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## **VDL-M2** Overview

W-CODE software contains a new mode, VDL Mode 2, which is intended to become the replacement for the now ageing, low speed ACARS. For many years, ACARS has been the work horse of air-ground/ground-air VHF data communications. However, global increase in air travel as well as the demand for more bandwidth hogging data applications has also led to an increase in the demand for aeronautical VHF communication channels. In addition ACARS is constrained to 7-bit character orient-

ed data, whereas VDL-M2 natively is bit-oriented. To comply with this demand, aeronautical voice channel band-width has been decreased to 8.33 kHz and new data modes has been considered which will replace some of the voice applications with data applications and thus relieve the congested radio spectrum and improve safety. One result of these considerations has been the introduction of VHF Data Link Mode 2, VDL Mode 2, which is meant to eventually replace ACARS.



Fig. 1 ARINC European VDL-M2 coverage

The overwhelming majority of both ACARS and VDL -M2 networks are operated by two private companies, the US based ARINC (Aeronautical Radio, Inc.) and the Euro-pean-based SITA (Societe Internationale de Telecommunications Aeronautiques), a data communication co-operative owned by the air lines. Both com-panies operate what is probably the largest private network in the world serving all



Fig. 2 SITA European VDL-M2 coverage

airports and air lines with AOC (Airline Operational...) traffic as well as ATS traffic.

At the time of writing more than 2500 aircraft world-wide have been equipped with VDL-M2 equipment, and the number of VDL-M2 ground stations are increasing on all continents with Western Europe as the most densely covered area.

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### **VDL-M2** Architecture

VDL-M2 supports connectivity to the Aeronautical Telecommunications Network ATN), the Internet of civil aviation authorities. It is also capable of transmitting ACARS messages as ACARS-Over-AVLC (AOA), AVLC (Aviation VHF Link Control) being the Data Link layer of the VDL-M2 protocol stack. The ATN provides an architecture which basically sees a VDL-M2 station onboard an aircraft as just another node in the ATN, a router in sky so to speak.



Fig. 3 SITA's ATN/VDL-M2 service by Eurocontrol



Fig. 4 Basics system architectur

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### **VDL-M2 Protocol stack**



VDL-M2 handles the two lower layers and part of layer three of the OSI seven layer protocol stack.

Layer 1, the physical layer, uses differential 8-phase modulation at a symbol rate of 10.5 ksps or 31.5 kbps (eight phase states yield 3 -bit symbols). In Europe a common signaling frequency has been allocated to VDL-M2, 136.975 MHz on which all stations must transmit their identification messages. This protocol layer is also responsible for bit interleaving and scrambling.

Fig. 5 VDL-M2 Protocol stack

*Layer 2*, the data link layer, has two sub-layers. One is the MAC (Media Access Control) implements the CSMA (Collision Sense Multiple Access) algorithm – the radio listens to the channel and if it is free it transmits; if not it retries after a random interval. There is no priority mechanism in VDL-M2.

The second Data Link sub-layer called AVLC (Aviation VHF Link Control) uses a HDLC-like proto-

col. This layer is responsible for error detection, sequencing and addressing.

*Layer 3*, the network layer, is partly implemented using the ISO 8208 protocol (X.25 Packet Layer Protocol) and acts as adaptive layer which for instance reassembles packets delivered by the data link layer.

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The ICAO VDL Mode 2 standard specifies the use over a VHF link of a Differentially Encoded 8-Phase Shift Keying (D8PSK) modulation scheme providing a data rate of 31.5 kbps, compared with the VHF ACARS rate of 2.4 kbps in the same channel width of 25 kHz.

The VDL Link Layer protocol specifies a Carrier Sense Multiple Access (CSMA) algorithm similar to VHF ACARS. The combination of the VDL D8PSK scheme and its CSMA algorithm provides for a greatly enhanced data load of 31.5 kbps, compared with classic VHF ACARS maximum effective link capacity of just 300 bps.

Fig. 6 VDL-M2 D8-PSK modulation

The radio burst consists of a burst header and a data section. Data is protected by interleaving and a Reed-Solomon Forward Error Correction (FEC) code. A special FEC protects the burst header.





Fig. 7 VDL Mode 2 radio burst

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Layer 3, the network layer, is partly implemented using the ISO 8208 protocol (X.25 Packet Layer Protocol) and acts as adaptive layer which for instance reassembles packets delivered by the data link layer.

Flag	Header AVLC	User Data	CRC	Flag
		The link layer adds 13 bytes : • 8 for adressing, • 1 for control, • 2 for the control sum, • 2 frame limiters		
Heade	er 8208	User Data		
		Layer 8208 adds 3 bytes : • 2 for identification of the connection • 1 for control		
		Data (from a BIS)		

Fig. 8 VDL-M2 user data envelopes

Example of an ACARS message sent via VDL-M2 (AOA) and decoded by W-CODE

File HF-Modes VHF/UHF-Modes Satellite Modems	<u>Options Favorites Setup View Window H</u> elp		
DL-M2 Baudrate: 10500.00	Sync 14:51:20		
0Hz , , 0Hz	56 48 28 ↔ → ☶ 團團₩₩	1/1 2	
2 W-CODE Text - Card 4		a X	
RR - Receive Ready N(r)= 1			
Source : 0x400D5A (Aircraft) - A			
Dest. : 0x10902A (Ground Statio	AV/I C anataral		
COMMAND FRAME	AVLC protocol		
INFO $N(s) = 1 N(r) = 1$			
ACARS Message			
Mode: 2			
Address: .G-DBCG			
Technical Ack: NAK			
Label: 5U	ACARS protocol	ACARS protocol	
Block Identifier: 6			
M31ABD467M 01 WXRQ 467M/05 EG	G-DBCG		
/TYP 1/STA LIPZ/STA LIPH/STA LIP			
<		•	
emodulator: IQ PB Bandwidth: 19000 Hz	Translation: 10000 Hz Input: vdl-m2	Res	

Fig. 9 VDL-M2 Message with AVLC- and ACARS protocol

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This example shows a ground station GSIF (General Station Information Frame) frame:

ile HF-Modes VHF/UHF-Modes Satellite Modems Demodulator Options DL-M2 Baudrate: 10500.00 INV	Sync 15:00:12
	M & ? № ← - → E
W-CODE Text - Card 4	
Source : 0x2D4918 (Ground Station) - GROUND Dest. : 0xFFFFFF (Aircraft) (Broadcast) COMMAND FRAME XID - Exchange Identification Public Parameters: Parameter set ID: 8885:1993	
Procedure Classes: 0x00 0x01 HDLC Options: 0x20 0XA4 0x88 Private Parameters: Parameter set ID: V AVLC specific options: 0x20 Airport coverage: LSZH ATN router NETs: 0x53 0x49 0x54 0x00 0x00 0x0 System mask: 0x94 0x00 0x00 0x00	AVLC protocol
Ground station location: 47.5N 8.6E	•

Fig. 10 VDL-M2 Message with AVLC protocol

VDL-M2       Baudrate: 10500.00       INV       Sync       15:29:04         0Hz       0Hz       0Hz       Hz       H	
W-CODE Text - Card 4     Image: Constant of the second secon	
Source : 0x47806D (Aircraft) - AIRBORNE Dest. : 0x10981A (Ground Station) COMMAND FRAME INFO N(s)= 0 N(r)= 0 ISO 8208 X.25 protocol	8
Dest. : 0x10981A (Ground Station) COMMAND FRAME INFO N(s)= 0 N(r)= 0 ISO 8208 X.25 protocol	
INFO $N(s) = 0$ $N(r) = 0$ ISO 8208 X.25 protocol	
0x1B 0xFF 0x0B 0x80 0x21 0x70 0x01 0x55 0x13 0x42 0x0A 0x0A 0x43 0x04 0x04 0x01	
0x80 0x00 0x0F 0xc9 0x07 0x8c 0x58 0x41 0x41 0x02 0x00 0x9B 0xc1 0x06 0x01 0x00	
0x00 0x23 0x80 0x00 0x82 0x1E 0x01 0x00 0x04 0x00 0x1E 0x00 0x00 0x14 0x47 0x00	
0x27 0x41 0x53 0x41 0x53 0x00 0x47 0x80 0x6D 0x00 0x01 0x00 0x00 0x00 0x00 0x00	
0x01 0x00 Source : 0x47806D (Aircraft) - AIRBORNE ISO 9542 ES-IS protocol	
emodulator: IQ PB Bandwidth: 19000 Hz Translation: 10000 Hz Input: vdl-m2	Re

Fig. 11 VDL-M2 ATN ISH packet (Intermediate "Say Hello")

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Fig. 12 Configuration for optimal VDL-M2 decoding results

W-CODE accepts input from the host built-in sound card, a number of SDRs, digital audio outputs, WAV files, I/Q data or TCP/IP streams. W-CODE provides all functions required to analyze, decode and process radio data communications throughout the radio spectrum from HF, VHF, UHF to SHF.

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Since more than thirty years Wavecom Elektronik AG has developed, manufactured and distributed high quality devices and software for the decoding and retrieval of information from wireless data communication in all frequency bands. The nature of the data communication may be arbitrary, but commonly contains text, images and voice. The company is internationally established within this industry and maintains a longstanding, world-wide network of distributors and business partners.

### **Product Information**

Products	http://www.wavecom.ch/product-summary.php	
Datasheets	http://www.wavecom.ch/brochures.php	
Specifications	http://www.wavecom.ch/product-specifications.php	
Documentation	http://www.wavecom.ch/manuals.php	
Online help	http://www.wavecom.ch/content/ext/DecoderOnlineHelp/default.htm	
Software warranty	One year free releases and bug fixes, update by DVD	
Hardware warranty	Two years hardware warranty	
Prices	http://www.wavecom.ch/contact-us.php	

#### **System Requirements**

	Minimum	Recommended
CPU	Core i5 or Core i7 2.8 GHz	Core i7-6700 3.4 GHz
Memory	4 - 8 GB RAM	16 - 32 GB RAM
OS	Windows 7	Windows 10 32-bit or 64-bit

#### **Distributors and Regional Contacts**

You will find a list of distributors and regional contacts at <u>http://www.wavecom.ch/distributors.php</u>



WAVECOM ELEKTRONIK AG 8090 Zurich, Switzerland E-Mail: sales@wavecom.ch Internet: www.wavecom.ch

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