



New Technology Review

Radio-free wireless communication based on Metal Surface Wave in the maritime sector

1 SUMMARY

Most shipboard and AtoN data systems tend to connect sensors for central control units by extensive lengths of cables. In the case of wireless implementation, radio-based communication must overcome characteristics of ships or AtoN surrounded by metal material, in particular, suffering from the severe reduction of received signal power.

Radio-free wireless communication, Metal Surface at Magnetic Substance (MS @ MS wave), is introduced as more efficient and capable of overcoming the limitation of metal surrounding structure for wireless communication and for primarily applying to the wireless IoT network in the maritime sector.

Following the introduction and reviews work of this technology, ENAV30-5.1.2.3, and EM1-5.1.2.1 the WG2 would review further in order to finalize the review of new emerging technology.

1.1 Purpose of the document

This document presents the results of the DTEC Committee review of the MS @ MS wave technology, using the IALA G1153 review template.

1.2 Related documents

ENAV30-5.1.2.3 Radio-free wireless communication based on Metal Surface Wave in the maritime sector

EM1-5.1.2.1 Further Review of Radio-free wireless communication based on Metal Surface Wave in the maritime sector

2 OUTCOME OF THE REVIEW

The overall review notes this as 'Green' – meaning the technology is identified as suitable. There were, however, some issues identified as Amber such as constraints to use the technology, more wide usage example for IALA remit, IPR (Intellectual Property Rights) for a non-discriminatory nature which required more time to get wide acknowledgement of foregoing technology, and training on the installation of the system (no training on the use of the system would be expected).

Details on the review are contained in Annex A.

ANNEX A EMERGING TECHNOLOGIES – REVIEW TABLE

	Question	Technology Candidate Response		Working Group Response	Green Amber Red
		Infrastructure	User		
1.	Where has the referral come from?	Referral has come from research of Franklin Bien and Haksun Kim from UNIST		UNIST is a public university in Republic of Korea which are dedicated to research in science and technology. Franklin Bien and Haksun Kim are professors in UNIST, and they have released articles to introduce the technology. (See the link at Q 29)	Green
2.	Name of technology and product name?	Product name: Aurora using MS@MS wave	MS @ MS wave is based on theory of metal surface wave	Aurora is the product name, and the technology it uses is MS@MS which stands for “Metal Surface at Magnetic Substance”.	Green

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3.	Functional description	A wireless communication technology based on Surface-wave to overcome the limitation of metal surrounding structure for wireless network and for primarily applying to the maritime IoT devices.	Users can use this MS@MS system, in the same way, as any radio-based system such as Wi-Fi, Bluetooth, Zigbee, etc. Just by attaching this system to the surface of the metal structure, the user can acquire the network connection on the metal surface.	<p>Note this is wireless communication in locations surrounding metal (reference ENAV30-5.1.2.2)</p> <p>MS@MS is an internal structural data communications system to support IoT devices. This could be within a shipboard environment, a lighthouse or other structure in a maritime environment.</p> <p>Conceptually, this can follow a system similar to wifi.</p> <p>The system does not rely on any protocol, it is a way to replace the radio frequency to a magnetic wave as the physical layer for the transfer.</p> <p>At this time there is no specific protocol stack developed for MS@MS</p>	Amber												
4.	Proposed user group	Any spaces or environment, which is surrounded by metallic materials, and where wireless communication by radio is difficult.	Ships, Aids to Navigation like buoy, Ocean Plant, Ocean Wind Farm, Environmental monitoring management	<p>Any user can adopt this technology to overcome the radio communications associated with metal structures.</p> <p>This can be used to replace radio frequency in an area confined on, for example, a ship, by structural interference.</p>	Green												

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5. What are its Key limitations?	<p>The resonator must be attached to a metal.</p> <p>The surface of metals must be continuous. If not, there should be an aperture between two closed spaces to connect the surface of the metal that is related to the frequency operation.</p> <p>MS@MS cannot be applied on diamagnetic materials, such as coppers and glasses.</p>	<p>There is a limitation where data speed is inversely related to distance between the resonators.</p>	<p>Noted</p> <p>MS@MS wave can be transmitted if the metal surface is continuous. If in case of closed space, there should be an aperture to allow for the magnetic wave to operate correctly. .</p> <p>The distance between resonators and the metal type has an effect.</p>	<p>Amber</p> <p>Requirement to attach resonators to the metal, affect of distance between resonators.</p>

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6.	Where is it currently used (geographic and/or industry)?	<p>The MS@MS solution has been applied to the vibration monitoring system in manufacturing process at a display factory in Korea.</p> <p>It has been tested in ships by building a living lab and communications network.</p>	<p>[examples of use on land?]</p> <p>MS@MS has been applied on the guardrails to analyse the communication distance on the continuous metal which show the com. Distance over several hundred meters</p>	<p>As seen in the reference provided, this technology is being used in the confined spaces of factories and ships that are surrounded by metal structures and is difficult to use a radio-based wireless system.</p> <p>Videos of system in operation:</p> <p>Ship 1: Samwoo47 (a steel tugboat) http://211.180.78.170:43000/#</p> <p>Ship 2: Hannarae (a steel ferry) https://youtu.be/q94y-TF-4MM</p>	<p>Amber</p> <p>As the technology is used this item is expected to move to Green</p>												

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7.	How is it currently used?	<p>Communication channel to monitor the vibration inside a Chamber in manufacturing process</p> <p>Vibration and temperature monitoring of various spaces inside the ship from engine and steering gear rooms to the bridge as main monitoring location</p>	<p>The user is able to use MS@MS where conventional wireless technologies are difficult to use and a suitable metallised environment is available.</p> <p>The user can communicate using their mobile devices, such as phones and PCs, by implementing MS@MS to communication services in ships like equipment controller or to satellite communication.</p>	<p>Noted the way of use this technology considering the example;</p> <p>Currently planned for use in at a ship building company in the Republic of Korea</p> <p>Further implementations planned.</p> <p>In most cases provided by the video on Youtube, MS@MS can be used to setup wireless communication not relying upon radio-frequency confined by the metal structure, but using the magnetic wave technology.</p> <p>MS@MS systems can be connected as a form of multiple constellation</p>	Green															

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8.	How could it be used within the maritime sector?	<p>MS@MS can be used as is or it can be adapted for use in the maritime domain (ship and shore side)</p> <p>MS@MS provides communication network in various areas, including the navigation management room, in ships which are covered of continuous metals.</p>	<p>The users in the maritime sector are associated with ship and shore side Aids to Navigation.</p> <p>This technology can be used for communicating on board using mobile phone, achieving data from security camera, communicating with land, etc.</p>	<p>Video link 1: https://youtu.be/PI78YZoQIU</p> <p>Video link 2: https://youtu.be/q94y-TF-4MM</p> <p>Opportunities for use within the IALA domain could include monitoring of lighthouses and sensor integration within structures. For more general purpose, it could form a network inside a structure of a ship to implement the IoT network, with access to a communications network in general.</p>	Green
9.	Who developed it?	<p>Sunny Wave Tech has developed the technology, researched by UNIST, for productization, and is in the productization stage.</p> <p>Sunny Wave Tech is the product supplier.</p>		Noted	Green

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10.	Is it commercial, non-commercial or military?	<p>Used in commercial projects</p> <p>e.g. #1 Implementation of MS@MS in metallised process chambers to measure real-time vibration and temperature status</p> <p>e.g. #2 Providing network services to laborers by implementing MS@MS in metallised places in engine rooms or any confined spaces in ships</p>		<p>Noted</p> <p>Commercial product but can be customized with the special requirements of specific use cases.</p>	Green															

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11.	Is there an existing technology that meets the same requirements? If so, what make this different?	<p>Metal Surface @ Magnetic substance wave(MS@MS wave) is the world's first technology.</p> <p>PLC technology might be a similar technology, but it sends through an electric wire, not any metallic surfaces.</p>		<p>Lately, PLC is not used in IoT markets because it is not suitable for large amount of data transmission with fast transmission speed.</p> <p>MS@MS wave is the first communication technology that only uses metal as a medium.</p>	Green
12.	Ease of implementation?	<p>Can be easily replaced with existing wired communication solutions applied in metallic environment.</p> <p>Can be easily attach equipment and not required to use converters.</p>		<p>Ease of use - The only required work is to attach resonators on metals and set up other communication equipment as APs.</p> <p>Video on attachment (https://youtu.be/q94y-TF-4MM)</p>	Green

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13.	What are the constraints for implementation?	The technology is suitable in areas which have continuous metals, but not suitable if the metals are discontinuous or separated.		<p>MS@MS not penetrating the metal but use the metal surface in one side</p> <p>If the metal surface have paint thickness of over 3mm, the performance decreased.</p> <p>Use in some environments may require electromagnetic compatibility testing and type approval.</p> <p>MS@MS cannot be operable at the surface of diamagnetic material, such as glass, wood, water and copper.</p>	Green												

14.	<p>what is the capability of the technology? (i.e. nominal range; data throughput; support for audio / video?)</p>	<p>When the surface wave solution is applied in the area which contains more than two septa (about 30m of distance) and supports Wi-Fi 802.11 n, the transmission speed is more than 30Mbps. If we use network technology, comm. Distance can be extended for audio, video, and digital data.</p> <p>MS@MS can be used any types of protocols, such as Wi-Fi, Bluetooth and Zigbee.</p> <p>Currently, equipment with Wi-Fi 6 is being developed, which can support high speed of communication (more than 100MB/s)</p>		<p>Refer to ENAV30-5.1.2.2 - performance of MS@MS technology is better than the radio-based system in aspects of nominal range, and data throughput inside the constrained spaces. For ease of understanding, MS@MS technology just replaces the radio wave with a magnetic wave, so it also supports audio and video streaming with any other services possible using the radio-based systems</p> <p>FYI, on an aluminium boat, MS@MS wave shows 2 to 2.5 times better performance than a radio communication technology.</p> <p>(Communication at the steering gear room: the performance of MS@MS wave(9.6Mbps) is better than radio communication technology (0Mbps)).</p> <p>On a steel boat, MS@MS wave shows about 10 times better performance than a radio communication technology.</p> <p>(Communication at the steering gear room: the performance of MS@MS wave(6Mbps) is better than radio communication (0Mbps)).</p> <p>For the refence of real use-case:</p> <p>Ship 1: Samwoo47 (a steel tugboat) http://211.180.78.170:43000/#</p> <p>Ship 2: Hannarae (a steel ferry) https://youtu.be/q94y-TF-4MM</p>	Green
15.	<p>What is the scalability of the technology?</p>	<p>Can build the communication system independently.</p>	<p>It is possible simple data</p>	<p>Users may have great flexibility for scalability using MS@MS.</p>	Green

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		Can expand the usages of the surface-wave communication system as it is compatible with existing wire/wireless communication systems	<p>communication(sensor) in local area.</p> <p>In the large part, it can possible to configure communication network for the whole ship.</p> <p>Include a simple data, audio, and HD video.</p>	Currently, the MS@MS only use the ISM band to implement it.													
16.	Is the technology backward compatible?	<p>The MS@MS expands the communication methods as it maintains existing network standards, such as Wi-Fi, but transmits signals in surface-wave form.</p> <p>The system is compatible with any types of communication systems and maintains backwards compatibility.</p>		Its backward compatibility is same to the compatible communication systems, such as Wi-Fi, Bluetooth, ZigBee and LoRa.	Green												

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		Infrastructure	User		
17.	Is the technology dependant on another technology?	independent to any technology		Noted	Green
18.	Can the technology be demonstrated?	Yes, technology has been being demonstrated by applying in ships.		Tested in ships in South Korea (See the document in #19)	Green
19.	Are there any results and test bed? Please List	See the results at https://sunnywt.com/bbs/board.php?bo_table=en_notice&wr_id=3		Noted	Green

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20.	Is there a compliance summary?	<p>There is no compliance in the MS@MS wave</p> <p>But we have been conducting test to apply on ship.</p> <p>The Compass safety distance test for interference of magnetic strength and IEC 60945:2002,11.2 (ISO694:2000E) test</p> <p>Also we prepare communication standard of MMW in near future</p>		<p>Noted</p> <p>MS@MS technology, brand named as Aurora, was tested for compass safety distance test and got a result for 70 cm separation from the magnetic compass, which showed the MS@MS technology using magnetic wave were available anywhere in the ship case.</p>	Green															

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21.	Are there legal issues associated with the implementation of the technology?	<p>As MS@MS uses conventional communication protocols, such as Wi-Fi and Bluetooth, no additional issues exist.</p> <p>No specific legal issues because MS@MS uses equipment that meets regulation of Maritime Equipment Directive</p>		Requirement to ensure that it is approved by regional rules	Green												
22.	Are there any intellectual property rights (essential patents) associated with the technology?	There is no problem related to IPR and commercialization.		<p>Noted</p> <p>IPR exists, but there is an indication it can be made available in a non-discriminatory nature.</p>	<p>Amber</p> <p>If access made available in non-discriminatory nature this will change to Green</p>												
23.	Is the technology safe to use <i>[note – safety could be understood in different ways]</i>	There is no health and safety consideration to the use of surface wave equipment, given that it is non-radiative.		<p>Agreed</p> <p>MS@MS is less interfered by other communication channels since it sends the signal through a metal, not through the air.</p>	Green												

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24.	Does the use of the technology require extra training?	The MS@MS is typically straightforward and easy to implement in various metallic environment.		The extra training may be needed for installation or maintenance engineer since the technology is totally new and may require understanding some backgrounds to apply it efficiently. In user aspects, there is no need to get extra training for use.	<p>Amber</p> <p>Use of the system does not require training, installation does</p>												
25.	Are there environmental considerations with the technology?	No environmental consideration exists.		Noted	Green												

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26.	What are the financial considerations for implementation and use?	Implementing MS@MS is about 10% more expensive than the existing wireless communication, but reduces the total install cost about 80% compared to wire system. The system can build communication network in the areas where existing communication technology cannot be applied, and the reliability and the performance are greater than existing ones.	<p>The user can implement MS@MS instead of wired-communication systems in metallised environment to reduce cost of cable purchase, human resources for installation, etc.</p> <p>Reduction of cable leads to reduction of weight. This causes to save energy which increases operation efficiency of ships.</p>	Noted	Green

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27.	Is the technology secure (i.e. protected against hacking; privacy of data)?	<p>The main difference of surface-wave communication and wireless one is that the signals are transmitted through metals as medium, not through the air.</p> <p>There is no additional security consideration needed compared to existing wireless communication systems.</p> <p>The MS@MS wave is less affective by signal interference since the signals are transmitted through metal surfaces.</p>	<p>If applied to a military or security-required environment, a security system can be applied depending on the user's requirements.</p> <p>In the case of special circumstances of the ship, security software can be added without any difficulties.</p>	<p>Agreed</p> <p>MS@MS uses communication systems that already exist, such as Wi-Fi and Bluetooth, and what system it actually uses determine the security level of MS@MS.</p> <p>MS@MS is just mentioned in aspects of medium among systems, so security has to be implemented by application.</p>	Green															
28.	Readiness (EU Technology Readiness level - TRL) (level of maturity of technology)	<p>Currently in TRL 6</p> <p>Desiring TRL 7-8 in 2023</p>		Noted	Green															

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29.	Can you provide independent References	<p><IET Microwaves, Antennas & Propagation> https://sunnywt.com/bbs/board.php?bo_table=en_notice&wr_id=4</p> <p><Scientific Reports> https://sunnywt.com/bbs/board.php?bo_table=en_notice&wr_id=5</p>		Noted	Green