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It is appropriate to reprise several of the issues raised in my earlier submission to the National Innovation Review entitled Innovation and Practise in Software and Systems Engineering that addressed issues in software and systems engineering as it relates to defence, telecommunications, utilities and other industries that rely on safety, integrity and reliable systems.

The distinctive issues that I wish to raise as crucial for Australia's defence and associated industry are:

1. It is important to encourage and support a strong, domestic Australian industry centred on software and systems engineering as foundational disciplines for the conception, design and construction of modern defence systems.
2. It is important to continue to support research and development in underwater acoustics, advanced signal processing and algorithms for the development of anti-submarine warfare systems in order to maintain Australia's strategic advantage and dominance in naval operations.
3. It is important to develop networked anti-submarine warfare as part of the wider development of the networked battlefield in order to enhance information management and situational awareness from multiple sensor networks and data sources.
4. It is important to address issues related to governance of systems development and in particular the central role played by architecture in the systems development life-cycle.

The development of large and complex systems is a demanding undertaking that must be supported by adequate programme and project management, software and systems architecture in order to be successful. The shortage of highly-competent software and systems architects is a challenge that needs to be redressed by an investment in education, mentoring and professional development by both academia and industry.

#### Software and systems engineering

The wholesale shift towards the networked battlefield, greater dependency on standoff weapons and sensor networks implies an increased investment in software and systems capability. The complexity of designing and implementing systems-of-systems including the integration of custom and off-the-shelf products means that an increased investment in systems analysis and architectural design capability in order to maintain and enhance the national defence capability.

It is necessary to deal with foreign governments and other collaborators but it is not sufficient to defer high-level software and systems architectural and design decisions to remote authorities. Australia needs to grow and enhance the capabilities of our existing software and systems engineering sector, in defence and wider academic and industry communities, by:

- \* Committing to support of innovative projects, systems and R&D.
- \* Supporting the development of software and systems centres of excellence.
- \* Encouraging the growth in undergraduate and postgraduate degree training in software and systems engineering and software and systems architecture.
- \* Focusing on implementation of best practice in software and systems architecture.
- \* Promoting Australian industry capability and purchasing from local small and medium enterprises (SMEs) in addition to multinationals.
- \* Encouraging joint venture and cooperative R&D and product development between multinationals, local corporations and SMEs.

\* Supporting the growth of forums for collaboration like the Australian Software Engineering Conference (ASWEC) which brings together academics and industry practitioners.

#### Systems-of-systems

The report entitled The Challenges of Complex IT Projects by the Royal Academy of Engineering and the British Computer Society states, "there is a broad reluctance to accept that complex IT projects have many similarities with major engineering projects and would benefit from greater application of well established engineering and project management procedures. For example, the importance of risk management is poorly understood and the significance of systems architecture is not appreciated."

The report goes on to paint the general direction that needs to be taken in order to remedy the situation facing organisations which undertake complex IT projects. Two key recommendations are: 1) There is an urgent need to promote the adoption of best practice amongst IT practitioners and their customers; and 2) Basic research into complexity and associated issues is required to enable the effective development of complex, globally distributed systems.

#### Software and systems architecture

The term architect is used appropriately to describe the role of the designer who conceptualises what is to be built. The term software architect was borrowed into the field of software engineering by a body of workers who constructed software design patterns based on the work of Christopher Alexander, a famous architect known for his theories of design and in particular his seminal book on planning called A Pattern Language: Towns, Buildings, Construction. In the software engineering community, the seminal book on design patterns is Design Patterns: Elements of Reusable Object-Oriented Software which follows the same pattern templates or scripts as laid down by Alexander.

There has been constant, gradual evolution in component-based software engineering towards object-oriented analysis and design, principles, patterns and practices. More recently, there has been a revolution in software and systems analysis with the embrace of:

- \* Model-driven architecture (MDA) for constructing models at different levels of abstraction then generating derived models by applying model transformations and applying a greater level of detailed elaboration to these serviced models.

- \* Platform-independent models (PIM) that are independent of technology can be defined and used to generate platform-specific models (PSM) that rely on a specific generation of technology.

- \* Business process modelling (BPM) is used to capture and model business processes that are composed of business services.

- \* Service-oriented architecture (SOA) is the notional decoupling of business services that are exposed through interface contracts.

In the context of defence, the notion of MDA is relevant to governance and management of the design process throughout the life-cycle of the system, sometimes spanning generations of systems each of which utilises different technologies. For example, the concepts inherent to vessel design include steering, navigation, weapons and combat systems, the hull and other notional elements of the platform are part of the platform-independent model while the concrete instances of each of these elements for the ANZAC or Collins class are part of platform-specific models.

I agree to my submission being published on the Defence website

I agree to my submission being quoted in the Community Consultation Report