An introduction to physical layer of VHF Data Exchange System (VDES)

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Abstract. The extended use of AIS (*Automatic Identification System*) and its bandwidth limitation are critical troubles for VHF channels saturation. To solve this, IMO and other organizations have proposed a new standardisation called VDES (*VHF Data Exchange System*), that includes the AIS and other services both for terrestrial and satellite links. In this paper, an overview about the VDES is presented, focusing on the main aspects about the physical layer in comparison with AIS features.

Keywords: AIS (*Automatic Identification System*) · ASM (*Application Specific Messages*) · e-Navigation · VDES (*VHF Data Exchange System*)

AIS (*Automatic Identification System*) is an open marine communication system, stablished as mandatory by IMO (*International Maritime Organization*) in 2003, which allows to know and share a lot of parameters about the vessels (location, speed, course, identifier, destiny and origin ports) [1]. This system works in VHF (*Very High Frequency*) band over two frequencies, AIS-1 (161.975 MHz) and AIS-2 (162.025 MHz), with channel spacing of 25 KHz and a baud rate of 9600 bps. It uses a FM-GMSK (*Frequency Modulation – Gaussian Minimum Shift Keying*) modulation, NRZI (*Non-Return to Zero Inverted*) line coding and diverse TDMA (T*ime Division Multiple Access*) schemes [2], able to organize the medium access of the stations with a low probability of packet collision.

The usage of AIS has been extended in recent years, and many users have adopted the AIS despite they have not to comply the IMO regulation. Although the AIS has many virtues (robustness, long range, low cost), there exist some problems associated with it. One of them is the bandwidth [3], which affects in some coastal areas where there is an overload of AIS channels. The other problem is regarded with security [4], because AIS is susceptible to be spoofed or used to support illegal operations because of encryption mechanisms are not included.

In regards to the AIS problems, VDES (*VHF Data Exchange System*) is conceived as an evolution of AIS. This new standardization allows to share data between vessels, shore stations and satellites. The maximum priority is assigned to AIS, but also integrates three new services: ASM (*Application Specific Messages*), VDE-TER (*VHF Data Exchange for Terrestrial stations*) and VDE-SAT (*VHF Data Exchange for Satellite stations*) [5]. Moreover, all of these services are allocated in different channels.

The physical layer in VDES presents new adaptive modulation and coding schemes [6]. In case of ASM and VDE-TER, a $\pi/4$-QPSK modulation is used, but also VDE-TER can use two additional schemes: 8-PSK and 16-QAM. For these modulations, different coding rates are used in function of services neccesities in terms of baud rate. However, the main improvement of VDES with respect to AIS is the increase of the bandwidth [7]. As it is shown in Table 1, the ASM baud rate is twice as much as the AIS baud rate, and VDE baud rate can reach eight times the AIS baud rate.

Table 1. Bandwidth comparison between VDES services

Services	Max. baud rate (bps)	Channel spacing (KHz)	Number of channels
AIS	9600	25	2
ASM	19200	25	2
VDE-TER	307200	25, 50, 100	8
VDE-SAT	307200	25, 50, 100	8

In conclusion, VDES will be not only the next evolution of AIS, but an expansion of AIS capabilities for the new generation of maritime communications that will concur in the e-Navigation technologies. In this paper, the main features of VDES physical layer are presented, and a comparison between AIS and VDES bandwidth is shown.

Acknowledgements

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