RTT TECHNOLOGY TOPIC
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5G at Sea

A combination of terrestrial and space based positioning systems is laying the ground for safer seas and autonomous ships that could transform the economics of maritime transport. Integration with existing communication systems including 5G, Wi-Fi and satellite broadband connectivity multiplies this added value.

In this month's Technology Topic we examine the technical and commercial potential for using 5G at Sea to integrate location and positioning systems with narrow band and wide band connectivity and remote telemetry and control. Every generation of cellular radio network, from AMPS and ETACS to present 4G systems have had the ability to locate and position device and users. As networks have become denser and as network timing has become more precise, location accuracy has improved. Beam forming provides additional positional and location capabilities but how will these systems work at sea?

On 20 May 1514, 505 years ago, Henry the Eighth granted a Royal Charter to the Corporation of Trinity House with an immediate brief to make sailing safer in the lower reaches of the Thames. Today Trinity House as the General Light House Authority continues to manage the light houses that make navigation safer around the coasts of Britain.

In April 1912, 1600 people drowned when the Titanic hit an iceberg. Although the radio operators used their spark gap transceiver to call for help it has been argued that the accident could have been avoided if a more modern multi-channel short wave CW system providing better communications with other ships in the area had been installed.

However the disaster prompted an international effort to address safety of life at sea with the Safety of Life at Sea Convention from 1913 establishing the basis for a regulatory environment for maritime safety (and more recently marine pollution) which remains in place today https://www.marineinsight.com/maritime-law/safety-of-life-at-sea-solas-convention-for-prevention-of-marine-pollution-marpol-a-general-overview/

GPS and other MEO based satellite constellations including Glonass, BeiDou and Galileo remain as the default choice for maritime positioning and are used by the overwhelming majority of the 50,000 merchant ships at sea.

The latest GPS 111 satellites have a civilian positioning accuracy of between 1 and 3 metres 95% of the time compared to 3 to 10 metres from the older generation satellites. This level of accuracy is generally sufficient for fully autonomous ships but can be further enhanced by deploying differential GPS from radio beacons installed in shore based and rock based lighthouses and light ships and radio buoys to provide a 95% probability of <5 metre accuracy in an area of 50 nautical miles around the coasts of the UK and Ireland.

The GPS corrections are transmitted on the low frequency and medium frequency band between 283.5-315 kHz in Europe and 285 to 325 kHz in the rest of the world and provides the basis for Integrated Navigations Systems (INS), Electronic Chart Systems ECS) and Automatic Identification Systems (AIS).

There are now radio beacon systems in 40 countries around the world but it is not universally available and it became clear some years ago that a closer integration with additional satellite systems (other than GPS) would be needed. These are known as Satellite Automatic Identification Systems (SAIS).

The choice of systems includes

Orbcomm - a VHF based LEO constellation (137 MHz) with a recently upgraded constellation of 16 satellites at 775 kilometres providing positioning and vessel monitoring.

Iridium- L Band with a recently upgraded constellation of 66 LEO satellites at 780 kilometres, the new constellation also supports an automatic identification system (AIS) payload in the VHF band with the longer term capability to support smart ships and e-navigation.

Inmarsat – set up in 1979 by the International maritime Organization with the specific remit to provide reliable satellite based marine safety communications including the Global Maritime Distress and Safety System. Inmarsat operates in L band (and S band and Ka band) from a constellation of geostationary satellites

Intelsat- maritime connectivity from C and Ku and Ka band geostationary satellites

Eutelsat – maritime connectivity from a Ku band GSO constellation

SES- maritime connectivity from a MEO and GSO constellation including C band, Ka band (O3b and Ku band.

The European Global Navigation Satellite System Agency is also promoting its Galileo (L band) based augmentation service promising one metre positioning precision. The Indian Navigation System, China's BeiDou constellation and the Russian Glonass network provide similar enhanced service capabilities (including two-way messaging from BeiDou).

Any and all of these systems are part of an overall industry connectivity offer covering everything from positioning and location through to internet access for passengers and crew and real time remote monitoring of ship engines, drive trains and electrical and mechanical systems. If any component needs replacing it will be pre ordered to be available at the next port to minimize maintenance time and cost. These systems can also reduce the environmental impact of ships – if a ship can be made more efficient it will generally produce less pollution. This could and should include the monitoring of sulphur and particle emissions. Sea IOT is therefore a discrete addressable market with significant growth potential.

A number of different modulation and radio protocol formats are used to support these services from VHF (50 KHz channel bandwidth within a 1 MHz pass band) to Ka-band (500 MHz channel bandwidth within a 3.5 GHz pass band).

To date there has been no real need to adopt universal radio standards across these maritime spectral assets. There are however initiatives to encourage the adoption of the 5G New Radio physical and MAC layer. This would help integrate satellite with shore based maritime support systems, for example 5G smart sea ports such as Hamburg.

The 5G community would benefit substantially from the extension of service coverage and service capability from land based to maritime markets. Conversely, the maritime satellite community would benefit from 5G global scale.

Lessons learnt from 5G research into autonomous car connectivity and control is also potentially transferable to autonomous maritime transport applications. 50,000 ships is a small number compared to a couple of billion cars but the financial benefit of realising globally automated maritime shipping would be substantial and when ships hit each other or run aground, often due to pilot error, they make a terrible mess.

Just over 100 years ago, the Titanic demonstrated the need for flexible but standardized radio communication across multiple channels and a common approach to connectivity that spanned terrestrial and maritime markets.

100 years on this remains an essential precondition for maritime safety and efficiency. Given that 70% of the earth is covered in water, 5G at Sea, integrated with existing maritime positioning and communications systems could be a critical enabler for an evolving maritime economy.

5G and Satellite Spectrum, Standards and Scale

Our latest book, **5G and Satellite Spectrum, Standards and Scale** is available from Artech House. You can order a copy on line using the code VAR25 to give you a 25% discount.

http://uk.artechhouse.com/5G-and-Satellite-Spectrum-Standards-and-Scale-P1935.aspx

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Geoff will be presenting at the Telecoms Heritage Conference at the University of Salford on Saturday June 22. The Conference is free to attend.
http://www.engagingwithcommunications.com/events/salford_telecoms_heritage_conference.html

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RTT, and **The Mobile World** are presently working on research and forecasting projects in the mobile broadband, public safety radio, satellite and broadcasting industry and related copper, cable and fibre delivery options.

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