Building a Safer City in Singapore

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Abstract

In January 2013, the Singapore government invited companies to participate in its Safe City Test Bed. A number of government agencies also participated in this test-bed to collaborate with the selected companies to validate the solutions that drive timely and accurate intelligence to the ground for better situation awareness of fast-developing situations.

A consortium led by NEC Asia Pacific was selected as one of the four consortia to develop such a system. Making use of an array of sensors and sense making through a unique fusion of information from the ground and cyberspace, NEC's Multi-Agencies, 1 Concert (MAG1C) platform allows consortium partners' analytic engines to achieve the desired goals and thus validated Singapore's belief in innovative safe city solutions.

Keywords

multi-sided platform strategy, Internet of Things, sensors, sense-making, geographical information system, C4I, smart & safer city, inter-agency collaboration

1. Introduction

When Singapore's government planners first considered high-tech plans to make the city-state a safer and more secure place for its citizens in 2012, they were in a situation that many foreign counterparts could only envy.

Well-connected, efficient and highly urbanized, the country of 5.4 million people was as ready as any to embrace the timely information that an array of on-the-ground sensors and cameras could immediately feed decision makers. The widespread use of social media also meant that users were tuned in to the latest news, sometimes becoming active participants or witnesses to developing incidents.

With a safe city system, police forces could react swiftly to a crowd that displayed unruly behavior. Emergency services could detect potentially unsafe locations where an increased number of people may make an evacuation difficult. Floods would be more easily detected with live monitoring of water levels.

Yet, despite Singapore's renowned advancements, it faced a number of challenges not unlike many other cities. One key concern was optimizing the limited manpower available, while maintaining effective day-to-day city management activities such as ensuring smooth vehicular traffic, upholding law and order and managing emergencies.

With a fast-paced economy came an expectation for fast, efficient service as well. Should the public be first on the scene of an incident, for example, emergency responders were expected to be on the ground within a short period of time, rendering assistance or upholding public order.

2. A Comprehensive Project

With these factors in mind, the Singapore government looked far into the future for a comprehensive safe city project in 2012. The country's planners had often been known to be far-sighted, ready to adopt new ways of doing things. In developing a safer city, they were no different. They expected the project to run in multiple phases in three to four years, eventually leading to ready-to-market solutions.

In January 2013, the Singapore government issued a Safe City Test Bed Call for Collaboration that would kick start a year-long pilot project. It would involve the specially set-up Safety & Security Industry Programme Office (SSIPO), as well as a number of participating agencies, including police, civil defense, environment and water, land transport and homeland security, to develop a comprehensive system to address a

wide spectrum of safety and security concerns.

The goals were clear. Police forces should be able to have better situational awareness that enabled them to better react to fast-developing incidents. With timely on-the-ground information, emergency services could better facilitate evacuation, for example, at a popular event where a fire may have broken out. At the command level, a team coordinating to any home front crisis incident should have better global awareness, which would allow for improved decision making.

Singapore already had existing camera systems and various sensors providing data feeds back to government agencies. A new system making use of new sensing technologies and analytics on the fly would do more, by enabling decision makers to better comprehend a situation and make critical and timely decisions.

Key to this would be pulling all the data together in a way that made the information meaningful. In a crisis, decision makers had to see the big picture, literally, on a large screen to make sense of what was being fed from cameras and sensors.

The SSIPO identified four sites to test the technologies. In one of them, a consortium led by NEC Asia Pacific won a bid in May 2013 to develop a safe city Test Bed for the Ministry of Home Affairs and the Economic Development Board.

With its experience developing safe city solutions, NEC would bring technology proven in markets around the world to Singapore.

3. A Sophisticated Test Bed

In Singapore, the NEC team knew that it was preparing for an exciting Test Bed. The SSIPO project would come with great complexity and sophistication, something which the NEC team was well prepared for.

The police would want to be able to detect aggression or fighting easily, so that officers on patrol nearby can be alerted more swiftly. Singapore agencies also wanted awareness of the traffic situation, through camera surveillance, and be able to better react to a traffic accident or the occasional congestion. At the same time, the environment authorities concerned with the cleanliness of city streets wanted a way to detect if someone was littering. Also useful to them would be a surveillance system that indicated how clean a place was, so cleaners could be deployed more efficiently. For the nation's security services, the safe city system from NEC had to pick up suspicious persons loitering at train stations.

Perhaps more importantly, the sensors and cameras had to provide information in a holistic way to help officers manage incidents. Armed with actionable intelligence, commanders could then better support officers on the ground with improved assessments of knock-on effects from an incident.

4. Multi-sided Platform Strategy

The NEC team adopted a multi-sided platform strategy to allow more than 2 partners (information producer and information consumer) to engage in the sense making activities. The Scalable Media Platform takes in multiple sensor feeds (video, acoustic and smell), analyzes them and triggers geo-spatial alerts to enable the various agencies make sense of the situation in a collective state (**Fig 1**).

5. Using the Right Technologies

The platform called for a number of technologies, which NEC pulled from its research laboratories in Japan, Europe and Singapore, together with consortium members ESRI Singapore, Force 21, G Element, Greenfossil, iOmniscient, Oracle and ZWEEC Analytics, as building blocks for a seamless safe city solution (**Table**).

It would use a number of sensors - physical ones for acous-

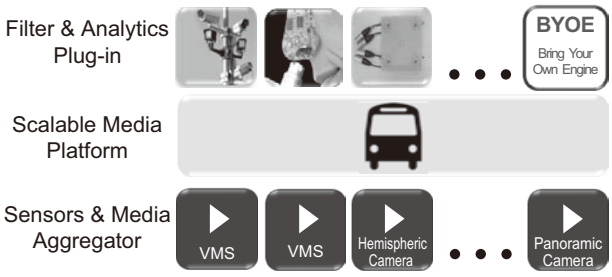

Fig 1 Scalable Media Platform.

Table Technologies and solutions provided by the consortium members.

Vendor	Technology/Solution
NEC	Acoustic analytics Alert event reasoning Cyber information surveillance system Device integrity Inter-Agency information governance appliances M2M gateway Sensor node Video analytics Video non-repudiation
esri	ArcGIS Platform
FORCE21	Video cameras Video management system
G element	3D situation visualization
Greenfossil	Inter-agencyinformation governance appliance
iOmniscient	Acoustic analytics Smell analytics Video cameras Video management system Video Analytics
Oracle	Event ProcessingPlatform Database
ZweecAnalytics	Acoustic analytics and acoustic capturing system Hemispheric camera (HemCam) Video Analytics

tic, video and smell as well as online ones for social media reactions - to identify an incident of interest. In particular, a hemispheric camera (HemCam) would be able to capture images without the distortion usually associated with wide-angle fisheye lenses.

A machine-to-machine (M2M) network would have to be built to allow these sensors to communicate and ultimately connect back to a central system for live feeds of what was happening on the ground. Sensors would be dynamically added or dropped.

With such analytic capabilities at users' disposal, accountability would need to be enforced. A governance appliance would have to be installed to provide various agencies with only relevant information they required. This appliance would authenticate and track the authorized accounts that access the data. Users would only receive information on a need-to-know basis.

In addition, a system that made use of semantic web-based risk models would attempt to make sense of cyber information. It would monitor postings based on predefined risk models and identify if a situation required the attention of various agencies.

Finally, the NEC-led team also had to develop a geo-spatial visualization platform that would put all the data in context. On a large screen, this fusion of information would have to make instant sense to operators at a command center.

6. Upgraded Capabilities

The results from the Test Beds were clear soon after the first deployments went online in late 2013, when the sensors on the ground started sending information to the relevant agencies.

In urban surveillance, the potential of early incident detection became clear. Video analytics could help detect a snatch thief thronging through a busy weekend crowd. Similarly, a fight occurring in view of cameras would be easily picked up. Video analytics would detect the particular motions as symptomatic of a fight, along with aggressive action. Audio analysis then enabled the system to understand that someone was shouting or crying, whether in anger or distress.

This provided vital information to officers reacting to a situation. But that was not all. The system would automatically look for potential points of congestion or blockage in the area, where the traffic flow might be affected. It would be able to alert relevant agencies and provide a visual map layout of the ground situation to both ambulance and security services. As they headed to the scene, they could be fed live information on the best route in and out of the area.

All in, the fusion of the various technologies gave an unprecedented amount of sense making and improved command and control. With this, officers and commanders did not end up overwhelmed with information. Instead, with the raw feeds analyzed and presented in a way that truly empowered them, their capabilities were upgraded to handle difficult situations.

The same technologies were used in other scenarios. Facial recognition and video analytics enabled officers to detect behavior such as loitering. If an officer alerted to this found it necessary, he could then check for similar, repeated occurrences. If a group of people were known to be lurking around a sensitive location, for a potential crime, they could be flagged by the system.

Besides suspicious persons, advanced video analytics could also detect suspicious objects being abandoned. For example, if a person left behind a suitcase in a train station, the system could look up a list of persons associated with it by analyzing previous video recordings. Using a blend of facial recognition and clothes recognition, it would then display the last seen location of the persons of interest, as captured on video footage.

Apart from the country's security services, the Singapore Test Bed also benefited other agencies immensely. The same technology used to detect an abandoned object could be used to monitor if an object was missing. For example, the authorities could check if someone had stolen items such as rubbish bins. Agencies also benefited from a system that could detect crowds in a specified area. More crowds usually meant there was more rubbish to be cleared. Once the threshold for a "geo-fenced" area was reached, an alert could be triggered to an officer, who would determine if a cleaning crew had to be dispatched.

At the same time, a slightly different system helped the transport authorities monitor cars on the roads, to see if congestion was building up. This was done with traffic volume monitoring as well as surveillance of the travelling speed of cars through important stretches of road. This was especially helpful because the system also took in information from real-time traffic reports already available. Together, the fusion of information provided situation awareness via a geographic information service (GIS).

Yet another agency that would benefit from the safe city project was Singapore's water agency. With advanced video analytics, it could detect if water level had risen beyond a pre-defined level at many drains around the island. Once a certain level was reached, an alarm could be sent out to an officer, who would determine if a flood was imminent and send out appropriate alerts to people near to an affected area.

All in, 20 analytics capabilities were successfully tested. Some 370,000 faces were detected a day. Crowd behavior was correctly detected 75 per cent of the time and crowd counting was 80 to 90 per cent accurate.

7. Understanding the Information

All that data, of course, would mean nothing if officers in charge were not able to make use of it in a timely fashion. This

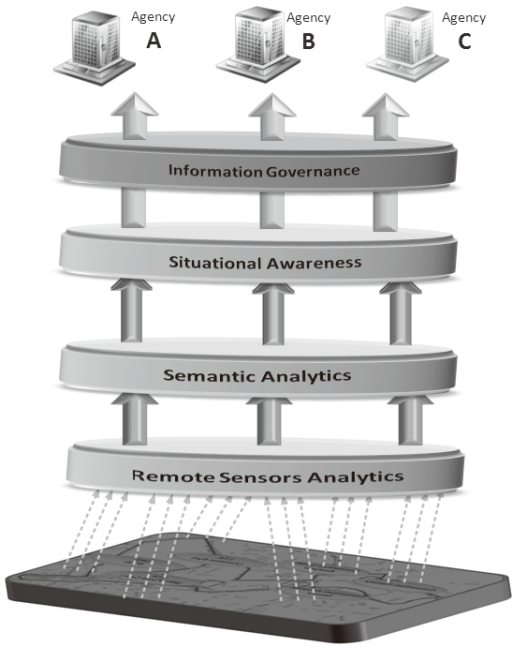

Fig. 2 NEC's Inter-Agency Collaboration Framework.

is where NEC's team made a difference. It had analytics to make sense of the data and sophisticated governance to guard its access (**Fig. 2**).

At the most basic level, remote sensor analytics picked up primary data such as fight detection, abandoned object detection and crowd detection.

Semantic analysis helped make sense of the data even further, by adding users' domain knowledge to the mix. Using ontology-based risk models, it analyzed patterns and inferences to predict potential incidents and likely follow-on effects.

In turn, that intelligence was presented on a city map or 3D building model that incorporated trends, real-time events, content and spatial analysis. These visual tools, based on ESRI's ArcGIS and G Element's NUCLEUS, enabled swift and effective decision making.

Finally, NEC's Multi-Agencies, 1 Concert (MAG1C) Suite enabled various agencies to access information they required, while protecting it using access rights. This meant various agencies collaborating on a situation could have access to a set of data – on a "need to know" basis.

8. Conclusion

Many lessons were learnt from the Singapore Test Bed. One was the importance of having all relevant agencies onboard a platform that would benefit from as much sense making as possible. At the same time, the trials also validated that a safe city solution would help address many of the challenges facing Singapore.

Perhaps most important in a project like Singapore's was the readiness and experience of technology vendors to meet the requirements of government agencies involved in the crucial job of ensuring safety and security in a city. Throughout the Test Bed, NEC spared no effort in refining small details in the system. It also ensured that it would work well with existing systems that were in place previously.

With decades of working with governments all over the world, NEC was well-positioned in this area. Backed by cutting edge innovations such as advanced biometrics and MAG1C suite, the company integrated the technologies of its consortium members to deliver a Test Bed that showed how a future city could keep safe and secure with the latest advancements.

*ArcGIS is a registered trademark of Esri.

*NUCLEUS is a registered trademark of G Element.

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Vol.9 No.1
January, 2015

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