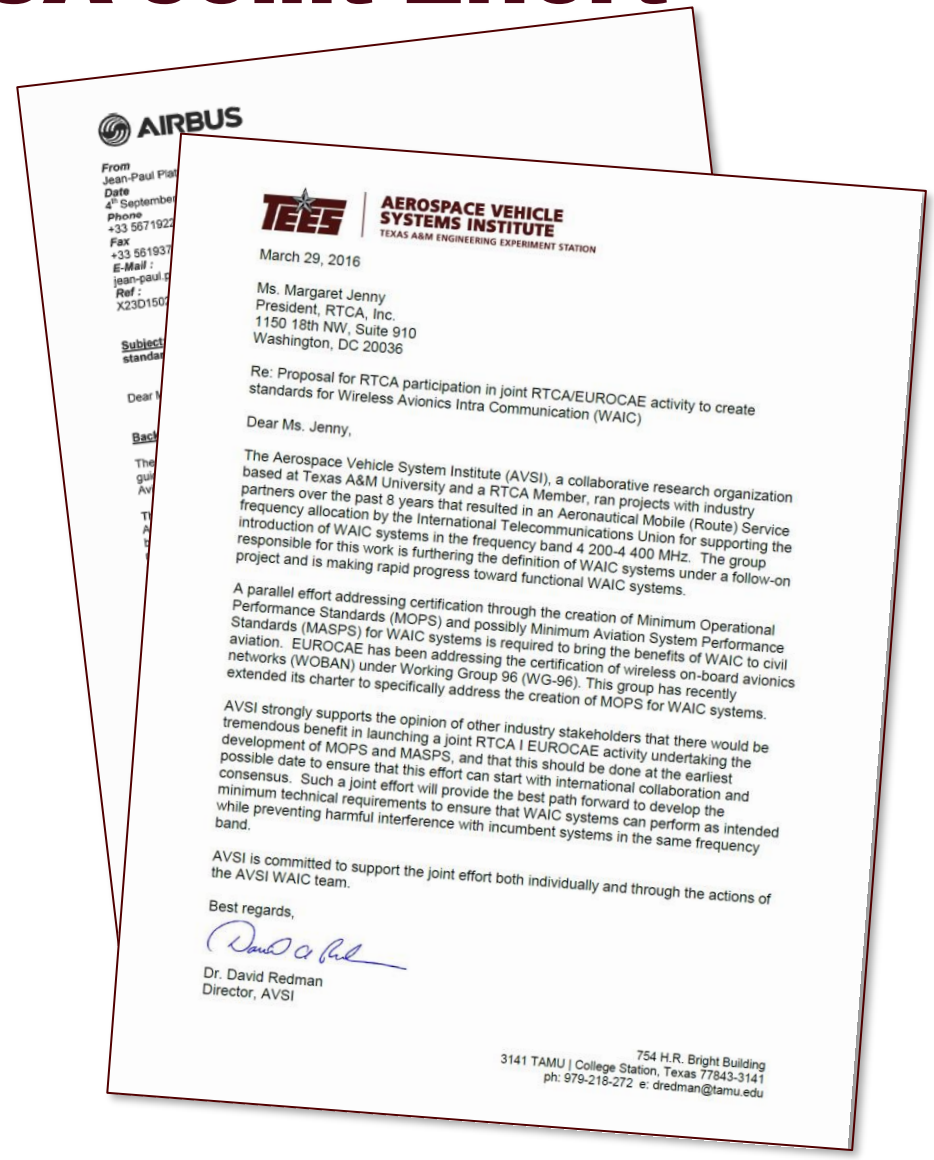
Initial Flight Testing with NASA



- Laboratory testing using optical delay lines to simulate range will be primarily used for WAIC protocol development
- Initial flight testing at Armstrong Flight Research Center planned for November will validate the laboratory testing and provide data needed to guide regulatory standards development
- Additional flight testing planned in 2017 under follow-on project

EUROCAE / RTCA Joint Effort

- EUROCAE and RTCA have formed a joint committee to develop a Minimum Operational Performance Specification (MOPS).
- EUROCAE extended the charter of Working Group 96 (WG-96) to develop a WAIC MOPS.
- AVSI WAIC member companies urged the US FAA to initiate a new Special Committee to develop a WAIC MOPS.
- RTCA established a Special Committee (SC-236) to develop the MOPS within two years.
- Terms of Reference establish these as a joint effort to cover both Europe and the US with a single document.



AIRBUS

AEROSPACE VEHICLE SYSTEMS INSTITUTE
TEXAS A&M ENGINEERING EXPERIMENT STATION

March 29, 2016

Ms. Margaret Jenny
President, RTCA, Inc.
1150 18th NW, Suite 910
Washington, DC 20036

Re: Proposal for RTCA participation in joint RTCA/EUROCAE activity to create standards for Wireless Avionics Intra Communication (WAIC)

Dear Ms. Jenny,

The Aerospace Vehicle System Institute (AVSI), a collaborative research organization based at Texas A&M University and a RTCA Member, ran projects with industry partners over the past 8 years that resulted in an Aeronautical Mobile (Route) Service frequency allocation by the International Telecommunications Union for supporting the introduction of WAIC systems in the frequency band 4 200-4 400 MHz. The group responsible for this work is furthering the definition of WAIC systems under a follow-on project and is making rapid progress toward functional WAIC systems.

A parallel effort addressing certification through the creation of Minimum Operational Performance Standards (MOPS) and possibly Minimum Aviation System Performance Standards (MASPS) for WAIC systems is required to bring the benefits of WAIC to civil aviation. EUROCAE has been addressing the certification of wireless on-board avionics networks (WOBAN) under Working Group 96 (WG-96). This group has recently extended its charter to specifically address the creation of MOPS for WAIC systems.

AVSI strongly supports the opinion of other industry stakeholders that there would be tremendous benefit in launching a joint RTCA I EUROCAE activity undertaking the development of MOPS and MASPS, and that this should be done at the earliest possible date to ensure that this effort can start with international collaboration and consensus. Such a joint effort will provide the best path forward to develop the minimum technical requirements to ensure that WAIC systems can perform as intended while preventing harmful interference with incumbent systems in the same frequency band.

AVSI is committed to support the joint effort both individually and through the actions of the AVSI WAIC team.

Best regards,

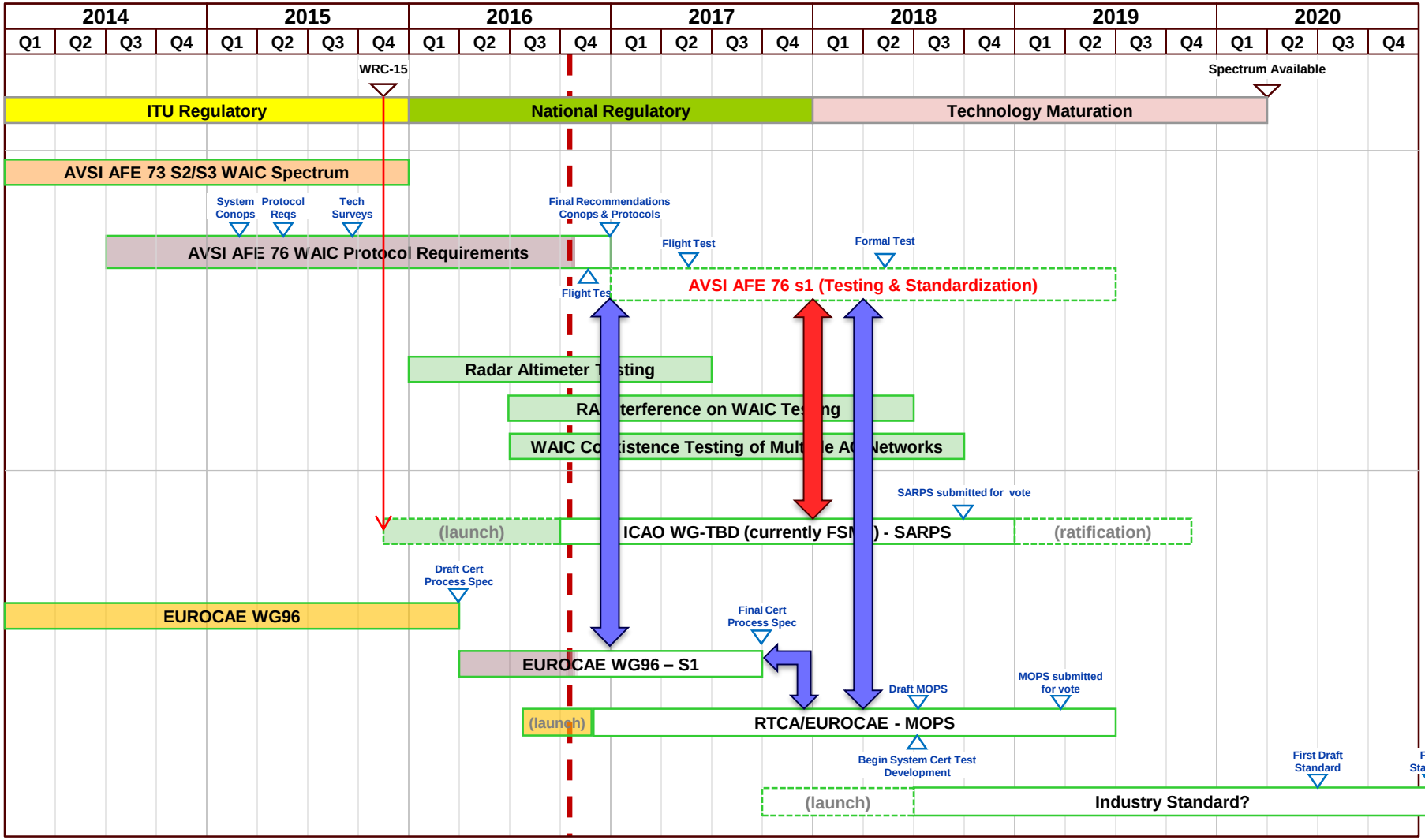
Dr. David Redman
Director, AVSI

754 H.R. Bright Building
3141 TAMU | College Station, Texas 77843-3141
ph: 979-218-272 e: dredman@tamu.edu

Support of ICAO Standards

- As directed by the ITU resolution, the AVSI WAIC team initiate an effort within the International Civil Aviation Organization (ICAO) to develop a WAIC Standards and Recommended Practices (SARPs) Document
- This will require a minimum of 2 years to develop (ICAO, like ITU is a treaty organization)
- SARPs will be limited to governing *inter-aircraft coexistence requirements*.
- Detailed performance requirements for intra-aircraft will be covered in the MOPS

WAIC Roadmap



Conclusions

- WAIC On-board wireless technology for safety services will benefit the airlines and aerospace industry.
- Safety will be enhanced, and not compromised.
- ITU, ICAO, ATU, CITEL, APT, CEPT, ASMG, RCC and aviation groups are all supportive and being updated.
- The ITU-R and WRC 2015 effort is the first to identify, analyze, justify and develop/prove WAIC concepts
- The high level the ability for WAIC to use (share) the 4200-4400 MHz frequency band was approved at WRC-15
- Significant analysis & strawman system design has been done that proves WAIC has the potential to meet aircraft needs, as well as RF community co-existence
- Network Protocols and Requirements Definition and System Design on AVSI AFE 76 are underway following the successful WRC2015
- ICAO and RTCA framework and technical expertise in generating SARPS and MOPS will steer WAIC towards enabling future aircraft certification efforts

The AVSI WAIC Team

Core Participants		Supporting Participants	
Airbus	Uwe Schwark, Thomas Meyerhoff, Peter Berwing	BAE Systems	Robin Davies
Boeing	Joe Cramer, Kim Kolb, Scott Marston, Dave Kirkland	Bombardier	Fidele Mopfouma
Embraer	Fernando Luiz, Aristides Cintra	GE Aviation	Luke Bolton
Honeywell	Michael Franceschini	Gulfstream	Simón Colmenares
UTC	Radek Zakrzewski, Christopher Fitzhugh	Sikorsky	Brian McCabe
		Texas A&M	Scott Miller, Greg Huff

Thank You!

- Questions?
- Dave Redman
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  - 979-218-2272

WAIC
WIRELESS AVIONICS
INTRA-COMMUNICATIONS