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SHORT COMMUNICATION

Communication Management Unit : Single Solution of Voice and Data Routing Unit

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ABSTRACT

Challenges faced by present avionics systems are low weight, less power, low volume, high mean time between failure and low mean time to repair. This paper is a feasibility study for single solution of voice and data switching/routing unit. This paper presents a new architecture for voice and data switching unit in the form of communication management unit. The proposed solution is obtained on integrated modular avionics architecture using commercial-off-the-shelf hardware. A single board computer is used as a processing engine with add-on audio boards to convert analog voice input and output signals into digital signals.

Keywords: Voice communication, data communication, voice routing switching unit, data routing switching unit

NOMENCLATURE

ACARS	Aircraft communications addressing and reporting system
ADF	Automatic direction finder
AOC	Aircraft operation centre
ATC	Aircraft traffic control
ATCAS	Automatic traffic collision and avoidance system
ATN	Aeronautical telecommunication network
CMU	Communication management unit
COTS	Commercial-off-the-shelf
CPDLC	Controller pilot data link control
DME	Distance measuring equipment
FMS	Flight management system
GPWS	Ground proximity warning system
H/W	Hardware
IMA	Integrated modular avionics
i2 s	Integrated IC sound
IVHM	Integrated vehicle health management
PTT	Press to talk
SATCOM	Satellite communication
SPI	Serial peripheral interface
VDL	VHF data link
VHF	Very high frequency
VME	Versa module europa
VOR	VHF omni range
V/UHF	Very/Ultra high frequency

1. INTRODUCTION

Present day aircraft communication is dominated by voice communication in all phases of flight. At present, two separate units are used for voice and data routing of an aircraft[1,2]. New aircraft which is applying for design approval from 2011 shall have controller pilot data link control (CPDLC) capabilities if, its flight envelop is above 285[3]. As per, ‘Final communications operating concept and requirements draft version 0.2’, data link is going to be primary means of communication in near future[4]. Network enabled data communication operations help in collaborative decision making (CDM), safety and security. All forms of communication in near future will be dominated by the data. Voice communication will be used only in critical situations. Role of communication system will shift from voice communication to more data communication. Voice system may become redundant. Under these circumstances, it makes sense to switch from two switching/routing units, one for voice switching/routing unit and one for data switching/routing unit to one switching/routing system to save dead weight, power and volume. This paper proposes a new solution for integrating voice and data routing.

2. VOICE AND DATA REQUIREMENTS

Voice communications are received from aircraft traffic controller (ATC), aircraft operation centre (AOC), side tone, intercom, warning tones and navigational tones. Typically, an aircraft has three communication radios such as V/UHF radio 1, V/UHF radio 2 (UHF for military platform) and SATCOM (voice). These radios require PTT signal and MIC input for transmission and at any one point only one is used for voice communication. Selection of the radio depends upon the pilot selection from cockpit via remote controller or mission controller.

Warning tones are received from different equipments such as ground proximity warning system (GPWS), automatic traffic collision and avoidance system (ATCAS), missile warning system and radar warning receiver (military platform).

Navigation tones are received from en-route navigational aids such as TACAN or distance measuring equipment (DME), automatic direction finder (ADF) or VHF omni range (VOR),

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instrument landing system (ILS).

Various audios are received from radio1, radio2, SATCOM, warnings and tones are summed and are routed to pilot's and co-pilot's headset via audio routing unit. Generally, guard audio is summed with receive audio (LCA, SU 30 MKI, Jaguar, ALH, LUH) at radio itself, as the same radio is housing both the guard receiver and the main receiver. Therefore, additional audio channel for Guard is not required at audio summing unit. Side tone is also routed on the same audio channel from radio set. Side tone is generated during the transmission to provide virtual feel to the pilot that the radio is working. Pilot can adjust the volume of each audio, warning and tone channel by selecting the appropriate knob on remote controller. PTT signal is routed as a discrete signal. Audio routing unit receives the commands such as volume control for each channel and the radio selection via avionics bus. Voice is also routed to cockpit Voice Recorder.

Data are received from ATC, AOC and on-board passenger system. Data is generally received on VHF data link (VDL) equipments such as CPDLC, VDL mode 2 and VDL mode 4. Data provides aircraft status such as pre engine start, passenger boarding, taxing, takeoff, cruise, landing, passenger de-boarding, and apron movement. Data is routed to a flight management system (FMS) or a dedicated display unit installed in the cockpit. Data is also exchanged between integrated vehicle health management (IVHM) unit and AOC using aeronautical telecommunication network (ATN). Cooperative network as used in military applications for exchanging mission or surveillance information among the cooperating platform is not considered as a requirement in this paper.

Requirements as functional, non functional, performance and interface[5] are represented as fishbone diagram in Fig. 1.

3. DETAILED DESIGN AND ARCHITECTURE

The proposed communication management unit (CMU)[6] treats analog voice as a digital data and takes all the routing decision in digital domain. A simple algorithm[7] is used for decision making, based on the command which is received on the avionics bus. Two logical processing blocks are used, one is dedicated for audio routing and second block is dedicated for data routing as shown in Fig. 2.

Four audio channels are required for navigation and warning tones as captured during the requirement analysis. These are provided by CODECs which convert the analog audio into the digital data. Volume is controlled by adjusting the codec gain. CMU configuration commands such as volume control and radio selection are received via avionics bus. CMU passes PTT discrete input to the required radio. The summed audios are routed to pilot's, co-pilot's and cockpit voice recorder.

Data processing block decides the data routing for FMS, IVHM system, data recorder and display screen based on the input from controller (pilot or co-pilot). Data from FMS, IVHM, recorder and display are routed through avionic bus. In-flight telephone, internet and entertainment data which are received from SATCOM are routed to cockpit controller. Cockpit controller further routes the data to the intended users. Fig. 2 illustrates signal inputs, signal outputs and processing blocks of CMU.

The proposed architecture is for IMA and in case of line replacement unit (LRU), an additional card is required for providing interface to different avionic buses such as ARINC or MIL 1553 B, depending upon the civil or military platforms. CMU interfaces consist of discrete lines, analog lines and digital lines. Digital lines are interfaced through versa module europa (VME) back plane. Audio interface is done through matching

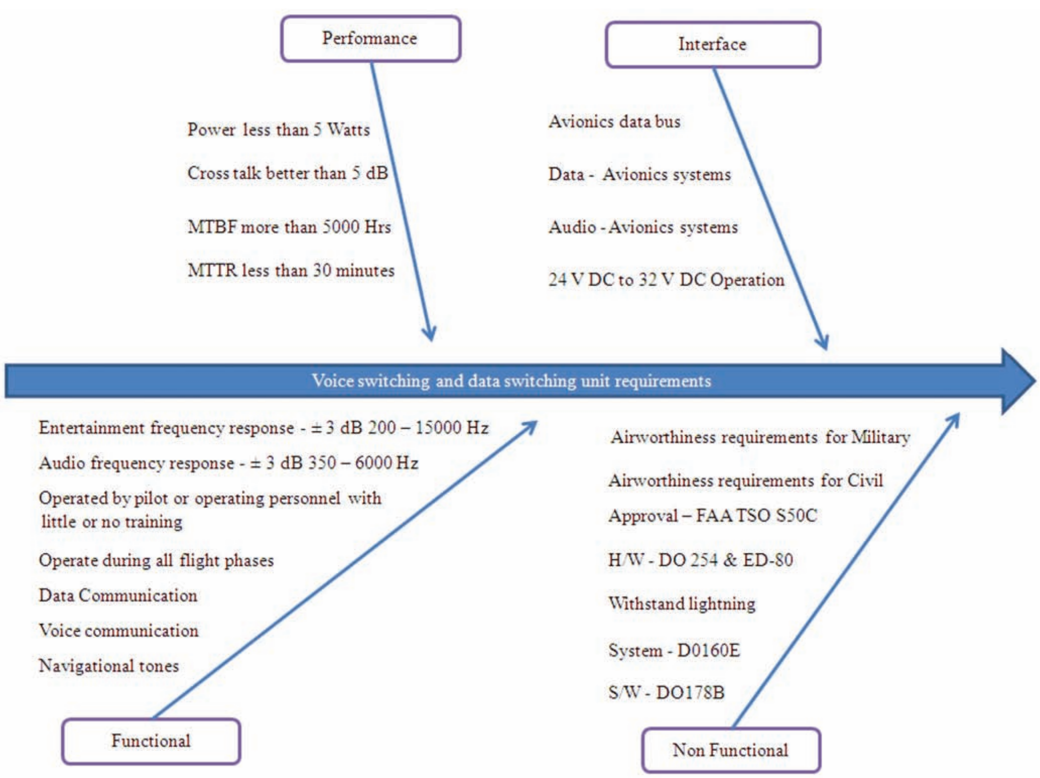


Figure 1. Fishbone diagram for voice and data requirement on an aircraft.

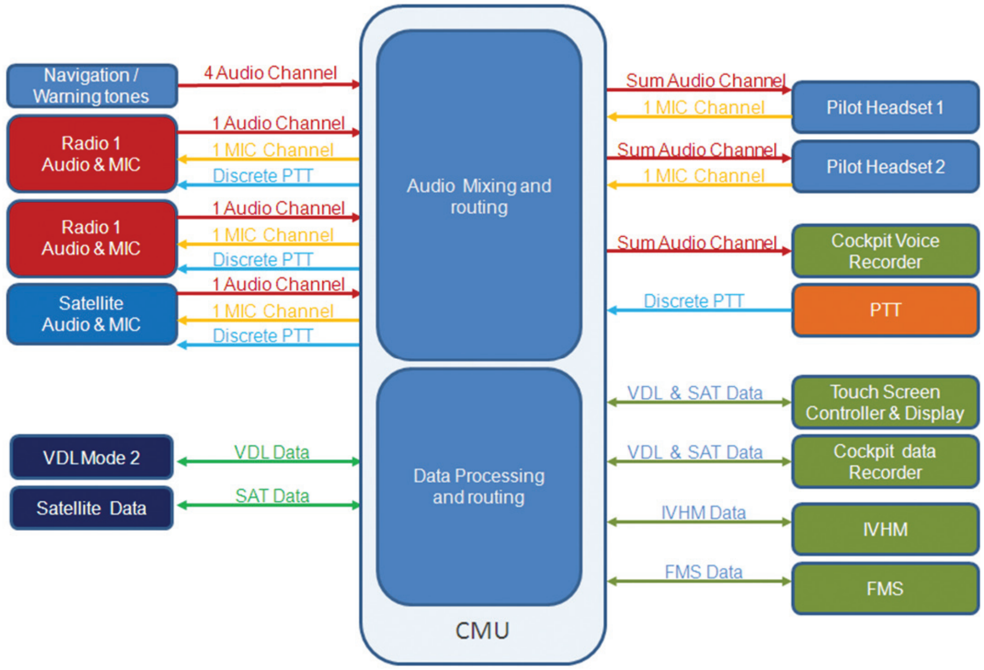


Figure 2. Communication Management Unit interface block diagram.

unit and codec unit. Matching unit takes care of audio impedance matching of 150 Ω or 600 Ω. Total requirement of the audio channels are 10 as shown in Fig. 2. I/O ports provide discrete input and output for PTT. MIC is routed as analog line to all radios. The proposed CMU architecture is shown in Fig. 3.

The CMU integration with avionics bus is shown in the Fig. 4.

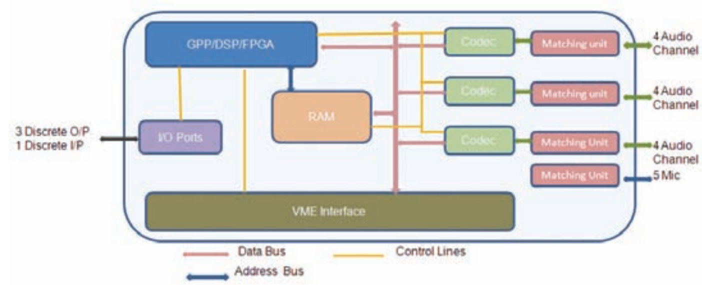


Figure 3. CMU architecture.

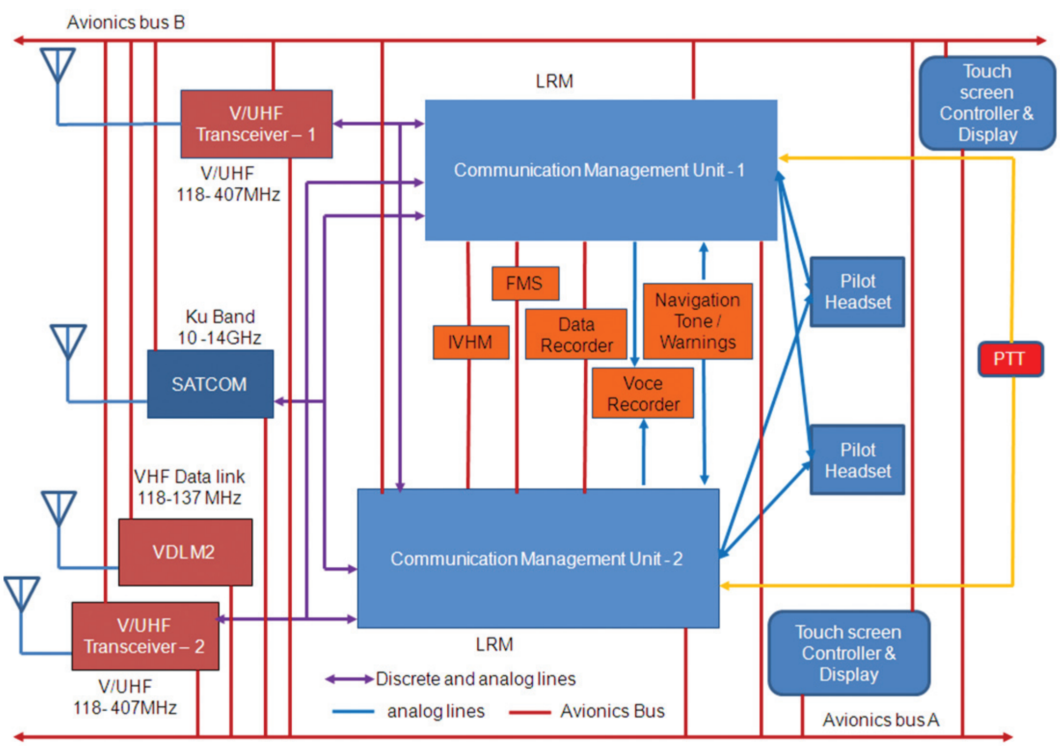


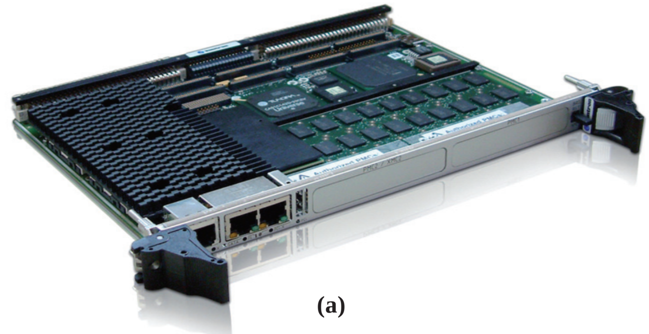
Figure 4. CMU integration on avionics bus.

4. HARDWARE IMPLEMENTATION

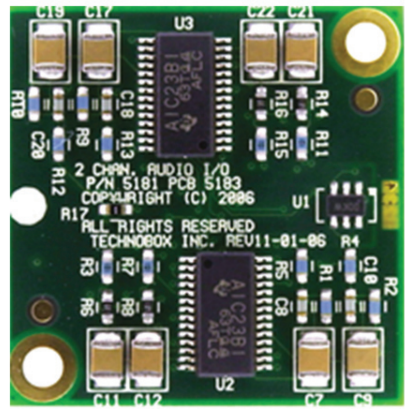
Hardware implementation of the proposed architecture is achieved using COTs H/W. Main board (processing block, Fig. 5 (a)) is a PENTEXM4 single board computer. Its processing speed is 1.67 GHz and RAM is 4 GB. Serial ports are used to generate discrete inputs and outputs. Audio acquisition is done by audio card (add-on board Fig. 5(b)). The audio card is selected from M/s Technobox and specification is tabulated in Table 1. TLV 320 CODEC is used in the board which provides gain adjustment from - 34.5 dB to 12 dB in step of 1.5 dB. Codecs are connected through Integrated IC sound (i^2 s) audio protocol and serial peripheral interface (SPI) protocol. Each audio card has two stereo channels. Each stereo channel is programmed as two independent input and output channels. Therefore, each audio card supports 4 audio channels. Requirement of ten audio channels is achieved by using three audio cards. Method used for audio summing is same as used in the development of remote control unit (RCU) and interface control unit (ICU) for ground based radio control[7]. Audio is routed to the pilot headset from the CMU is analog audio as the codec again converts digital audio into analog audio.

Table 1. Audio card characteristic

Characteristic	Value/Comments
Input/Output	Analog
Sampling rate	48 KHz to 96 KHz
Channel	2 Stereo
Gain	-34.5 dB to 12 dB in 1.5 dB step with mute
SNR	90 dB
Interface (Electrical)	Refer data sheet



(a)



(b)

Figure 5. CMU boards (a) Main board[8] , (b) Audio card (Add-on board)[9].

Figure 6 shows the location of audio card on the main board. Four audio boards are placed on the main board to support any future requirement of additional audio channel (upto six).

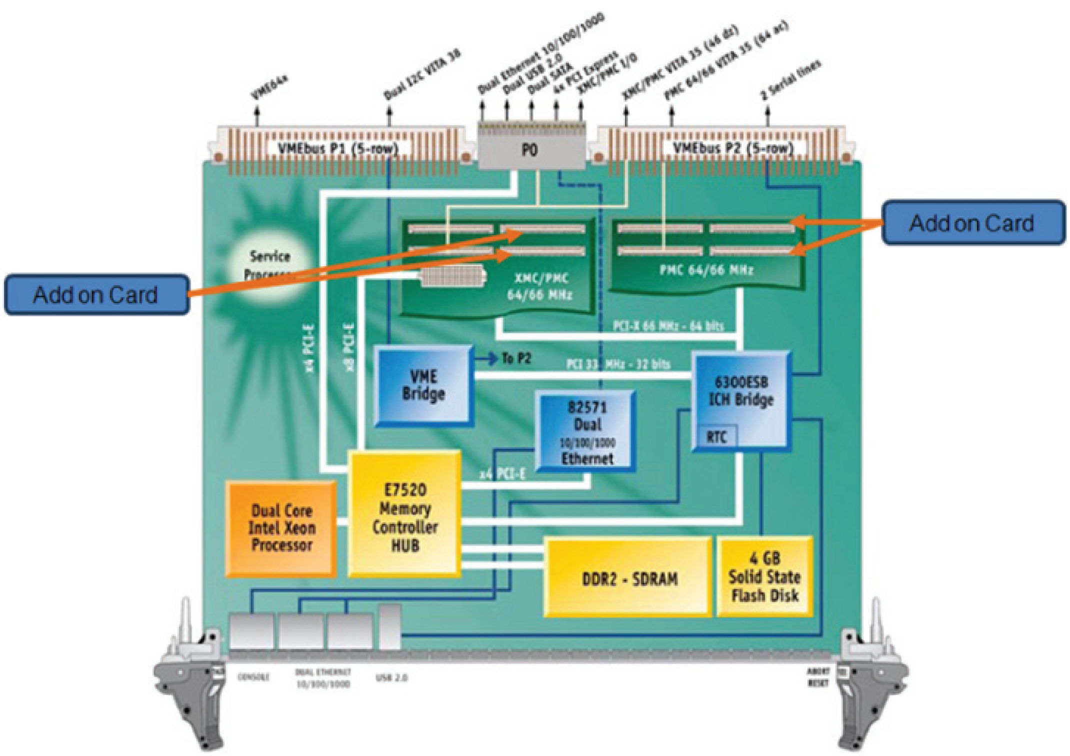


Figure 6. Location of add on board (audio card).

5. CONCLUSION

This paper presents a single solution for voice and data routing required for an aircraft. This architecture reduces the number of hardware, dead weight, volume and power requirements on an aircraft. The proposed solution can be used for any avionics architecture and avionics bus.

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