Coastal connectivity using Mobile communication technology

9th NOV 2021

Dr. Woo-seong Shim (unit director)

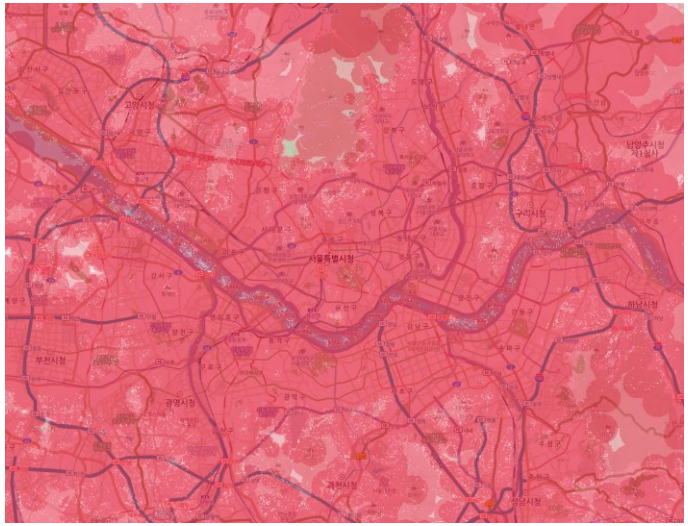
Maritime Digital Application Unit
Maritime Safety and Environmental Research Division
Korea Research Institute of Ships & Ocean engineering

Generation of Mobile Technology

* IALA e-Navigation Committee 27th WG2 working file, 2021

Generation	Major Systems Milestones
1G	Analogue technology, from the 1980s onwards. Various technologies were deployed, Nationally or Regionally, including: 1. NMT (Nordic Mobile Telephone), 2. AMPS (Advanced Mobile Phone System), 3. TACS (Total Access Communications System), 4. A-Netz to E-Netz, 5. Radiocom 2000, 6. RTMI (Radio Telefono Mobile Integrato), 7. JTACS (Japan Total Access Communications System) and 8. TZ-80n (Source:wikipedia)
2G	First digital systems, deployed in the 1990s introducing voice, SMS and data services. The Primary 2G technologies are: 1. GSM/GPRS & EDGE, 2. CDMAOne, 3. PDC, 4. iDEN, 5. IS-136 or D-AMPS.
3G IMT 2000	The 3G system from 3GPP is based on evolved Global System for Mobile communication (GSM) core networks and the radio access technologies that they support. This has allowed for the maintenance and development of GSM, with the evolution of General Packet Radio Service (GPRS) and Enhanced Data rates for GSM Evolution (EDGE), as well as further developments with the Universal Mobile Telecommunications System (UMTS) and High-Speed Packet data Access (HSPA). 3G brought a global vision to the evolution of mobile networks, with the creation of the ITU's family of IMT-2000 systems which included EDGE, CDMA2000 1X/EVDO and UMTS-HSPA+ radio access technologies.
3G/4G IMT Advanced	LTE and LTE-Advanced have crossed the “generational boundary” offering the next generation(s) of capabilities. With their capacity for high-speed data, significant spectral efficiencies and adoption of advanced radio techniques, their emergence has been the basis for all new mobile systems from Release 8 onwards. It should be noted that LTE-Advanced (From Release 10) is 3GPP's ITU-R IMT-Advanced radio interface. LTE-Advanced is the first true 4G technology to be specified by 3GPP. LTE-Advanced Pro is the name that helps the industry describe what has been achieved with the completion of Release 13. LTE Pro is set to be used by other sectors, beyond telecoms, including Critical Communications (blue light services & other Mission Critical systems), the machine-to-machine or Internet of Things (IoT) sector, Transport (Rail, ITS, etc), Education and many other areas. LTE-Advanced Pro is 3GPP's steppingstone to 5G systems.
5G IMT2020	5G brings another major technology step, with the creation of a 'New Radio' (NR). Unlike with 4G, where 3GPP hesitated to join the generational march onwards beyond 3G, 3GPP have embraced the alignment of the industry on NR and on LTE-Advanced Pro to provide 5G – from 3GPP Release 15 onwards.

Scheme of Mobile Cell Allocation: Land



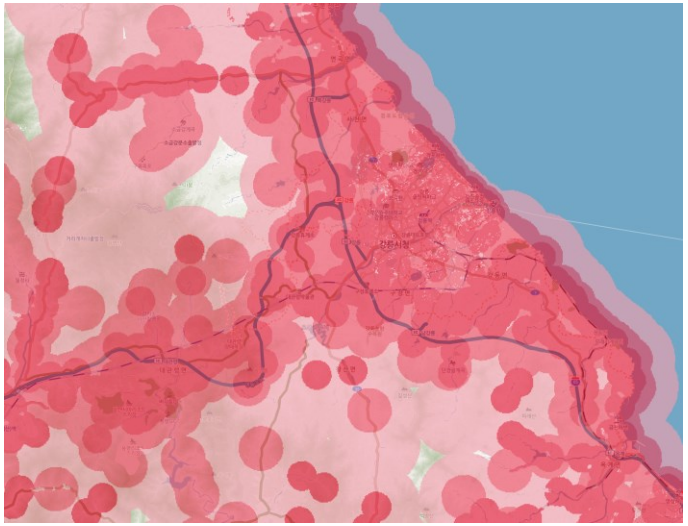
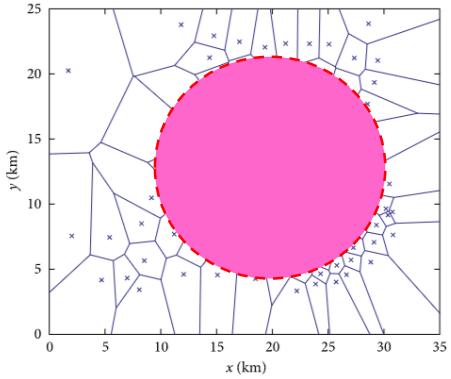


Figure 2

Voronoi diagram for a set of sites in a real cellular scenario.



A. J. García, V. Buenestado, M. Toril, S. Luna-Ramírez, J. M. Ruiz, "A Geometric Method for Estimating the Nominal Cell Range in Cellular Networks", *Mobile Information Systems*, vol. 2018.

- ◆ Use of Mobile Tech. on Land.
  - Generally, do not care the maximum distance of coverage
  - Just care the maximum user for serving

Capacity of Mobile Tech.(e.g. LTE) for Maritime Use

LTE;
Evolved Universal Terrestrial Radio Access (E-UTRA);
Physical channels and modulation
(3GPP TS 36.211 version 12.8.0 Release 12)

Table 5.7.1-1: Random access preamble parameters

Preamble Format	T_{CP}	T_{SEQ}	T_{CP}	Guard Time	Cell Radius
0	$3168 \cdot T_s$	$24576 \cdot T_s$	103.125 us	96.875 us	~ 14 km
1	$21024 \cdot T_s$	$24576 \cdot T_s$	684.375 us	515.625 us	~ 75 km
2	$6240 \cdot T_s$	$2 \cdot 24576 \cdot T_s$	206.250 us	193.	
3	$21024 \cdot T_s$	$2 \cdot 24576 \cdot T_s$	684.375 us	715.6	

T_s = 32.55 ns
Guard Time = I
Cell Radius = 0.3 (km/us)

5

Cell Radius of LTE

✓ LOS(km) = 4.11 * {√(h_{BS}) ·

1, h2 in meter

h_{SS}	h_{BS}	Coverage(LOS+)
2	525	?
2	200	?
30	355	?
30	200	?

~ 94 km

$D = \sqrt{2H_t} + \sqrt{2H_r}$

D = Line-of-sight distance (miles)
H_t = Height of transmitting antenna
H_r = Height of receiving antenna

If H_t = 200 ft and H_r = 40 ft,
$D = \sqrt{2(200)} + \sqrt{2(40)} = \sqrt{400} + \sqrt{80}$
D = 20 + 8.94 = 28.94 miles

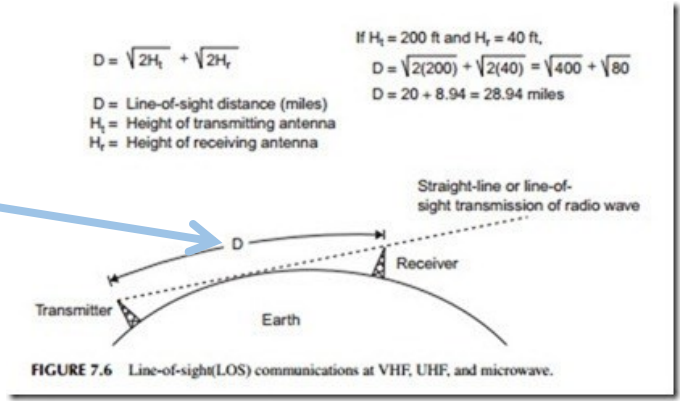


FIGURE 7.6 Line-of-sight(LOS) communications at VHF, UHF, and microwave.

Perspective of the Private Market for Coastal Connectivity

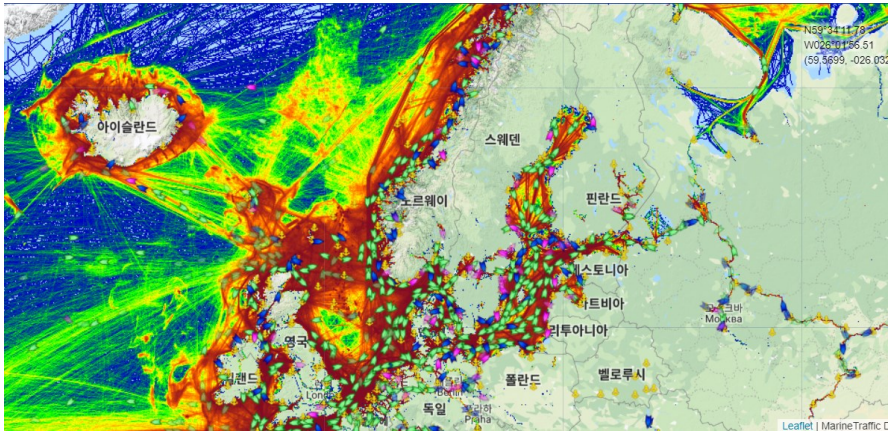
From 『Near shore connectivity whitepaper 2019』, FutureNautics & Vodafone
by the near shore connectivity survey 2019 of nearly 6,000 deep-sea commercial ships

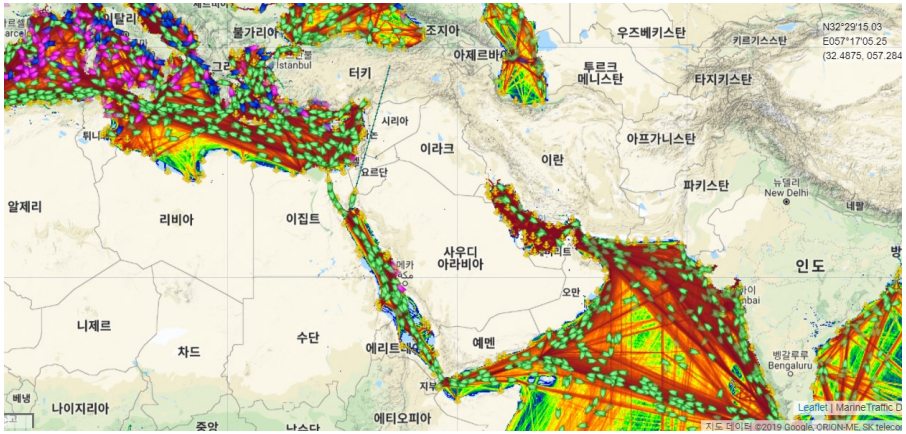
◆ 249%
- increase of data generation per vessel compare to the figure in 2019
- from 111GB per month in 2019 to 387GB per month in 2024 estimated

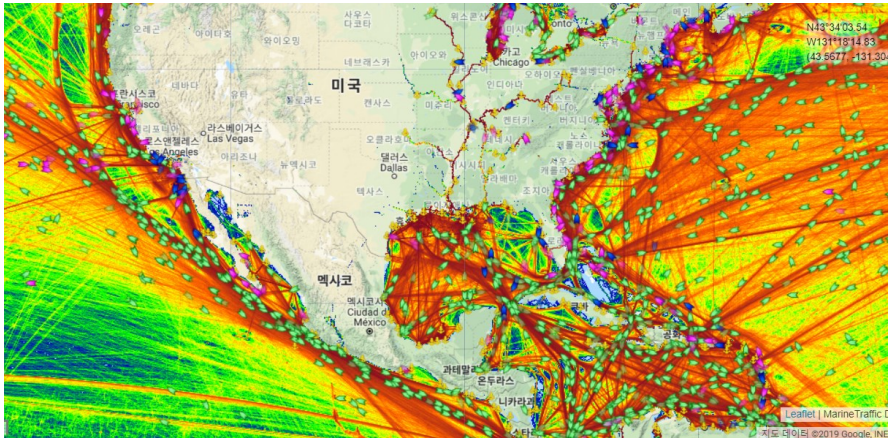
◆ 89%
- non real-time data generated on-board in aspects of btw ship and shore transmission
- only 11% of data transmission required real-time
- 47% of data transmission by daily and 42% by less frequent

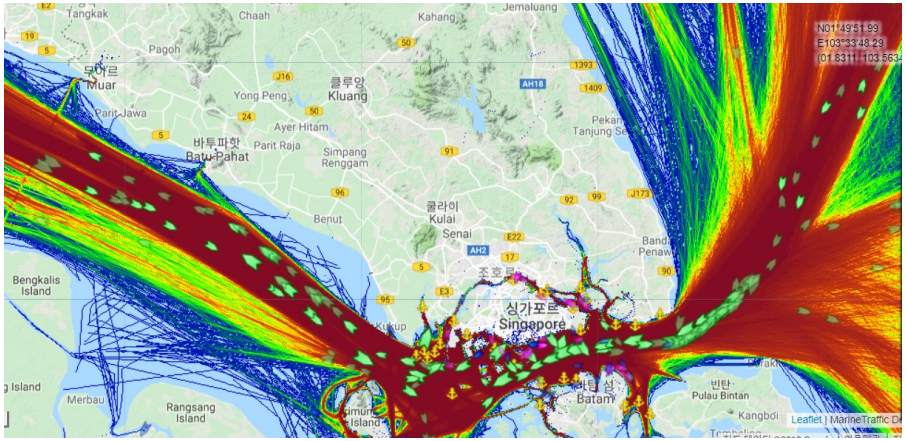
◆ 60%
- of their time in port or coastal waters
- of their time potentially within 4G/LTE coverage worldwide

Ship Traffic Density of Coastal Sea









Source: marinetraffic.com

LTE-Maritime: Korean Coastal LTE Communication

$D = \sqrt{2H_t} + \sqrt{2H_r}$

H_t = Height of transmitting antenna
H_r = Height of receiving antenna
D = Line-of-sight distance (miles)

If $H_t = 200$ ft and $H_r = 40$ ft,

$D = \sqrt{2(200)} + \sqrt{2(40)} = \sqrt{400} + \sqrt{80}$

$D = 20 + 8.94 = 28.94$ miles

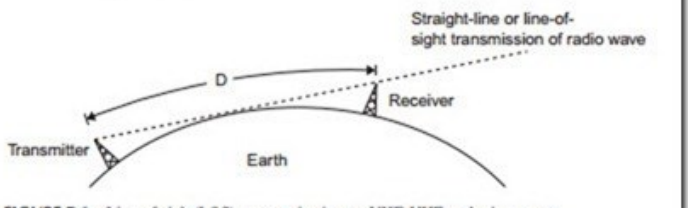
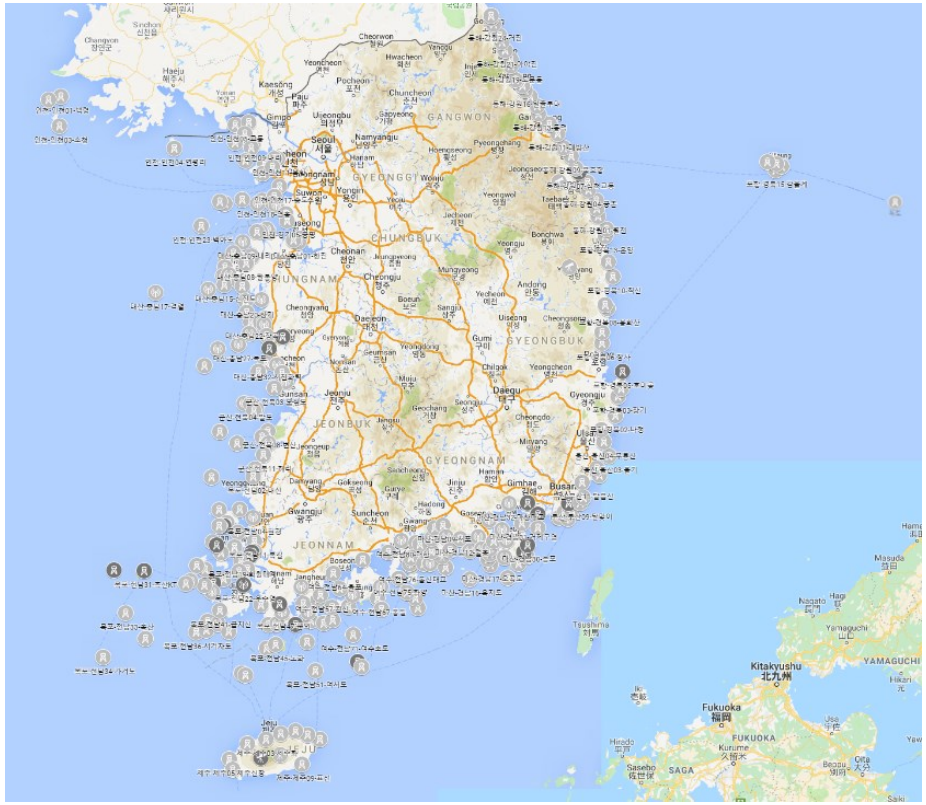
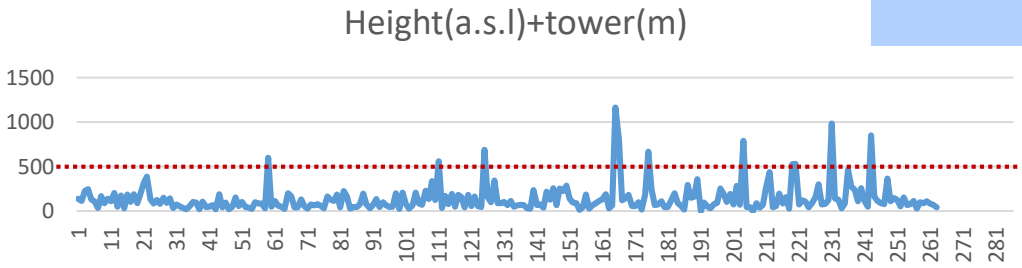
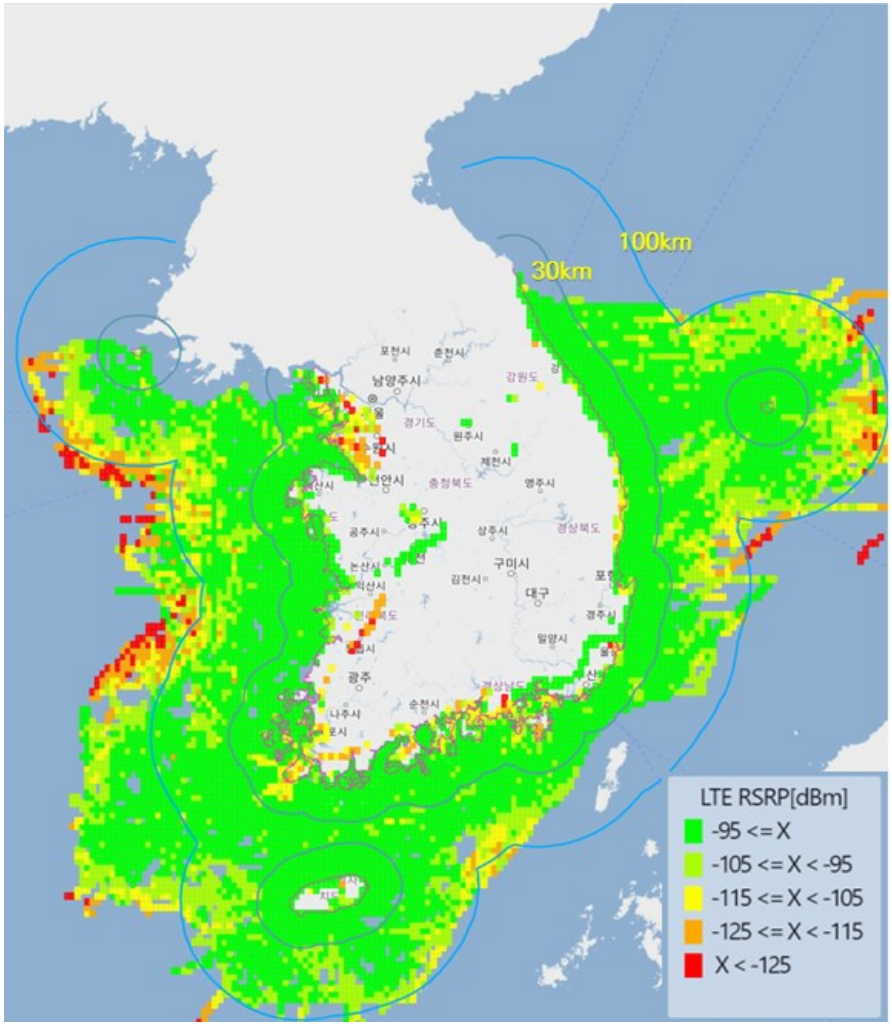


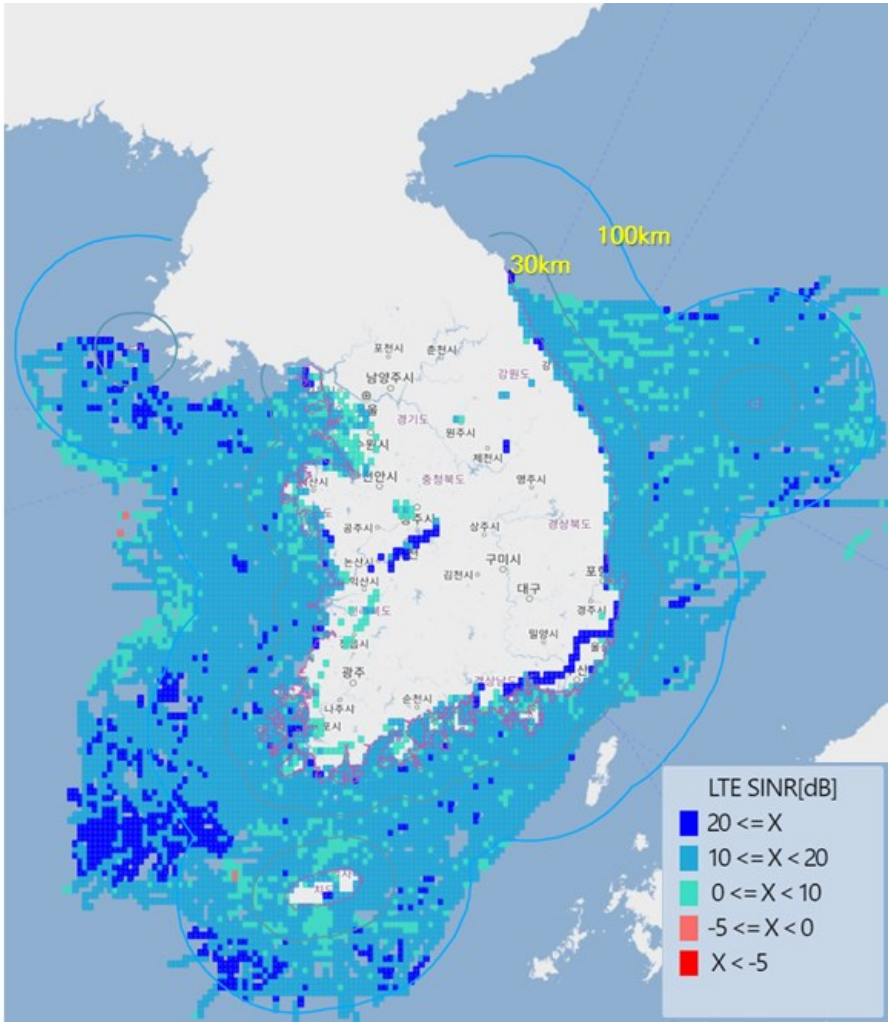
FIGURE 7.6 Line-of-sight(LOS) communications at VHF, UHF, and microwave.



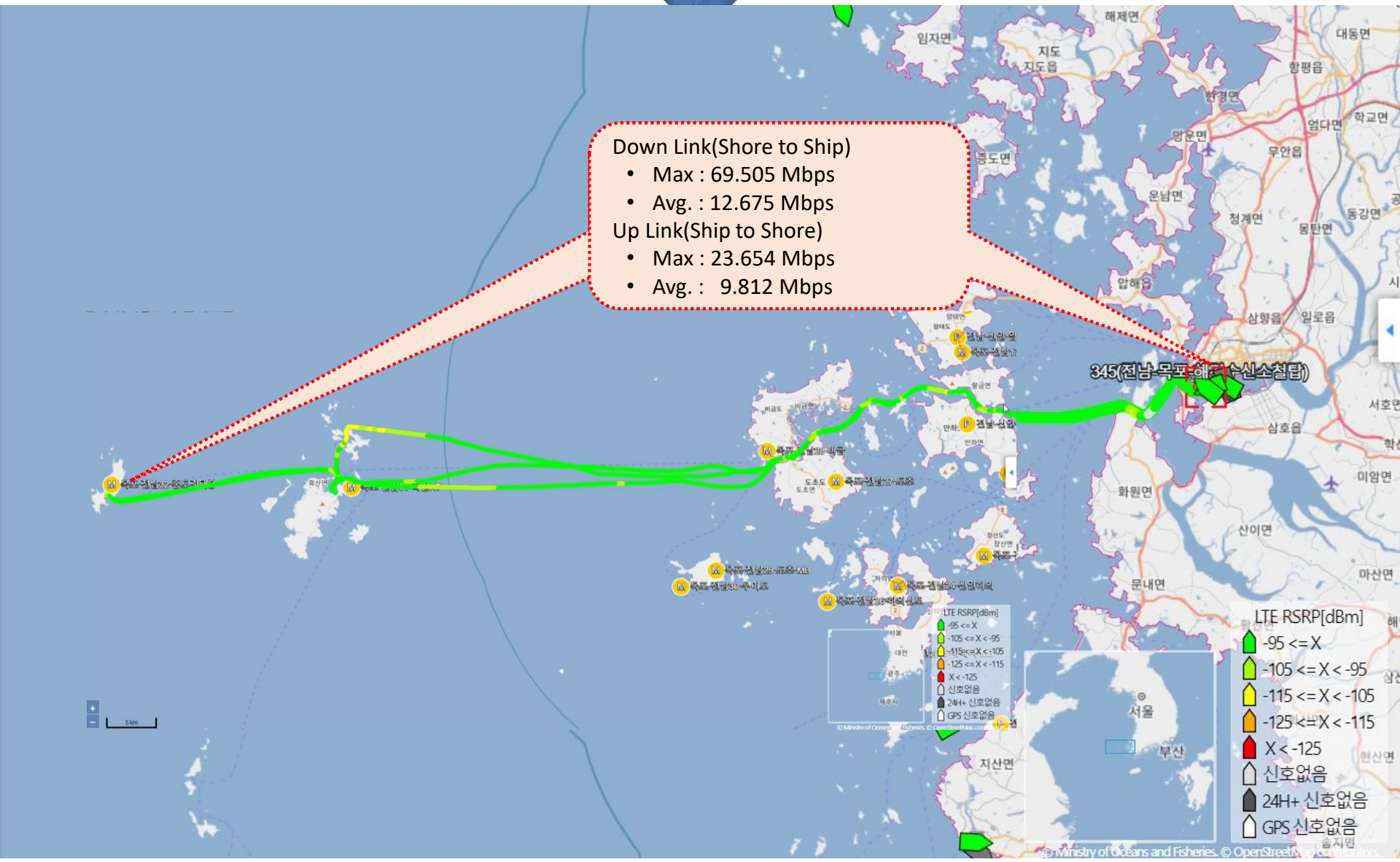


Not just Possibility, But it's Real

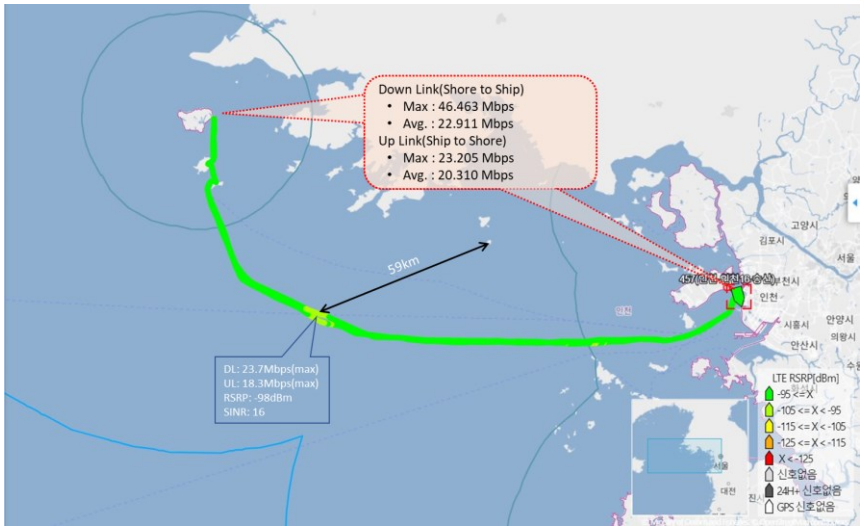


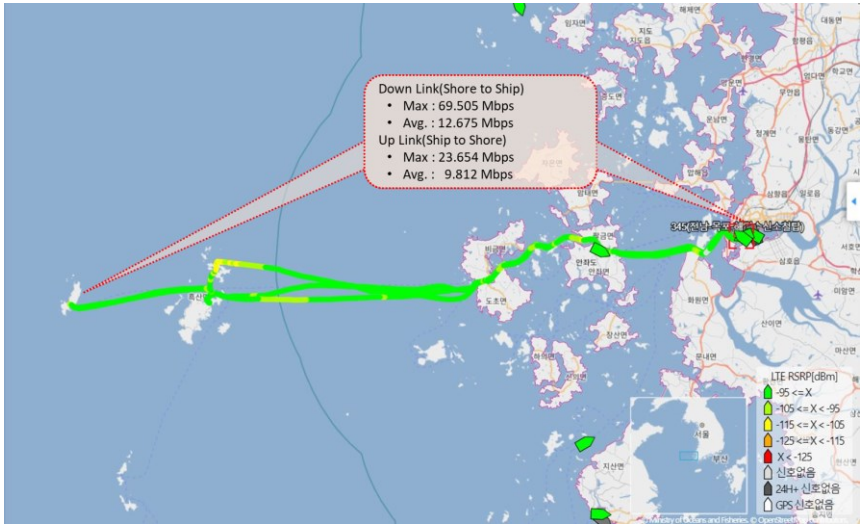


Example of Speed Test and Monitoring Function



LTE-Maritime: Network Performance and its Systems





Epilogue

'SMART' doesn't have to mean 'almighty', but 'appropriate'
for SMART Navigation and Communication.

Appropriate communication means
to provide it seamlessly by appropriate systems
on required time at required waters.

Korea Research Institute of Ships &
Ocean Engineering

Thank You

(34103) 32, Yuseong-daero 1312beon-gil, Yuseong-gu, Daejeon, Republic of Korea
Tel. +82-42-866-3662 / E-mail. pianows@kriso.re.kr / www.kriso.re.kr