Australian Government
Defence

EDTAS
EMERGING DISRUPTIVE TECHNOLOGY ASSESSMENT SYMPOSIUM

The EDTAS series is a key program that helps the Next Generation Technologies Fund future-proof Australian Defence. The series considers expansive science and technology topics that will heavily impact Defence and National Security domains over a 20+ year timeframe.

Run as a 2-day hybrid (virtual and face-to-face) event in Canberra on 22-23 June 2022, the Quantum Computing EDTAS enabled Defence to engage the national S&T enterprise to develop a comprehensive and evidence based understanding of this exciting technology field.

QUANTUM COMPUTING

TECHNOLOGY OPPORTUNITIES SYMPOSIUM 22-23 JUNE 2022

Quantum computing (QC) technologies are developing rapidly in Australia and across the world, with potentially wide implications for Defence and National Security.

The QC EDTAS was attended by over 100 delegates from across government, industry and academia. This included Australia's leading quantum researchers; the Chief Defence Scientist; the Australian Chief Scientist; Defence officials from Australia, the US, UK, Korea, Singapore and Japan; and Australian government representatives.

Australian quantum community provided
DIVERSE PERSPECTIVES on:

Tech options of the
QC STACK
- Advantages
- Limitations

TECHNOLOGY PATHWAY
- Timeframes
- Sub-components
- Technology readiness level

FUTURE USE-CASES
Innovative solutions to challenging environments

Domestic and International
COLLABORATION + COMPETITION

WHAT HAPPENED?

AT THE SYMPOSIUM The 2-day event was split into 4 sessions which informed work in syndicate groups and speaker panel sessions

DAY 1 USE CASES | **THE STACK** | **DAY 2 STRATEGY** | **ENABLERS**

Session 1: Algorithms & Applications

Panel session 1
Dr Muhammad Usman **UNIVERSITY OF MELBOURNE**
Prof Lloyd Hollenberg **UNIVERSITY OF MELBOURNE**
Dr Florian Preis **QUANTUM BRILLIANCE**
A/Prof Dominic Berry **MACQUARIE UNIVERSITY**
Dr Marika Kieferova **GOOGLE / UNI. TECHNOLOGY SYDNEY**

Session 2: The Stack - Competing Technologies

Panel session 2
Prof Michelle Simmons **SILICON QUANTUM COMPUTING**
Dr Charles Hill **UNIVERSITY OF MELBOURNE**
Dr Ludwik Kranz **SILICON QUANTUM COMPUTING**
Prof Andrew Doherty **UNIVERSITY OF SYDNEY**
Dr Maja Cassidy **MICRODOTS QUANTUM SYDNEY**

Session 3: Strategy, Policy and Programs

[Defence]

Panel session 3A
Mr Duncan Tailby **DSTG**
BRIG Ian Langford **ARMY**
Dr John Burke **US DEPARTMENT OF DEFENSE**
Prof Michelle Gee **DSTG**

[Government]

Panel session 3B
Mr Duncan Tailby **DSTG**
Mr Brett Cooper **AUSTRADE**
Prof Jim Rabeau **CSIRO**
Ms Camille de Burgh **DEPT. OF INDUSTRY, SCIENCE AND RESOURCES**

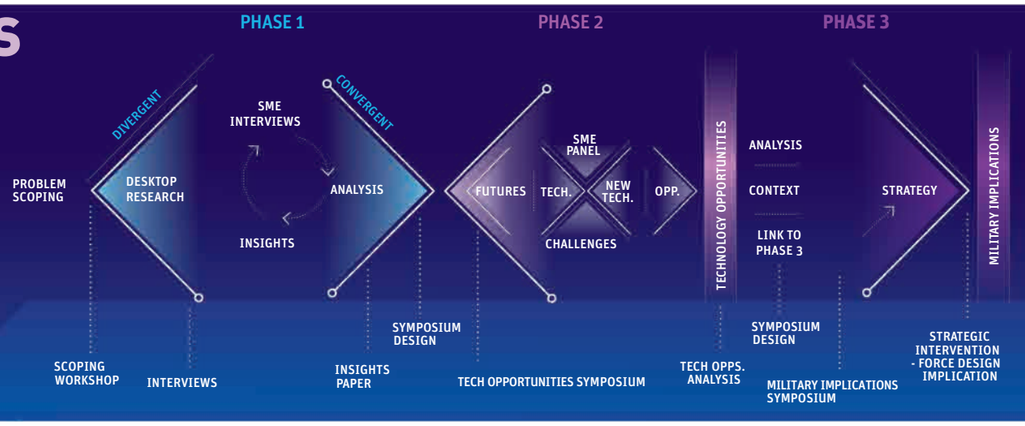
THE PROCESS

Each EDTAS theme is explored via three phases:

PHASE 1 PROBLEM DEFINITION
Identifies key stakeholders, potential applications, capability implications and key issues of the technology theme and recommendations for the conduct of subsequent phases.

PHASE 2 TECHNOLOGY OPPORTUNITIES
Explores technology theme, advances, breakthroughs, trends and defines capability opportunities that could be achieved with technology advances.

PHASE 3 MILITARY IMPLICATIONS
Explores future Defence capability needs and how emerging technology might be used to ensure an enduring capability advantage for Defence.



DEFENCE'S ROLE in the quantum R&D eco-system

Encourage research directions that will deliver benefits to Defence capability

Demonstrate the benefits of QC and develop QC-enabled and assured capability for the ADF

Support initiatives to grow the future workforce and sustain the industry

Develop long term relationships with the R&D community

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KEY CONCEPTS

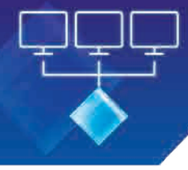
To identify emerging and disruptive technology concepts, delegates workshopped an adverse space weather scenario to analyse how QC technology might be useful in the future.

THEME:
People & platforms

Ideas focussed on potential opportunities offered through QC-enabled chemical simulation and design. Advanced materials which may be tailored to possess key characteristics, including:
- enhanced protective properties (e.g. electromagnetic shielding, corrosion resistance, light-weight and high strength)
- enhanced damage recovery properties (e.g. self-healing materials).

Mainframe qubits centralised QC resources accessible through a secure cloud

This is a centralised machine with cloud access. It has hundreds of millions of qubits that are high-fidelity with optical fibre communications between the qubits.



THEME:
Intelligent decision making

QC may create novel opportunities to model societal and physical environments and support the development of digital twins. These may be used to optimise decision making, policy and response plans. Environmental modelling will require:
- Distributed multimodal sensor to capture diverse data sources
- Advanced communications networks to transmit the data
- Distributed and classical quantum computing to analyse the data.

Distributed qubits

The interconnection of quantum computers through a distributed network allows for rapid exchange of quantum data.

THEME:
Sensing & sense-making

How QC may improve sensing resolution, increase stand-off detection and enhance data processing from diverse sensors. Ideas generated include:
- Autonomous search and rescue systems, integrated with hybrid quantum and classical computing, that conduct simultaneous localisation and mapping (SLAM)
- Ubiquitous quantum bio-sensors for large-scale environmental monitoring. Collected data may be analysed using QC to aid strategic planning and optimise disaster recovery operations.

Qubits on the edge – room-temperature portable, quantum computers

Quantum computers which can be deployed in the field to provide real-time quantum processing in network restricted environments.

THEME:
Cyber and communications

This theme examined how quantum information, computing, networks and communications can be hardened and made more resilient. Ideas explored the development of:
- Quantum-enhanced modelling of networks to assist in detecting intrusions, optimising performance or adapting to failures
- Quantum-based networks to support QC that can route and fully exploit quantum data at a global or local scale.

Multi-scale networked qubits

Secure and fast quantum communication channels will link quantum computing devices of different scales and capabilities.

KEY INSIGHTS

Analysis of the presentations, discussions and workshops identified a series of key insights.

GLOBAL INVESTMENT IS ACCELERATING

Global investment in QC is accelerating with significant new initiatives emerging in recent years. Australia's edge in some areas may erode if unable to match these investments.

Response options may include:
- Policies to protect local innovation
- Prioritising Defence-focused R&D.

HARDWARE CHOICES

Much uncertainty remains over which hardware platform will prevail as the superior option in the future.

This places Australia in a challenging position when considering investment options.

NARROW
Early and concentrated resourcing towards a narrow set of hardware options

BROAD
Smaller investments across many different hardware options

DELAYED
Delayed investment until the emergence of a globally preferred hardware option

GROWTH PATHWAYS

The EDTAS raised a tension between ideologies in how to best grow our domestic R&D within the private sector.

TO ATTRACT
international industry into Australia, to drive research competition and guide the development of a highly trained and mobile workforce

TO SUPPORT
enterprises, with deeply collaborative networks across the Australian quantum ecosystem

SKILLS SHORTAGE

The quantum R&D sector suffers from a global skills shortage in quantum science and engineering.

For Australia to meet the demand, we must train a future workforce that spans the breadth of fields required to build QC technology.

STRATEGIES FOR SCALE

The fabrication facilities required for large-scale manufacture of QC hardware will likely cost billions with long construction times.

Strategies to support the scaling up of different QC technologies in a globally competitive environment will be a key consideration for growth.

WHAT NEXT?

Insights captured at the EDTAS will undergo analysis, refinement and prioritisation by DSTG. Some of these will be further explored and tested with Defence stakeholders at the next stage of the EDTAS campaign, the Military Implications Workshop.
The Military Implications Workshop will provide a mechanism for Defence to assess the impacts of quantum computing strategic research opportunities on Defence capability. The outcomes of this activity are intended to inform planning about Defence's future posture and investment.