

# A Venture Capitalist's Perspective on Innovation

## ABSTRACT

In 2003, Cap Vista Pte Ltd was set up in Singapore as DSTA's strategic investment arm to seek cutting-edge technologies and innovative start-ups to meet defence and security needs. Since its establishment, Cap Vista has invested in a portfolio of local and overseas companies which has reaped a steady stream of technology returns. This portfolio covers a broad spectrum of technology areas such as sensors, force protection, energy, robotics and unmanned technologies, communications and IT.

This article shares Cap Vista's efforts in working with start-up and entrepreneur communities. It also shares how Cap Vista collaborates with partners in the broader entrepreneurship ecosystem to nurture innovative technology start-ups as well as small and medium enterprises in Singapore.

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## INTRODUCTION

Traditionally, military technology has played a leading role in technological innovation. Major technological advances, such as the Internet, radar systems and the Global Positioning System, were first developed for military use before they were adopted for commercial applications. However, fundamental shifts in the technological innovation landscape have taken place over the past few decades.

As many nations are now focused on bolstering their economies, commercial R&D expenditure has surpassed that for military technology development. According to National Science Foundation (2004), there was a decreasing share of military R&D expenditure in national R&D budgets from 1988 to 2000, for leading military nations such as USA (from 31% to 14%), France (from 19% to 8%) and UK (from 16% to 15%).

Globally, the explosive growth of the private equity industry and liberalisation of financial markets have also provided entrepreneurs and start-ups with easier access to funding. Those who were deterred by lengthy processes of securing government contracts chose to pursue growth opportunities in commercial markets instead.

The distinction between military and civilian technology may be fast disappearing. Today, many commercial technological innovations have high dual-use potential. The defence community can leverage innovations that are driven by strong consumer market forces to attract significant R&D investments. Examples include mobile devices and user-interface technologies, communications, energy, unmanned technologies (autonomous

vacuum cleaners<sup>1</sup> and cars), flexible printed electronics as well as IT (cybersecurity and data analytics).

## STRATEGIC INVESTOR AND INNOVATION SCOUT

Recognising the growing opportunities in exploiting commercial dual-use technologies, DSTA set up Cap Vista Pte Ltd (Cap Vista) in 2003. Cap Vista operates as a strategic venture investment company to seek innovative commercial technologies to meet the defence and security needs of Singapore.

The US Central Intelligence Agency (CIA) was one of the first government agencies in the world to leverage venture capital to tap commercial innovation. In 1999, the CIA set up In-Q-Tel (Hardymon et al., 2004) as a private, not-for-profit, venture corporation, to tap the latest technologies brought about by the Internet boom. The Internet boom was also redefining the CIA's threat landscape with a huge amount of digital information that CIA analysts had to manage.

Cap Vista is a strategic investor similar to In-Q-Tel. Unlike traditional venture capitalists (VC) which seek to maximise financial returns on investment (ROI) over a fixed fund life, Cap Vista focuses on technology ROI, i.e. the accumulation of technological capabilities and know-how for Singapore's defence and security.

As a VC, Cap Vista attracts start-ups seeking investments and opportunities to develop their innovative ideas and technologies in the military domain. Given the good standing of Singapore's defence sector in the international community, securing Cap Vista as a strategic investor is a tacit endorsement of technology excellence.

Beyond sourcing for promising start-ups on its own, Cap Vista receives half of its stream of investment opportunities (also known as dealflow), through collaboration and referrals, from its network of local and overseas partners. This extensive network comprises VCs, angel investors<sup>2</sup>, business incubators, research institutions and entrepreneurs. Start-ups with promising technologies are shortlisted for potential investment or project opportunities.

It is common to find these start-ups operating in "stealth mode" without any web presence, as they are either in the early stage of formulating business plans or maintaining a low profile to avoid competitors. Cap Vista's unique role as a VC allows it to engage start-ups at an early stage and collaborate on the development of their business and technology roadmaps, seeding win-win relationships to meet the defence and security needs of Singapore.

Using various VC-enabled investment instruments (e.g. equity, warrants, and convertible debt), Cap Vista establishes strategic partnerships with investee companies and secures privileged rights as a strategic investor, facilitating technology access and collaboration.

For each investment, the investor-investee relationship is largely driven by a technology engagement plan which outlines the strategy for technology engagement and the desired technology ROI. The technology engagement plan guides the Investment Team during negotiations to devise suitable investment instruments and investor terms. The terms and structure of each investment deal are unique, and are largely dependent on the needs and concerns of the investor and

investee. Investment terms may include safeguards such as anti-dilution clauses, voting rights over transfer of company's core intellectual property (IP) as well as incentives for early completion of technology development milestones.

Due diligence on the business, financial, legal and technological aspects of the investment deal is conducted before obtaining approval from the Cap Vista Investment Review Board.

## LOCAL ENTREPRENEURSHIP ECOSYSTEM

Technological innovation hotbeds such as Silicon Valley and Israel enjoy substantial competitive advantage. However, many countries are also actively strengthening their local infrastructure and systems for innovation and entrepreneurship, to remain competitive and relevant globally. In Singapore, the entrepreneurial scene has become more vibrant with strong support and concerted efforts from various government agencies, which have introduced financial grants and tax incentives to local enterprises and investors.

### Nurturing Local Technology Start-ups

In March 2008, the Research, Innovation and Enterprise Council launched the National Framework for Innovation and Enterprise. Now managed by the National Research Foundation (NRF), the S\$360 million framework aims to spur innovation and entrepreneurship through programmes that bring together key players in Singapore's entrepreneurial ecosystem i.e. entrepreneurs and small medium enterprises, investors, technology incubators, and institutions of higher learning.

DSTA and Cap Vista are part of NRF's review panel for grants.

NRF co-invests up to 85% (capped at S\$500,000) in Singapore-based start-ups nurtured by selected technology incubators, under the Technology Incubation Scheme implemented in August 2009. Since then, seven appointed incubators have invested in 31 start-ups. In March 2012, NRF added eight new incubators to the scheme. Under the Early Stage Venture Funding Scheme, NRF also invested S\$10 million each in six VC funds to seed early stage investments in Singapore technology start-ups.

SPRING Singapore, Singapore's Economic Development Board (EDB) and the Infocomm Development Authority of Singapore (IDA) have implemented schemes to assist businesses and entrepreneurs. For example, the Technology Enterprise Commercialisation Scheme from SPRING Singapore provides Proof of Concept grants (of up to S\$250,000) and Proof of Value grants (of up to S\$500,000) for R&D and technology prototypes that demonstrate strong potential for commercialisation.

Local research and educational institutions have established innovation and technology licensing units. These units offer their IP portfolios for licensing by the wider industry, and provide mentorship and

incubation for researchers who wish to spin off their technology. Two of Cap Vista's portfolio companies are spin-offs from the National University of Singapore (Microfine Materials Technologies) and Nanyang Technological University (Denselight Semiconductors).

To encourage local R&D in defence and security, the Defence Innovation Research Programme was initiated by the Defence Research and Technology Office of the Ministry of Defence (MINDEF). Since 2011, the programme has extended beyond local research institutes to include companies based in Singapore.

Cap Vista works closely with these agencies, organisations and institutes to nurture promising local start-ups and entrepreneurs. Together with investors of the Technology Incubation Scheme and Early Stage Venture Funding Scheme, Cap Vista provides expert advice to promising start-ups and entrepreneurs on how to further develop their technologies. In particular, untapped opportunities in the dual-use domains are explored to maximise potential in both commercial and military markets. Figure 1 shows Cap Vista's technology focus areas, which attract significant commercial R&D investment that can be tapped to meet the operational needs of the Singapore Armed Forces (SAF).

Sensors	Energy	Communications
<ul style="list-style-type: none"> <li>• Low cost networked sensors</li> <li>• High-fidelity location tracking (indoor/outdoor)</li> <li>• Gunshot detection and localisation</li> <li>• Lightweight and wearable sensors</li> </ul>	<ul style="list-style-type: none"> <li>• Portable power systems</li> <li>• Advanced photovoltaic, fuel cell and energy storage systems</li> <li>• Micro power sources</li> <li>• Self-sustaining energy systems</li> </ul>	<ul style="list-style-type: none"> <li>• Robust wireless communications</li> <li>• Cognitive radios</li> <li>• Secure and directed techniques</li> <li>• High bit-rate and low bit-error techniques</li> </ul>
Technologies to enhance Survivability	Robotics & Unmanned Technologies	Information Technologies
<ul style="list-style-type: none"> <li>• Lightweight, flexible materials and designs</li> <li>• Signature management techniques and materials</li> <li>• Heat management techniques and materials</li> </ul>	<ul style="list-style-type: none"> <li>• Guidance, Navigation and Control Systems</li> <li>• Cooperative Network-Centric Operations</li> <li>• Innovative and Low Cost Systems</li> </ul>	<ul style="list-style-type: none"> <li>• Networked security, efficiency and robustness</li> <li>• Data-mining and processing</li> <li>• Cognitive computing and sense-making</li> <li>• Planning and decision support</li> <li>• Modelling and information visualisation</li> <li>• 3D simulation and war-gaming</li> </ul>

Figure 1. Cap Vista's technology focus areas

In addition, Cap Vista assists promising start-ups in securing grants under the Defence Innovation Research Programme, as well as from SPRING and EDB. Cap Vista also partners with investment arms of these agencies (SPRING SEEDS Capital, EDBi, and IDA's Infocomm Investments) to attract overseas entrepreneurs and companies to establish operations in Singapore, enhancing our local defence capability build-up.

### Seeding Defence Capability Development

Cap Vista has a portfolio of seven local and overseas start-ups which are developing new technologies and capabilities to support the defence and security needs of Singapore.

Cap Vista's investments have helped the start-ups to accelerate their technology development, shortening the technology acquisition cycle and time-to-market for their products (see Figures 2 to 4).

Cap Vista reaches out to start-ups with innovative technologies and introduces them to potential partners from the defence ecosystem. Through these introductions, promising start-ups have received project funding from MINDEF, the SAF, DSO National Laboratories and Singapore Technologies. In addition, Cap Vista works with key internal stakeholders to streamline business processes, thus facilitating interactions between start-ups and partners in the defence ecosystem.



Figure 2. Portable fuel cell chargers for mobile devices (Source: Lilliputian Systems<sup>3</sup>)



Figure 3. Advanced piezoelectric crystals for underwater projectors and sensors (Source: Microfine Materials Technologies<sup>4</sup>)



Figure 4. Inertial navigational units for unmanned ground vehicles (Source: TungRay Instruments & Control<sup>5</sup>)

## INNOVATING IN THE FAST LANE

It is common to find VC units within large corporations now. To nurture new capabilities, many corporations have adopted the venture capital approach to search for new technologies outside the organisation. This is often part of a broader organisational "Open Innovation" strategy, which was popularised by Henry Chesbrough, Executive Director of the Centre for Open Innovation at the Haas School of Business.

"Open innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology."  
– Henry Chesbrough (2006)

In today's knowledge-based and globalised economy, knowledge flows as freely as investment capital through international networks of innovation. To leverage external R&D resources, global enterprises distribute R&D activities along their global value chain instead of concentrating them in one location or entity. A new breed of innovation marketplaces and innovation intermediaries (also known as inno-mediaries) has emerged to facilitate more efficient matching of IP and expertise to market demands.

In a complex and highly competitive global environment, organisations have to innovate and deliver value to their customers at a faster pace but with fewer resources. Innovation has become a critical success factor and a prerequisite for sustainable development. To meet these new challenges, governments and large corporations are adopting new approaches to their innovation strategies and processes.

## The Power of Open Innovation

To derive cost-effective solutions to complex business and technology problems, new practices such as crowd sourcing (i.e. leveraging large groups of people for ideas or problem solving) and challenge-driven innovation are emerging. Notable examples of challenge-driven innovation include the US Defense Advanced Research Projects Agency (DARPA) Grand Challenges, the National Aeronautics and Space Administration (NASA) Centennial Challenges and DSTA's TechX Challenge.

Organisations and corporations have turned to the increasing number of commercial crowd sourcing platforms in the market. InnoCentive is one such company which specialises in open innovation. It started out as an innovation initiative within a global pharmaceutical company, Eli Lilly. In 2005, it spun out as a new business, providing a platform for "Seekers" (organisations) to post their "Challenges" (problems) and crowd source solutions from a global network of 250,000 "Solvers". These "Solvers" include engineers, scientists, inventors, business professionals and research organisations from more than 200 countries.

InnoCentive has hosted over 1,300 "Challenges" and awarded over US\$28 million in prize money. Depending on the complexity of the problem, solutions to the "Challenges" carry prizes ranging from US\$5,000 to US\$1 million. Customers of InnoCentive include Fortune 500 companies like Procter & Gamble and Dow Chemical, as well as government agencies like the US Air Force Research Laboratory, NASA (InnoCentive, 2012) and In-Q-Tel (InnoCentive, 2010).

In September 2010, US President Barack Obama launched Challenge.gov, which is a portal managed by the US General Services Administration for federal agencies to post their challenges and crowd source proposals from the public. The portal listed more than 130 challenges from 37 organisations, out of which 17 are related to defence. The most popular challenge, DARPA's "Shredder Challenge", attracted more than 9,000 teams in a race to reconstruct five different documents shredded into 10,000 pieces. The US\$50,000 prize was won by a three-man team who solved it in 33 days with the aid of an image recognition algorithm they had developed.

Cap Vista is embracing this new paradigm of doing business and experimenting to find the best way to exploit such new crowd sourcing approaches. It also aims to broaden its outreach to the increasing number of start-ups, in particular, those which have promising technologies but are unfamiliar with the defence and security domain.

In 2012, Cap Vista published a list of "challenge topics" to invite start-ups to offer ideas and proposals for innovative solutions to specific areas of need. For easier understanding by the external community, the challenge topics were translated from problems that had been gathered via a collaborative process involving key internal stakeholders. Each challenge topic outlines key operational considerations and needs within a problem area. To allow start-ups to propose technologies which will be relevant to Cap Vista, challenges are framed such that they provide enough information on specific requirements and design constraints without compromising information security.

## CONCLUSION

New approaches to open innovation are still in the early stages of adoption. These approaches have strong potential in helping organisations to reach out to a broader community and finding solutions to their needs within a shorter time. To exploit these approaches fully, new processes, skills and mindsets are needed.

## REFERENCES

Chesbrough, H.W. 2006. Open Innovation: The New Imperative for Creating and Profiting from Technology. Harvard Business School Press.

Hardymon, G.F., Lerner, J., Leamon, A. and Book, K. 2004. In-Q-Tel. Case Study, Harvard Business School. Harvard Business Publishing (804146-PDF-ENG). <http://hbr.org/product/in-q-tel/an/804146-PDF-ENG> (accessed 24 May 2005)

InnoCentive. 2012. NASA Innovation Pavillion. <https://www.innocentive.com/ar/challenge/browse?pavilionName=NASA&pavilionId=8&source=pavilion> (accessed 24 December 2011)

InnoCentive. 2010. InnoCentive and IQT Establish Strategic Partnership. <https://www.innocentive.com/innocentive-and-iqt-establish-strategic-partnership> (accessed 24 December 2011)

National Science Foundation. U.S. and International Research and Development: Funds and Technology Linkages. Science and Engineering Indicators 2004. <http://www.nsf.gov/statistics/seind04/c4/c4s4.htm> (accessed 24 December 2011)

### ENDNOTES

<sup>1</sup> The first robot vacuum cleaners originated from a company called iRobot, which has its roots in building robots for military. Since iRobot introduced the Roomba in 2002, the market for such products has grown as numerous commercial companies launched similar products. Revenue from iRobot's Home Robots Division now accounts for more than half of its 2010 revenue, surpassing its defence business.

<sup>2</sup> Angel Investors are wealthy individuals who provide capital for business start-ups, often in exchange for an ownership stake.

<sup>3</sup> Lilliputian Systems is one of Cap Vista's portfolio companies. Based in USA, the company spun out from the Massachusetts Institute of Technology.

<sup>4</sup> Microfine Materials Technologies is one of Cap Vista's portfolio companies. Based in Singapore, the company spun out from the National University of Singapore.

<sup>5</sup> TungRay Instruments and Control is one of Cap Vista's portfolio companies based in Singapore.

### BIOGRAPHY



Joseph Tan Tow Hua is Chief Executive Officer of Cap Vista Pte Ltd which invests in innovative technologies that serve the defence and security needs of Singapore. Prior to joining Cap Vista, Joseph was Head of the Risk Assessment and Horizon Scanning Experimentation Centre. He was also a key member of the National Security Engineering Centre, involved in developing strategic technology road maps and providing technological advice to the National Security Coordination Secretariat and national security agencies. He held key appointments in the Ministry of Defence (MINDEF) Chief Information Officer Office and was involved in managing MINDEF's IT investment portfolio, spearheading the SAP Enterprise Resource Planning implementation and IT governance initiatives such as portfolio management and enterprise architecture. Under the Public Service Commission Scholarship, Joseph obtained a Master of Engineering (Electrical Engineering and Information Science) degree with Distinction from the University of Cambridge, UK in 1998.

Wah June Hwang is a Senior Investment Manager in Cap Vista Pte Ltd, responsible for identifying companies developing promising technologies that can be applied to DSTA's work. He is concurrently a Senior Engineer (Land Systems) in DSTA. He managed the acquisition of specialist army equipment for the Singapore Armed Forces (SAF), including the Advanced Combat Man System. He also worked as an Investment Manager in Fortune Venture Management Pte Ltd. June Hwang graduated with a Bachelor of Engineering (Mechanical Engineering) degree and a Master of Science (Applied Finance) degree from the National University of Singapore (NUS) in 1996 and 2002 respectively. In 2003, he earned the Chartered Financial Analyst (CFA) Charter from CFA Institute and the Financial Risk Manager certification from the Global Association of Risk Professionals.



Lee Keen Sing is a Senior Investment Manager in Cap Vista Pte Ltd. He holds a concurrent appointment as a Principal Engineer (Land Systems) in DSTA, leading a programme to innovate technological solutions in response to urgent requirements of the SAF. He conducted technology risk management and facilitated funding requirements for major projects. He was a systems architect and worked closely with stakeholders to develop master plans for complex Systems of Systems. Keen Sing obtained a Master of Engineering (Mechanical and Production) degree from Nanyang Technological University (NTU) under the NTU Research Scholarship and the National Science and Technology Board Postgraduate Training Initiative scheme in 1999. He further obtained a Master of Science (Engineering and Management) degree from the Massachusetts Institute of Technology, USA, under the DSTA Postgraduate Scholarship in 2004.

Cheng Wee Kiang is a Senior Investment Manager in Cap Vista Pte Ltd, primarily responsible for identifying new and promising technologies in the area of unmanned systems that can be used by the SAF. He holds a concurrent appointment as a Principal Engineer (Land Systems) in DSTA, overseeing the acquisition and development of ground unmanned systems and their enabling technologies for the SAF. He played a key role in developing and equipping the first locally developed chemical, biological, radiation and explosive robotic suite for the SAF which had started as an R&D project. Wee Kiang graduated with a Bachelor of Engineering (Mechanical Engineering) degree from NUS in 1998. Under the DSTA postgraduate scholarship, he obtained two Master of Science (Defence Technology and Systems; Combat Systems) degrees from the Temasek Defence Systems Institute (TDSI) in 2003.



Ng Chin Chin is an Investment Manager in Cap Vista Pte Ltd. She holds a concurrent appointment as a Senior Engineer (Infocomm Infrastructure) in DSTA. She leads a team in providing cyber security threat risk assessment and solutions to ensure that systems are securely designed and maintained throughout the system's life cycle. Chin Chin plays an active role in planning and formulating cyber security strategies, master plans and solutions architecture to guide information assurance development and implementation within MINDEF and DSTA. She has more than 10 years of experience in infocomm infrastructure design and implementation. She has been supporting DSTA, MINDEF and the Ministry of Home Affairs in areas such as enterprise data networks, identity and access management solutions, as well as security assessments and solutions recommendation. Under the DSTA Postgraduate scholarship, Chin Chin obtained a Master of Science (Defence Technology and Systems) degree from TDSI in 2007, and a Master of Computer Science (Information Assurance) degree with Distinction from the Naval Postgraduate School, USA in 2006.

Teh Shi-Hua is an Investment Manager in Cap Vista Pte Ltd, and she prospects for innovative start-ups which are developing technologies with potential defence applications. She holds a concurrent appointment as a Senior Engineer (C4I Development) in DSTA, where she designs and develops command and control systems to support sensemaking, decision making and collaboration. She is also a member of the team which is spearheading the development of the Cognitive Systems Engineering technical competency in DSTA. Under the DSTA Undergraduate Scholarship, Shi-Hua graduated with a Bachelor of Engineering (Electrical Engineering and Computer Science) degree from the University of California, Berkeley, USA in 2005. She further obtained a Master of Science (Management Science and Engineering) degree from Stanford University, USA in 2006. Having completed the CFA Programme in 2009, Shi-Hua is in the process of earning the Charter.



Dennis Khoo Ken Leong is an Investment Manager in Cap Vista Pte Ltd. He seeks new communications capabilities to realise a Third Generation networked SAF. He holds a concurrent appointment as Senior Engineer (Networked Systems) in DSTA, leading a multi-disciplinary programme to acquire and develop software defined radios and related technologies for MINDEF and the SAF. Dennis has worked on a myriad of communications projects ranging from integration of legacy transmission systems and deployment of wireless communications solutions, to experimentation of emergent technologies and techniques. In 2009, he won the Outstanding Team Award at the annual MINDEF Productivity and Innovation in Daily Efforts Day. Dennis obtained a Master of Engineering (Electronics, Telecommunications and Signal Processing) degree from École Spéciale de Mécanique et d'Électricité, France in 2004.