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Defence Technology Prize 2021 Team (Engineering) Award Winner

COVID-19 COMMAND AND CONTROL SYSTEMS TEAM
Defence Science and Technology Agency, Singapore Armed Forces, ST Engineering, and NCS Pte Ltd

CITATION

The COVID-19 Command and Control (C2) Systems Team delivered C2 solutions for the multi-ministry task forces to collaborate effectively and respond swiftly in the fight against the pandemic. These include a system to manage COVID-19 operations in the dormitories, and solutions for contact tracing, testing operations and food supply chain risk management. These were instrumental in providing comprehensive situational awareness, and facilitating the rapid scaling up of our nation's testing capacity, the safe resumption of work, and the strengthening of our food supply chain resiliency. In recognition of its outstanding achievements and contributions, the team is awarded the DTP2021 Team (Engineering) Award.

ABOUT THE COVID-19 C2 SYSTEMS TEAM

The team comprises members from the Defence Science and Technology Agency (DSTA), the Singapore Armed Forces (SAF), ST Engineering, and NCS Pte Ltd, with a range of expertise including C2, software development, data science, modelling and simulation, systems architecting and integration, and cybersecurity. DSTA provided its multidisciplinary expertise in spearheading the architecture and design, and managed the overall development of the COVID-19 C2 systems. In addition, the SAF provided key operational insights that guided the systems' designs, and industry partners ST Engineering and NCS Pte Ltd were involved in the development, integration, deployment and maintenance of the systems.

TECHNICAL INNOVATION AND OPERATIONAL IMPACT

Shortly after the virus was first detected in Singapore in early 2020, the number of COVID-19 cases started increasing rapidly with the emergence of a number of local clusters. The virus was spreading quickly on two fronts: first, through a rising number of unlinked cases in the

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community; and second, through migrant worker dormitories. Due to the unprecedented nature of this crisis, the Government had to quickly make sense of the evolving situation and roll out measures to keep the spread under control. These challenges were amplified by manual ground processes and a lack of common data sources, making it difficult to coordinate in real time across multiple agencies. The global disruption to supply chains also presented threats to the country's food supplies. The multi-ministry task forces needed a good situational picture to make critical decisions and carry out operations more effectively.

Thus, a suite of C2 systems was conceptualised to integrate indigenous technical solutions developed by the team. These solutions, which span across areas such as contact tracing, patient care, testing operations, and supply chain risk management, were developed and deployed in a matter of weeks. Integrated with more than 10 Whole-of-Government and private sector systems, the C2 systems provided comprehensive situational awareness for real-time cross-agency collaboration. Given the evolving COVID-19 situation, an agile software development approach was adopted, where the systems were improved iteratively and expanded to support a wide range of use cases and diverse users.

The team's innovations include:

a) Command & Control Capabilities for Efficient Monitoring and Response

With more than 300,000 migrant workers living in dormitories across Singapore and hundreds of new migrant worker cases reported every day in April 2020, there was an urgent need to stay on top of the situation and carry out timely interventions where required. The team developed and deployed a C2 system under two weeks to support the Singapore Army in managing migrant workers housed across SAF camps which were converted to community recovery facilities. The system was then enhanced to support the COVID-19 operations of the Inter-agency Task Force, by integrating and facilitating the access of data across the ministries. The C2 system provided real-time visibility of the situation within COVID-19 care facilities and dormitories, such as the migrant workers' living situation and health status, for holistic patient care. It captured the check-in and check-out statuses of workers to monitor their movement across facilities, and kept track of every swab test planned and conducted, clearing up the infection in the dormitories systematically. The system also enabled real-time updating of medical records, and seamless transmission of patient information across facilities. It served as a common platform for the different agencies to access the same data for an accurate real-time situational picture, supporting decision-making and efficient response.

To facilitate the workers' exit from dormitories and entry to worksites upon the end of the Circuit Breaker on 1 June 2020, a computational engine was developed. The engine ingested data sources from various agencies to generate the colour code indicator – AccessCode – for one million workers daily, allowing Singapore to re-open its economy and the safe resumption of work.

b) Situational Awareness for Management of Large-Scale Testing Operations

Another C2 system was designed to manage end-to-end testing operations at the national level. Integrated with the Health Promotion Board's Swab Registration System and the COVID-19 Test Repository, the C2 system is able to aggregate swab test demands, testing resources, swab operations and test results data, and recommend resource allocations via an optimisation engine. Robotic process automation was utilised to generate demand and supply dashboards by cleaning

and ingesting data from existing data sources. Taking planning considerations into account, the optimisation engine allocates optimal pairings between laboratories and swab demands. The system allowed MOH to scale up its testing operations, from a daily average of around 14,000 individuals swabbed per day to 200,000 at a steady state, and shorten the turnaround time from two days to 12 hours. The system can also be customised to include different testing modalities, such as saliva and serology testing, as well as testing procedures (e.g. pooled testing).

c) Network Analysis Tool for Automated Discovery of Case Linkages and Clusters

The team leveraged technology to convert the manual and memory-intensive process of contact tracing into a digitalised process. A network analysis tool was developed to help MOH's epidemiology department identify new clusters and links among cases, to enable swift contact tracing. The tool exploits network analytics – a data science technique – to process complex and large data sets rapidly, automate the extraction and fusion of data for analysis, and provide visualisations to uncover possible links between cases and discover potential new clusters quickly and more accurately. The system maps out a visual network representation of confirmed cases by linking them through activities, locations and time. Using nodes and arrows to represent cases and their links, contact tracers can examine the commonalities and identify linkages between cases, which shortens the contact tracing process. The system was deployed in a week, and supported the discovery of significant clusters including the Ce La Vi rooftop bar and Black Tap restaurant at Marina Bay Sands, Mustafa Centre, the Project Glory construction site and several migrant worker dormitories.

d) Simulated Risk Assessment for Food Security

The team designed, developed and deployed a dashboard that enabled Singapore to strengthen its food security position, through better situational awareness and use of risk assessment models. The dashboard integrated data from multiple government agencies and local supermarkets, to build a common situation picture of the national food supply and demand. It included risk simulation models with dynamic time elements that projected impact to the national stockpile under various consumption and supply disruption scenarios. This risk assessment capability uncovered potential bottlenecks and constraints in the food supply chains, thereby enabling agencies to review the adequacy of national stockpile targets and quickly formulate stockpiling strategies in response to the fluid global situation.

PROFILE OF TEAM REPRESENTATIVE

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