Introducing Harbour Craft Transponder System (HARTS) in the Port of Singapore

Teo Chee Beng, Assistant Director, Electronics & Communications, **Chan Keng Nee**, Assistant Director, Port Operations Control, **Sunny Lee Chwee Thiam**, Deputy Manager, Communications, Maritime and Port Authority of Singapore

Maritime and port security remains a key concern for Singapore as it is the busiest port in the world in terms of shipping tonnage. Apart from the ocean going vessels that call at our port everyday, there are also many small harbour and pleasure craft plying our port waters. Reality has shown that small craft could be exploited and used as a conduit to target bigger ships and port facilities. The terrorist attack on the French tanker Limburg by a small boat off the Yemeni coast in October 2002 is frequently cited as an example.

In managing our global port, the Maritime and Port Authority of Singapore (MPA) and the security agencies take the responsibility of keeping a closer watch over small craft very seriously. Relying on radar systems alone is not enough and following a successful trial, we introduced a vessel tracking system known as the Harbour Craft Transponder System (HARTS) as an added defence against potential threats of attacks by small craft. This paper provides an overview of the implementation of HARTS.

Introduction

In 2005, the Port of Singapore received more than 130,000 vessel arrivals totalling 1.15 billion gross tons (GT). Apart from the ocean going vessels that call at our port everyday, there are also many harbour and pleasure craft plying our port waters. Most of these craft are small passenger launches, tug boats and bunker barges. Being less than 300GT and not engaged on international voyages, these craft do not come under the Safety of Life At Sea (SOLAS) regulations and hence are not required to carry the Automatic Identification System (AIS) transponders stipulated by the International Maritime Organisation (IMO).

Reality has shown that small craft can be exploited and used as a conduit to target bigger ships and port facilities. HARTS would further enhance Singapore's maritime and port security.

Following a successful trial to assess the technical feasibility of HARTS, we began implementing it in Singapore in July 2005. Some 3,000 MPA-licensed powered harbour and pleasure craft are required to have the HARTS transponders fitted by end 2006.

System objectives

Information received from HARTS and other surveillance systems enable us to have an even more comprehensive picture of the activities taking place at sea. Having a more inclusive situational picture at sea helps raise the operational capabilities of all agencies in monitoring and enforcing security.

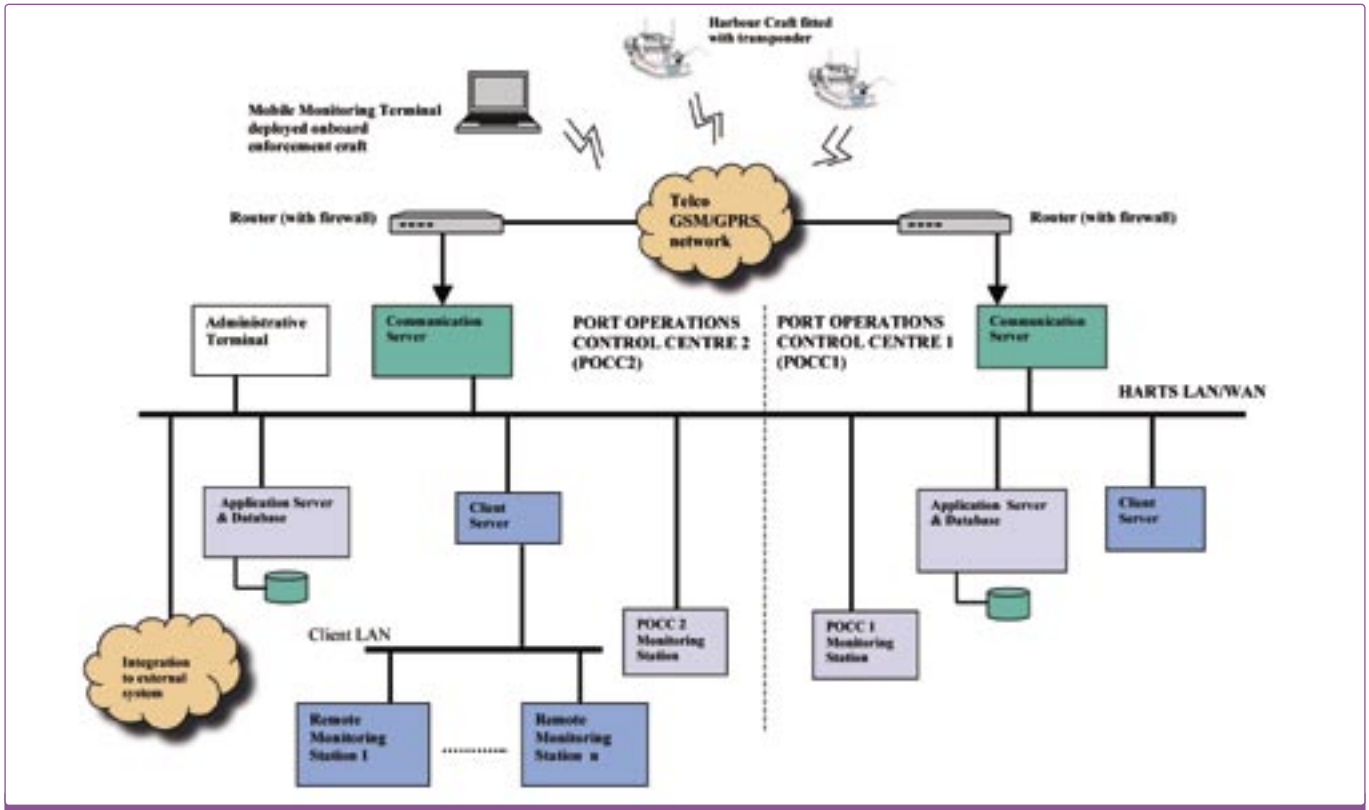

Figure 1. System Architecture of MPA Harbour Craft Transponder System (HARTS).

System architecture and design

The HARTS set-up comprises three main components as follows:

- HARTS transponders fitted onboard the craft
- A shore-based tracking system
- Wireless communication link

The system architecture is shown in Figure 1. Real time data from the transponder such as vessel identity, position, speed, course and other information is transmitted to a shore-based system via the wireless communication link. The data received is then processed by system servers and sent to the operator workstations at the control centres of the security agencies.

The HARTS' design is based on the following criteria:

- The cost of the transponder unit shall be affordable to the harbour and pleasure craft community
- The shore-based infrastructure and system to support the HARTS shall, as far as possible, use existing public wireless infrastructure
- The transponder shall be designed for automatic operations with no or minimal intervention by the vessel owner/user
- The transponder shall be easy to install, reliable and able to withstand the harsh marine environment
- The system shall provide reliable and consistent tracking of the vessels.

To ensure minimal or no intervention from vessel owner/user, a 'black-box' design has been adopted for the HARTS transponder to be installed onboard the craft. The Global System for Mobile communications/General Packet Radio Service (GSM/GPRS) offered by the local Telecommunications Service Providers (Telco) was selected for the wireless communication link. This is currently the most cost effective solution requiring minimum set up cost as the base station is already in place.

Harts transponder

The main function of the HARTS transponder is to transmit the craft's identity and positional data to the control centre via the GSM/GPRS network. Each transponder consists of three main components:

- A GPS Receiver
- A GPRS Modem
- A Processor/Controller

A block diagram of the HARTS transponder unit is shown in Figure 2.

The GPS Receiver receives positioning data from the GPS satellites and enables the craft to know its current position. The Processor/Controller gathers the data from the GPS receiver including other useful information (e.g. craft's identity), processes the data and sends it to the GPRS modem. The GPRS Modem then transmits the data to the shore-based system via the GSM/GPRS link.

The transponder is able to transmit the data and its updates at different rates according to the real-time speed and status of the craft. The data transmitted includes:

- Transponder identity
- Position of craft in latitude and longitude
- Speed in knots
- Course in degree
- Time stamp
- Security alert status

All the basic components of the transponder are housed in a single 'box', which conforms to the IP67 standard for a casing and is designed to weather the harsh marine environment. There are two types of transponders, fixed and portable, available. The fixed transponder is used for harbour craft that has a power supply (generator or DC battery) and a proper cabin onboard. The portable transponder is used for harbour craft which does not have a power supply onboard and is open-decked. Figures 3 and 4 show the standard installation of the fixed and portable transponders respectively.

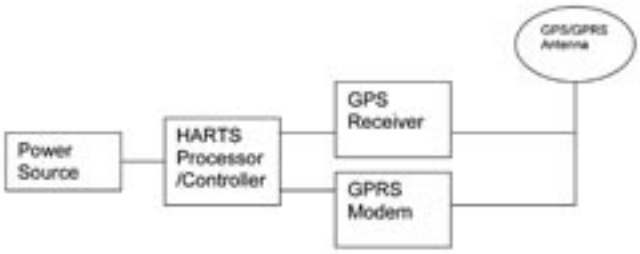

Figure 2. Block diagram of a HARTS transponder.

System features

Individual identity

Each transponder has a special coded identity that matches the craft's registration number upon commissioning. A database of the individual craft particulars is maintained and controlled by the MPA.

Prevention of unauthorised usage

The special coded identity of each transponder ensures that the transponder deployed can only operate on the harbour craft it is first installed on. The coded identity on the transponder must match that of the mounting bracket. This security feature ensures that the transponder does not work if it is used on another craft. In the event of a security breach, an alert would be sent to the control centre operator.

Panic button

Every transponder is equipped with a panic button. The panic button allows the craft owner/master to alert the MPA in the event of distress or a security threat. After activating the panic button, an alert message containing the identity, position and time will be sent to the control centre operator. This function is similar to the IMO Ship Security Alert System for ocean-going vessels.

Area alarm

The Singapore port waters have restricted areas and areas with speed limits. HARTS is able to monitor the unauthorised entry of the craft into these restricted areas or if the craft violates the speed limits. The control centre monitoring stations will be alerted of any such violations by the craft.

Remote software and configuration update

HARTS is designed to receive updates/changes to the system's software or configuration wirelessly from the control centre via the GSM/GPRS network. For example, a change to the transmission rate for information updates can be done from the control centre. The wireless capability removes the need to recall the 3,000 craft to make the change physically.

HARTS shore-based system

In line with the design principle for mission critical system, the shore-based system is modular in design with built-in redundancy. The main components of the shore-based system are the Communication Server, the Application Server, the Client Server, the Monitoring Station, the Local Area Network and ancillary equipment.

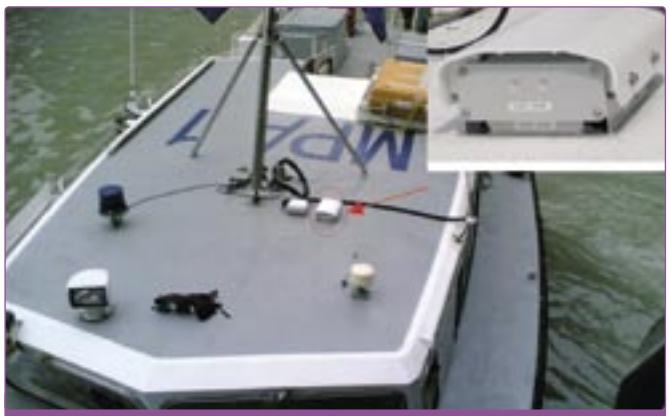

Figure 3. Standard installation of a fixed HARTS transponder onboard a harbour craft.

Figure 4. Standard installation of a portable transponder onboard a harbour craft.

Communication server

The communication server handles the communication between the Telco and the HARTS network. It receives the incoming data stream from the Telco via a dedicated leased line connection and forwards it to a communications router within the application server. It will listen for incoming data i.e. the transponder messages and then forward them to the communications router via a Transmission Control Protocol/Internet Protocol.

Application server

The application server processes the HARTS data including the database application. The application server is also responsible for data logging, system and operational alarm function, access control and other system functions. There is an administrative terminal responsible for the overall control and management of the HARTS network. It performs the following basic functions:

- Status monitoring of the various network components
- Visual presentation of network status, alarm and traffic etc
- Event logging
- Maintenance and administration of Clients connected to the network
- Initiate diagnostic functions
- Generating of reports

Client server

The client server is responsible for disseminating the HARTS data to both internal and external clients. The external clients will be connected via dedicated leased lines. At the client's end, a monitoring station has been set up to produce a graphical display of the harbour craft traffic. Each client will have a "Client Profile" created to control and restrict the access/dissemination of the track data. The system is able to support multiple clients with different access rights.

Monitoring station

The monitoring station is the user interface terminal which allows the operator to visually monitor and track the harbour craft. Each monitoring station is a workstation PC with a graphic display monitor and has the necessary application software. The harbour craft data received from the transponder is displayed as target tracks on an Electronic Navigational Chart (ENC) of the Singapore Port Waters. The basic features of the monitoring station include:

- Real-time traffic display
- Target data
- Operation alarms when violation is detected
- Recording and play back of historical harbour craft tracks

It also serves as the operator interface for system administration such as the management of transponder identity codes, wireless updates of transponder firmware and transmission rate and monitoring of transponder's status.

Local area network

The local area network is based on industry standard Ethernet 10/100 Mbps. It is built with data handling capability to track more than 3,000 harbour craft simultaneously.

Conclusion

The implementation of the HARTS project commenced in July 2005 and the first craft was fitted with the transponder in October 2005. By December 2006, some 3,000 harbour and pleasure craft operating in Singapore port waters will carry the HARTS transponders. The full operation of the HARTS will commence from January 2007 onwards.

By fitting the smaller harbour craft with HARTS, the MPA and the security agencies would be able to monitor the movements of these craft and take the necessary preventive action in the event of any suspicious activity. This would serve as a deterrent for potential terrorists.

HARTS complements the other security measures already in place in the Singapore port. These include the Harbour Craft Security Code (HCSC), which ensures that masters of harbour craft plying within port waters comply with general security standards, and a Ship Self-Security Assessment Checklist, which small craft are required to submit prior to entering the port. Together, these measures underscore our commitment in making the Port of Singapore a safe and secure haven for the many ships that call here for trade.

ABOUT THE MPA

The **Maritime and Port Authority of Singapore** (MPA) was established on 2 February 1996 as a statutory board under the Ministry of Transport. Its key functions are to develop and promote Singapore as a premier global hub port and an international maritime centre, and to safeguard Singapore's strategic maritime interests. As the designated 'Champion Agency', the MPA is tasked with expanding the Singapore maritime industry by developing a strong and attractive cluster of maritime ancillary services. These range from, among others, ship broking/management, marine insurance/finance, maritime legal/arbitration services, R&D initiatives, and manpower expertise.

ENQUIRIES

Teo Chee Beng – Assistant Director, Electronics & Communications
Chan Keng Nee – Assistant Director, Port Operations Control
Lee Chwee Thiam, Sunny – Deputy Manager, Communications
Maritime and Port Authority of Singapore
460 Alexandra Road, #20-00 PSA Building, Singapore 119963
Tel: +65 63751264 Fax: +65 63751719
Website: www.mpa.gov.sg