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Research and Implementation of Automatic Ship Identification System for Network Performance

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Abstract: Automatic identification system is a kind of vessel monitoring systems and affiliated areas in wireless mobile communication network. Its network performance is a key problem in study and application of AIS. AIS as a nautical technology, which quickly reflects both objective and urgent needs of development, is also very impressive, but at the same time to apply universal ship borne automatic identification system and constantly improve its rationale put forward higher requirements. *Copyright © 2014 IFSA Publishing, S. L.*

Keywords: Automatic identification systems (AIS), Self-organized time division multiple access, Network performance, Real-time interaction, HDLC.

1. Introduction

Traditional radar (radio direction-finding location), was a milestone for maritime surveillance systems. But as the number of ships and marine traffic density in the world and ever-increasing load of dangerous goods and ship to the direction of large-scale and high-speed development, important waterways of the world becomes more and more crowded, and maritime traffic accidents occur frequently, to the safety of navigation and the marine environment pose a huge threat. In order to strengthen maritime traffic control, marine pollution monitoring and ensuring the safe navigation of ships, increasing exchange of information between ships and between ship and shore, and identification of the ship are also highly valued. But because of the limitations of traditional radar principles, determines that it can only be generated by a very small amount or even misleading information [1]. Thus, marine automatic identification system (AIS) has appeared.

Automatic identification system (AIS) was born in the 1990 of the 20th century, is spearheaded by the developed countries, with information technology as the forerunner, many categories of high-tech backbone for new navigation equipment and systems. So far, AIS development process can be divided into two phases [2]:

VHF-DSCAIS, it is mainly used for automatic identification VTS;

Based on STD broadcasts AIS, it not only can be used for automatic identification VTS, and can be used for ship to ship when the collision.

Future should be based on wireless local area network (LAN) technology to AIS development phase III, refers to the wireless channel of wireless local area network as the transmission medium of computer local area networks. A15-equipped ship to be wirelessly connected to a computer network, as a network, not only between ships equipped with AIS and sharing of resources, but also with wired networking system supports a variety of functions.

2. System and its Performance Evaluation

Universal shipborne automatic identification system's main function is the identification of the ship start sailing, location information, campaign parameters and status and other important data in connection with the safe navigation of ships, through VHF data link, broadcast around the ship in order to achieve this maritime ship identification and monitoring. Therefore, in order to support the realization of the above function, the basic composition of the universal shipborne automatic identification system: built-in GPS sensor, VHF communication, communication controllers, ship motion parameters, sensor interfaces and display interface [3].

Universal shipborne automatic identification system is the core idea of broadcast transponders of the satellite positioning data, as shown in Fig. 1. Its main purpose is to make full use of those obtained through modern satellite navigation technology of high precision position and other information, made it not only for its service on a single boat, and around other vessels and installations can share this information [4]. Installed universal shipborne automatic identification system for ships under the condition of ships can be stopped without the need of driver involvement, according to the ship's movement, and periodically on maritime VHF channels dedicated to automatically broadcast the ship's identity, location and other information.

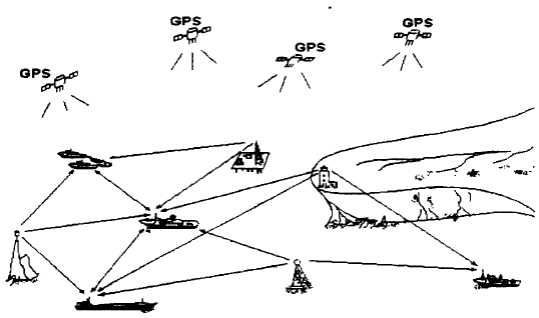

Fig. 1. Schematic diagram of satellite transponder.

AIS automatically broadcasts the ship not only shipping information, also capable of receiving and processing the surrounding ships to broadcast the same message, then graphics or text mode display to ship pilots. Universal shipborne automatic identification system to transmit information consists of information that is static, dynamic, voyage-related information and security-related text message four categories [5]. Ship for ship identification identification code is a maritime mobile service identity (MMSI).

Data-link universal shipborne automatic identification system using high level data link control (HDLC) Protocol, message structure, timing and the relationship between packets and time slots as shown in Fig. 2. A packet's total length of 256 bits, which began with alternate synchronization sequence consisting of 0 and 1, the default is set to 24-bit, or assign command-and-control for 32 bit. Synchronization sequence is used to train the receiver receiving data synchronization. Next is the starting mark (01111110), is used to indicate the packet begins. Packet detection method is a 16-bit cyclic redundancy check. Validation data behind the end of the packet tag, it marked the beginning of a same [6]. Control of bit stuffing bits in the data stream. This suggests that once it is found in the output bit-stream more than 5 consecutive 1 o'clock, a 0 should be inserted. This method can be applied to any except HDLC data element of the mark.

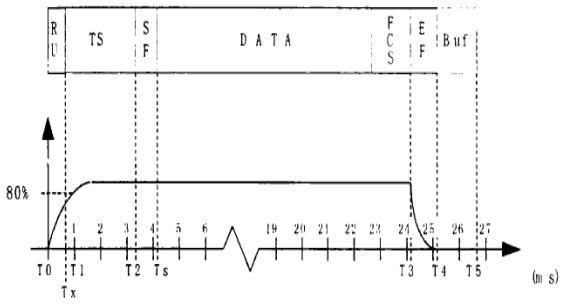

Fig. 2. AIS data link message structure.

Messages are divided into 22 types, to support ship reporting, binary multiple services such as broadcasting and polling. Some special data transmission can be used longer packets, packets can occupy 5 of the longest consecutive time slots. Use long data packet transmission can save some overhead, such as load time, synchronization bits and flags, and so on. TDMA scalable messaging architecture enables the radio to transmit messages while scheduled time slot you want to use in the future. This is the important link in the realization of self-organizing communication [7].

3. AIS Network Throughput Performance Analysis

AIS network throughput performance evaluation of network performance has an important position in the index. It is not only one of the AIS network efficiency-oriented performance indicators at the same time, it is also an important quality of service-oriented performance indicators, because it not only affects the network efficiency itself, but also directly affects the success rate of AIS information exchange between users.

At all stations in a group always has to some extent organized, but not exactly the organization. When stations launch capability in the use of new time slot, which is by observing its own channel on the VHF network time slot table to select it. Imagine

such a scene: there are two stations a and b is sending out letters start, but because they are located outside of the respective range of VHF network are unable to send and receive information [8]. Is based on c, and another station within VHF coverage of stations a and b, so it can receive information on the stations a and b. Despite the stations a and b at the time of their slot allocation follows the STDMA algorithm, however, station c, and they select a time slot is random. Therefore, stations a and b have not been organized, they appear when you select the time slot for automatic slot reuse.

A more extreme scenario is that r stations all around the station are launched on a random reservation slot. However, in this discussion, the assumption is that if there is a default launch conflict will cause confusion, without taking into consideration the recognized phenomenon. However, identified in the practical application and aliasing are coexisting, the problem is these organizations will be able to get a better transmitter station, identified or confused when it will happen. In order to solve the problem, based on STDMA technology principle and principle of recognition in electromagnetic propagation, combined with previous findings in this paper for further study [9]. Make two assumptions in the study, starts with the assumption that at the reception desk of stations evenly distributed around: second hypothesis in which time slot reuse is automatic slot reuse.

4. AIS Monitoring Capacity and Network RADIUS

AIS as a new set of identification, communications, navigation and other features as one of the maritime monitoring technology, its fundamental task is to solve the VTS System (VTS), automatic identification of problems in ship collision avoidance during communication, and to meet needs of ship identification and for shipping new observing instruments. Therefore, apart from the study of AIS throughput performance, monitoring capacity and monitoring of AIS radii are two other important indicators to measure performance is good or bad, is AIS network in an important part of the performance evaluation index system. International standards in accordance with AIS in this chapter, set out from the principle, monitoring capacity and monitoring of AIS RADIUS for in-depth analysis [10]. In addition, AIS target also provides a brief analysis of errors to be able to reflect more comprehensive service performance of AIS.

AIS-equipped ships will make use of STDMA technology to publish static information on VHF channels, dynamic information, navigation-related information and security-related messages. Different waters, the ship of the type, quantity and State were not the same. In order to minimize the load the wireless channel, while IMOAIS performance standard requirements are met, in the IALA recommendation ITU-RM.1371 revised draft (version 1.3) for ships under a variety of conditions in the different sports State reporting rate provision had been made. As shown in Table 1.

Table 1. Reports of different motions of ships.

CLKMD1	CLKMD2	CLKMD3	CLOCK MODE
0	0	0	PLLx15
0	0	1	PLLx10
0	1	0	PLLx5
1	0	0	PLLx2
1	1	0	PLLx1
1	1	1	½ (PLL disabled)
1	0	1	¼ (PLL disabled)
0	1	1	Reserved (Bypass mode)

4.1. Printed Circuit Board Design

Printed circuit board (PCB) is the electronic circuitry and components in a product support, it provides an electrical connection between circuit components and devices. Against interference had a great influence on PCB design. Practice has proved that even if circuit diagram design is correct, inappropriate design of printed circuit boards can also have an adverse effect on the reliability of electronic products [11]. DSP because this system works in 100 MHz, USB 2.0 theory 480 MHz of bandwidth on the data line interface chips, a high frequency, the entire system belongs to the high-speed system, PCB design is crucial to the design of the system, at the time of designing printed circuit boards, should pay attention to using the right method, and should comply with the requirements of the anti-jamming design, doing so may result in system instability or even does not work.

In components layout Shi, to reasonable to uses space, to wiring short, and placed order reasonable for based, both note makes components in PCB Shang layout beautiful and weight distribution uniform, also should consider components layout on circuit performance of effects, should as by they in circuit Shang of has order arrangements, such as entered level, and zoom level, and signal conversion level, and output level of levels signal not cross and mixed put in together: simulation devices and digital devices relative separated placed; hot components and magnetic components away from entered level And input and output levels separately: input signal cables as short as possible.

This system was used in the design of two-layer PCB and SMD components, components layout easier. For noise suppression, placement of decoupling capacitor in power input, while in between each IC in power and is close to 0.1 μF

decoupling capacitor is set, and in order to reduce the high-frequency inductive effect of the ground wires in the circuit, the ground plate of the whole system was deposited copper [12]. This design uses voltage converter electric circuit as shown in the Fig. 3 below.

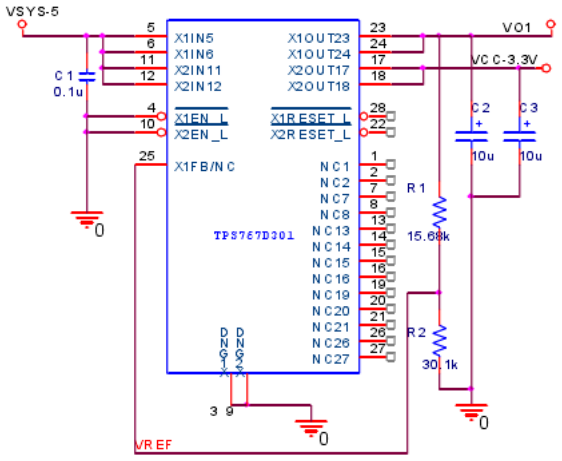

Fig. 3. Adjustable voltage source circuit diagram.

4.2. AIS Network RADIUS

AIS is a digital mobile radio communication network system and a monitoring system applied to navigation, so in addition to care outside the network throughput performance and capacity monitoring system, its network RADIUS must also have a special understanding and concern. In addition, AIS as a new set of identification, communications, navigation and other functions for the integration of maritime surveillance technology, the fundamental task is to resolve the VTS System (VTS), automatic identification of the problems, to meet the ship in collision of ship identification during communication needs and for shipping of new observing instruments. These task apparently needs AlS answered a problem, that is Dang VTS or ship equipment has AIS Hou, as VTS what can monitoring more big range within of ship, and as ship and can "has looked" to more far of waters, its "visibility" whether enough to meet she take effective of avoidance touch action, also has the "visibility" whether will occurred changes, and radar ranging has what different wait.

Electromagnetic waves propagate from the launch site to the receiving point has the following means: ground, sky, space-wave (including straight beam and the ground or other object of reflection), there are also tropospheric scatter wave and so on. Based on the provisions of ITU, Universal ship borne automatic identification system on the Marine VHF band, his international private channels and 161.975 MHz [13]. This band optical nature of the propagation of radio waves, diffraction power and experiencing barriers that create reflections, so be more stable to receive signals in the line-of-sight distance, beyond the beyond line-of-sight distance, electromagnetic decay quickly. Therefore, work on the Marine VHF band will be under the influence of the radius of curvature of the Earth. As shown in Fig. 4.

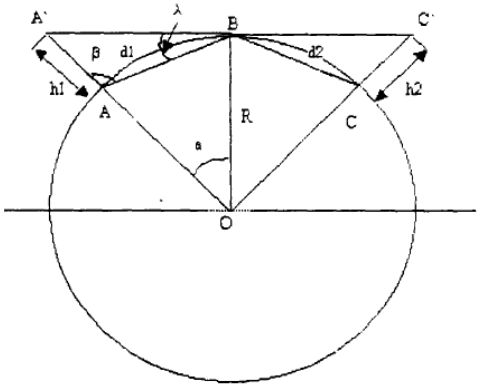

Fig. 4. Earth curvature effects.

AIS radio communication, dissemination of information on the existence of delays. AIS data link is time, which means that the launch of each packet must be completed in the allocated time slots for yourself. However, even if the two AIS station clocks are fully synchronized due to propagation delay, signal reaches him when a ship or shore station AIS receiver, probably because of the delay of two adjacent different emissions overlaps.

Interference in order to prevent such overlap, each frame of the final part of the AIS are leaving a buffer zone, a total of 24 specialty and distance delay is 12 bit, designed for different distances of radio communications provide protection time frame, thereby protecting in the receiving station receives the time slot when the child frame integrity.

As long as the transmitter station in less than this maximum protection distance, the individual AIS stations won't launch information propagation delay between overlap interruption caused when the information was received. Normally between the berth and berth between the Bank and the actual maximum transmission distances are 25 nmile and 45 nmile respectively, which does not exceed the maximum distance of the scope of protection, that is to say the protection distances himself enough to play a protective role. Even for some special reasons leading to beyond the protection distance, in order to avoid overlapping interference while protecting messaging throughput performance, can also be artificially made certain of the AIS station antenna height limit, or lower transmission power of AIS equipment, so that actual transmission distance is less than the protection distance of AIS [14].

AIS is time division multiple access communication system, system timing is the key to the system timing is also called network

synchronization. AIS system using time slots frame synchronization and phase synchronization. AIS synchronization option is primarily obtained from the GPS receiver GPS, GPS time is coordinated universal time (UTC), so that each AIS slipway timing synchronization.

4.3. Analysis of Real-time Interactive Modules

Real-time interactive module from the application point of view is a student and teacher in two parts. The student module as shown in Fig. 5.

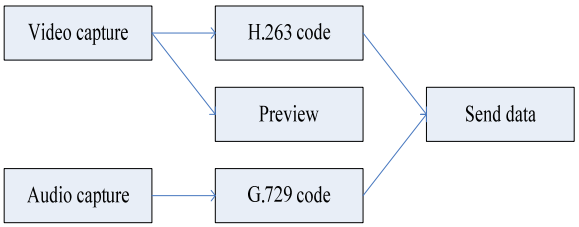

Fig. 5. Real time interactive student module structure.

This is a student's data flow diagram, due to the symmetry of the data flow, only for the teacher data describes the inflow and outflow of student data. Audio data and video data collected after coding for compression of their transfer to network the sender send data, receive data after their respective decoders decode to play.

Each module features:

1) Video capture module uses Microsoft's VFW video capture API set the acquisition parameters (collection sources, size, color depth, capture frame rate and compression formats, and so on) global set callback function entry (when the hardware after you capture the frame image, call the function from the function entry, and data collection passed as an argument to a function).

2) Video preview module with Microsoft provides GDI drawing interface on the levels of images drawn square-by-point, in the practical application of point-by-point draw a better image is placed in a buffer device when copying frame drawing is complete, and then to the display area, improving display smoothness.

3) Audio sample module using the API function to set the audio system comes with acquisition parameters (type of compression, sampling frequency, single point depth, number of channels, and so on) global set callback function entry (when the hardware after you capture the frame image, call the function from the function entry, and data collection passed as an argument to a function).

4) Audio encoding module, select a G.729 encoded. Many audio coding standard, select an encoding is because G729 call bandwidth G.729 speech coding standard, 8 kHz for the input analog signal sampling, linear PCM 16 bit quantization, a fixed and very high compression ratio of 16:1, is ideal for double 16 kHz audio compression of audio and video communication in real time.

5) The data sender module not only sends video and audio data, text data, control data are sent using the same channel, reducing system overhead. Send simultaneous data flow control policy.

Teacher data flow diagram shown in Fig. 6.

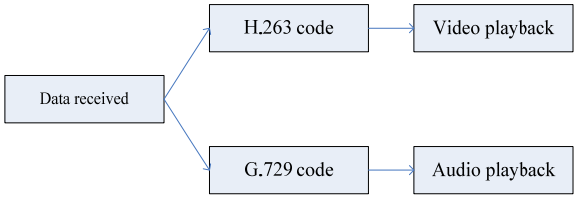

Fig. 6. Real time interactive teacher modules.

Receives data first for data separation, H263 decoding video data is decoded using the GDI function play, G729 codec for audio data after decoding a multithreaded audio playback (background). Other control information to be processed.

Real-time interactive systems need to operate on the data, such as user information, login information, interactive audio/video archive (if necessary). These databases are needed for operation, but these operations need to be synchronized.

4.4. Establishment of Network Communication Platform

Winsock control works at the transport layer, this layer, there are two popular protocols include TCP and UDP: TCP protocol for those who require higher levels of reliability of the data, most of the network application layer protocol is TCP-based protocol; UDP protocol is suitable for less demanding and require a higher speed of data reliability.

Winsock provides a convenient means of access to TCP and UDP network services. Writing a client or server application, you don't have to understand the details of TCP or call the lower-level WinsockAPI. By setting the control's properties, and call its methods can be easily connected to a remote machine, and can also is a two-way exchange of data. System simulation using Visual Basic programming and realization of network communication using Winsock control.

AIS slipway is equivalent to the client, it to another berth and base stations (AIS shore station) to send navigation information; AIS shore station corresponds to the server, it receives information from the slipway:

- set up to receive information about Winsock Protoeol properties for SckUDPProtocol.

- wait for information access, fire the DataArrival event, receive information via the GetData method in the DataArrival event.

- after receiving information, waiting for information to once again fire the DataArrival event, loop receives.

It reads two endpoints, including maximum endpoint 0 packets to 0x400, vertex 1 maximum packet for setting values in the firmware to 0x2. With the Cypress EZUSB Control Panel reads the development environment provided by the company to the pipeline pipe1 and pipe0 correspond to the same value in the information. This acquisition systems USB device drivers and API call was successful. The information acquired by the Control Panel is shown in Fig. 7.

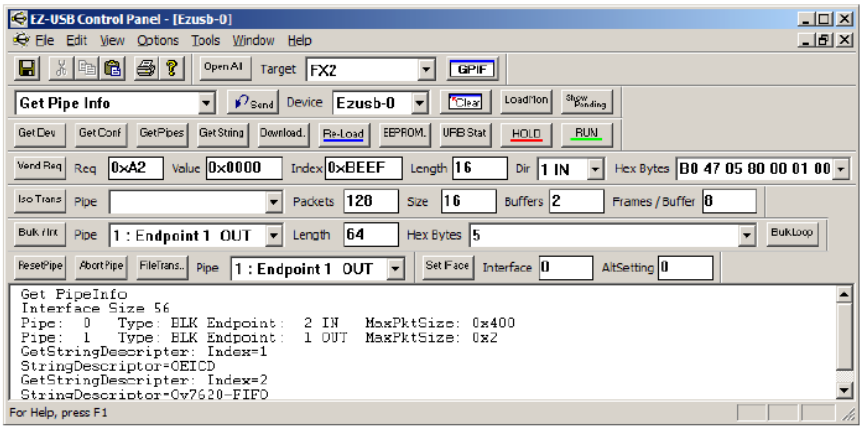

Fig. 7. Information acquired by the Control Panel.

4. Conclusion

Based on marine automatic identification system (AIS) is based on the international standards, computer network, wireless communications, electromagnetic fields, and the theory of probability theory as a guide, with the help of physical experiment and computer simulation tools such as quality of service-oriented aspects of the AIS network performance made a thorough analysis and research.

Based on marine automatic identification system (AIS) is based on the international standards, computer network, wireless communications, electromagnetic fields, and the theory of probability theory as a guide, with the help of physical experiment and computer simulation tools such as quality of service-oriented aspects of the AIS network performance made a thorough analysis and research.

Current AIS berth are more expensive, some non-mandatory installation on ship will be installed shortly, proposes a new AIS system based on wireless local area network, with independent knowledge of technology to facilitate improved, reduced the price of AIS equipment, meet the needs of lower standards of navigation. Ships that would allow more able and willing to install the AIS system, can be more effective in achieving the transfer of information between ships and solving on ship collision avoidance.

Based on a true performance requirements of the AIS system, according to international organizations under the AIS information format for sending and receiving information, meet the needs of the safe navigation of the ship's dynamic and static information. And you can keep the information received in the ship information database, you can query vessel information by entering keywords. A good AIS communication interface and design.

Designed shared key authentication information combined with WEP encryption security measures applied in the AIS system based on wireless local area network. Easy networking, low cost, easy to maintain and extend.

References

[1]. Wang Shiyuan, navigation radar and ARPA, *Dalian marine University Press*, 1998.

[2]. Lin Chuang, computer networks and computer systems performance evaluation, *Tsinghua University Press*, 2012.

[3]. Liang Chuan, Request-Authorization System in Traffic Business, *Sichuan University*, Vol. 4, 2007.

[4]. A. Cavoukian, J. Stoianov, Biometric Encryption: A Positive-Sum Technology that Achieves Strong Authentication, Security and Privacy, *Information and Privacy Commissioner of Ontario*, 2007.

[5]. IEEE Standards Board.802 part11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications: Higher-Speed Physical Layer Extension in the 2.4 GHz Band, *IEEE Standard*, 802.11a, 1999.

[6]. W. Green, D. John, Internet and Distributed Application Development, *Beijing Mechanical Industry Press*, Vol. 7, 2012.

[7]. Jain, A. K., Hong, L., Pankanti S., Bolle, R., An Identity-Authentication System Using Fingerprints, in *Proceedings of the IEEE,* Vol. 85, Issue 9, 1997, pp. 1365 - 1388.
[8]. Sun Wenli, Sun Wenqiang, Shipborne automatic identification system, *Dalian Marine University Press,* 2004.
[9]. IETF RFC2284, PPP Extensible Authentication protocol (EAP), *Blunk and Vollbrecht,* March, 1998.
[10]. P802.1x, IEEE Draft Standards for Local and Metropolitan Area Networks: Standard for Port based Network Access Control, *IEEE*, 2001.
[11]. C. Rigney, W. Willats, P. Calhoun, IETF RFC 2869, RADIUS Extension, June 2010.
[12]. R. Sandberg, Sun Network File system Protocol Specification, Technical Report, *Sun Microsystems*, 1985.
[13]. Zou Min, Jai Gay, Concept of Subsytem, *T-Engine Application Development Centre (TEADEC)*, 2011, pp. 3-4
[14]. T-Engine Forum, T-Format (3): Global Symbol Naming Rule in C Language, *T-Engine Forum Specification*, 2013, pp. 6-8.