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Wireless data transmission segment for Pilot Navigation and Docking System, dedicated to use with commercial mobile devices

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Abstract

The main task carried out by the Pilot Navigation and Docking System is to provide the navigation information for the pilot or captain, during the vessel berthing. The form of presentation of such information may be implemented using various methods. The form of lighting arrays located on the quay is the least technical complicated method to present the navigational parameters of manoeuvring vessel. Much more advanced way of communication is the delivery of the necessary data on the manoeuvring vessel's bridge, using the selected wireless data transmission technology. The visualization is done via dedicated device's screen or commercial laptop, tablet, smartphone or mobile phone. The remainder of this article describes the construction, specifications and algorithm of wireless data segment intended for the commonly used mobile devices.

Introduction

The main task carried out by the Pilot Navigation and Docking System is to provide to the pilot or captain the navigation information about the distance and speed of berthing vessel. This task can be done in many ways, differing in the complexity of the presentation. Among the data transmission techniques, which can be used to carrying out the task, it can identify such techniques for wired or wireless transmission of information.

One of the main purposes of PNDS is the possibility of using its services through wireless access from mobile devices such as laptop, tablet, smartphone or mobile phone. The variety of commercial devices available on the IT market and telecommunications requires, however, the use of such solutions that maximize flexibility in accessing the mobile PNDS.

These solutions mainly concern the selection criteria of technology for the wireless packet data transmission, as well as protocols and programming languages used on the site.

Construction and technical parameters of the system

System's architecture

The wireless segment has been designed, constructed and implemented to the PNDS system, intended for users benefiting from access to the vessels' navigational parameters via mobile platform. It is based on two blocks of transmission:

Local – the ISM (Industrial, Scientific, Medical) transmission band is used, intended for communication between the measuring segment and PNDS integrated visualization interface;

Global – based in part on the unlicensed ISM transmission – measuring segment / server applications, but primarily using the WWAN (Wireless Wide Area Network) wireless data transmission, offered by telecommunications operators and, where possible, WLAN (Wireless Local Area Network) – user / server. The idea is to increase the versatility (including coverage) and the reliability of access to the PNDS system services, through multiple redundancy points (Access Points) [1].

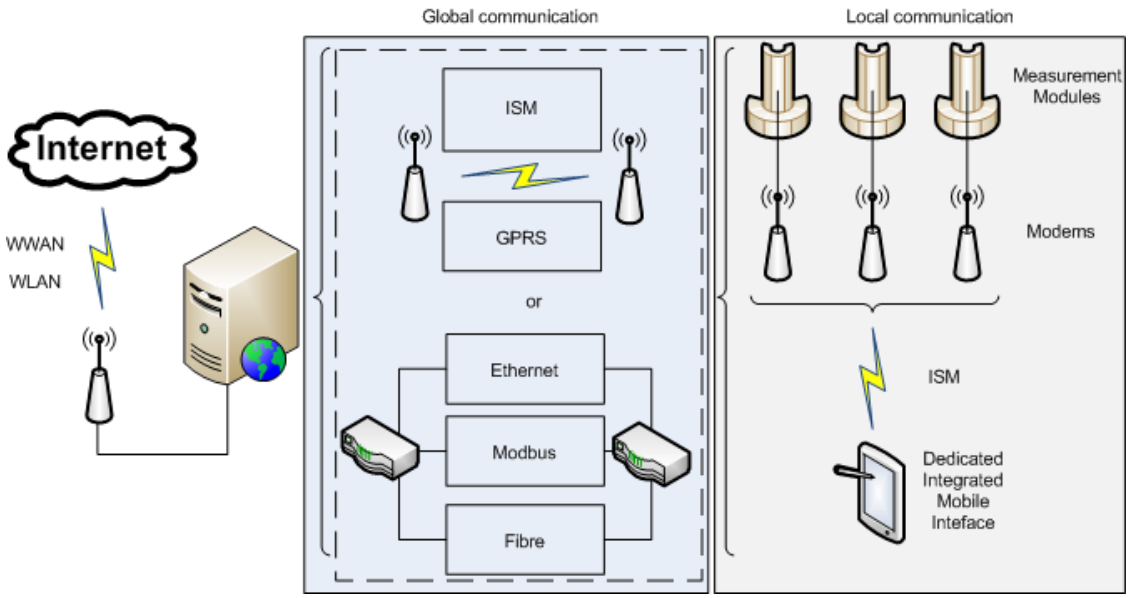

Fig. 1. Block diagram of system architecture [own study]

This approach seems reasonable given the fact that the system is dedicated for utilization on restricted areas, which is within range of shore communications transmitters.

The rest of the article is devoted to issues related to the construction and technical parameters of the second block of data.

Analysis of selected parameters of data transmission technology for mobile system

1. Communication block: measuring block – the server. To accomplish the task, involving the transmission of data from the measuring modules to server, the ISM band radio modem was used. That band are not subject to licensing, but the requirement to use it, is the legal limit power transmitters, so that many devices can work simultaneously on different networks, even though they are located in close proximity. Devices operating in the ISM band are easily programmable, and thus characterized by high versatility in application [2], including the PNDS.
2. Communications block: server – mobile device. To accomplish the task, involving the transmission of data from the server to the mobile device, the following wireless transmission technologies are available to use:
   a) WLAN – is a flexible communication system that has been designed as an alternative or complement to traditional cable network. It is characterized by high data capacity [3]. The principal disadvantage of this type of solution is short range of possible connection, as in the case of the PNDS, limits its use.
   b) WWAN – uses the cellular network infrastructure to provide users with roaming wireless connections (switching between networks), covering large areas. Via WWAN you can maintain network connectivity even when it is in motion. WWAN connection is smooth and "wandering", so it can move in different areas of the range, and even use different types of network connectivity, without interrupting the data transfer.

Unlike WLAN technology, which is dependent on the location and the associated with 802.11 Wi-Fi, WWAN provides greater coverage, using different types of technologies. The main "generations" of technology supported WWAN (Fig. 2) are:

- 2G – GSM / HSCSD (High Speed Circuit Switched Data);
- 2.5G – GPRS (General Packet Radio Services);
- 2.75G – EDGE (Enhanced Data GSM Environment);
- 3G – UMTS (Universal Mobile Telecommunications Service);
- 3.5G – HSDPA (High Speed Downlink Packet Access) [4].

Type of technology used in conjunction with the PNDS service depends on the type of wireless modem installed in the mobile device and coverage area of the WWAN. The user is automatically assigned with the highest bandwidth technology supported by the device. 2G technology is outdated technology, in which the packet data transfer is not available (connection cost is conditioned by time, not the weight of transmitted information). For this reason, the mobile service does not support devices

that communicate in this standard (e.g. installed Wireless Application Protocol – WAP 1.0 browser).

The versatility and range of WWAN make this technology the most often used in conjunction with the mobile PNDS services (is a technology-paid, unqualified by the operator tariffs).

Software, standards and protocols

The specification of the PNDS system assumes the possibility to access to navigation information such as speed and distance of approaching vessel's hull, via commercial mobile device. Access to this type of information is realized through the applications available in standardized languages, using the Hypertext Transfer Protocol (HTTP), WAP and TCP / IP, which is popularly called Internet.

Depending on the type of mobile device used for wireless communication with the PNDS server, the following standards were possible to implement (Fig. 3):

a) Laptop, Notebook – Mozilla Firefox, Opera, Internet Explorer, Netscape – HTML (HyperText Markup Language);
b) Tablet, smartphone, cell phone in the specification of CLDC (Connected Limited Device Configuration) and CDC (Connected Device Configuration) – a mobile version of your browser – XHTML (eXtensible HyperText Markup Language) and Java Micro Edition (J2ME);
c) Portable devices in the standard WAP 1.2 and 2.0 – language WML, XHTML-MP (eXtensible HyperText Markup Language Mobile Profile).

Operating algorithm

For the navigational parameters presentation (head No., speed, distance) on the mobile device, it was necessary to provide the data packet generated by the particular measuring modules to the PNDS server and their transformation to specific standards of language and communication protocols.

Selected information shall be provided in aggregate form of frame having the form:

$$\$SENS,00,000000,+0000*0C \quad (1)$$

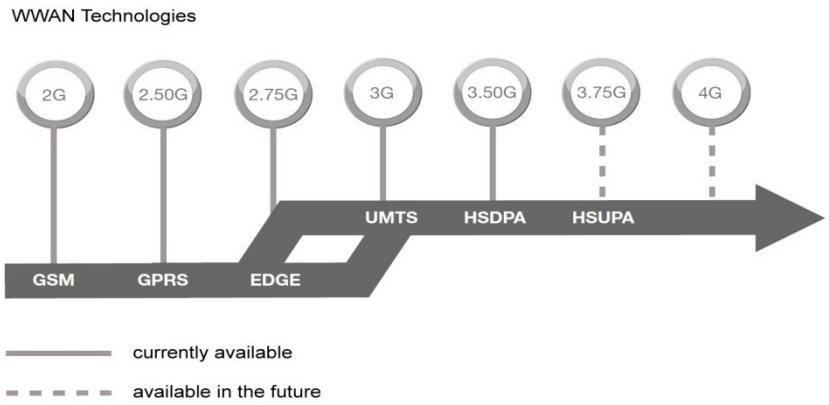

Fig. 2. Technologies supported WWAN standard [4]

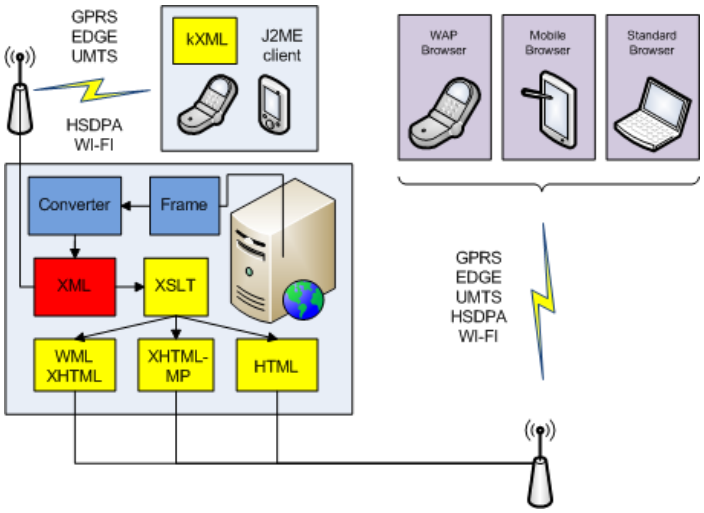

Fig. 3. Block diagram of a PNDS mobile server architecture [own study]

where:

five bytes:	head "$SENS";
one byte:	0x2C (",");
one byte:	frame type, one hex digit;
one byte:	head No., one hex digit;
one byte:	0x2C (",");
six bytes:	distance [mm] to target;
one byte:	0x2C (",");
jeden bajt:	speed indicator "+" means distance decreasing, "–" distance increasing;
four bytes:	target speed [mm/s];
one byte:	0x2C (",");
one byte:	0x2A ("*");
two bytes:	checksum counted as XOR signs between "$" i "*", i.e. bytes from 01 to 20.

Depending on the location and technical conditions of the system, the generated frame can be transmitted to the PNDS server using technologies described in Section 2.2. After conversion from RS232 to TCP / IP data packet is given on the appropriate server's port where, using a dedicated application, is transformed to a file in Extensible Markup Language format, called XML.

Access via WWW browser

When connecting to the server, the user is automatically redirected to a web page written in language understandable to the mobile device. Redirection algorithm (recognition headers) has been implemented for the Apache libraries based on PHP (Personal Home Page).

For the tabular values presentation of the distance and speed variables in the mobile service, it was necessary to apply a transform data in an XML file to a form recognized by various browsers, including mobile and WAP. This process is implemented by XSL transformations (XSLT).

XSLT (XSL Transformations) is a language for transforming XML to XML. XSLT processor converts the input XML document (source tree) based on the XSL form the resultant XML document (result tree) [5].

In order to reduce the weight of wireless transmitted data, thereby increasing the speed of information transmission and reception, all the ways to format text (eg using Cascading Style Sheets CSS) have been deliberately unsaved.

Data refresh rate is 1 Hz. This value is optimal for ergonomic and effective variables presentation on-screen of the portable device.

Access via Java / Dalvik application

In the case when mobile device used to the communicating is applied with the KVM virtual machine (Virtual Machine kilobyte) or Dalvik (Android operating system), it is possible to access the navigational information from a dedicated application written in Java. KVM is a Java virtual machine, developed for the CLDC configuration. It is very limited and has much lower hardware requirements compared to the full version of the JVM (Java Virtual Machine) for stationary equipment and was created for devices equipped with processors 16 – and 32-bit and operating at frequencies from 12 to 60 MHz and a minimum 128 kB of memory [6].

Similar to service support from a Web browser, an application written in J2ME is generated based on server-side XML database as. By using the appropriate code syntax, using an appropriate XML parser (kXML 2.0), it is possible to transfer data to a portable device and display them on the screen (Fig. 4).

Fig. 4. Mobile service dedicated for commercial devices [own study]

Determining the level of system reliability and availability

In order to determine the level of reliability and availability of mobile platforms for PNDS service, the questionnaire survey were conducted with the population of 83 devices (students).

The studies assumed the launch mobile service on particular mobile device and define the answers to the following questions:

- the number of devices using a standard – which specifies whether the mobile device, according to the manufacturer's specification, is equipped with software for a particular standard;
- the number of devices that enable use of the service – as defined by the number of devices on which the observed failure-free operation of mobile PNDS service;
- the number of devices that return an error while operation – as determined by the number of devices on which the error was noticed, while using the PNDS service. It takes into account errors caused by i.e. the applied software that was earlier than version required for the system, improper configuration of the mobile device, the random noise in wireless transmission, other.

Table 1. The level of system reliability and availability running on different platforms

Number of devices:	WAP 1.0 (unavailable in PNDS)	WAP 1.2	WAP 2.0	XHTML	HTML	Java
using the standard	2	6	11	25	39	66
enable use of the service	–	6	11	22	37	44
return an error while operation	–	1	–	3	–	8

Statistical summary of the results are presented in table 1.

The specification of most modern mobile devices defines the application software to support standards: WAP 2.0, XHTML and HTML in combination with virtual machine Java or Dalvik. On such configured platforms, there is possibility to choose the work with a Web browser or a dedicated Java application.

Conclusions

The analysis results shows that the most reliable standards use in mobile communications are WAP 2.0, HTML and XHTML (Fig. 5).

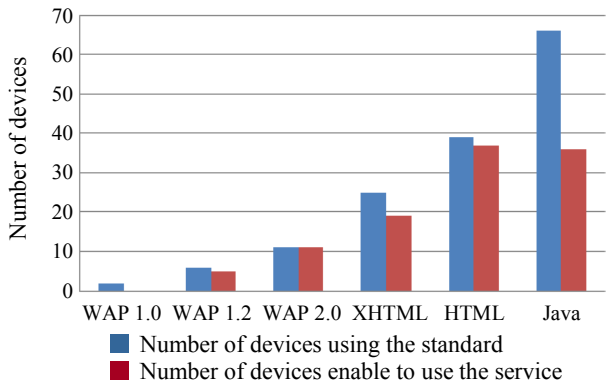

Fig. 5. The level of system reliability and availability running on different platforms

WAP 1.0 standard is an obsolete technology, currently not developed. A small number of these devices participating in an experiment confirms the assumption of no implementing this standard to support PNDS mobile service.

The highest unreliability of access is characterized by an application written in Java. This is mainly due to two factors:

a) the application is written for devices in a specific CLDC configuration, supplemented with appropriate classes of Java – MIDP. Installing the runtime file on the device is incompatible with the specification of software that can generate errors;
b) the product software does not allow to connect automatically for an application installed without a digital signature, using a trusted certificate.

Segment of the wireless data transmission intended for commercial mobile devices is an excellent source of information about vessels movement. Solutions used in the mobile PNDS allow to use its services, through the most recently available on the market mobile devices.

The described service is a complement to a dedicated PNDS integrated visualization interface. It cannot, however, be the alternative.

The unification process of the solutions in applications for mobile devices, using a commercial wireless communications network, increases the likelihood of distortion and reduces the credibility of the values displayed on the screen, i.e. distance and approach speed of the ship.

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