IMDA 5G Use-Case Findings

PSA makes waves in the future of maritime operations

A global first in 5G mid band and mmWave trials for port operations

Singapore – 3rd August 2022:

Singapore's maritime industry is an undeniable lynchpin in engendering the country's economic success, contributing 7% of Singapore's GDP and comprising 5000 companies that employ more than 170,000 people. Singapore has the second largest port in the world (in TEU volume[1]), and its new Tuas Mega Port, slated to open in stages and complete by 2040, aims to be the world's single largest automated container terminal. In 2019, Port Of Singapore Authority (PSA[2]), Singapore's premier port operator, embarked on 5G trials to automate parts of its operations to drive future-ready port solutions in line with the development of Tuas Mega Port.

The global first trials specifically looked at 5G 3.5GHz (mid band[3] frequency) and 26Ghz/28GHz (mmWave[4] frequencies) as enablers for the transformation of PSA's port operations, specific to fleet control and management of Automated Guided Vehicles (AGVs[5]), automated Rubber Tire Gantry (aRTG[6]), and Empty Container Handlers (ECH[7]). The 5G standalone architecture[8] (SA) network was deployed by Singtel[9] at PSA's Pasir Panjang Terminal.

"From an operational point of view, we wanted to look at how to make this technology reliable, highly available, and deployed efficiently," explains Klenn Chong, Assistant Vice President at PSA, adding that the right use of 5G technology would open doors to many new opportunities and broaden revenue streams for PSA. In turn, this would enhance Singapore's economic competitiveness regionally and globally.

Supporting yard optimisation with AGVs that perform better

---

[1] TEU Volume - Measured in volume of twenty-foot equivalent units (TEUs) of containers
[2] Port Of Singapore Authority (PSA) - Collective facilities and terminals that conduct maritime trade and handles Singapore's harbors and shipping
[3] 5G mid band frequencies - Radio frequency bands ranging from 2GHz to 6GHz
[4] 5G mmWave frequencies – Radio frequency bands above 24GHz and has the fastest 5G speeds
[5] Automated Guided Vehicles (AGV) - Robotic vehicles that follow along marked long lines or wires on the floor, or uses radio waves, vision cameras or lasers for navigation
[6] Automated Rubber Tire Gantry (aRTG) - A wheeled mobile gantry crane operated in manual, semi-automatic or fully automatic mode to ground or stack intermodal containers
[7] Empty Container Handlers (ECH) - A key equipment for container transportation, widely used in the stacking and transhipment of empty containers in ports
[8] 5G standalone architecture (SA) - 5G deployed on 5G components and it will have 5G core and 5G radio access network
[9] Singtel – A major mobile, fixed, internet and content service provider in Singapore. They are one of the 4 major telcos operating in Singapore

AGVs are currently 4G enabled and receive periodic instructions whilst in operation. Current 4G latency means that AGVs do not perform at their optimum and require a larger swath of space to operate.

"At present with 4G, we allocate significant space for the AGVs to manoeuvre around the port. This ensures there is sufficient margin for error when the AGVs navigate with existing network latency[10]. With 5G and the reduction in latency, AGVs can potentially operate within a much more confined space. This might help free up highly valuable space for yard storage, which leads to improved yard optimisation at our ports. All this has an impact on the bottom line," explains Chong.

During trials, the AGVs achieved a minimum network latency of 10ms using the 5G 3.5GHz mid band frequency. This was a significant reduction in latency by 50%, compared to the previous 4G network. This lower margin for error also enables PSA to increase the number of AGVs in operation, resulting in improved productivity. Following the positive results of this trial, PSA already has plans to increase its AGV operations from 32 to 2,000 vehicles when they move to Tuas Mega Port.

aRTGs enable upskilling of workers and higher productivity

aRTGs are gaining widescale adoption in the port industry, with some studies suggesting that aRTGs can reduce fuel costs by up to 70%. Port operators therefore have an impetus to train their crane operators to remotely operate RTGs and increase their remote operator ratios.

With most current aRTGs connected through fibre networks, mobility has been the trade off in exchange for the high video uplink required for operations. This first of its kind trial using mmWave for RTGs has been able to increase the remote operator ratio from 1:3 to 1:6.

The 5G 26Ghz/28GHz (mmWave frequencies) were used in these trials in order to meet the minimum data uplink[11] of 105 Mbps and network latency of 50ms. A reliable 5G network, high data bandwidth and good network coverage within the port infrastructure was critical in ensuring the stability of throughput, which eventually returned better than expected results of 140 Mbps uplink and an even lower network latency.

"We have close to 200 RTGs in the Pasir Panjang port which currently requires a lot of manpower to operate," explains Chong. During the Covid-19 lockdowns, it became a challenge to source and retain manpower. "With wireless solutions like 5G, PSA would be able to completely automate its RTG operations and drive efficiencies, freeing up crane operators from doing mundane tasks, so that they can be moved to work on other areas, even upskill themselves," he adds.

---

[10] Network latency - Used to indicate delay in data communication over the network.

[11] Data uplink - A data connection for the upload of information from end user equipment toward the network core.

Conducted in a brownfield setting, one of the findings while running these trials in the Pasir Panjang Terminal was noting the importance of mmWave antenna placements. For example, the team discovered that the way mmWave antennas were placed around the metallic containers were critical to ensure optimal 5G coverage. The dynamic nature of container stacking would also impact the overall network design. More importantly, having full visibility on how mmWaves propagate within the grounds meant engineers could calculate the cost and viability of deploying such networks and extract that knowledge for future planning at Tuas Mega Port.

As 5G mmWave deployments are still nascent, an important learning was the evolution of the mmWave deployment architecture. "As early adopters of this 5G technology, we trialled with 5G non-standalone architecture[12] (NSA). mmWave SA and devices are only starting to roll out in 2022 but despite the technology being new, we recognised the benefits of using mmWave for 5G use cases which require higher uplink speed beyond 200Mbps" explains Edmund Quek, Senior Director, 5G Enterprise Networks at Singtel. He adds that, "Though we're working with evolving 5G technology, a lot has been achieved in understanding the gaps, so that further trials can be implemented as mmWave SA and devices mature."

Leading global port operations 5G

The journey to Tuas Mega Port will signal many new opportunities for the maritime industry in Singapore and its economic competitiveness. Expected to be the largest fully operated terminal in the world, it will rely on a strong 5G network to support the speed of operations that is expected.

"This trial has been a good sandbox environment for many learnings on how to successfully design a network, so that we can be prepared for the 5G commercial deployment at Tuas Mega Port," says Chong.

Beyond port operations, PSA is also looking to use 5G to drive efficiencies in the way ships come into dock. "At the end of the day, it's about optimising time and space. The learnings that we've gained from this trial have been very valuable. More trials will need to be done but with the right partnerships, I believe we are well positioned to become a global leader in port operations," says Chong.

[12] 5G non-standalone architecture (NSA) - 5G Radio access network deployed on existing 4G network core networks and hardware.