

TRANSFORMING TOMORROW

A Safer World for Everyone

SPOTLIGHT

TECHNOLOGIES AT THE EXHIBITION

TECH BYTES

Analysing Digital Signatures

DEEP DIVE

CLOUT OF THE CLOUD

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Introducing our CoEs



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TRANSFORMING TOMORROW

A Safer World for Everyone



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Core Curation Team
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Toh Keng Han (JCPMC)
Strat Comms

Tech Bytes Team
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Peng Chongtian (RAUS COE)
Dr. Ben Soon (RAUS COE)
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Sivakumar Maniam (Disruptive Technologies Office)

Deep Dive Team
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Back Page Team
Cassie Ong (Biometrics & Profiling COE)
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Linette Leow (DIF COE)
Ong Hong Yuan (JCPMC)

Publication Team
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Rexanne Yap (Strat Comms)
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Jacqueline Woo (Strat Comms)

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Good day everyone

I would like to welcome you to this special edition of TechXplain for TechX Summit (TXS). In this special edition, we have curated a selection of TechXplain articles for our TXS guests and participants.

In conjunction with TXS, I am also pleased to announce the launch of our TechXplain blog, <https://www.htx.gov.sg/techx/techxplain-blog>. TechXplain is an e-magazine created by the scientists and engineers at HTX, written to introduce readers to the various science and technology domains of interest to Home Team. The blog is a collection of some of the articles from the magazine.

Focusing on the partnership with Microsoft and TXS guest speaker Mr Satya Nadella, our Deep Dive article is on the power of Cloud Computing.

Our Xponent, Pan Yong, writes about the “why” of Cloud Computing and how Cloud Computing has become a transformative force both in the public and private sectors. We have a significant push into Cloud, with re-skilling and re-tooling of our organisation currently underway. As our Chief Executive Mr Chan Tsan has said, “The strategic partnership with Microsoft to develop a Sovereign Cloud here in Singapore will enable us to push the boundaries of innovation and be in the forefront of technology. This way, we will be well-poised to exponentially enhance the capabilities of the Home Team and to keep Singapore as the safest place on the planet.”

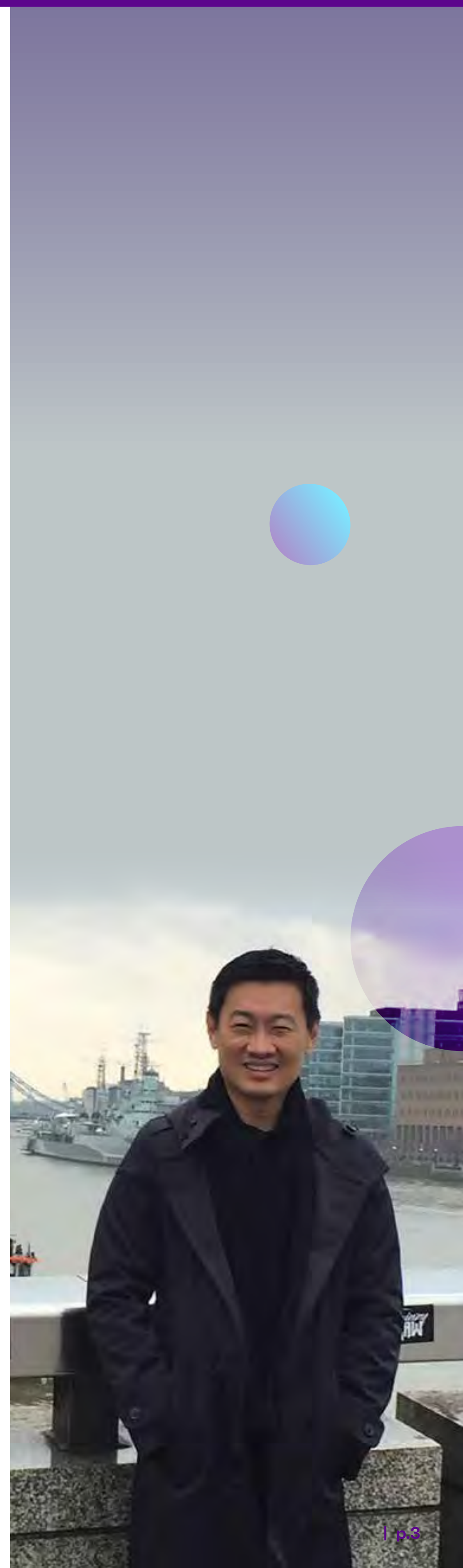
As digital signatures become more prevalent, have you ever wondered how the authenticity of these signatures can be analysed? Well, in this issue, Forensics CoE (Centre of Expertise) explains the science behind examining Digitally Captured Signatures. CBRNE (Chemicals, Biological, Radiological, Nuclear and Explosives) CoE shares about Wastewater Epidemiology and how it has played an integral part in enhancing public safety, especially in the context of COVID-19. The Disruptive Technologies Office looks into the future potential of Quantum Random Number Generators, while Data Science and Artificial Intelligence CoE leverages AI to tackle the challenges of Speech-To-Text technology. Human Factors and Simulation CoE shares how Manikin testing is conducted alongside human trials, and how Gait Analysis can help to improve our officers’ performance.

In HTX, we have passionate scientists and engineers delivering cutting-edge technologies and solutions for the Home Team. Driven by a common mission to be the Home Team’s Force Multipliers, take a glimpse into the different CoE (Centres of Expertise) and PMC (Programme Management Centres) as they showcase their Avatars and tag lines.

Before I sign off, TXS is taking place this week, from 5th to 8th April. TXS will welcome many distinguished guests and speakers, including Senior Minister and Coordinating Minister for National Security Mr Teo Chee Hean. There will also be a physical tech demo at our headquarters, and virtual conferences where our panellists will provide insightful analysis on technology topics relevant to our Home Team. Whether in person or online, see you at TXS!

Best regards,
Yu Leong

EDITOR’S NOTE



TECHNOLOGIES AT THE EXHIBITION

TRANSFORMING TOMORROW, A SAFER WORLD FOR EVERYONE

HTX's inaugural TechX Summit (TXS), April 5 to 8 2022, will showcase some of the exciting and transformative solutions that HTX is developing along three domains – Man, Machine, and Mission.

MAN

Augmenting our officers by using technology to help Home Team Officers perform stronger, faster, and better.

MACHINE

Force multiplying our Home Team by leveraging platforms, unmanned, and automation systems to extend the capability reach of the Home Team.

MISSION

Transforming safety and security through science and technology (S&T).

These technologies aim to empower the **Home Team to solve crimes, save lives, enhance public safety and security, secure borders, and safeguard data and systems.** Here are some highlights...

ENHANCING PUBLIC SAFETY AND SECURITY

HTX has been progressively leveraging science and technology on multiple fronts to maintain Singapore's safety and security through unmanned systems, artificial intelligence (AI), and automation.

UNMANNED SURFACE VESSEL (USV)

By Robotics, Automation & Unmanned Systems (RAUS) Centre of Expertise (CoE)



- The USV aims to augment the Police Coast Guard's (PCG) maritime patrolling capability in safeguarding our waters.
- "The use of USVs to augment manned patrol is a strategic initiative to address the lean manpower and increasing workload challenges as we secure our borders and enhance public safety and security," said Ho Choong Chuin, Deputy Director, Maritime Systems, RAUS CoE.
- The USV's autonomous navigation, collision detection and collision avoidance (CDCA) systems are customised to safely and autonomously navigate the USV in Singapore's congested and narrow channels. A live video feed of the USV's surroundings is streamed to the Operator Control Station (OCS) via multi-layered communications technology, providing the USV operators with a live view of the situation in the waters.

SUSTAINING OPS CAPABILITIES FOR MARITIME EMERGENCIES (ULTRASONIC ANTIFOULING TRANSDUCER)

By Marine Systems, Platforms Systems Sustainment Centre



- Barnacles' growth on the underside of a vessel hull can cause drag resistance to the vessel and burn more fuel, leading to significant financial and environmental costs. To sustain and improve the operations of marine vessels, HTX's Platform Systems (Marine Systems) uses ultrasound technology to remove barnacles from vessels – a solution that is environmentally friendly, easily implemented, and reduces the cost of underwater hull washing.
- The Ultrasonic Antifouling Transducer emits bursts of ultrasonic waves at multiple frequencies, enabling microscopic bubbles to form on the underwater hull of a vessel. These bubbles implode and clean away algae and barnacles.
- This technology is currently being used on two classes of Singapore Civil Defence Force's (SCDF) marine vessels and can potentially be used to tackle the barnacle problem across the other Home Team's vessels.

PRISON AUTOMATED SCREENING SYSTEM

By RAUS CoE

- The Prison Automated Screening System (PASS) is not an ordinary toilet, but the first-of-its-kind that automates urine procurement and illicit drug screening in a fully automated and seamless manner.
- PASS provides a complete end-to-end solution that automates the whole process to allow SPS officers to work on more value-added tasks.
- PASS uses a robotic gantry system to handle the test kit and leverages deep learning to analyse the test kit's results. The system is designed to be contactless for hygiene purposes, and automations such as a urinal shutter and sensors are incorporated to ensure that the user deposits the urine sample only at the right time with all steps conducted in the right sequence. PASS is also installed with various technology to safeguard against any potential foul-play.



SECURING OUR BORDERS

Our borders are our first line of defence against the entry of threats. We are developing cutting edge technologies to keep Singapore and her residents safe, while giving travellers a seamless and efficient experience.

RAPID PCR FOR BIO WARFARE AGENT IDENTIFICATION

By CBRNE (Chemical, Biological, Radiological, Nuclear, and Explosives) CoE



- Many of us are now familiar with Polymerase Chain Reaction (PCR) tests due to the COVID-19 pandemic. PCR is a widely established and gold standard method used for the detection and identification of biological agents such as Anthrax that can pose a threat to public security and health.
- A PCR system consists of two parts: (1) PCR machine (hardware) that runs the PCR and (2) PCR reagent mixture – prepared by combining different PCR reagents into a specialised tube.
- CBRNE scientists optimised a new PCR assay formula (with specific composition, amount, and combination of reagents) that is compatible for fast-speed PCR. This will reduce the PCR process significantly from >90 min to <30min, improving efficiency by at least 3 times. This will allow for faster response effort to minimise impact should a biological agent threat be detected.

NEXT-GEN TELL-TALE INDICATORS FOR AUTOMATED PROFILING

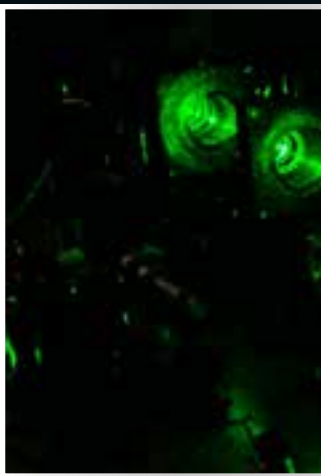
By Biometrics & Profiling (B&P) CoE

- To augment checkpoint officers’ current capabilities to identify suspicious travellers based on their observed traits for enhanced security checks, HTX’s Biometrics and Profiling (B&P) Centre of Expertise is looking to automate the detection of suspicious travellers.
- B&P engineers are studying behaviours and physiological reactions exhibited by people harbouring malicious intent and translating tech-based Tell-Tale Indicators (TTI) into algorithms to sift out abnormal behaviours. TTIs are markers associated with travellers with suspicious or malicious intent. Some examples of TTIs include excessive sweating and fidgeting.
- “Contactless technologies provide additional data points that augment the visual assessment by officers to increase the consistency and objectivity of profiling. We are harnessing contactless technologies to enhance the Home Team’s profiling and behavioural analysis capabilities and effectively deter possible threats,” said Willy Lee, Director of B&P CoE, HTX.

- B&P CoE has also been evaluating Visual Stress Analysis (VSA), which is designed to detect deception during an interrogation through contactless means. VSA is a system that uses a 4K camera to detect the stress level of the interviewed subject – both cognitively and emotionally – with no physical probes required.
- The algorithm uses an optical technique to analyse colour changes on the face, undetectable by the naked eye, and translate the pixels into signals that are correlated to stress levels.
- Significant stress reactions to specific questions are shown by spikes in the graphs generated by the system, thereby guiding the interrogators to dig deeper in a certain direction.

VISUAL STRESS ANALYSIS

By B&P CoE



SAVING LIVES

Smart technology solutions can make a crucial difference in saving lives by enabling frontline officers to be better prepared and respond more quickly in times of emergency.



SPEECH-TO-TEXT

By Data Science and Artificial Intelligence (DSAI) CoE

- The Automatic Speech Recognition for 995 emergency calls is a transcription proof-of-concept by HTX, Nanyang Technological University, and the Singapore Civil Defence Force. It is a trilingual system that supports Singapore English, Malay, and Chinese. This is the one of the first-of-its-kind as most other models are bilingual.
- The vision is to have an end-to-end tool incorporating the various Home Team speech-to-text models developed, where Home Team officers can self-service to reduce unwanted background noise and transcribe their audio recordings while achieving the best optimal accuracy automatically.

SCDF MOTORISED STRETCHER

By RAUS CoE



- The SCDF Motorised Stretcher was developed to improve the operational efficiency and crew well-being of SCDF Emergency Medical Services (EMS) by combining classical mechanism with modern actuation schemes.
- Current loading and unloading of a stretcher from an ambulance needs three Emergency Medical Services (EMS) personnel and approximately 30 sec for loading and unloading. The SCDF motorised stretcher requires just one EMS personnel to perform the loading or unloading process. It takes no more than 12 sec.
- “Combining our technical expertise with SCDF’s operational experience, the motorised stretcher is designed to be safe, easy to deploy, and nimble to suit the local terrain; all of which, collectively, will enhance the conveyance experience for both the patient and the operator,” said Dr Daniel Teo, Head of Home Team Process Automation, RAUS CoE, HTX.

This is an improvement over the version that was published in The Straits Times in June 2021. It is more ergonomically designed with improved the stability for comfort of the patient.



NATURAL LANGUAGE PROCESSING

By DSAI CoE



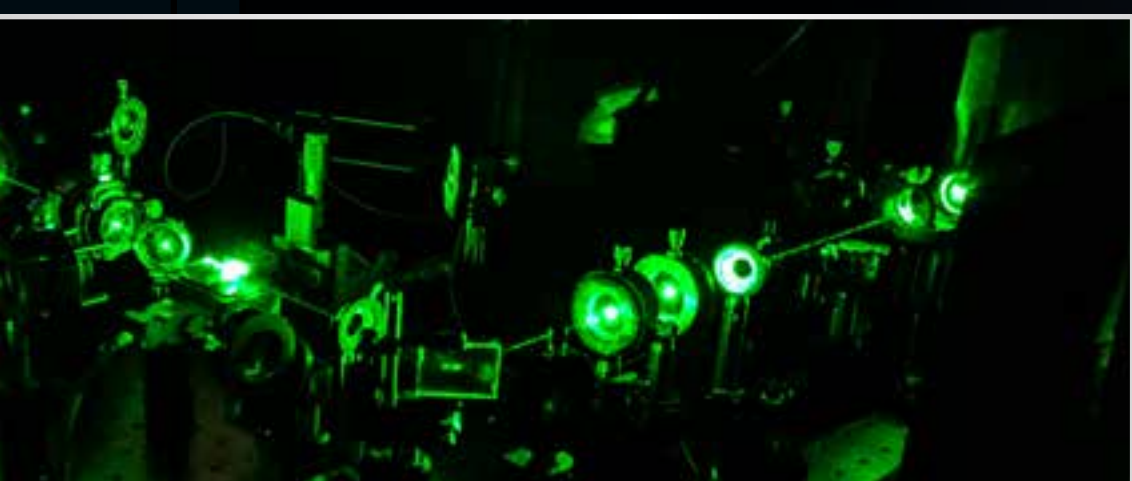
- We also have other AI-enabled tools, e.g. natural language processing (NLP) tools that can be accessed via a one-stop self-service platform called “Vertext”. The NLP tools developed include: Multi Document Summariser that summarises multiple documents on the same topic, and Extractive Question Answering that improves complex information retrieval from the posing of relevant questions that are currently hard to answer using traditional NLP techniques.
- “AI is rapidly changing the way we conduct our daily tasks and enabling opportunities for automation and efficiency. However, AI is often seen as complicated and remote for the uninitiated. We want to bring AI and its benefits to the Home Team and support officers by providing user-friendly AI tools and resources so that they can utilise AI to improve productivity in their daily work,” said Sylvia Liaw, Ag Deputy Director, Cognitive Computing, DSAI CoE, HTX.

SOLVING CRIMES

HTX also ventures into the realm of emerging S&T and explores the use of computational forensics and quantum technology to solve crimes to augment the Home Team’s mission of keeping Singapore safe and secure.

COMPUTATIONAL FORENSICS AND QUANTUM TECHNOLOGY

By Disruptive Technologies Office (DTO)



- In today’s highly connected world and with the advent of IoT (Internet of Things), rogue devices that could be malicious pose a security risk to the network. The machine learning algorithms developed by DTO are able to effectively learn the signatures of small data packets of hard to detect rogue cyber devices so that they can be quickly identified.
- Novel psychoactive substances (NPS), a category of illegal drugs, are continuously evolving with new varieties being produced all the time. DTO’s work attributing unknown NPS to their family class can help in the early detection of illegal drugs. Beyond reactive detection, DTO is also exploring a proactive approach that aims to derive new NPS derivatives based on historical precedents.
- DTO, in a collaborative effort with A*STAR’s Quantum Technology Engineering division and National Institute of Education’s Natural Sciences and Science Education faculty, developed a proof-of-concept application of quantum technology that obtains the visualisation and chemical mapping of latent fingerprints using the power of quantum entanglement.

Analysing Digital Signatures

In the course of our lives, we would have signed thousands of signatures to authorise financial transactions or establish the legality of important documents. Signatures serve as powerful personal identifiers, from parents signing their child’s report card to businessmen sealing million-dollar deals.

But what happens if we suspect that someone has forged or tampered with the signatures on an important document? In the field of forensics, we can investigate these ‘Questioned Documents’ to prove if the signatures on handwritten, printed, or machine-generated documents are authentic.

There are two main types of signatures that we examine, traditional ‘wet ink signatures’ and ‘digitally captured signatures’.

Wet Ink Signatures

Wet ink signatures are handwritten on documents using writing instruments. When comparing wet ink signatures, the forensic scientist will analyse features such as the formation, slant, and alignment of strokes, as well as the pen pressure, directionality of stroke, and fluency of the signature.

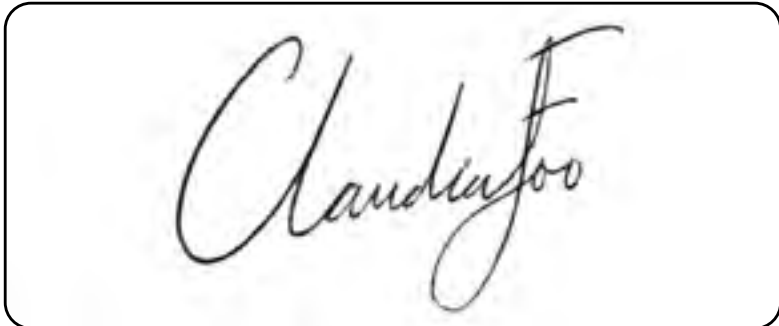


Figure 1: A wet ink signature.
(Image Credit: HTX)

However, with the convenience of digitalisation, there has been an uptick in using **digitally captured signatures** to sign documents. If these signatures are not physically signed with pen ink, how do forensic scientists analyse them for authenticity?

A New Frontier - Examining Digitally Captured Signatures

A Digitally Captured Signature (DCS) is a handwritten signature that has been digitised. It is produced using a digital device such as a signature pad or tablet, with a capturing software.

When a DCS is signed, a two-dimensional image of the signature is captured, along with its spatial X-Y coordinates, motion trajectory, and pressure values. This information is recorded and stored in the system, along with metadata such as location, date, and time when the signature is captured. Some devices may even capture data such as the pen angle and trajectory of the pen tip while it is above the surface of the signature pad.



Figure 2: Signature plotted from the values of the X-Y coordinates recorded from a DCS.
(Image Credit: HTX)

In the case of a DCS, the pictorial representation of a signature, along with information extracted from its stored biometric characteristics, such as writing speed and pressure, will allow forensic scientists to analyse, compare, illustrate, and calculate features of the DCS to determine the identity of the writer.

When comparing between wet ink signatures and DCSs, the forensic scientist has to also consider other factors such as the type of digitiser, sensor technology, writing instrument (e.g. a stylus or finger), and signature pad used, as these would affect the capture of the different biometric characteristics.

Honing these skills in examining DCSs is increasingly important for today’s forensic scientists as more documents are being digitally signed in our rapidly advancing digitised world.

Staying ahead of the curve, HTX’s Forensics CoE is pre-emptively seeking out ways to meld traditional expertise with the latest technologies, to develop new capabilities that force-multiply our Home Team.

Did you know?

You would probably have signed a couple of DCSs, e.g. when you made a purchase using a credit card and signed on a signature pad, or bank documents on a tablet.



Crystal Tan | Senior Forensic Scientist, Forensics CoE
Having courage and an open mind are philosophies that Crystal brings into her forensics work...and into her meals too! Kangaroo meat, fried mealworms and pig brain are some examples of the exotic delicacies she enjoys.

Digital Dictation

Remember those dreaded dictation tests we did in our early primary school days? Pencils furiously scratching away as we strained to hear our soft-spoken English teacher over the rattling fans, other classes doing PE in the basketball courts, and the distraction of schoolmates passing in the corridors. Did she say 'leave' or 'leaf'?

Dictation tests are how humans are taught to convert speech to text. But how do we teach computers to do the same? We use Speech-to-Text technology.

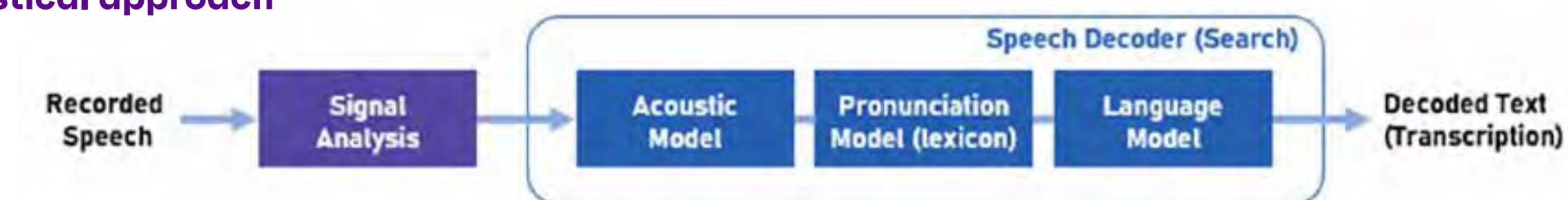
Speech-to-Text (STT), also known as automatic speech recognition, is how machines use Artificial Intelligence (AI) techniques to transcribe speech that is recorded in audio into written text. This is done via signal processing and machine learning techniques.

Simple as it sounds, STT has several critical applications in the MHA context. For example, STT can be used to transcribe spoken words in video-recorded interviews, radio communications, focus group discussions and emergency calls to 995 and 999.

For these emergency calls, when STT is applied, operators will be able to focus on helping the caller, over trying to manually record important incident information during the call.

There are two general approaches to STT – the statistical approach and the Deep Learning approach.

Statistical approach



The statistical approach makes use of signal processing techniques to break down the speech into a digital format that can be understood by the machine. These are then sent to three different models – acoustic, pronunciation and language. These three models work to recognise the basic units of sound, match these sounds to words and then predict the sequence of words that are transcribed.

Deep Learning approach

The Deep Learning approach feeds recorded speech data into one end-to-end model in the computer and uses artificial intelligence techniques to process the spoken words into a written transcript.

One key advantage of using the Deep Learning approach is that it is better at recognising dialects, accents and multiple languages compared to the statistical approach. However, both approaches are not without their challenges.

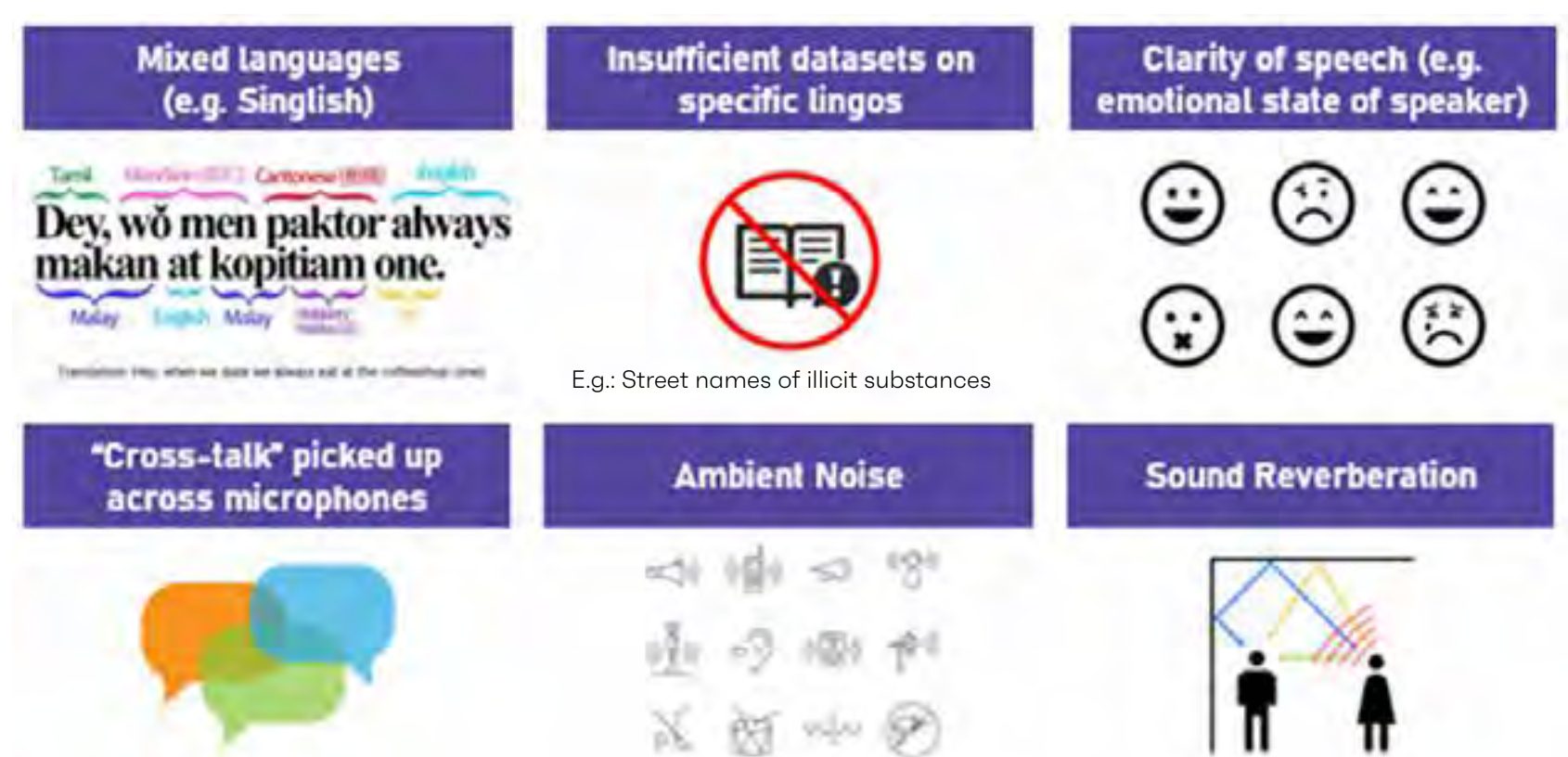
Beyond the Lines

Done well, STT is useful beyond the mere recording of speech.

Other Natural Language Processing techniques can also be applied on STT's textual data, allowing us to translate different languages, build tools that automatically summarise text, and create question-answering systems like Siri, which provide a reply to spoken queries on the phone.

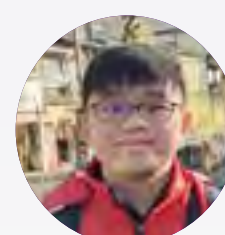
The many useful applications of STT for the MHA context is the key motivation for its continual development. Thus, as a first giant step, HTX's DSAI is collecting datasets within the Home Team so that we can develop better STT models.

Challenges of Speech-to-Text



Aloysius Tan | DSAI

Aloysius creates multi-language STT engines for computers, but his own brain can only manage two – English and Mandarin. Away from the computers, he likes to unwind by folding origami.



Ho Jun Liang | DSAI

Jun Liang is a modern-day renaissance man. An auditor in his past life, he also wields the épée as a fencer too!

How are Random Numbers Generated?

We may not think too much of random numbers, but did you know that many applications require them? From generating winning lottery numbers to simulating stock market predictions, random numbers – sequences of numbers with no recognisable patterns – are used in many aspects of our lives.

In HTX, random numbers are especially important for cryptography. We use random number generator (RNG) technology to create ‘keys’ or passwords that are used to secure computer accounts, communications and information transfer.

The more random and unpredictable these ‘keys’, the harder it is for someone to hack into our systems. Thus, we aim to use RNGs with a high degree of randomness in our science and technology solutions for the Home Team.

Did you know?

Throwing dice is one of the oldest forms of generating random numbers.

To maximise randomness and prevent bias, dice manufacturers go to great lengths to ensure that the weight, size, and density of each dice are all equal.

Types of RNGs



Pseudorandom number generators (PRNG)

PRNGs are computer algorithms that use mathematical formulas to churn out random numbers. They generate ‘pseudo-random’ numbers that still have a pattern.

For example, the numbers are random from the first to 500 numbers, but the same number repeats itself every 500th time. PRNGs are usually used in games and simulations but are not ideal for cryptography as the numbers can be predicted by sophisticated hackers.



True random number generators (TRNG)

To get truly random numbers, we need to turn away from computers and look to Nature. Nature is full of truly random events – for example, the rate at which lightning strikes during a thunderstorm is a random phenomenon.

Thus, TRNGs generate truly random numbers by observing microscopic natural phenomena. Some TRNGs measure fluctuations in atmospheric noise and turn it into a string of random digital numbers. With their high degree of randomness, TRNGs are commonly used in cryptography and lottery machines.



Quantum random number generators (QRNG)

An exciting development in RNG technology are QRNGs.

As it is rooted in nature, Quantum phenomena (interactions at the atomic level) are also truly random. By measuring fluctuations in Quantum phenomena, QRNGs can rapidly generate truly random numbers.

Some QRNGs use vacuum fluctuations to generate random numbers. Many people think that vacuums contain nothing, but in quantum mechanics, vacuums are full of particles appearing and vanishing all the time. These energy waves are like ocean waves that have peaks and troughs, and by measuring those highs and lows, such as the phase and amplitude in the vacuum, the electromagnetic field of the vacuum can be used to generate random numbers.

Still a nascent technology, the proposed uses of QRNGs range from cryptography to forecasting financial markets.

QRNGs have great potential for use in the Home Team. We can dramatically strengthen our cryptography for secure communications, as well as create highly realistic simulations such as crowd modelling to predict the movement of crowds in a fire.

Through DTO, HTX is keeping abreast and continually exploring the latest developments in QRNGs, so that the Home Team will always be at the forefront of science and technology to safeguard our homeland.



Sivakumar Maniam | DTO
Siva may be a number-crunching quantum scientist, but his guilty pleasure is watching brainless, logic-defying zombie movies.

Turning Wastewater into Valuable Information

When we think of our daily ‘business’ on the toilet, we usually turn our noses up and flush it away, hoping it never sees the light of day again. However, did you know that human excrement can actually be a useful source of information for scientists?

What is WBE?

Wastewater epidemiology (WBE) is the science of analysing the sewage of a local population. When humans are infected with diseases, or consume certain chemicals, the waste that we produce will contain specific substances derived from the infection or the chemical. Analysing human wastewater in the lab can give scientists valuable insights to pre-empt the outbreak of diseases, monitor pollution levels, and even detect drug use¹ in the community.

The wastewater sampler installed at a manhole. As each person only passes waste at certain times of the day, the wastewater sampler has to automatically collect samples at regular intervals throughout the day in order to capture a representative sample. (Photo credit: HTX)



What is WBE used for?

In Europe, WBE was used to track drug usage in the community². When a drug is consumed, the liver will break it down into a ‘metabolite’ and expel it as waste. While WBE cannot identify specific drug users, it can be used to track trends in drug usage across the wider population through monitoring the levels of drug metabolites in sewage.

Internationally, WBE is used to monitor polio virus transmission³. Polio is currently on the brink of eradication, with ongoing transmission in only a few countries. Some countries maintain a routine WBE programme to detect poliovirus in the wastewater, which can be used to guide outbreak response and resource allocation, when needed.

WBE for COVID-19

In our local context, WBE is used to detect the presence of COVID-19 in the community. When a person is infected with COVID-19, the infected cells in the body will release a genetic material known as RNA. The body will then release RNA into the stool.

WBE can then be used to detect the presence and amount of RNA. Counting the amount of RNA fragments in a sample enables scientists to estimate the prevalence of COVID-19 in the community. WBE can also be used as an early detection tool as the body will release RNA into the wastewater even before an infected person shows symptoms.

At the peak of the COVID-19 pandemic in early 2020, HTX officers conducted WBE sampling and lab testing as part of a nationwide pilot programme to complement the PCR test. At that point, there was a large number of infections in the workers’ dormitory, making it hard to swab and test all of them for the virus. So WBE was used to quickly identify which dormitories had virus clusters and authorities then followed up by testing and quarantining workers as necessary. As COVID-19 moves into the endemic phase, WBE is still relevant in establishing the dominant or variant strain circulating in the population.

HTX’s CBRNE CoE has been continually using WBE to monitor the prevalence of COVID-19 infection at various locations in Singapore, playing an integral part in enhancing public safety. Beyond detecting COVID-19, HTX is also looking into other use cases for WBE to detect and intercept any CBRNE-related threats early, keeping a vigilant eye on our nation’s security.



Sheldon Ho | CBRNE CoE

Sheldon can tell you that wok hei is a result of the Maillard chemical reaction between sugars and proteins. An avid foodie, this scientist is always looking forward to his next umami-rich meal.

1. <https://academic.oup.com/femsmicrobes/article/doi/10.1093/femsmc/xtab011/6354777>
 2. <https://www.kwrwater.nl/en/actueel/wastewater-analysis-reveals-trends-in-international-drug-use/>
 3. https://academic.oup.com/jid/article/210/suppl_1/S294/2194423

The Science Behind Our Walk: Gait Analysis

Walking may seem like a simple, routine motion for many, but did you know that by observing your style of walking, or gait, researchers and practitioners can deduce your state of health or even detect potential neurological disorders like Parkinson's disease at an early stage?

Despite it being the most basic means of transport, walking is a complex task that requires impeccable coordination between the musculoskeletal and nervous systems to produce smooth motion, maintain balance, minimise energy expenditure, and prevent injury. Your gait is also affected by factors, such as age, personality, mood, underlying health conditions, and even sociocultural factors.

When we walk, our bodies and limbs move in highly unique and repeated patterns. By examining our walking process and breaking the cycle into phases, we can obtain unique insights into every individual.

The systematic study on walking is known as Gait Analysis.

Analysing the Gait

During Gait Analysis, common spatiotemporal variables such as cadence (number of steps per unit of time), step width, step length, and stride length are studied.

Additionally, sophisticated instruments are also employed to collect biomechanical data on joint kinematics (angles and movements), joint kinetics (ground reaction forces), and muscle activity.

In the Home Team, HTX's Human Factors and Simulation Centre of Expertise is looking to utilise real-time Gait Analysis to improve officers' operational performance. It also acts as a quantitative method to evaluate the effectiveness of new equipment and training regime, to minimise injury risk and maximise physical efficiency.

Depending on the tools used, different sets of data are collected. Together, they provide a holistic evaluation and offer insights on what can be improved for ground officers.

If we find an abnormality caused by donning certain operational gear, such as a fully loaded police duty belt, solutions would include redistributing the load evenly so that officers' movements and postures are not impeded.

State-of-the-Art Facility

Gait Analysis, as well as many other cutting-edge research on human performance, will be conducted in ExCEL (Emergency Responders' Fitness Conditioning & Enhancement Lab), a first-of-its-kind facility co-developed by HTX and the Singapore Civil Defence Force. To be unveiled by early 2022, ExCEL would further optimise frontline officers' performance and capabilities.

Officers can look forward to the next frontier of research, training, and assessment in the Home Team, to eXponentially impact Singapore's safety and security!

Figure 1: High speed cameras, 3D motion capture systems and force plates are also employed to collect the biomechanical data on joint kinematics (angles and movements), joint kinetics (ground reaction forces), and muscle activity. (Image Credit: HTX)

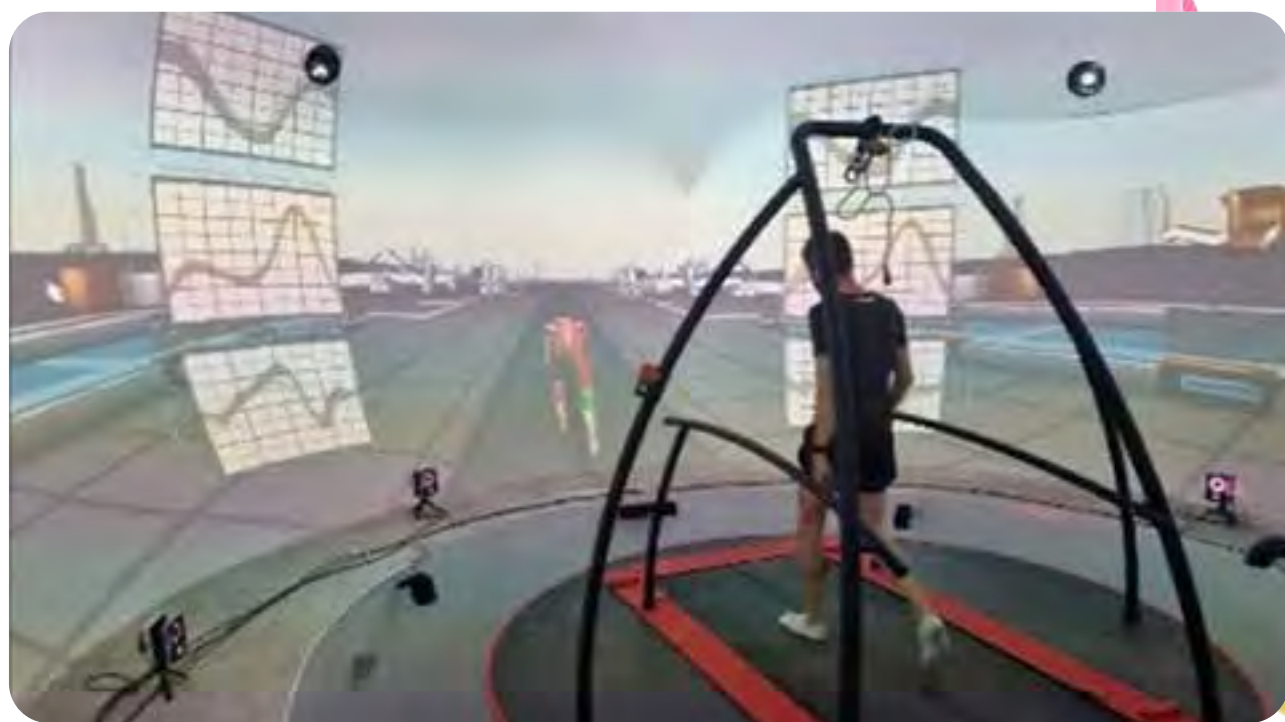
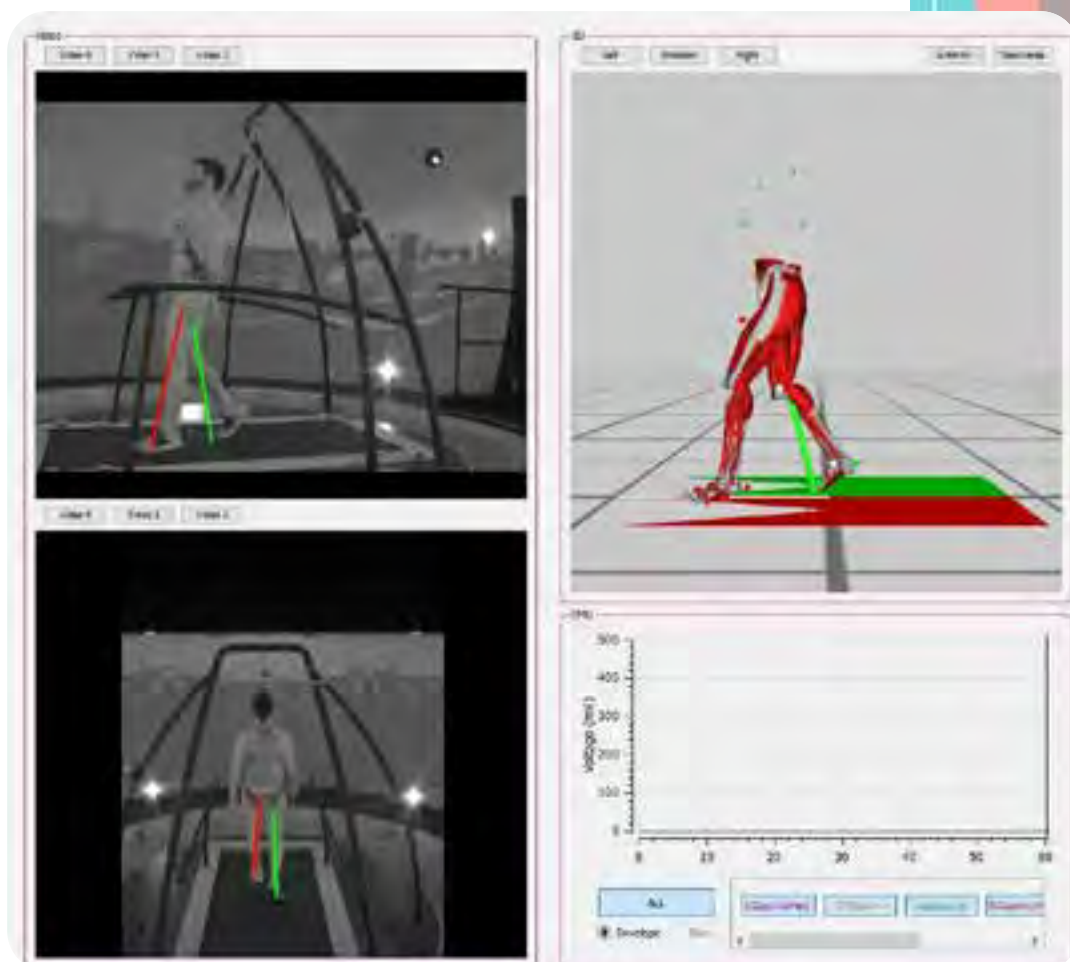


Figure 2: A sneak peek at STRiVE (STrength, Conditioning and Rehabilitation in Virtual Environment), a facility in ExCEL which allows us to conduct real-time Gait Analysis. (Credit: HTX)



Liaw Ying Qi | Engineer, Human Factors and Simulation CoE
Don't be fooled by her bookworm exterior - Ying Qi loves outdoor adventures! She enjoys camping and hiking, and had even conquered a 1500km road trip across Vietnam on a motorbike.



Lowell Chong | Scientist, Human Factors and Simulation CoE
An expert in measuring and analysing bodies to improve human performance, Lowell has concluded that he is in a constant "long distance relationship" with his wife - their height difference is 30cm!



Leong Hin Fong | Senior Scientist, Human Factors and Simulation CoE
In her work, Hin Fong pushes Home Team officers to their maximum potential to help them succeed in their jobs. In her free time, she likes to push the boundaries of her own abilities too! An adventure junkie, she has scuba dived, skydived, and even left footprints at the Everest Base Camp.

Man versus Manikin

When you hear the word, “manikin”, what is the first thing that comes to mind?

No doubt, in your mind’s eye, you will see a “mannequin”. The model on display in shopping centre showcases, decked out in the latest fashion trends. Right?

Well, that’s not exactly it.

While manikins are actually similar to mannequins, they don’t just stand pretty. They are used for the specific purpose of simulating human beings in scientific research.

Many are built to further provide real-time sensorial feedback – making them indispensable and significant contributors to scientists and their projects.

And how is that so?

Well, a manikin or, to use its proper nomenclature, the “Instrumented Manikin” – is a physical model built to represent a human body and fitted with an array of sensors for use in testing.

These sensors, embedded strategically throughout its body, offer valuable information about what the manikin experiences, such as temperature, pressure, force, position, speed, and orientation.

It is akin to putting a human being through a scenario and have him/her live to tell the tale accurately and effectively.

It gets even more interesting!

Advanced instrumented manikins not only successfully mimic the human body in size, weight, and skin elasticity, but they can also be programmed to walk, jump, breathe, and sweat like anyone of us.

At the HTX Human Factors and Simulation Centre of Expertise (HFS CoE), manikin testing is conducted alongside human trials to test the safety and efficacy of a product or technology.

Standardised and representative manikins are generally preferred because they are consistent test subjects that will produce unbiased results in experiments that are often repeatedly done. Comparatively, human beings are far less reliable test subjects given our inconsistent attributes – that includes the impact of weather conditions, time of day, mood, diet, and other variables – all of which may unwittingly skew the outcomes.

There are also other advantages of using manikins over human beings. Manikins can be used in high risk experiments that may endanger lives, such as car crash tests or fires. In addition, a manikin is indefatigable while a human must eat, drink, and rest to perform as needed.

Dr Saravana Kumarasamy and his team at HFS CoE have been deploying a thermal manikin in their projects to evaluate a human’s thermal comfort with the use of different uniforms, PPEs, cooling devices and personal equipment. The experiments have gone a long way to developing better gear and conducting more effective training for frontline Home Team officers.

“HFS intends to develop a suite of manikin systems to support the Home Team in head-to-toe evaluation of body-worn items such as personal protective ensembles and load carriage systems. Essentially, we will monitor relevant human performance indices such as their thermal physiology, tactile pressure, and biomechanics. In addition, manikins will also help in the tactical and close combat training of officers,” said Dr Saravana.

So, the next time you spy a person in the HFS lab, take a second look, it might just be a manikin!



*A Newton Thermal Manikin in HFS Lab
(Photo credit: HTX)*



Rensheng Deng | Lead Scientist, Human Factors and Simulation CoE
Rensheng is equally adept at managing plants and humans, as evidenced by his work in HF&S, and his success with cultivating more than 20 flourishing potted plants in his house.



Saravana Kumarasamy | Deputy Director, Human Factors and Simulation CoE
Not only does Saravana develop tech to increase human performance, he also doubles up with a strict fitness and diet regime to optimise his own performance. Truly walking the talk!



Meng Fai Ying | Director, Human Factors and Simulation CoE
To bring out the best in the body, Meng Fai sees the merit in both Western and Eastern medicine. To him, one treats the symptoms, and the other treats the root of the problem.

CLOUT OF THE CLOUD

Cloud computing is key for the Home Team to accelerate digital transformation and innovation. But what exactly is the cloud? Here’s a quick primer.

I’m a big fan of the Marvel Cinematic Universe (MCU) series - if you don’t know what the MCU is, you are probably from another universe (pun intended). In particular, my favourite film is Guardians of the Galaxy. There is this one scene in Infinity War when the Guardians met the Avengers and the conversation goes,

Star-Lord: “ ... where is Gamora?”

Iron Man: “I’ll do you one better, who is Gamora?”

Drax: “I’ll do you one better. Why is Gamora?”

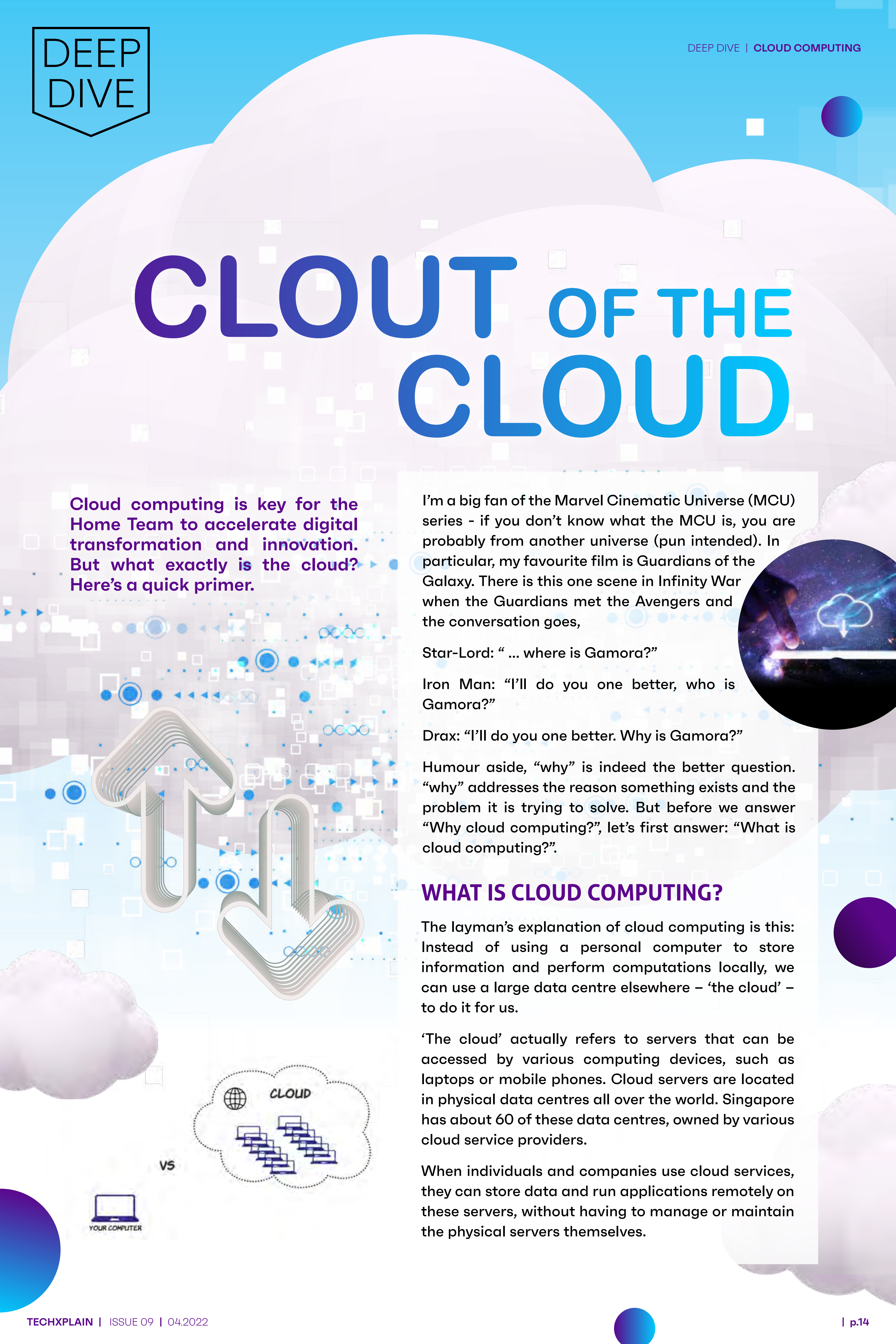
Humour aside, “why” is indeed the better question. “why” addresses the reason something exists and the problem it is trying to solve. But before we answer “Why cloud computing?”, let’s first answer: “What is cloud computing?”.

WHAT IS CLOUD COMPUTING?

The layman’s explanation of cloud computing is this: Instead of using a personal computer to store information and perform computations locally, we can use a large data centre elsewhere – ‘the cloud’ – to do it for us.

‘The cloud’ actually refers to servers that can be accessed by various computing devices, such as laptops or mobile phones. Cloud servers are located in physical data centres all over the world. Singapore has about 60 of these data centres, owned by various cloud service providers.

When individuals and companies use cloud services, they can store data and run applications remotely on these servers, without having to manage or maintain the physical servers themselves.



Many of us encounter cloud computing in our daily digital lives. **In fact, our entire mobile experience today depends on our data being stored in the cloud.**

When we run out of storage space on our 32-gigabyte phones, we turn to iCloud or Dropbox to store our family photos.

When we get uncanny recommendations in our favourite e-commerce app, that's because the e-commerce company used cloud computing to analyse our data in order to send us customised suggestions.

When we use a navigational app to go from one place to another, the maps will always be updated in real-time, thanks to cloud computing.



CLOUD SEEDING

The idea of cloud computing has been around as long as computers and networks existed. In fact, in the early days - up till the 1980s, computers were centralised (in the cloud) as it was too expensive for individuals to own personal computers. So, back in those days, researchers in universities will access central computers in a time-sharing model.

WHY CLOUD COMPUTING?

In the 1990s and early 2000s, computer hardware became cheaper and more accessible, which led to many individuals and organizations obtaining personal computers and server hardware. But, as the demand for more and more processing power increases, problems started to arise with localised hardware:

- Hardware infrastructures were often underutilised
- Organisations lacked the elasticity to support the dynamic surge and shrink of demands
- Over time, owning disparate hardware with different capabilities and lifespans became messy to manage
- Fault lines were created between hardware operations engineers and software developers. Operations engineers needed certainty to procure hardware, but developers cannot confirm what the hardware demands would be until the software is operational.

We needed an agile solution to counter the rigidity of local hardware.

HERE COMES THE CLOUD

Many attribute modern cloud computing to Amazon Web Services (AWS), a spin-off from Amazon's core e-commerce business. Amazon, hampered by their traditional infrastructure, was struggling to support the applications that their developer teams were rapidly churning out. Thus, Amazon went on to transform its infrastructure into a service that was reliable, scalable and cost-effective.

But they did not stop there. Amazon then turned this solution into a business by allowing other developers to **consume** its new infrastructure as a service. This became 'the cloud' as we know it today, with the following characteristics:

On-demand self-service	Software developers can now provision their own infrastructure without friction from hardware operations engineers.
Broad network access	The cloud's services can be accessed from any internet-connected device.
Resource pooling	Different clients can share a common pool of computing and storage resources, creating economies of scale.
Rapid elasticity	Resource availability can be automatically increased or decreased to according to the customer's demand.
Measured service	Resource usage can be monitored, controlled, and reported, providing transparency for both the provider and consumer of the cloud service.

CLOUD, CUSTOMISED TO OUR NEEDS

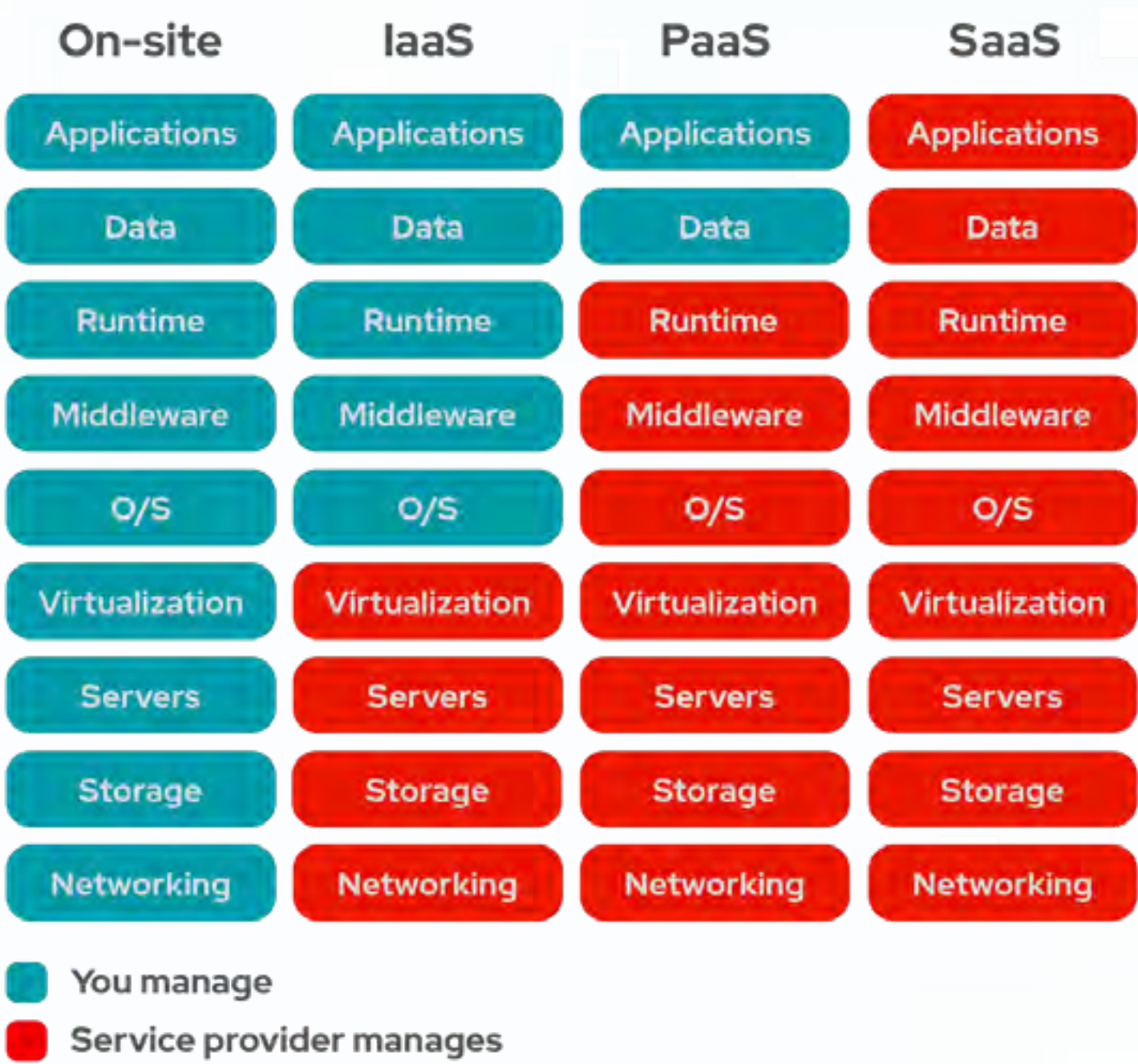
Following in the footsteps of AWS, other big tech companies like Microsoft and Google have also built their own data centres and allowed other individuals and organisations to consume their cloud services. Broadly speaking, cloud services can be grouped into 3 service models:

- **Infrastructure as a Service (IaaS):** Customers are provided with the capability to provision processing, storage, networks, and other fundamental computing resources to run their software on top. E.g., Virtual Machines, AWS.
- **Platform as a Service (PaaS):** Customers don't even need to provision the underlying computing resources, but just need to deploy the application. E.g., Google App Engine, Windows Azure.
- **Software as a Service (SaaS):** Customers just need to access the application via the internet. E.g., Gmail, Dropbox, and Office 365.

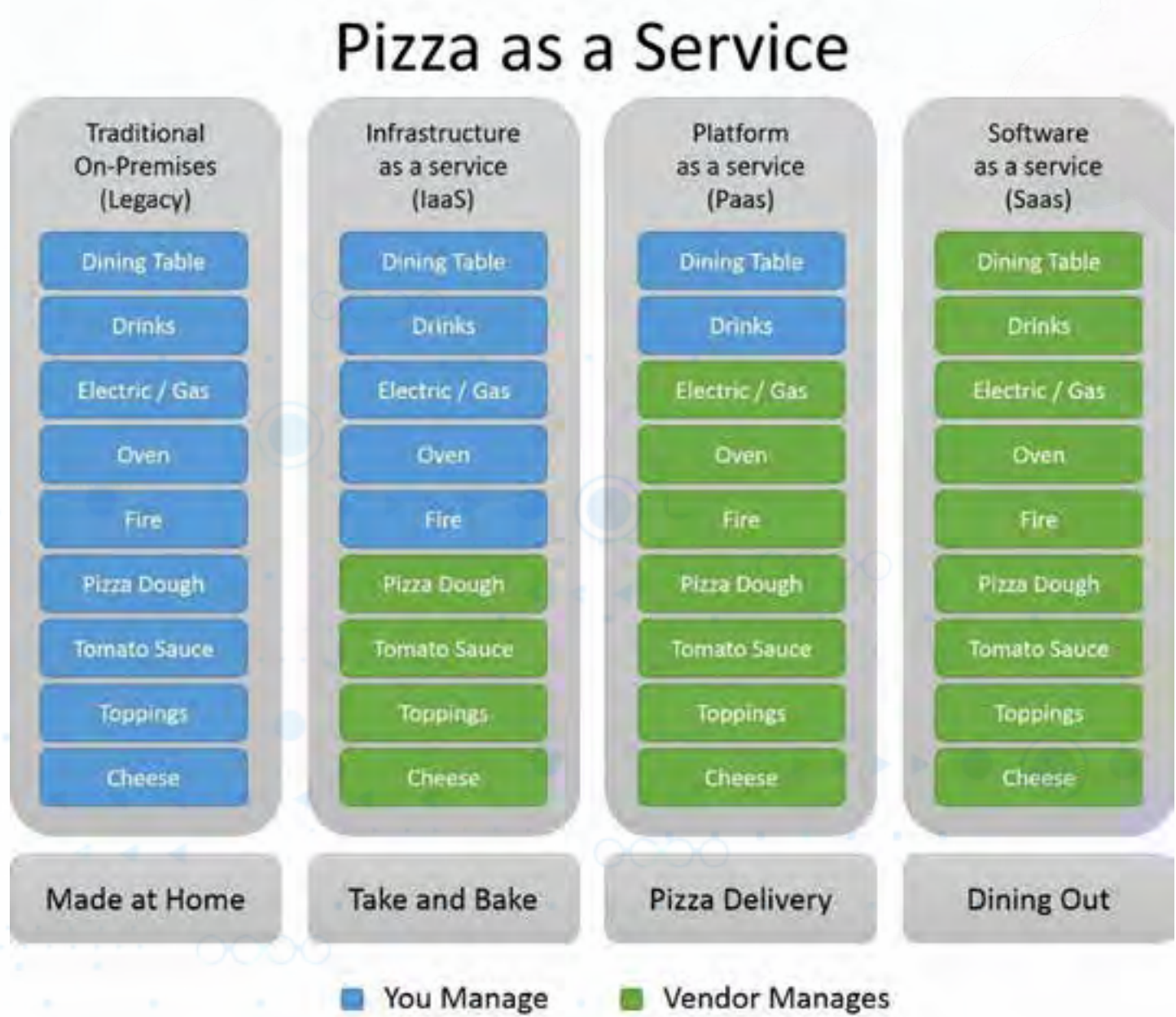
These different cloud service models allow us to customise the level of service we need for our projects.

The services are immediately available to everyone globally, will automatically scale up and down based on our demands, and we only have to pay for what we consumed! Through simple clicks on the cloud service provider's portal, we can launch our IT services in the cloud within minutes.

No more long lead times buying and installing hardware; developers can just focus on building apps - we love it!



Here's how these models would look like, if the service provided was pizza instead of IT.



CLOUD, THE INEVITABLE

Today, the majority of the digital tools we need for productivity, collaboration, publishing, and creativity are offered as SaaS with a subscription model.

Many Artificial Intelligence (AI) capabilities, whether it is for voice commands, chatbots, text-to-speech, computer vision, content creation, etc are also offered as SaaS, leveraging on the massive data stores in the cloud to constantly improve their algorithm.

The number of services that cloud service providers add to their arsenal increases daily – be it for AI, Machine Learning, Internet of Things, Augmented and Mixed Reality, Robotics, Quantum Computing, Gaming, Media, cybersecurity, and 5G.

That means the barrier to entry is removed for anyone (individuals, startups, or large organisations) who wants to build solutions based on these cool technologies.

STORMY SKIES

However, as the capabilities of the cloud providers continue to grow, so will our dependency on the cloud.

Something that we should be cognisant of is that the cloud is still a shared resource. Since many companies can share the same data centre for their cloud computing needs, there is a security risk when these data centres become compromised.

To minimise these risks, organisations and individuals must not put all their eggs in one basket and rely on a single cloud provider entirely for all their computing needs. Adopting a security-by-design principle would also help to mitigate any potential vulnerabilities of the cloud.

THE SKY'S THE LIMIT

The Singapore Government is adopting cloud computing to accelerate our digitisation and digital transformation efforts. The Government on Commercial Cloud will provide the agility needed to build modern applications that can leverage on the latest technology to support our rapidly evolving operational needs. For example, applications needed to support COVID-19 operations.

On HTX's end, we are enabling our Home Team to move our apps into the cloud as part of our **Cloud Transformation** initiatives. One way is to collaborate with industry to create a sovereign cloud solution which will enable the Home Team to reap benefits such as rapid deployment of digital solutions, provision of applications with sophisticated AI and Machine Learning capabilities, and increase the storage space for shared data. And at the same time, ensure that our data centres maintain a high level of security.

BEYOND THE ATMOSPHERE/ CLOUD SPACE

Back to the *Guardians of the Galaxy*, space could indeed be the next frontier for cloud computing. With the abundance of solar power, cooling, and a lunar terrain that is not subjected to natural disaster, the moon could just be the perfect place to build cloud data centers.

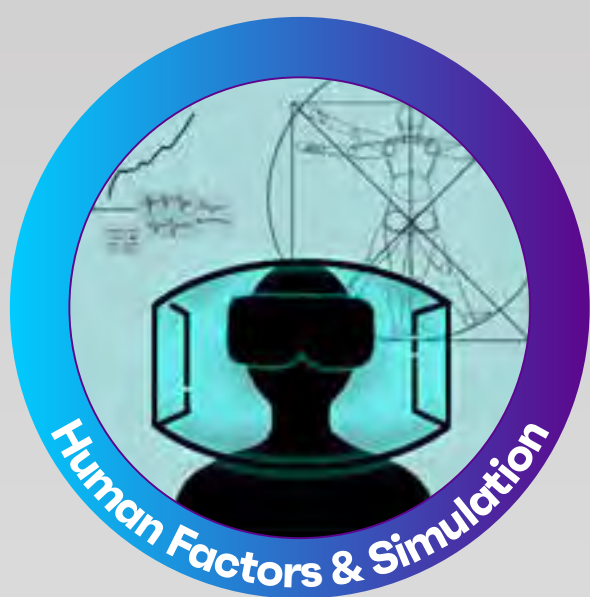


Pan Yong | JCPMC

Pan Yong leads the Cloud initiatives in HTX, which take up the bulk of his time.

When he finally has 'me-time', he likes to unwind with a long run paired with a good podcast.

HTX CENTRES OF EXPERTISE



“Optimizing human performance with pivotal technology”



“No room for gaps and vulnerabilities”



“Shedding light on the truth”



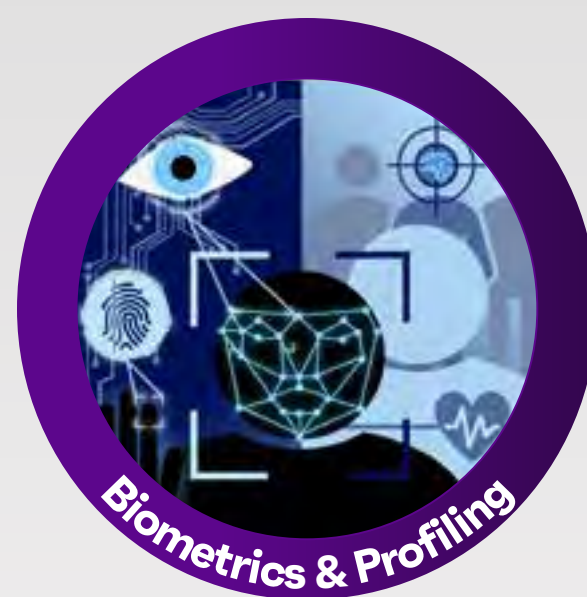
“Multiplying senses to track and identify”



“Discerning patterns and trends to make good decisions”



“Securing our borders through surveillance, detection and mitigation”



“Don’t know who you are? Don’t know what you’ll do? Let us tell you.”



“Pushing the limits, reaching the impossible”



“Unleashing top-notch innovations in the land air and sea”



“Hide your tracks and lock your phones but we’ll still find evidence”



“Developing cutting-edge capabilities to safeguard our sea borders”



“Engineering solutions to deter intrusion and destruction of installations”



“Helming the development of high-tech platforms and weapons”



“Rapid prototyping to deliver impactful solutions”



“Enabling real-time decision making, coordination, and response”

HTX PROGRAMME MANAGEMENT CENTRES



“To Detect, Deter, and Prevent Crimes with Cutting-edge Technologies”



“Delivering Intuitive Digital Services for Citizens and Businesses”



“Technology Advocate to Support ICA Core Functions on Border Security and Identification”



“A Tech Multiplier to Save Lives and Property”



“Working in the Shadows, Supporting Our Home Team”



“Embracing Technology for Better Enforcement & Rehabilitation”



“Heartbeat of HTX, Pulsing Through the Home Team”



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impacting
Singapore's
safety and security_