NAVY

ROYAL AUSTRALIAN NAVY

RAS-AI CAMPAIGN PLAN 2025

WARFARE INNOVATION NAVY

OUR VALUES

SERVICE COURAGE RESPECT INTEGRITY EXCELLENCE

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A plan for action

FOREWORD

When the Chief of Navy launched the *RAS-AI Strategy 2040* in October 2020 he made clear that we are experiencing the most consequential strategic realignment since the Second World War. Since his comments, the pace of the emerging challenges we face, of regional military modernisation, the risk of state-on-state conflict and technological disruption has only continued to grow. In the face of these challenges, accelerating the delivery of RAS-AI is essential to maintaining Navy's edge.

The Australian government recently made a significant commitment to the development and provision of advanced military capabilities to promote security and stability in the Indo-Pacific region with the signing of the Australia – United Kingdom – United States (AUKUS) partnership in September 2021. This Campaign Plan supports Navy's contribution to Australia's trilateral cooperation on undersea capabilities, artificial intelligence and autonomy and acceleration of our innovation enterprise, including ways to more rapidly integrate commercial technologies into maritime capability.

Major new projects such as SEA 1905 *Maritime Mine Counter-Measures Capability and Military Survey*, SEA 5012 *Integrated Undersea Surveillance Systems* and SEA 129 *Phase 5 Maritime Unmanned Aircraft System Continuous Development Program* will add scale and breadth to Navy's significant ongoing investment in RAS-AI Capability. The success of these new investments relies on continuous, agile, incremental enhancement through a process of 'Evergreening'. The connections this plan draws between the process of experimentation, and delivery of RAS-AI capability provides a means to consistently achieve 'Evergreening'.

To ensure the success of the activities detailed in this plan I have established a One Star position as Director General of Warfare Innovation Navy. However, experimentation and discovery will not occur in isolation. To maintain our ability to Fight and Win at sea we will work in partnership with Defence Science and Technology Group (DSTG) to leverage our national science and technology (S&T) enterprise to deliver Navy's RAS-AI Plan. Navy will work alongside DSTG to communicate priorities to allies, industry and academia - ensuring that innovative concepts can be translated into real-world capability that meets our current and future needs.

This Campaign Plan sets out the mechanisms that Navy, in partnership with DSTG, will use to communicate priorities, share problems and rapidly develop RAS-AI capability solutions with industry. Participation in the activities set out in this plan is an excellent way to understand Navy's priority issues and I encourage industry and academia to collaborate with Navy through this program

RAS-AI capability, developed and employed by an innovative and dedicated workforce, epitomises a *Thinking, Fighting and Australian* Navy. This plan provides a means of clearly defining our problems and opportunities, and collaborating with partners to deliver and sustain outcomes. I look forward to seeing it in action.

Rear Admiral Peter Quinn, AM, CSC, RAN
Head Navy Capability

INNOVATION PARTNERSHIP

As Head Navy Capability makes clear, the pace of the challenges Australia faces, particularly technological disruption, is growing faster every day. Defence's S&T Strategy, *More Together*, aims to meet this challenge and ensure that our national S&T enterprise is focussed on mission-directed research.

DSTG plays a key role in leading, shaping and nurturing this enterprise and coordinating S&T capability to support Navy's needs. With a proud history of working with the best and brightest, we are more committed than ever to growing our networks to ensure that our innovations are put into action protecting Australia and our interests.

Technologies underpinning Robotic and Autonomous Systems, and Artificial Intelligence will play a crucial role in providing Australia a capability edge over the coming decades. As Navy's S&T partner DSTG will ensure that Australia's S&T enterprise is focused on the key technical challenges to be able to deliver capability against Navy's priority issues at the scale required to Fight and Win at sea.

DSTG brings together interdisciplinary teams to create solutions that confer strategic advantage, generate opportunities for developing sovereign industry capabilities and critically, support more streamlined transitioning of ideas in capability.

DSTG is committed to collaborating with Navy in the execution of this campaign plan, specifically by:

- providing S&T leadership to Warfare Innovation Navy Branch and to shape and participate in specific activities;
- working with Navy to develop and articulate priority RAS-AI challenges that require S&T focus; and
- shaping and supporting engagement with industry and academia to pursue Navy's priority issues.

We look forward to working with Navy to deliver RAS-AI capability to enable Australia's Defence Force to Fight and Win at Sea.

Professor Emily Hilder
Chief Maritime Division
Defence Science and Technology Group

EXECUTIVE SUMMARY

Head Navy Capability, Rear Admiral Quinn, highlights the need for rapid capability delivery to meet the challenges Navy faces in a dynamic and uncertain strategic environment. He also makes clear that Navy needs to be continually seeking an advantage through a process of ‘evergreening’. This plan lays out an executable process to deliver just that.

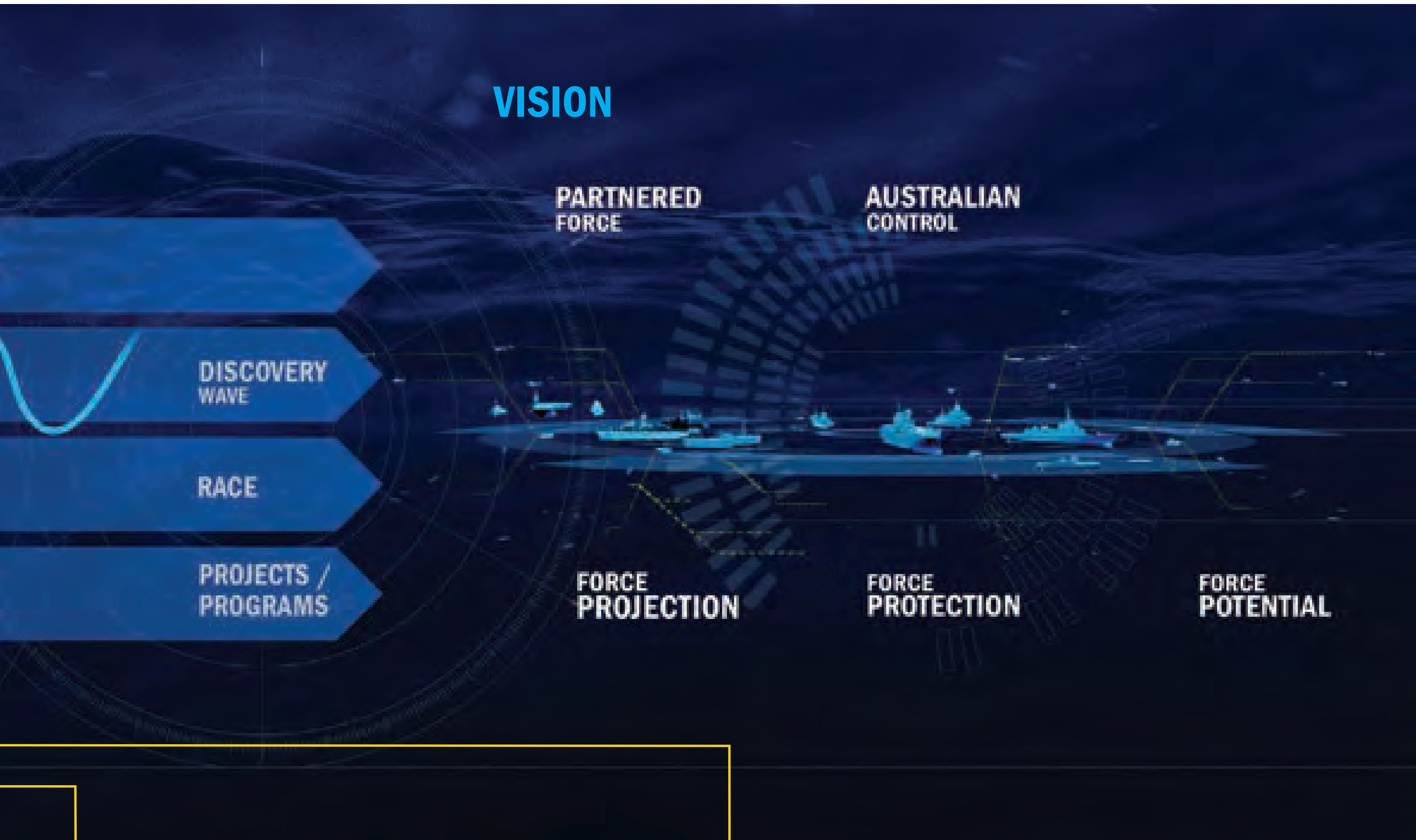
Figure 1. Lines of Effort

People: Future Navy Workforce is undertaking a significant body of work to anticipate the demand for and then deliver suitably qualified and experienced personnel to operate and maintain RAS-AI systems. Moreover, Navy will continue to increase our understanding of Human Machine Teaming through the second line of effort, Discover.

Discover: Discovery activities are an excellent way for industry and academia to collaborate with Navy in the RAS-AI field. As the chapter on executing details, discovery activities are directly connected to gaps and opportunities that Navy is seeking to resolve. Participating in them is a way for industry to gain an understanding of Navy’s RAS-AI priorities. Autonomous Warrior will continue to be Navy’s flagship program for discovery and will grow to incorporate a wide variety of activities described in this document which are tailored to resolve specific problems or opportunities.

LINES OF EFFORT (LOE)

The **RAS-AI 2040 Strategy** set out four LOE (People, Discover, Develop and Deliver) as the means by which Navy will achieve its RAS-AI Vision. Navy's RAS-AI Campaign Plan sets out a process for connecting discovery activities to delivery. Key aspects of these LOE addressed in this plan are:



Develop: As Navy continues to develop and employ RAS-AI it will add to a growing Body of Knowledge (BoK) which will be captured to form a RAS-AI Collaboration Environment (*The RACE*). *The RACE* is informed by Discovery and supports Delivery. *The RACE* already includes elements such as the RAS-AI Architectures, which provide an objective design for the maritime force, independent of specific mission scenarios. These architectures guide capability development while providing an understanding of Navy's RAS-AI priorities. It also includes a roadmap for the delivery of a Common Control Environment (CCE) and an outline of Navy's developing maturity models, along with numerous other resources still under development. Although *the RACE* will contain artefacts at varying levels of classification, it is intended to be a resource available to partners involved in delivering Navy RAS-AI.

Deliver: Navy's Capability Program Sponsors will continue to sponsor the delivery of RAS-AI, in conjunction with delivery agencies, through maritime projects and programs as a part of the Integrated Investment Program (IIP). In addition to supporting existing IIP projects and programs, given the rapid pace of technological development, Navy may also implement dedicated RAS-AI programs under the IIP.

INNOVATION WITH PURPOSE

Navy is an organisation charged with solving complex, dynamic problems in the maritime domain. Navy faces many complex challenges that create both gaps and opportunities that require innovation. Although this plan sets out provision for adding to this list of gaps, risks, issues and opportunities (GRIO), 'innovation with purpose' is at the core of this plan. As such it sets out a process to identify those existing GRIO that RAS-AI can address; conduct Discovery activities to address them; and support capability developers and users to implement them.

SEA 1905 Maritime Mine Counter-Measures and Military Survey, represents a major investment by Navy in RAS-AI capability. As one of Navy's largest and most complex RAS-AI programs, SEA 1905 will be used as an exemplar to operationalise this campaign plan. GRIO that support SEA 1905 will be prioritised in the first execution of the innovation wave.

PARTNERSHIPS

When the Chief of Navy released the RAS-AI Strategy 2040, he made clear that this Campaign Plan would be unclassified and releasable to industry. Our process of Discovery, Development and Delivery is bigger than Navy and requires partnerships across Defence, coalition, industry and academia. There are some elements that, due to their classification, will be internal artefacts. This Campaign Plan however, seeks to create opportunities where the Joint Force, Coalition, Industry and Academia can collaborate in an environment that fosters innovation while appropriately managing security and intellectual property. Importantly, this plan also describes the various activities that Navy will use to allow partners to better understand Navy priorities so that they in turn, can support Navy to deliver them.

This campaign plan forms an important component of Navy's mission to prepare naval power in order to enable the joint force. For example, Warfare Innovation Navy (WIN) Branch collaborates closely across the Joint Force and chairs Defence's RAS-AI Roundtable, a forum where cutting edge thinking is shared and opportunities for joint activity are identified. WIN also sponsors a dedicated coalition liaison function to understand partner nation plans and inform our allies of our progress. Key pillars of this plan, notably the CCE, Maturity Model and Architecures, represent thought leadership by Navy. They will underpin interoperability and will inform, and be informed by, joint capability development.

A PLAN FOR ACTION

The final chapter 'Executing', is an action plan, setting out the battle rhythm that Navy will use to collect and define Gaps and Opportunities, prioritise and schedule Discovery activities, and connect them to Delivery of maritime capability. In the process informing, and being informed by, a growing RAS-AI Body of Knowledge. This battle rhythm is based on an 'action research' model and is expressed as an 'innovation wave' which captures the punctuated but continually repeating nature of Discovery, Development and Delivery.

Executing the wave will deliver a forward work program that is resourced; integrates Whole-of-Defence, industry, academia and our joint and coalition partners; is aligned to Navy's priorities; and above all, directly informs and accelerates RAS-AI capability.

Navy will continue to develop this plan for action, this includes developing supporting processes and products, some of which will be classified, including:

1. RAS-AI Roadmap identifying specific linkages and dependencies (being supplied by CASG)
2. Joint RAS-AI efforts
3. Resourced forward Work Program
4. Classified level RAS-AI Architectures
5. Navy RAS-AI Maturity Assessment
6. Campaign Plan operationalized using SEA1905-1 as an exemplar.

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STRATEGY-LED

The development of maritime capability must be 'strategy led, and evidence based', as made clear by VCDF in the *Defence Capability Administrative Policy.*[1]

As Figure 2 illustrates, this campaign plan is nested within the hierarchy of Defence strategic guidance, cascading from the highest level, through Joint Force Directives and Concepts and the Navy's Maritime Domain Strategy. Navy's RASAI priorities are aligned with this strategic guidance, allowing capability decisions to be traceable to a strategic purpose.

This campaign plan has a similar relationship to the RASAI Strategy, in terms of scope and timeframe, as Navy's Plan Pelorus has with Plan Mercator.

Informed by Concepts

Concepts are the method by which Defence links strategy to the development and employment of capabilities through ideas that embrace opportunities and confront challenges. Navy's development of RASAI is informed by the Joint Concepts Framework (the collective of concepts approved by VCDF) notably the Joint RAS Concept, which gives depth and operational context to strategic guidance.

Evidence based

The development of maritime capability must be 'aligned with strategy, policy and resources, and supported by evidence'[2]. The Discovery, Development and Delivery activities described in this plan generate evidence to support decisions that are traceable to these priorities.

Innovation

Defence's approach to capability development requires capability managers to innovate by 'considering alternative approaches to achieving the outcomes throughout the capability process'.[3] To ensure Navy's capabilities maintain a warfighting edge in the maritime domain requires the comparison of conventional options with innovative options, from R&D through to incremental evolution of existing systems, to determine which is the most suitable.

This plan provides a means by which Warfare Innovation Navy (WIN) Branch, with DSTG, will consider and accelerate emerging technologies, or new ways of employing existing systems, to deliver a capability advantage, better value or reduced costs.

This plan considers projects and programs out to ten years. Many of these relate to significant and sensitive capability investments and government decisions yet to be made. As such, specifics will be classified. Navy is also developing a forward work plan for key activities and outputs out to four years. As these are also connected to capability investments and government decisions, it too will be classified, although the program of activities will be shared with partners (including industry) where possible.

1 Defence Capability Administrative Policy, p1.
2 Defence Capability Admin Manual (ibid), p2.
3 Defence Capability Handbook, para 1.31

Figure 2. Strategic Hierarchy

Defence Strategic Update | **Force Structure Plan** | **Defence Transformation Strategy**

Defence Planning Guidance

Integrated Campaigning (The ADF's Capstone Concept) / Theatre Concepts / Functional Concepts / Maritime Domain Operating Concept / The Joint Concept for Robotic & Autonomous Systems

Five Domain Strategies

Maritime | **Land** | **Air** | **Space** | **Information & Cyber**

Maritime (Mercator)

Provides Domain Leadership
Aligned with strategic direction
10-20 year vision
Informs subordinate plans

Plan Pelorus

4 year plan for achievement of Mercator outcomes

Clear articulation of a Navy target

Navy Business Plan

Risk management to focus on functions and achievement against KPI

Pelorus KPI assessed annually

RAS-AI Strategy

Provides thought leadership
Aligned with Maritime domain strategy
10-20 year vision
Informs program plans

RAS-AI Campaign Plan

4 year plan to move Navy towards RAS-AI Vision

Clear articulation of a battle rhythm

WIN Business Plan

Risk management to focus on functions and achievement against KPI

Pelorus KPI assessed annually

People

Navy will achieve the workforce transformation it needs to meet future challenges and opportunities, including addressing the impact of technology and innovation on the future of warfare through the Workforce Transformation Strategy 2035.

THE WORKFORCE SYSTEM

Navy's ability to realise its RAS-AI vision depends on having suitably qualified and experienced personnel (SQEP). Navy currently does not possess many of the essential skills and competencies needed for RAS-AI development and employment. Navy has recognised that the current workforce system does not adequately match the changing character of maritime warfare utilising RAS-AI, or the complex and contested environment in which the Navy operates RAS-AI.

Navy will achieve the workforce transformation it needs to meet future challenges and opportunities, including addressing the impact of technology and innovation on the future of warfare through the Workforce Transformation Strategy 2035. The strategy will be supported by the *Workforce Transformation Campaign Plan 2035* which seeks the optimal workforce structure, governance, training continuums and culture required by the Future Maritime Operating Concept (FMOC). These documents provide a comprehensive, service wide approach to meeting the requirements of the people line of effort.

The 'Navy Mastery Model' provides a further level of detail for the development of a RAS-AI Skilled workforce. Mastery is the process of progressively acquiring; through learning, practice and mentoring, an appropriately skilled workforce. This means for the Navy workforce that, for the first time, rank will not be the most important signal of success. Instead, it will be a combination of a person's level of mastery in the three core elements: Social Mastery – mastery with and through our people, Technical Mastery – mastery as a skilled practitioner, and Maritime (Domain) Mastery – mastery as a naval mariner.

Navy has commenced the development of warfare mastery plans for a number of its workforces to meet RAS-AI challenges and opportunities. The most mature of these are Mine Warfare (MW) and Maritime Geospatial (MG) as well as Maritime Aviation. Individual projects and programs will still produce detailed workforce plans which set out specific workforce requirements and pathways for realising Navy's RAS-AI portfolio.

HUMAN MACHINE TEAMING (HMT)

The teaming of humans with intelligent machines offers the potential to build on the strength of each. Humans excel at reasoning, dealing with ambiguity, making ethical and moral decisions, and thinking creatively. Autonomous systems can rapidly synthesise and analyse large amounts of data and will operate with precision in complex, time constrained environments. They are also more expendable, can learn from experience, are unaffected by human emotions and offer solutions that humans have never conceived. Navy already employs a degree of HMT in some combat and navigation systems, building on and normalising HMT is a key enabler of all of Navy's workforce.

HMT GOALS

Normalising and optimizing HMT requires common goals in HMT concepts. The following five modes of human-machine interaction[4] provides a framework to distinguish between different types and contexts of HMT and also provide guidance as to how and where Navy will seek to team. These modes are focussed on the nature of the problem to be solved and the optimal ratio of human to machine interaction.[5]

- **Automator.** The machine has nearly all the context and can quickly make decisions. Human involvement would only slow down an otherwise fast process.
- **Decider.** The machine "derives solutions but the human may still need to 'check' or 'search' before implementing the solution as there may be contextual information that the machine does not have access to or the implications are not entirely understood."
- **Recommender.** This mode "relies on historical data to derive its recommendations. If circumstances drastically change the machine may no longer reliably make recommendations and therefore the human can agree, disagree and provide feedback to improve both the current and future recommendations."
- **Illuminator.** The machine "generates insights given attributes people display (e.g., patterns of life) or decision-making processes people may have – that provide improved analysis."
- **Evaluator.** Those situations which are complex, involve an operational environment in which decision makers have little control, the tempo is fast and there are significant implications of failure. In such situations, the human is best placed to come up with the ideas for tackling the situation or solving the complex problem. The machine may be used to validate ideas especially the second- or third-order effects (data permitting), which a human may not be able analyse in complex scenarios.[6]

HMT Discovery. HMT represents a frontier of knowledge in the Maritime RAS-AI domain and remains a critical focus for Discovery activities. Consequently, it is the central focus of one of the four risk domains (People [HMT], Platforms, Policies and Integration) of the Autonomous Warrior program, detailed in the next chapter. These domains define the focus area for each Discovery activity.

Discovery activities address four risk domains that provide the focus area for the activity. People (along with Platforms, Policy and Integration) will progress Navy's HMT knowledge.

COGNITIVE LOAD

HMT is fundamentally about using the partnership to get the very best from the human, in both mental and physical capacities by using RAS-AI to free up mental capacity. The array of highly capable sensors across the fleet already have the potential to overload decision-makers while new capabilities offer the potential to exponentially increase the volume of data collected and options available. In the short term, Navy will need to invert the ratio of human to RAS from the current average of four humans to one platform at present to one human for four platforms. In the middle to long term Navy will need to significantly expand this ratio to one human for large numbers of agents, including swarms.

Navy's RAS-AI design principles include decision support and user centred design. These set out the expectation that RAS-AI systems would reduce the cognitive load on commanders and operators, allowing them to achieve greater shared situational awareness and facilitate human teams, in command of teams of machines, to deliver effective, efficient and ethical decision-making.

The development of a Common Control Environment (CCE), detailed in Chapter 8, will enable one human to supervise many RAS and different types of RAS simultaneously. It will also allow Navy to leverage technology and growing computer processing power to rapidly develop mission options and solutions beyond the capacity of a human operator. The CCE will prevent cognitive overload and decision paralysis and deliver mission solutions that an adversary cannot anticipate.

Navy will mitigate the risk of cognitive load, and enhance decision support and user centred design, through the development of a common control environment over a four year period.

4 developed by MIT and employed by the US defense advanced research projects agency (DARPA)

5 Matthew Johnson, Jeffrey Bradshaw, Robert Hoffman, Paul Feltovich, and David Woods, Seven Cardinal Virtues of Human-Machine Teamwork: Examples from the DARPA Robotic Challenge, Intelligent Systems, IEEE, 29, 74-80

6 Sam Ransbotham, Shervin Khodabandeh, David Kiron, François Candelon, Michael Chu, and Burt LaFountain Expanding AI's Impact With Organizational Learning, Findings From The 2020 Artificial Intelligence Global Executive Study And Research Project, MITSloan Management Review, October 2020

TRUST

Care must be taken such that humans do not become overly dependent, complacent, or uncritical in RAS-AI employment. Training scenarios must avoid complacency and develop users who ‘trust but verify’ i.e. have confidence in, but not become uncritically accepting of, autonomous systems.

Of particular importance is the need for trust to be proportional to risk. Too little trust in robotic systems may lead operators to disengage the autonomous capabilities of a system which may result in damage to both the robot and its environment while too much trust may lead to negative consequences. Navy will need to capture and manage data generated in training environments to refine machine learning and system improvement. A key element of this will be the development of ‘digital twins’, a virtual representation that serves as the digital counterpart of an existing process (e.g. a stand alone model of an operational application). This is one way that data generated in training and simulation may be used to enhance and update deployable (or even deployed) systems and applications, while data from deployed systems will in turn inform training environments.

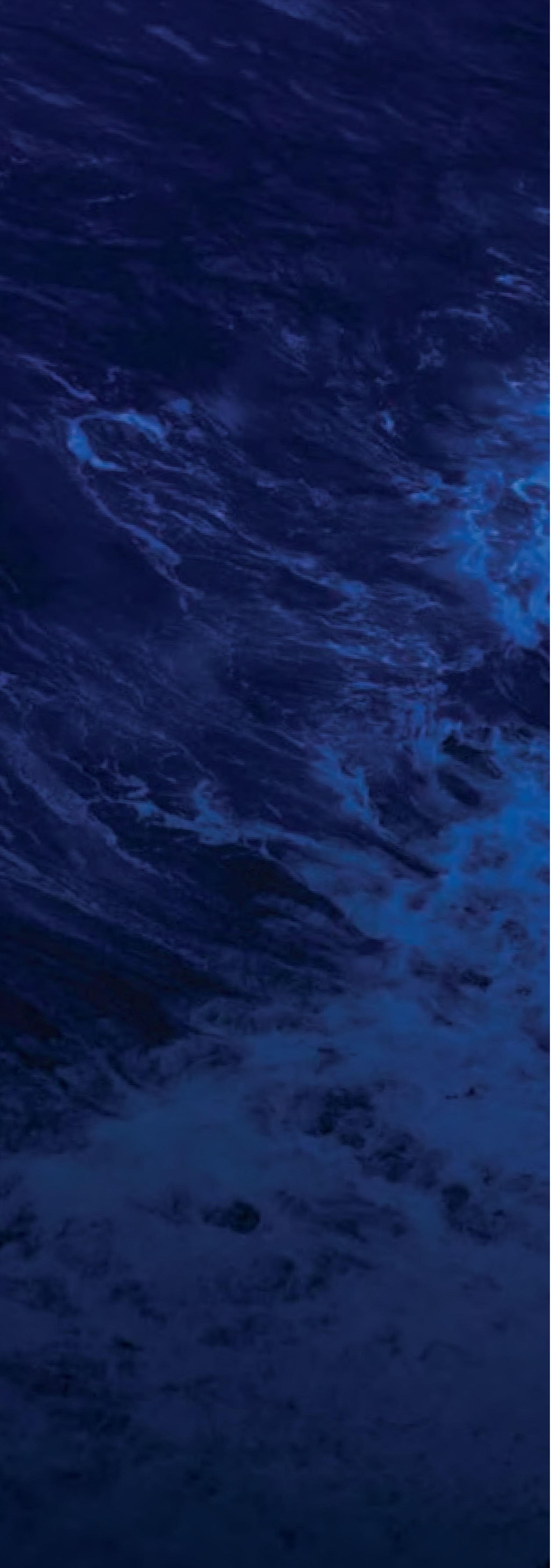
> Navy will foster, and calibrate, trust by users of RAS-AI capabilities by supporting training and operational environments through the development of digital twins.

Incorrect levels of trust results in a failure to capitalise on the capability of the RASAI, and defeats the purpose of the effort of moving to autonomy in the first place.

Discover

"Discovery activities are one of the foremost ways that industry and academia can collaborate with Navy in the RAS-AI field. Discovery activities directly connect to gaps and opportunities that Navy is seeking to resolve, and are an excellent way for industry to gain an understanding of Navy's RAS priorities.

Commodore Darron Kavanagh AM, CSC, RAN
Director General Warfare Innovation Navy



INNOVATING WITH PURPOSE

In a rapidly developing field such as RAS-AI it is essential that Navy has a collaborative approach to obtaining, supporting and leading research with the Whole-of-Defence Industry and academia. This is the Discover Line of Effort set out in the RAS-AI Strategy 2040[7]. Discovery activities are undertaken by WIN Branch which leads 'RAS-AI future warfighting' activities. All Discovery actions are focussed on **innovating with purpose**, they are never undertaken for their own sake but with a clear linkage to enhancing Navy warfighting capability whether tomorrow or as far out as 2040. The time horizon may vary, but there will always be a focus on how RAS-AI can improve Force Protection, Projection, Partnering, Potential and Sovereign Control (4PC) in the maritime domain.

7 Navy's approach to Discovery has continued to evolve since the release of the Strategy. Consequently a number of activities which were described in the 'Development' Line of Effort in the strategy are now included as 'Discovery' in this campaign plan.

EXPERIMENTATION

Discovery activities are generally a form of experimentation as they are a procedure used to test a hypothesis carried out under controlled conditions. Military experimentation is a tool used to test new technologies, examine new concepts, to understand integration and interoperability and, to examine other aspects of military systems and operations in a controlled environment.

RAS-AI experimentation is a form of Test and Evaluation (T&E). Navy's Maritime Warfare Centre (MWC) is Navy's lead agency for T&E, responsible for the validation and assurance of operational standards and suitability.

RAS-AI experimentation is more than field trials. It includes concept development, knowledge creation and capture, and modelling and simulation as part of the entire system involved in testing the worth of new technology and methods of operating.

RAS-AI EXPERIMENTATION GUIDELINES

Experimentation is conducted in accordance with the RAS-AI Experimentation guidelines set out below.

SENIOR LEADER INVOLVEMENT

Navy Senior Leader engagement and endorsement is sought through a series of briefs and decision points. Wherever possible, mature experiments will provide opportunities for Navy Senior leadership to observe and provide immediate feedback.

PROBLEM ORIENTATED

Experiments will be defined in terms of problems to be solved not specified requirements. This requires the expression of the problem independent of a solution in order to allow all options to be considered.

TASK ORGANISED

Experiments are led by a core team from WIN Branch but project teams will be task organised to include relevant expertise where ever it is, whether in Defence, industry or academia.

AGILE CONTRACTING

Contracts with Industry will be designed with commercial managers from the outset to ensure the straightest and fastest path for successful experiments to progress to subsequent stages and, at Navy's discretion, capability delivery.

STANDING PLATFORMS & PROCESSES

Although every experiment will be different, most will have common processes and equipment requirements that will benefit from a dedicated common command platform(s). These platforms and protocols will be advised to industry participants early, to support effective preparation and able to the conduct of 'turn-key' participation.

FAILURE IS AN OPTION

Disruptive innovation requires the ability to fail and an understanding that failing fast is an essential element of the process. Even a dis-proven hypothesis still adds to the RAS-AI Body of Knowledge (see Develop Line of Effort).

T&E WHERE EVER POSSIBLE

All capability plans will eventually need rigorous T&E in order to be introduced into service. Where practical, experiments will incorporate T&E processes and develop objective quality evidence and artefacts which could inform or accelerate subsequent T&E. A successful experiment could be one where the data gathered is sufficiently rich and rigorous as to obviate subsequent T&E.

Figure 3. RAS-AI Experimentation Guidelines

GAPS, RISKS, ISSUES AND OPPORTUNITIES (GRIO)

Navy uses Gaps, Risks, Issues and Opportunities to provide a single source of information to understand risk and prioritise resolution. The enterprise wide, Defence Capability Assessment Program uses a higher level, simplifed category of Gaps and Opportunities (GO). Some Navy GRIO will be identified as requiring resolution through the strategic centre and will be escalated to GO. Regardless as to whether categorised as Defence GO or Navy GRIO these items inform Navy's innovation process and drive Discovery priorities

In order to innovate with purpose, it is important to set out what that purpose is. RAS-AI innovation is generally about two activities: either solving problems, which are in the form of either gaps in capability or gaps in knowledge; or exploiting opportunities, generally arising from new technology or new concepts & business models. In line with leading innovation literature, notably the USAF Studies Board, there are four drivers which provide the source of the GRIO that Navy will address. They are set out in Figure 4 below.

This Campaign Plan describes how Navy will identify, prioritise and pursue these GRIO.

Figure 4. Four Drivers for GRIO

THE DISCOVERY WAVE

RAS-AI discovery is constructed visually on the discovery wave. The wave is a symbol for the forces of innovation and the nature of the work that the discovery phase embodies.

The wave begins with the collection of inputs in the identification phase:

- The 'shaping' of GRIO from strategic priorities;
- 'Powering' discovery from technology push;
- Bottom-up opportunities 'riding' the discovery insight process, and
- The user pull 'catching' the wave through its iterations.

Innovating with purpose means a bias to action through the wave. It is open to input and continuously moving with the environment. The wave's momentum delivers the energy typical of the growing energy in an innovation cycle, as iteration occurs and outputs get more refined.

Even as a wave is building, cresting and reforming it is traveling forwards. Navy's Gaps and Opportunities will continue to mature or evolve while Discovery is being undertaken.

Waves have both frequency and amplitude. The frequency (of the process) and the amplitude (the amount of Discovery activities which can be undertaken concurrently) is dependent on the energy (resources) with which the wave is propelled.

All the way through the Discovery Wave process, insight, results and analysed GRIOs are collected in the rising body of knowledge that is the RAS-AI collaboration environment (*the RACE*).

The following page shows the Discovery Wave as it works across the lines of effort. A more detailed description of the Wave process is explained in the executing chapter starting at page 54.

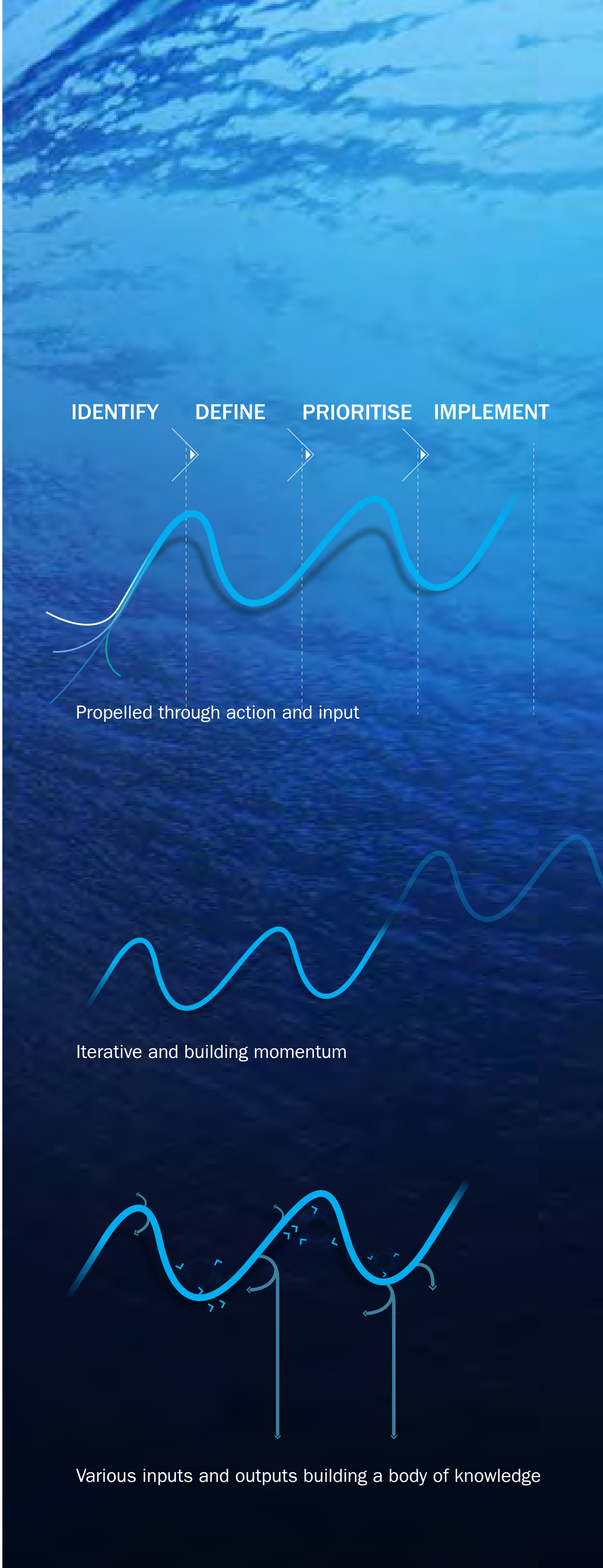


Figure 5. Characteristics of the Discovery Wave

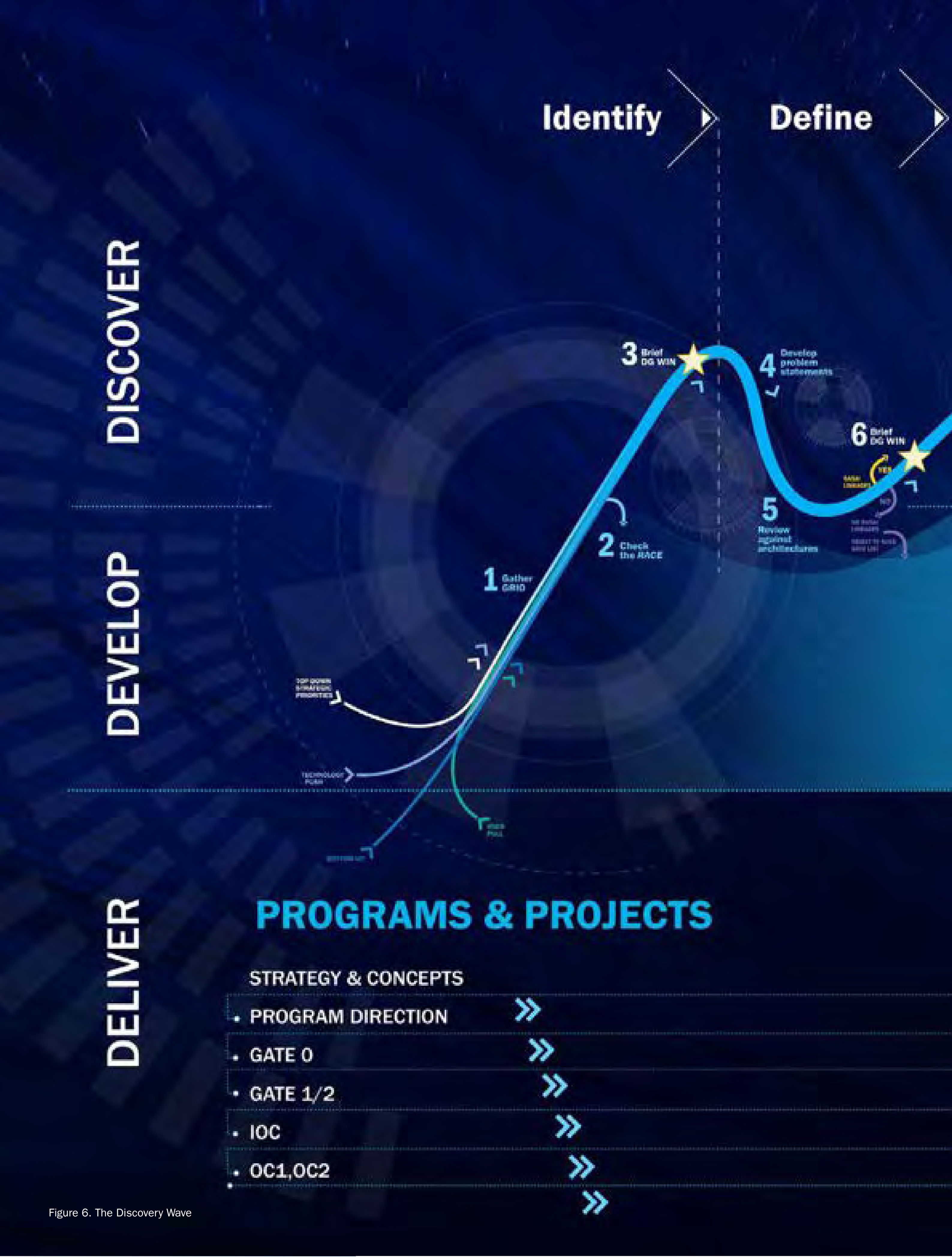


Figure 6. The Discovery Wave

Prioritise
Implement
OUTPUT TO GRIO SPONSOR
9 1st Steering Group
Preliminary assignment of tools
10 Approve & release
8
7 Maturity framework
12 Review & adjust
11 Execution
DISCOVERY WAVE
RACE
RAS-AI COLLABORATION ENVIRONMENT
PROGRAM DIRECTION
GATE 0
GATE 1/2
IOC
FOC / OC1,OC2
OCn

TOOLBOX

Navy has a wide variety of tools available to undertake discovery. This includes a variety of industry engagement tools, internal Defence activities, research and synthetic activities. Navy takes a 'toolbox' approach, allowing it to select the most appropriate tool (or tools) to explore a gap or opportunity. A list of the most prominent tools is included below.

AUTONOMOUS WARRIOR EXERCISE PROGRAM

Field trials, demonstrations and dynamic displays.

RASAI INDUSTRY INVITATIONAL WORKSHOPS

Opportunities for Defence and Industry to collaborate on designs and concepts.

PREVIEW T&E ACTIVITIES

T&E conducted to evaluate the feasibility & performance of alternative capability options & identify risk area.

SENIOR LEADER WORKSHOPS

Senior Leader engagement to gain strategic perspective on a gap or opportunity.

SUBJECT MATTER EXPERT WORKSHOPS

Subject Matter Expertise to gain insight on a gap or opportunity.

CONCEPTS

Exploring new methods and warfighting tools.

INTELLIGENCE

Leveraging Australian and partner intelligence communities to inform Navy Discovery.

ACADEMIC RESEARCH

Leveraging Australian research centres for excellence.

COMBAT READY PROTOTYPING

With limited strategic warning time, prototypes will be developed to allow rapid deployment if required.

TECHNOLOGY SCOUTS

Agile teams who scan new technologies outside of traditional Defence industry.

TRUSTED AUTONOMOUS SYSTEMS

Defence Cooperative Research Centre.

COALITION

Leveraging coalition partnerships to accelerate capability.

JOINT EXPERIMENTATION

Leveraging Joint Experimentation through Navy Experimentation.

DEFENCE INNOVATION HUB

A means of connecting innovators with Defence.

SYSTEMS ANALYSIS & INTEGRATION LABORATORY

Rapid understanding in a synthetic maritime environment.

MODELLING & SIMULATION

Using data to support evidence based decisions, understand problems and progress solutions.

NEXT GENERATION TECH FUND

Along with the Innovation Hub, the Next Generation Tech Fund forms part of the Defence innovation system. It supports collaborative research into emerging and future technologies, generally with a time horizon greater than 10 years.

AUTONOMOUS WARRIOR EXERCISE PROGRAM

An ongoing program of field trials, demonstrations and dynamic displays.

The existing program of field trials, demonstrations and dynamic displays will continue as a way of evaluating options and as a forcing function to bring operators and designers together.

Autonomous Warrior is designed to address GRIO through a spiral approach with the conduct of at least one major Autonomous Warrior Evolution per year.

The majority of Discovery activities detailed in this section will be branded 'Autonomous Warrior' to ensure clear understanding of their intent by stakeholders.

Autonomous Warrior is a 'learn by doing' activity where our sailors get hands on experience with RAS-AI, in turn helping them contribute to the RACE and concept development, whilst also helping build a suitably qualified and experienced workforce.

RASAI INDUSTRY INVITATIONAL WORKSHOPS

Opportunities for Defence and Industry to collaborate on designs and concepts of a specific Gap or Opportunity in a classified environment with IP protections.

Workshops are conducted to address specific problem sets, usually technical in nature and potentially classified. They are often preliminary activities to determine the feasibility of a particular technological solution or to identify alternatives that Navy has not perhaps considered.

These workshops generally comprise a targeted invitation to industry to participate, with Navy selecting firms with specialist technical knowledge to the problem at hand. They are facilitated by WIN Branch and are intended to be conducted at a sufficient level of classification to allow exploration of the problem in appropriate detail. A defining feature is the strict management of background IP through a comprehensive framework. Industry (and academia where applicable) should be able to share enough of their background IP to inform the activity with foreground IP produced in the activity owned by the Commonwealth but accessible by participating firms.

The workshop is not a business development activity and does not obligate the Commonwealth to proceed with an acquisition. It does, however, allow participants to gain a detailed and technical understanding of the particular gap or uncertain opportunity that Navy is contending with. Collaborative problem solving is an important component of building teams.

The Maritime Environment Working Group will hold similar collaborative workshops for Navy and industry to discuss those cross-program capability gaps or opportunities that required broader capability solutions beyond RAS-AI technologies.

PREVIEW T&E ACTIVITIES

Developmental T&E conducted to evaluate the feasibility & performances of alternative capability options and identify risk areas prior to a final decision to acquire.

This is a form of formal T&E, that characterises the majority of discovery activities. This is conducted within the Defence T&E framework and with the technical oversight of the Maritime Warfare Centre or CASG T&E agencies. Regulation of new technology will be appropriately managed through a comprehensive governance framework.

Preview T&E is intended to support RAS-AI delivery by increasing understanding of requirements prior to formal tender and contracting. It allows Navy to confirm manufacturer claims of performance; understand different manufacturer's design philosophies; and quantify capability differences between tendered options. In turn it provides industry with an opportunity to understand the capability needs and constraints associated with particular projects and to inform capability sponsors as to opportunities to meet them.

COMBAT READY PROTOTYPING

With limited strategic warning time, prototypes will be developed to allow rapid deployment if required.

Prototyping is a form of experimentation which is essential to evergreening capability. 'Combat Ready Prototyping' acknowledges that Defence no longer has significant strategic warning time of potential operational tasking as well as taking advantage of the rapid development of RAS-AI technologies.

Wherever practicable, Navy will develop RAS-AI prototypes that maintain a clear path to deployment should they be required to 'fight tonight'. This requires having a robust and agile contracting mechanism. It also requires prototyping experiments with sufficient rigour in their test and evaluation process that they clearly capture 'what they can do' in the context of a problem statement rather than 'what they can't do against formal T&E requirements'.

This will allow any prototype to be able to deploy early on urgent request through a 'battle-worthiness assessment' utilising Navy's Seaworthiness Framework to provide an operational commander with a clear risk profile.

'Combat Ready Prototyping' is based on a progressive model beginning with:

- Minimum Viable Product (potentially one platform, sufficient to demonstrate functional performance) then,
- Minimum Viable Capability (potentially the minimum number of assets to conduct a mission profile) and finally,
- Operational Capability (the number of assets that may be required to sustainably deliver reliable capability over time).

WIN path from MVP to War Winning Capability
What can the capability do, at what stage of development, and what challenges need to be addressed?

MINIMUM VIABLE PRODUCT	MINIMUM VIABLE CAPABILITY	WAR WINNING CAPABILITY
WILL IT DO THE JOB?	MAKE IT USEFUL?	MAKE IT THREATENING?

TECHNOLOGY SCOUTS

Agile teams who scan new technologies outside of traditional Defence industry and rapidly engage to identify and develop potential Defence application.

Navy's *Industry Engagement Strategy 2019* made clear that Navy seeks innovative approaches to partner with industry and deliver capability.

In its RAS-AI Strategy 2040, Navy committed to developing relationships with non-traditional industry sectors, i.e. individuals, firms and sectors which do not have existing relationships with Defence. Building relationships with non-traditional partners, however, will require non-traditional approaches.

Navy will employ technology scouts, a combined team led by technology experts in the Autonomous Warrior program but partnered with more junior operators with contemporary experiences. These task-organised teams will principally address the technology push source of Gaps and Opportunities. They will conduct wide ranging engagement across a range of fields to develop concepts and identify how technologies from other fields could be adapted or re-purposed to meet a Navy need.

Technology Scouts will address the technology push GRIO and run under the auspices of Autonomous Warrior.

TRUSTED AUTONOMOUS SYSTEMS

Trusted Autonomous Systems - Defence Cooperative Research Centre

Trusted Autonomous Systems (TAS) is a Defence Cooperative Research Centre which includes participants from industry and academia. With a focus on collaboration between Defence industry and research organisations, it aims to increase small and medium enterprise participation in its collaborative research.

The combined skills of TAS participants, specialist areas of expertise, agility, and capacity mean that it may be the best means of addressing certain GO.

DEFENCE INNOVATION HUB

The Defence Innovation Hub is a means of connecting innovators with Defence.

DG WIN sits on the Hub Investment Advisory Board while proposals from industry (of interest to Navy) are managed by a team within the WIN Branch. In addition to proposals which flow in from industry, the DIH provides two tools for Navy RAS-AI discovery:

1. Rapid Assessment. A Rapid Assessment is a mechanism that allows Navy to quickly obtain answers from industry, academia or research organisations about Defence capability gaps, opportunities or needs. Suited for situations where:

- Navy wants to leverage expertise within the private sector to answer questions relating to GRIO; or
- Navy wants to understand what technologies are available within the market to address GRIO and who supplies them.

Rapid Assessments do not involve technology development or procurement and are funded by the Hub.

2. Defence Innovation Hub Special Notices. A special notice allows Navy to draw upon the Hub's expertise to engage industry and research organisations in a targeted solicitation and aims to:

- Provide a vehicle to allow Navy to define a problem to the market
- Leverage the innovative capacity of a wide spectrum of business and research organisations to solve the problem.

The Special Notice facility is a user-pay service, with Navy Program Sponsors funding the costs of the activity, including any subsequent contracts.

SENIOR LEADER WORKSHOPS

Senior Leader Engagement to gain strategic perspective on a gap or opportunity.

Navy will conduct Senior Leader Engagement when addressing a GRIO that has cross-program or even portfolio wide implications. It is particularly important to communicate convergence – where several separate gaps and opportunities have, through the Discovery wave, been identified as being inter-related or potentially having a common solution set.

This may use standing fora, such as Navy's One Star Program Steering Groups or escalation to the Two Star level through the Navy Capability Committee

SME WORKSHOPS

Subject Matter Expertise to gain insight on a gap or opportunity.

Similar to Senior Leader engagement Subject Matter Expert Workshops allow SMEs representing a diversity of disciplines to be brought together to explore a specific issue that requires multiple specialist inputs. It is most useful when addressing convergence – where several separate gaps and opportunities have, through the Discovery wave, been identified as being inter-related or potentially having a common solution set.

SME Workshops are also the format which supports the use of the Maturity Framework to determine Navy's readiness to develop and employ new concepts. This will identify areas that need attention including joint limitations and constraints.

JOINT EXPERIMENTATION

Leveraging Joint Experimentation through Navy Experimentation.

Defence Experimentation is led by the Joint Experimentation Directorate (JED) which supports decision making by the Vice Chief Defence Force and Capability Managers. It does so through the Joint Experimentation Framework and the execution of the annual Joint Analytical Programs (JAP). The JAP is the primary mechanism to coordinate analytic efforts supporting across Defence. WIN will engage with JED through Navy experimentation. Where there are GRIO which have significant joint inputs or equities, WIN will seek insight from existing Joint Programs or to request the addition of a GRIO to future analytical activities.

CONCEPTS

Exploring new methods and warfighting tools.

A concept is the description of a method or scheme for employing specified military capabilities in the achievement of a stated objective or aim. A Maritime RAS-AI concept articulates how it is envisioned Navy will generate a particular capability in some future context. Initially, a future concept is untested and will be the subject of synthetic and, if validated, physical experimentation. Successful concepts should lead to prototypes, new projects or enhancements to existing projects.

ACADEMIC RESEARCH ACTIVITIES

Leveraging Australia research centres for excellence.

Where specialist research needs to be undertaken and where a University (or other research partner) may be better placed due to capacity or resident expertise to undertake a research activity. These tasks will be undertaken utilizing the Defence Science Partnerships 2.0 program to establish long-term research partnerships with prominent research institutions. This program includes all thirty-seven public universities in Australia and provides a framework for implementing the higher value, longer term collaborative research agreements that will be required to address the underpinning knowledge base for developing RAS-AI.

COALITION

Leveraging coalition partnerships to accelerate capability.

In signing the AUKUS Partnership the Australian Government highlighted the need to accelerate our defence innovation enterprise and learn from our AUKUS partners, including ways to more rapidly integrate commercial technologies to solve warfighting needs. This includes critical areas such as undersea capabilities, AI and autonomy in the maritime domain. To that end, Navy maintains an active network across coalition partners with an interest in RAS and AI capabilities. This includes active participation in the NATO Maritime Unmanned Systems Initiative (MUSI) co-chaired and co-managed by the US and UK navies.

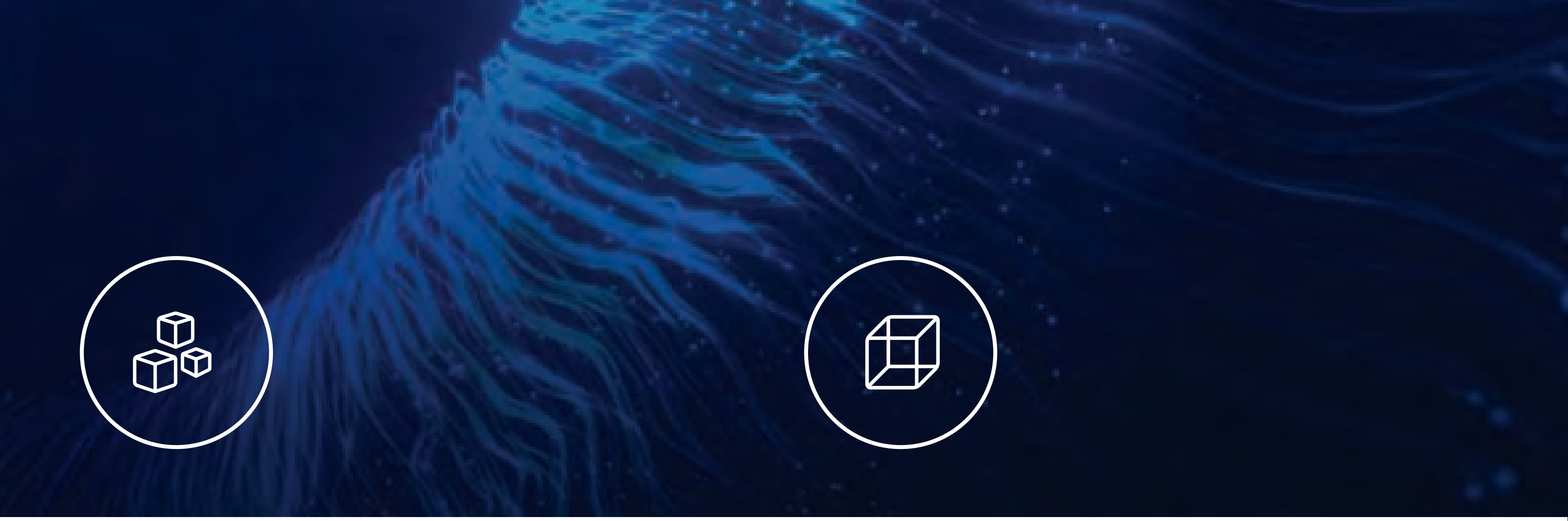
Navy also contributes to coalition Operational Experimentation (OPEX) through activities such as Autonomous Warrior and collaborates with coalition partners through numerous working groups, notably the AUKUS Undersea Robotics Autonomous Systems (AURAS) project. This collaboration supports the development of doctrine, concepts and tactics; standards and data sharing; test and evaluation; and common frameworks and capability maturity assessments.

Cooperation on AI and autonomy will provide critical enablers for future force capabilities, improving the speed and precision of decision-making processes to maintain a capability edge and defend against AI-enabled threats. Early work is focussed on accelerating adoption, and improving the resilience of, autonomous and AI-enabled systems in contested environments which will complement initial trials and experimentation of autonomous underwater vehicles planned for 2023. Many GRIO may have been addressed by a close partner and Navy will leverage existing networks and periodic information exchange to accelerate RASAI capability delivery.

INTELLIGENCE

Leveraging Australian and partner intelligence communities to inform Navy Discovery.

Defence has deep technical expertise in a variety of technical fields, available at high levels of classification, through its Intelligence Groups. Navy will leverage intelligence capabilities in executing the Discovery Wave and will include Priority Intelligence Requests (PIR) as a tool to resolve or better refine GO.



SYSTEMS ANALYSIS AND INTEGRATION LABORATORY

Rapid understanding in a synthetic maritime environment

The Systems Analysis and Integration Laboratory (SAIL) is an important tool for both fleet development as well as integration assessment. It will provide an environment where integration of potential RAS-AI with Navy systems can be explored and validated before hardware hits the water. A SAIL provides a scalable model of Navy to, inter alia,

- Anticipate Integration and Interoperability requirements
- Evaluate Integration and Interoperability interfaces across combat functions prior to developing or fielding hardware
- Develop and validate concepts
- Design and modify mission packages
- Provide support to Fleet Options Testing
- Capture data to inform real world procedures and decision making.

Such an environment is managed by the Navy Modelling and Simulation Office. It would, for instance, allow Navy to determine if a particular platform's control system was likely to be able to interface with a CMS or Common Control Environment prior to entering into further, more expensive and lengthy development activities. The SAIL is already establishing a new wargamining environment capable of high levels of classification and developing an engineering reliability tool.

MODELLING AND SIMULATION

Using Data to enhance decisions, understand problems and progress Human Machine Teaming (HMT)

Modelling and simulation (M&S) will be utilised extensively to support smart decision-making, force planning and capability management across the entire Capability Life Cycle. Navy will also routinely use sophisticated synthetic and augmented environments to train, assess and certify personnel, Units and Task Groups across the full spectrum of high-end warfighting operations.

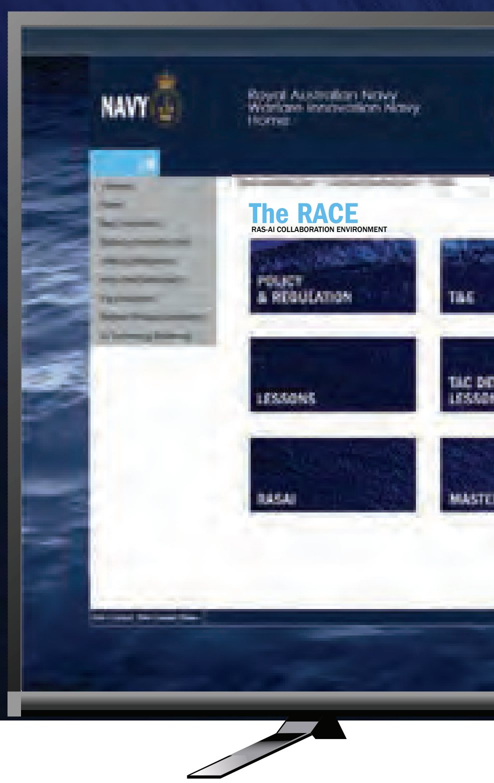
CONCLUSION

The prioritisation of gaps and opportunities is a staff driven, command led activity which is detailed in the executing chapter of this campaign plan. It involves gathering gaps and opportunities, defining them in the RAS-AI context, prioritising them and selecting the right tool(s) for the question at hand. Once the gaps and opportunities have been prioritized and the tools allocated to them this will be sequenced and resourced and form the Autonomous Warrior Forward Work Program.

Develop

The RAS-AI Collaboration Environment *The RACE*

ENABLING TOOLS ACROSS THE MARITIME PORTFOLIO



DEVELOPING A RAS-AI BODY OF KNOWLEDGE

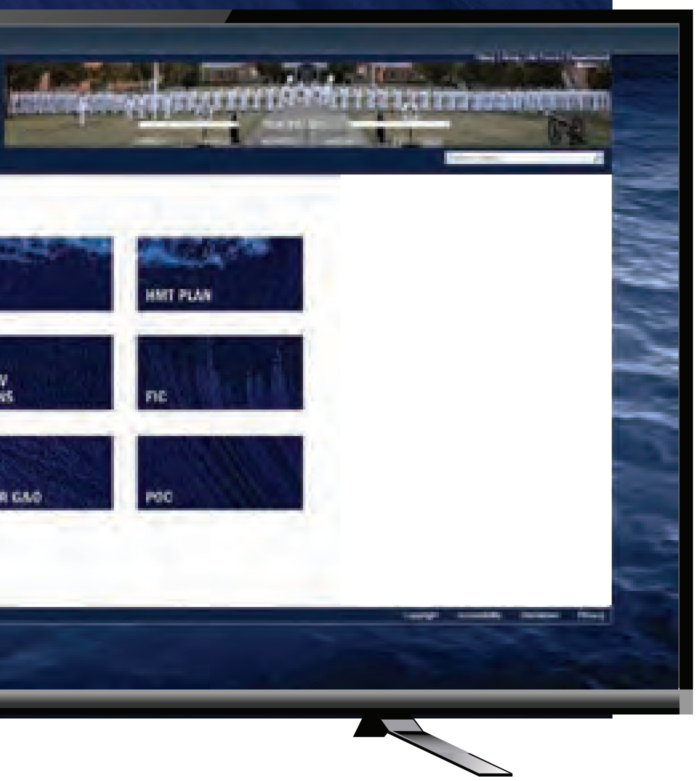
As Navy continues to develop and employ RAS-AI it will add to a growing body of knowledge which will be captured to form a RAS-AI Collaboration Environment, The RACE, that is informed by Discovery and supports Delivery.

The RAS-AI Collaboration Environment includes physical and virtual environments.

THE CAVE The physical environment is centred around WIN Branch's Centre for Autonomous Vehicle Experimentation (CAVE). The CAVE is a key enabler of combat ready prototyping and houses and supports the platforms and capabilities that enable experiments including field trials, PT&E, demonstrations and displays, as well as the validation of concepts and business processes. It also supports assessment of system interoperability and integration prior to the conduct of experiments. The CAVE is located in Canberra at Navy Headquarters with the ability to deploy assets around the country to support AW activities.

The RACE already includes elements such as the RAS-AI Architectures, which provide an objective design for the maritime force, independent of specific mission scenarios. These architectures guide capability development while providing an understanding of Navy's RAS-AI priorities. It also includes a roadmap for the delivery of a Common Control Environment and Navy's developing maturity models, along with numerous other resources still under development described throughout this chapter. Although the RACE will contain artefacts at varying levels of classification, it is intended to be a resource available to partners involved in delivering Navy RAS-AI. Additional elements of the RACE include:

- Navy RAS-AI Stocktake which will establish and maintain the baseline of Navy's current RAS-AI capabilities.
- RAS-AI Policy and support to regulation
- Navy's Human Machine Teaming Plan
- A RAS-AI lessons and post-activity report register
- Fundamental Inputs to Capability (FIC) requirements. As Navy expands its use of RAS-AI it will grow its understanding of the common elements of FIC to develop and deliver RAS-AI capability.
- As concepts are developed through Discovery they will be incorporated into the RACE.
- Master list of Problems/Information Gaps/Opportunities
- Acquisition methods.



AGILE ACQUISITION RAS-AI is defined by rapid developments in technology and application. Navy's ability to access critical artificial intelligence, machine learning, autonomy, cyber, and human systems is essential to deliver maritime capability to the joint force. To do so while ensuring maritime RAS-AI systems remain evergreen, will require agile application of Defence acquisition and sustainment pathways. WIN Branch are developing agile approaches to accelerate introduction into use and service of RAS-AI technologies to support projects and programs through fast and flexible contracting processes. This includes both the ability to rapidly move from prototype to acquisition at scale and continual system development methods.

MATURITY FRAMEWORKS

A maturity model is a set of structured stages or levels that describe how well an organisation is able to apply processes to reliably and sustainably produce an outcome. Generally, models are qualitative tools that can be used as a benchmark for comparison.

In the case of technology adoption and integration this is generally a comparison between a current state and a future state (or sequence of states across time). Navy is developing two initial maturity models under the auspices of a maturity framework. These are an Enterprise Model that provides an holistic, service wide model that helps Navy leadership to understand progress, manage risk and apply resources and an Autonomy Maturity Model (shown in Figure 7, right) which describes the accessibility and availability of capability functions (Sensing, Command and Control, Mobility, Information, Logistics and Effects [SCMILE]).

PURPOSE

Navy's RAS-AI Maturity Frameworks have a number of applications including:

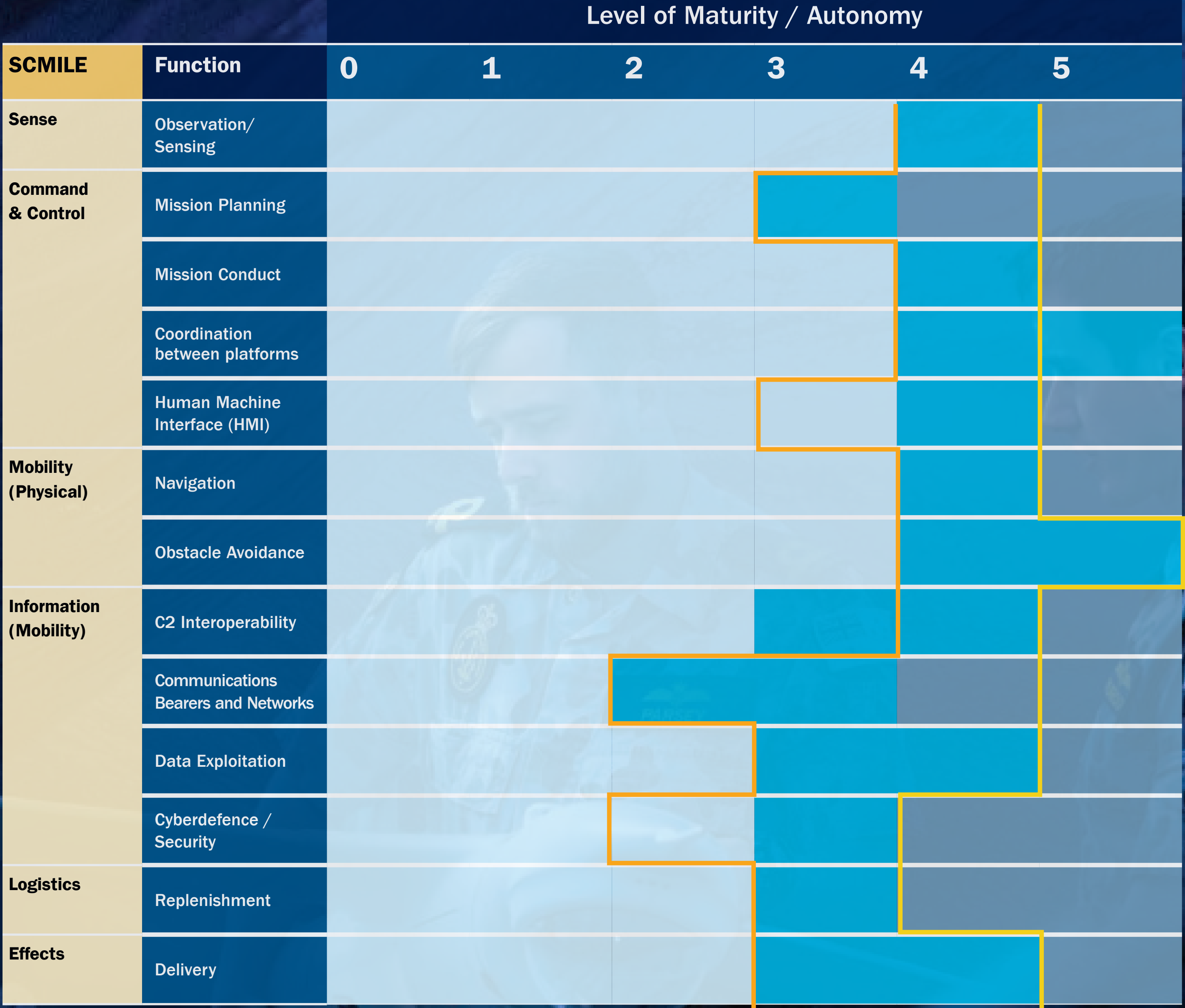
- To support Maritime Portfolio management and risk reduction priorities
- A tool for communicating progress and plans to the Joint Force and coalition partners
- A possible tool for request for tender assessment providing objective metrics
- The prioritisation of RAS-AI gaps and opportunities, a critical component of this plan for action, by clarifying linkages and dependencies between projects/programmes and the relative maturity (and availability) of key enablers. In doing so it helps determine the critical path(s) for RAS-AI capability by answering two key questions: which factor(s) are limiting capability and how many projects/programs are being held back by that factor. Some factors may be critical capability limitations, but only impact one specific project deliverable and so have a low criticality to Navy capability. Others may seem less obvious but actually be constraining the entire maritime RAS-AI portfolio.
- Prioritisation of gaps and opportunities allows the planning of Discovery activities.
- The maturity framework also build a common language to describe the current state of RAS-AI (or emerging tech) and desired future state - which then lends itself to planning actionable activities to fill the gaps.

ROADMAPS

Maturity models allow an appreciation of timeframes, helping Navy understand how a solution may be compared with how urgent the problem is. In doing so it provides a roadmap for the development path of:

- Capability functions SCMILE;
- Navy's organisational readiness for new concepts; and
- Navy's progress towards its RAS-AI Vision measured across Fundamental Inputs to Capability.

Figure 7. Autonomy Maturity Framework



Example of the Autonomy Maturity Model for illustrative purposes and not an actual assessment. Detailed metrics of levels of autonomy by capability function are maintained at the classified level.

Legend

AVAILABLE – either already in use or available for integration into current or planned systems

DEVELOPING – will be available in the near term but requires some research or development

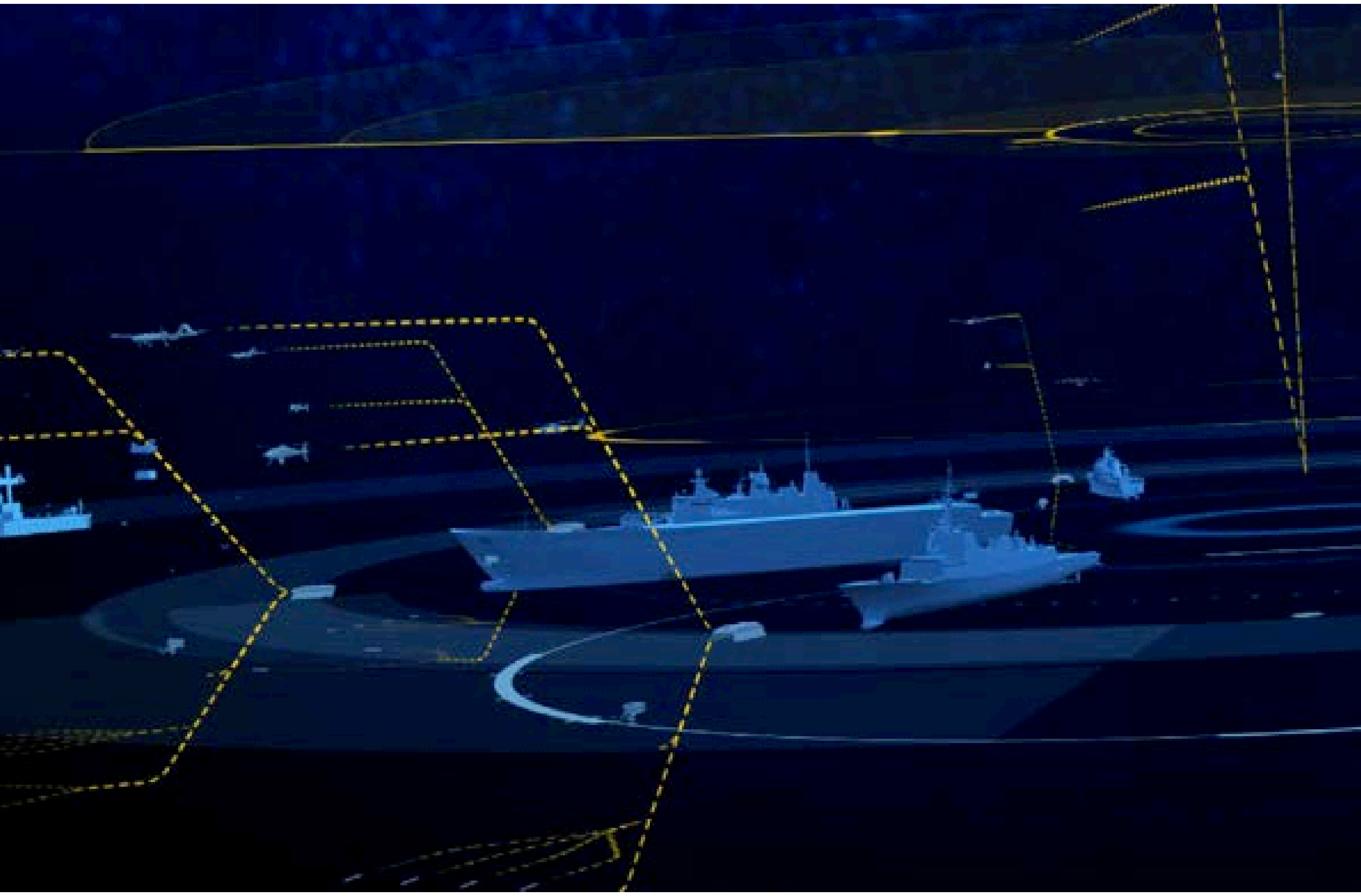
FUTURE – anticipated to be available in the longer term but requires significant research or development

RAS-AI ARCHITECTURES

Defence uses architectures for many reasons, most commonly for: the expression of operating concepts; capability development and integration; system design and engineering; and detailing operational procedures (where the procedure is stable and frequently repeated). In each case they provide a meta-model that promotes common understanding.

The master RAS-AI architectural view, Figure 9, provides an objective design for the maritime force, independent of specific mission scenarios. The Effects Generation View shows how effects may be generated and controlled while the data cycle shows how Command and Control is performed as data moves through the RAS-AI network. Subsequent, classified views, demonstrate RAS-AI design aspirations for specific maritime concepts and mission scenarios and detail operational processes and requirements; services and their exchanges; and technical standards.

WIN Branch are currently developing more detailed models at higher levels of classification to support Navy Capability Program Sponsors. Navy's intent is to maximise sharing of these architectures with coalition, industry and academic partners wherever classification and intellectual property allows.



APPLICATION OF THE ARCHITECTURE ACROSS THE LINES OF EFFORT

As a dynamic and emerging field that comprises a bundle of technologies and techniques at varied levels of maturity, establishing a common understanding of how Navy seeks to employ RAS-AI capabilities is critical across all Lines of Effort. The RAS-AI Architecture does this by:

People – RAS-AI Architectures will help inform, and serve as a reference to, Navy's Workforce System Transformation Strategy and Capability Mastery plans.

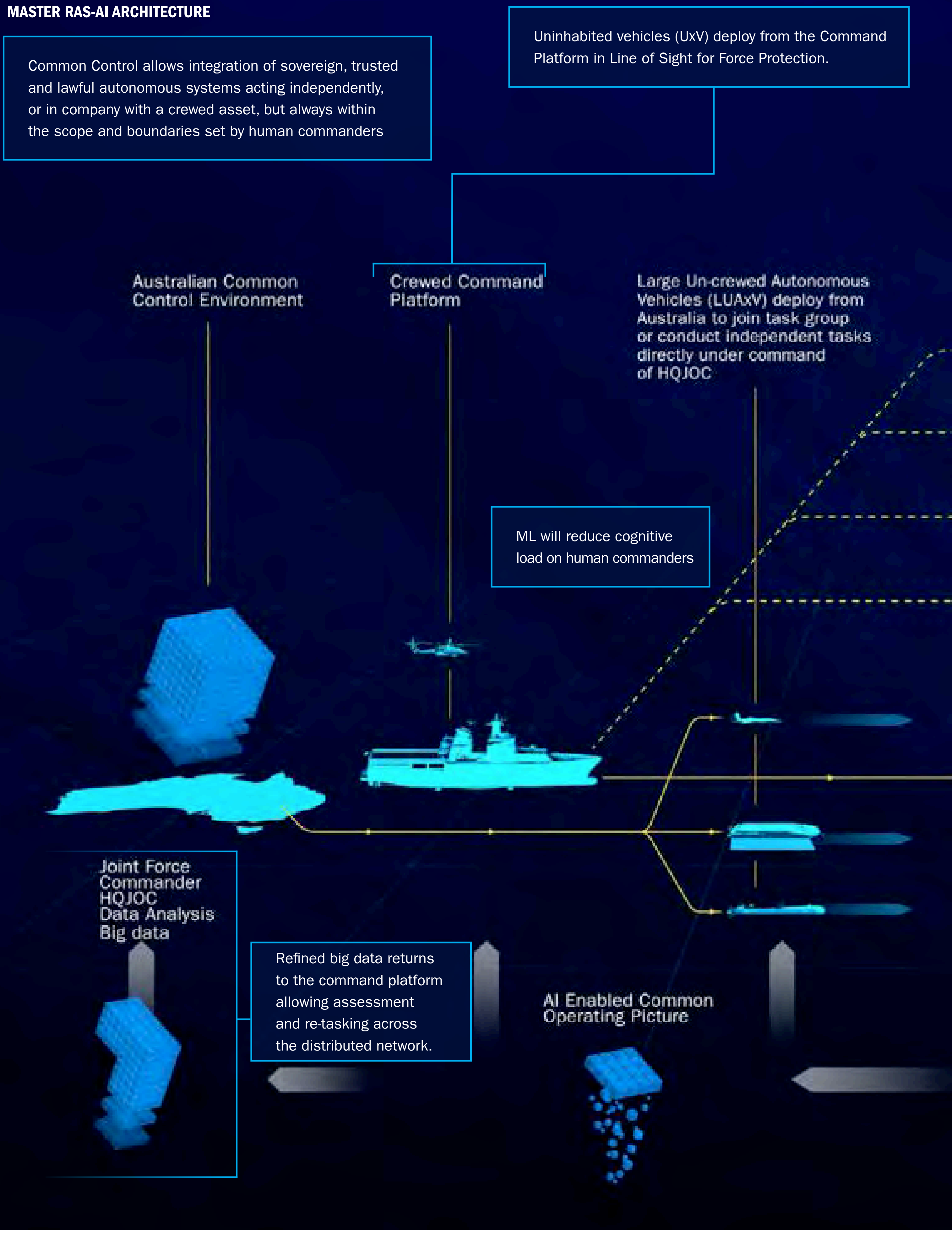
Discover – Navy's RAS-AI Discovery Wave, set out from page 14 of this campaign plan, seeks to connect Navy's Gaps Risks, Issues and Opportunities (GRIO) with Discovery activities to ensure Navy innovates with purpose. The Architectures are used in this process to allow the RAS-AI dimensions of GRIO to be clearly understood and to prioritise Discovery activities to address those GRIO which have the most significant impact on RAS-AI capability delivery.

Develop – The Architecture forms one of the foundations of body of knowledge in the RAS-AI Collaboration Environment (see Develop Chapter). It serves to create a common understanding of problems and solutions and will connect discovery activities with capability delivery.

Deliver – In addition to supporting program managers in the development of their own system architectures and associated artefacts, the RAS-AI architecture provides a signal to industry about how Navy seeks to use RAS-AI to enhance Naval Power and what capabilities it will need.

Figure 8. Current State Architecture

Figure 9.
MASTER RAS-AI ARCHITECTURE



Large UxV* move Over The Horizon from the Command Platform or from locations in Australia, into higher risk waters

- They can deliver smaller UxV, thus increasing their range (than launching directly form the command platform)
- They maintain communications with the command platform via meshed relays.

Larger UXV* are capable of edge platform tasks such as Sense and Control:

- Larger UxV act as network nodes between edge platforms and command platforms to relay pre-processed intelligence, e.g. contacts of interest (COI).
- Control: Using Ai to re-assign edge platforms when comms are lost with command based on the intelligence they have collected, e.g. manoeuvring to continue to track a COI.

Smaller UxV can Manoeuvre, Sense, Network and Think using pre-trained and validated machine learning (ML) models.

- E.g. processing big data, such as full motion video, into intelligence data (such as a track for a COI) reducing the amount of data needing to move through the network in a contested environment.

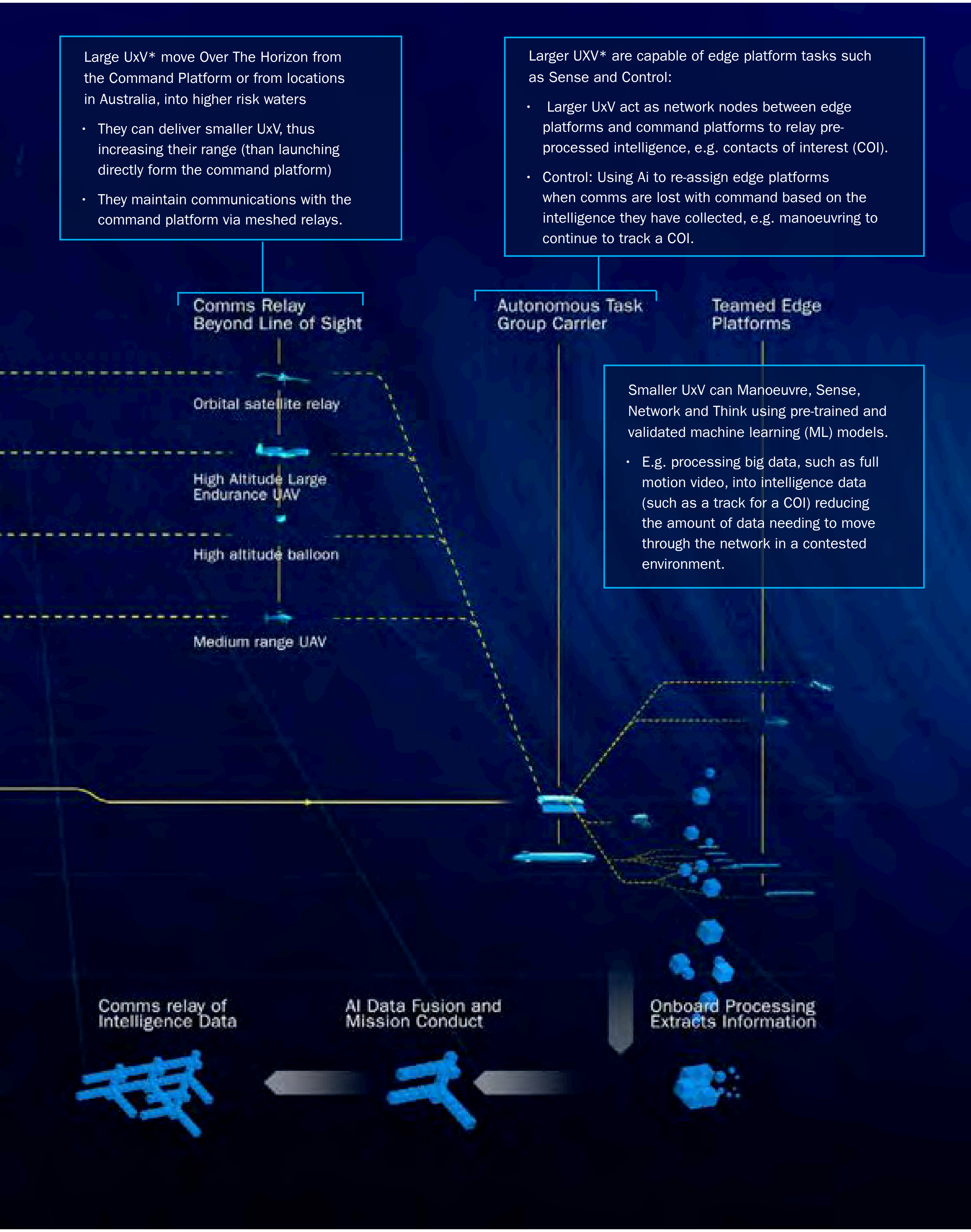


Figure 10.
EFFECTS GENERATION VIEW

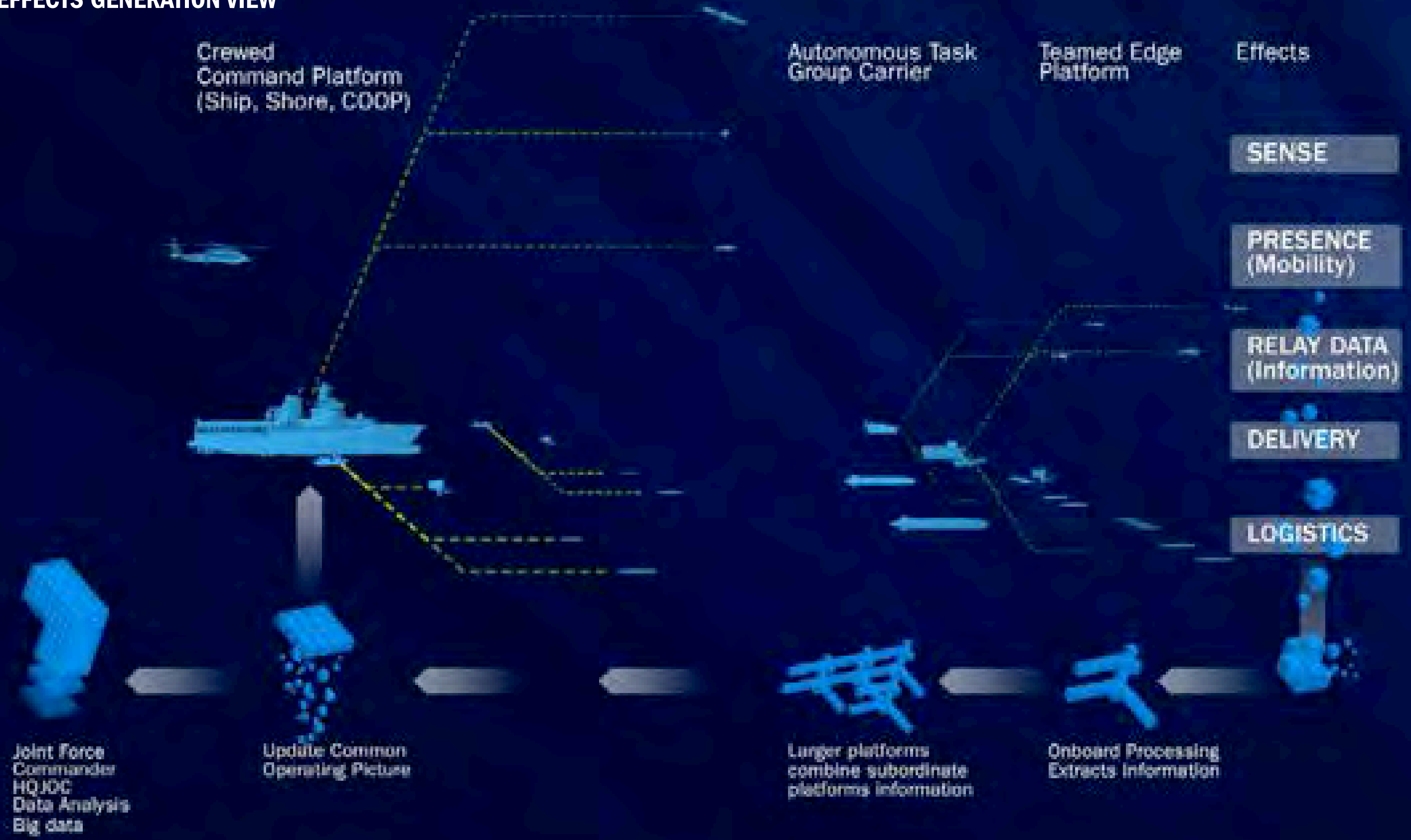
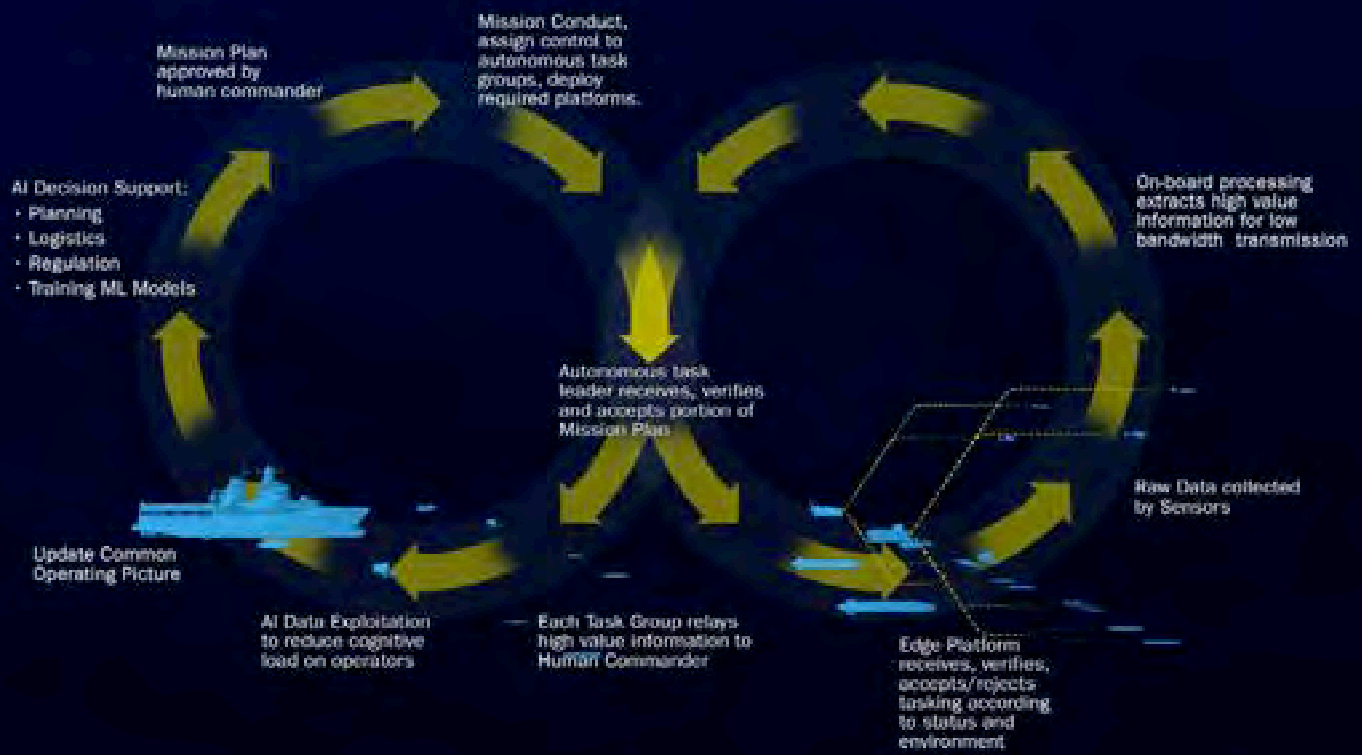


Figure 11.
RAS-AI C2 AND DATA CYCLE VIEW



Human Machine Teaming

COMMON CONTROL ENVIRONMENT

Navy's plan to employ a wide and diverse range of RAS across sub-surface, surface, air, littoral and information domains will require a Common Control approach in order to ensure trusted, lawful autonomy and to be inter-operable as part of the Joint Force, as well as with our Allies. Navy has commenced implementation of elements of RAS Common Control and now seeks to cooperate and build RAS Common Control in partnership with ADF Groups, Services and Industry. The development of a Common Control Environment (CCE) is a vital enabling capability for Navy and forms a central component of the body of knowledge expressed in the RACE.

CCE Defined. Navy will achieve 'Common Control' by establishing a Governance and Architecture framework of protocols, policies and standards that each RAS will need to adhere to, regardless of the variant or manufacturer. This environment covers a range of requirements ranging from the architectural and technical, such as bearers, networks and communications protocols (to send and receive data between the vehicle, the control station, and a broader combat management system) through to the governance of standards.

Figure 12. Common Control

COMMON CONTROL NEEDS AND OBJECTIVES

Common Control Environment. The Governance Framework and Architecture Framework that will enable the scale, agility, ever-greening, mass and asymmetric advantage of RAS-AI to augment traditional forces while mitigating the weaknesses of exquisite centralised traditional force elements in a trusted and lawful way. To be smarter, safer, and achieve an asymmetric advantage over a potential adversary.

Sovereignty. Common Control will enable Navy to rapidly integrate new sovereign and international RAS, including the ability to rapidly modify systems at sea, without sovereignty or treaty restrictions.

Standards. Common Control will identify common standard for OEMs to develop and integrate too.

Compliance. Common regulatory and legal standards for Navy RAS and AI will allow for the rapid integration and deployment of new RAS and AI systems. This in turn builds trust with regulators, Government and the Australian public.

Human command. The ability for a RAS/artificial intelligence system to operate within the scope and boundaries set by a human in a scenario when direct contact with the commander is lost.

Mass. Common Control Governance and Architectures across Navy's fleet of RAS will enable one human to command many (and many types of) RAS simultaneously.

Human machine teaming. Common Control Environment will allow Navy to leverage technology and growing computer processing power to rapidly develop mission options and solutions beyond the capacity of a human.

Self-organisation. Common Control will enable RAS to self-organise and self-heal to achieve the effects without humans in the loop.

Interoperability. Common Control will allow RAS to be handed over between one control system and between services and/or coalition partners, as directed by ADF Commanders.

COMMON CONTROL IMPLEMENTATION

Navy has commenced a range of risk reduction activities, in conjunction with major projects, to establish Common Control principles. These include building partnerships with DSTG, industry, academia and coalition; undertaking feasibility testing for a number of Common Control components; shaping international standards and engagement in war gaming, simulation, sea trials and T&E.

Completion of the risk reduction activities will lead to the development of the Common Control Environment (CCE), which sets the protocols, policies and standards. The CCE will then be used to complete systems engineering for the design and implementation of the architecture into RASAI. Finally, products will be acquired that are compliant with the Common Control Environment Governance and Architecture.

COMMON CONTROL ENVIRONMENT 4 YEAR PLAN (GOVERNANCE FRAMEWORK AND ARCHITECTURE)

INITIAL LINES OF EFFORT	2022 Discovery (Define/Design)	2023 Develop (Build)
1. CC Governance	Define scope of problem and requirements	Initial Governance design
2. CC Collaboration	Define collaboration levels and requirements. High level design	Simulated demonstrations. Systems integration (inter-system). Limited field demonstrations.
3. CC Autonomy	Define RAN Autonomy priorities and design experimentation	Simulated demonstrations of key features
4. CC Commonality	Define Priority elements and design experimentation	Small scale demonstrations. Iterative research driven experimentation.
5. CC Integration	Define level of integration required and scope	Initial system design and simulated demonstrations

2024 Trial (Test/Field)	2025 Deliver (Commence)
Scale demonstrations Iterate design	Commence at scale
Implementation of minimum viable product (MVP)	Commence with operational systems
Integration with/between RAS systems.	Commence with operational systems at scale
Develop and demonstrate multiple RAS of different classes	Commence at scale with groups of RAS
Iterative development and simulated with multiple RAS	Commence and refine with Combat Ready Prototypes

MODELLING AND SIMULATION

Modelling and simulation (M&S) is critical to the design of the future fleet and preparing the fleet in being for high end warfighting. M&S will be used to support Chief of Navy outcomes across the Capability Life Cycle, this includes planning (the design of future capability, concepts and tactics), collective and individual training and supporting the optimisation and battle worthiness of the Fleet in Being.

Navy will also routinely use sophisticated synthetic and augmented environments to train, assess and certify personnel, units and Task Groups across the full spectrum of high-end warfighting operations.

Navy will release a Modelling and Simulation Strategy in 2022 to set out current and future strategic objectives, opportunities, and challenges for RAN and how these may evolve in light of an evolving threat environment resulting in high-end warfighting operations.

Navy's development of a maritime synthetic environment (MSE) is essential to its ability to utilise M&S to support high end war fighting.

The Maritime Synthetic Environment (MSE) is an adaptive digital eco-system that provides Navy an integrated simulation network, capable of providing high fidelity training opportunities in preparation for live evolutions.

The MSE comprises multiple cross-domain simulation platforms, each enabling specific and agile functions. High fidelity databases of military models and effects support these synthetic training and experimentation platforms by providing the users with up to date capability and functionality.

Modelling and simulation systems will need to be able to operate in highly classified environments to adequately integrate and evaluate all high end warfighting effects.

M&S supports Navy outcomes across three core areas, plan, train and fight.

Plan. M&S support to planning ranges from system of systems (Force Options Design and Testing) to systems (Operational Analysis [OA], TAC DEV etc.) and Sub-systems (engineering and logistic models). M&S will enhance Navy's contribution, and maintain its equities, in Joint Capability Development.

Train. M&S Support to Training ranges from individual through collective within the MSE where integration of compatible simulators will occur. This integration must have a Joint and multi-domain focus, with capacity to support integrated coalition activities

Fight. M&S will support Fleet Command and the deployed commander to 'fight tonight' delivering MFU, TG and TF synthetic certification and enabling underway rehearsals and force integration. M&S will enhance operational plan testing, and non-kinetic effects planning. In addition, Digital and Virtual Twins will reside within the engineering layer of Fight.

Figure 13 below provides an overview as to how Navy will leverage Modelling and Simulation to enhance high end warfighting. **The Maritime Synthetic Environment** underpins Navy's Modelling and Simulation enterprise. It forms the connective tissue ensuring data developed in planning and training supports operational commanders while operational lessons inform planning and training.

Figure 13. The Maritime Synthetic Environment

COMBAT READY PROTOTYPING

Prototypes are a form of experimentation, one that for maritime RAS-AI capability can be built rapidly and modified easily to enable numerous iterations. Although some may appear mature, prototypes are inherently still developmental, having not been through the formal introduction into service processes. This includes the development of comprehensive capability life cycle documentation, and the rigorous regime of assurance that underpins it.

Navy can, however, no longer rely on "warning times… to gradually adjust military capability and preparedness". Contributing to the pressure to evolve capability quickly and continually, is the pace of radical and architectural innovation in RASAI (the Discovery Wave's 'technology push') which threatens to outpace conventional processes.

Therefore, wherever practicable, Navy will develop RAS-AI prototypes that maintain a clear path to deployment should they be required to 'fight tonight'. This requires a number of critical enablers.

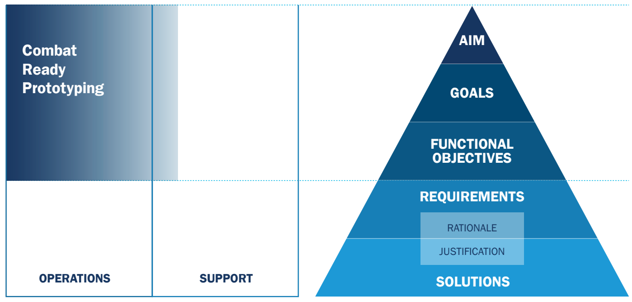
- **Agile Contracts.** Through a robust and agile contracting mechanism, prototypes will be developed under arrangements that allow for rapid acceleration of development and/or deployment of the prototype.
- **Evidence.** Prototyping experiments are conducted with sufficient rigour that they generate Objective Quality Evidence (OQE) of system capabilities and limitations. Their standards of data collection and evidence should inform risk acceptance by the operational commander.
- **DSwMS.** Prototypes require a plan to be able to deploy early on urgent request from an operational commander. Clearly experimental capabilities will have limitations and risks however, in a 'fight tonight' scenario, these must be weighed against not having a capability at all. Navy achieves the balance between assurance and operational effects through the Defence Seaworthiness Management System (DSwMS).

OPERATING AND SUPPORT INTENT (OSI)

The DSwMS aims to ensure the operation of a maritime mission system, in accordance with its Capability Manager's OSI. This maximises the likelihood of achieving the operational effect while ensuring efforts have been made to eliminate or minimise so far as is reasonably practicable (SFARP), hazards/risks to personnel, the public and the environment.

Combat Ready Prototypes will be developed with an initial plan that forms the foundation of an OSI, should the prototype be developed further. This also provides a framework for an operational commander to accept risk and employ the prototype if required. OSI are developed incrementally as a capability proceeds through the life cycle, as detailed in Australian Navy Publication 3802. Combat Ready Prototyping will, at a minimum seek to follow the early stages of an OSI.

Figure 14. Combat Ready Prototyping



A mature OSI is comprised of aims, goals, functional objectives, requirements and solutions as indicated in the pyramid.
A Combat Ready Prototype will specify a minimum level of details (down to functional objectives) and is biased towards operating concepts with essential supporting concepts only.

Operations would typically include:

- operational effects and roles to be realised
- Primary Operating Environment
- typical mission profile(s)
- typical threat

Support would include:

- integration to existing force/replacement of existing capability
- Command and Management
- Industry needs and requirements.
- Sustainment model (e.g. repair by replacement, expendable etc.)

This approach will allow a prototype to be able to deploy early on urgent request through a 'battle-worthiness assessment', aligned to Navy's Seaworthiness Framework that provides an operational commander with a clear risk profile as indicated in Figure 14 above.

WIN path from MVP to War Winning Capability
What can the capability do, at what stage of development, and what challenges need to be addressed?

Combat Ready Prototyping is a progressive model beginning with:

- Minimum Viable Product (potentially one system, sufficient to demonstrate functional performance) then,
- Minimum Viable Capability (potentially the minimum number of systems to conduct a mission profile) and finally,
- Operational Capability (the number of assets to provide required operational availability).

Therefore Combat Ready Prototypes may not be a single platform. They may be a piece of software, a control system for existing capabilities, a small swarm of independent mission systems or a heterogeneous team of differing platforms.

Deliver

SUPPORTING DELIVERY PARTNERS

Navy delivers capability, including RAS-AI effects, under the direction of its Capability Program Sponsors in accordance with the One Defence Capability System. This occurs over four phases: Strategy and Concepts: Risk Mitigation and Requirements Setting; Acquisition; and In-Service and Disposal.

Ultimately all RAS-AI Discovery and Development activities outlined in this campaign plan support the delivery of maritime capability, either by enhancing the current fleet or supporting the delivery of the future fleet. Specifically

- By supporting the Fleet Commander to use RAS-AI to enhance maritime forces for current operations, exercises, engagements and future contingencies.
- By supporting Head Navy Capability leverage the use of RAS-AI to meet current requirements, evolve with changes in threats and technology and deliver and sustain agile and lethal naval capability.

In concert with DSTG, WIN Branch works closely with its delivery partners and maintains processes which synchronise Discovery activities with Delivery outcomes.

STRATEGY & CONCEPTS

RISK MITIGATION & REQUIREMENT SETTING

ACQUISITION

IN-SERVICE & DISPOSAL

MILESTONE	WIN BRANCH

STRATEGY AND CONCEPTS	The application of RAS-AI Discovery tools:
	• To conduct experimentation in support of the development of new concepts
	• To help inform Navy DCAP analysis (through *Smart Owner* processes) in particular:
	  • Maintaining awareness and provide insights for new and upcoming innovative concepts against GRIOs through ongoing engagement with industry, academia and coalition RAS-AI specialists.
	  • Scanning and developing new and upcoming ideas and concepts.

PROGRAM DIRECTION	• Informing updates to Program Strategies and the Maritime Operating Concept through experimentation.
GATE 0	• Support Capability Program Sponsors, through experimentation and resident knowledge on technology, to identify capability options to develop, the activities needed to provide quality information and mitigate risk.
GATE 1/2	Provide subject matter expertise, a body of knowledge and, through Discovery, OQE to inform the development of the: • Preliminary Operational Concept Document including the Integrated Logistics Support (ILS) Concept; • Preliminary Function and Performance Specification (FPS);
IOC	• Provide ongoing support through Preview T&E.
OC1, OC2	• Support user optimisation requests (through RPR, Fleet Command Optimisation, OUR etc).

Figure 15. Delivery Milestones

MILESTONE

- Leveraging modelling, simulation and synthetic environments to evaluate and provide OQE on the feasibility, acceptability, suitability and distinguish-ability of different ideas / options can be combined.
- Identifying solutions and evaluating the availability of the solution against prioritised opportunities.
- Developing solutions through defence R&D.

PROGRAM DIRECTION

- Supporting (or leading where it is an entirely new RAS-AI concept or capability) the development of Joint Capability Needs Statements, Project Execution Strategies and Gate 0 business cases.

GATE 0

GATE 1/2

- Other FIC requirements;
- Support Technology Risk Assessment;
- Help to identify industry opportunities;
- Support rapid acquisition through tailored, agile methodologies.

IOC

- The provision of specialist advice
- Support rapid acquisition through tailored, agile methodologies.

FOC / OC1, OC2

- Support Mission Package enhancement.
- Support evergreening through continuing Discovery and agile acquisition.
- Support the development of new concepts, approaches and tactics for in-service capabilities.

OC*n*

Executing

The Discovery Wave

CONNECTING DISCOVERY TO DELIVERY

As described in the preceding chapters, Navy's RAS-AI Lines of Effort are connected through the Discovery wave. All Discovery activities inform the body of knowledge in the RACE, thus progressing Navy's understanding of RAS-AI capability and setting the foundations to accelerate capability development.

The outcome of Discovery activities however, is to enhance the Delivery of RAS-AI capability, either through entirely new means of producing effects or the evergreening of existing (or planned) maritime capability.

The immediate output of the Discovery Wave is the establishment of a Forward Work Plan, which is aligned to Navy's priorities, is resourced and can be communicated to internal and external stakeholders.

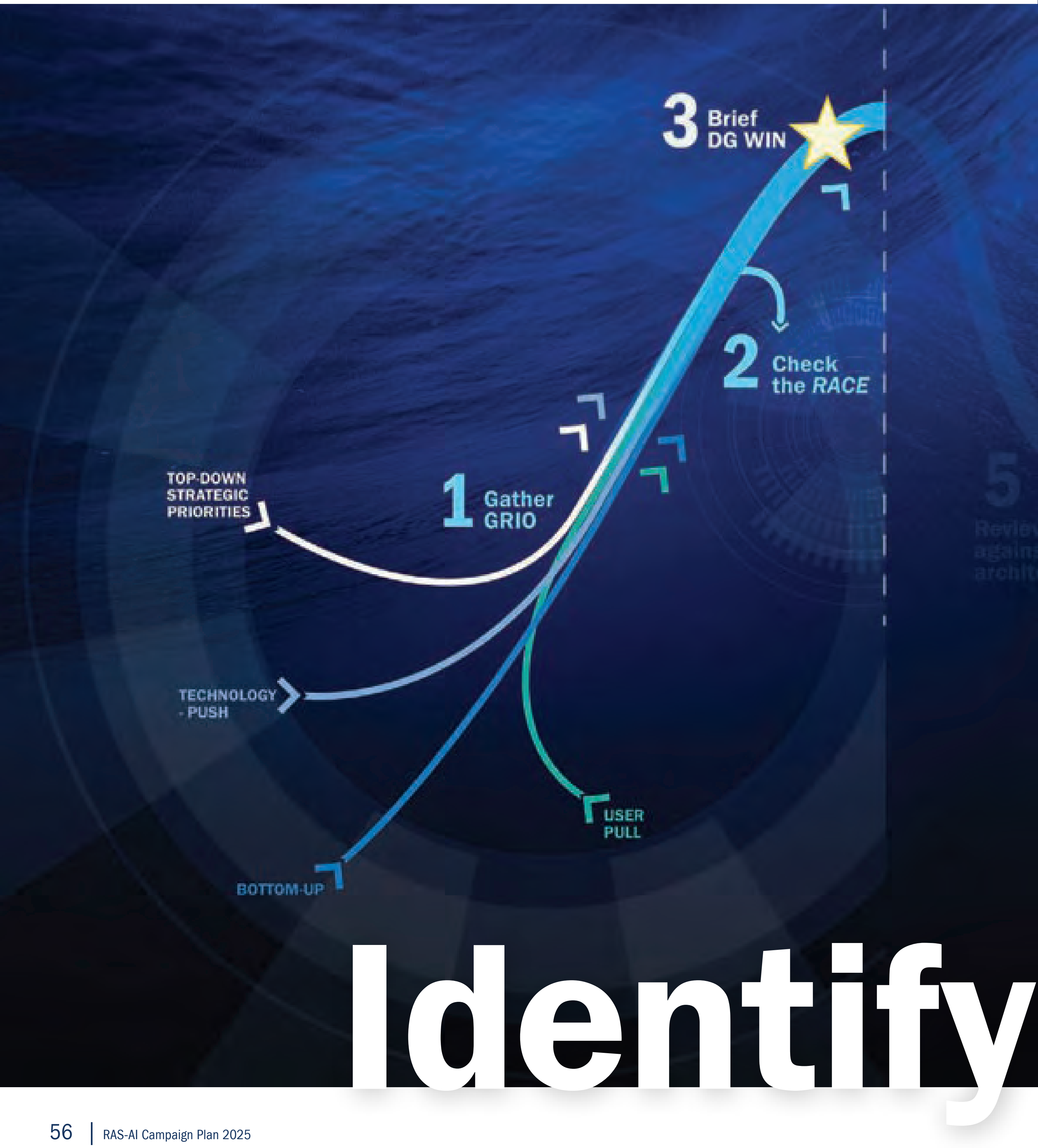
This action research cycle, embodied in the wave, will compound Navy's RAS-AI knowledge and investment, and comprises four distinct steps: Identification, Definition, Prioritisation, and Implementation.

- **Identification** is the process of drawing together existing, and emerging, gaps and opportunities (GRIO) from various sources.
- **Definition** seeks to articulate them in a consistent and comparable way and to understand their relation to RAS-AI and to Fundamental Inputs to Capability.
- **Prioritisation** seeks to identify the potential impact of addressing a particular gap or opportunity in terms of imminence (how soon can it be addressed) and portfolio management (how many projects, programs, or products will it impact). This includes identifying completely new capabilities as well as enhancing existing capabilities or products with new systems, concepts or technologies.
- **Implementation** assigns and executes a suite of tools, seeking the most efficient program of activities and resourcing them accordingly.

PHASE 1 OF THE WAVE: GAPS AND OPPORTUNITY IDENTIFICATION

Innovating with purpose means addressing Navy's existing and emerging challenges and priorities. As such the Identification phase collects and consolidates Gaps Risks, Issues and Opportunities (GRIO) that RASAI may be able to resolve.

Navy's master GRIOs are maintained by the Maritime Domain Support Office. WIN will review them, along with other sources to provide fundamental, authorised and empirical sources for innovation activities.



1 Gather GRIO

This phase is conducted on an ongoing basis by WIN Branch as described in detail below.

TOP-DOWN STRATEGIC PRIORITIES

i. These are provided through direction from Chief of Navy and Head Navy Capability (both standing as well as through immediate directives); standing strategic guidance (see the taxonomy on page 4) notably Plans Mercator and Pelorus, *The RAS-AI Strategy 2040* and additional classified guidance.

ii. Navy Headquarters undertakes a deliberate process of collecting and analysing gaps and opportunities under Maritime Domain Support Branch.

iii. Navy's Smart Owner program also generates GRIO which are harmonised with the DCAP process and are also connected to the RAS-AI process.

iv. Outcomes of Navy's one-star cross program steering groups (NxPSG) responsible for coordinating and resolving RAN RAS-AI efforts across the One Defence Capability System, including the allocation of funding.

TECHNOLOGY PUSH

WIN works in conjunction with Defence Science and Technology Group (DSTG), Defence Intelligence Organisation, Academia, NGTF, DIH, Industry and with Joint and Coalition partners to identify new technologies and new concepts which create opportunities or present threats. These include

i. Intelligence Assessments

ii. DSTG Emerging and Disruptive Technologies Symposia

iii. The development of unique RAS-AI Concepts (primarily within the RASAI Directorate but in collaboration with all areas of Navy)

iv. Joint Experimentation outcomes

v. Technology Scouts conducting outreach with non-Defence industry

vi. DIH submissions and unsolicited proposals made directly to Navy personnel

vii. Coalition Engagement

viii. RASAI roundtable proposals

Although there is a deliberate GRIO consolidation phase of the wave, they are continually identified or solicited by WIN Branch as they engage with Navy capability program sponsors, industry and academia and broader Defence.

BOTTOM-UP

Are those GRIO identified as part of day-to-day operations with most of these generated from Fleet Command. Sources of GRIO that will be incorporated into the identification phase include:

i. Fleet Commander's Optimisation Program

ii. Requests for Problem Resolution (RPR)

iii. Safety cases

iv. Maritime Warfare Centre lessons, and

v. Innovation proposals from the Centre For Innovation and other user groups.

USER PULL

In the Navy context, 'User Pull' reflects GRIO confronted by Capability Program Sponsors in the course of capability development. These are being elicited continually through regular engagement between RASAI staff and project officers. These GRIO will often be closely aligned, or overlap, GRIO sourced through the DCAP and Smart Owner processes. Key sources include:

i. Project and Program Managers

ii. CASG SPO

2 Check the *RACE*

This list is regularly reviewed against the RACE to determine if a resolution to the GRIO already exists or if a sufficiently similar GRIO has been addressed that it may provide a suitable answer? If so, the GRIO may be referred back to its originator with the information from the RACE to confirm its validity.

3 Brief DG WIN

The list of GRIOs periodically is submitted to DG Warfare Innovation Navy (WIN) for approval to be analysed in Phase 2. DG WIN may remove or insert GRIO at this point. The deliberate identification phase 'ends' when GRIO have been consolidated and are ready for subsequent phases. No GRIO are rejected outright at this stage.

PHASE 2 OF THE WAVE: GAPS AND OPPORTUNITY DEFINITION (ASSESSING VULNERABILITY)

This phase seeks to define the GRIO in a consistent way in the form of uniform Problem Statements. This allows subsequent analysis, and determination of which aspects of RAS-AI capability GRIO are connected to. Problem statements describe the problem needing resolution and the benefit to be realised (especially if generated from a new process or technology). GRIO which are rejected from this point onwards will not be progressed further in this cycle but will be captured for possible future consideration.

4 Develop problem statements

The one-star cross program steering group approved list of potential GRIO is expanded to allow analysis of the RAS-AI aspects of GRIO, and a description of the impact in terms of Defence’s Fundamental Inputs to Capability.

5 Review against Architectures

GRIOs are now assessed against the RAS-AI Architectures to determine how they may affect or be affected by RAS-AI capabilities. Once reviewed against the architectures GRIOs are refined and restated as they relate to RAS-AI capability. A solution to the GRIO already exists or if a sufficiently similar GRIO has been addressed that it may provide a suitable answer. If so, the GRIO may be referred back to its originator with the information from the RACE to confirm its validity.

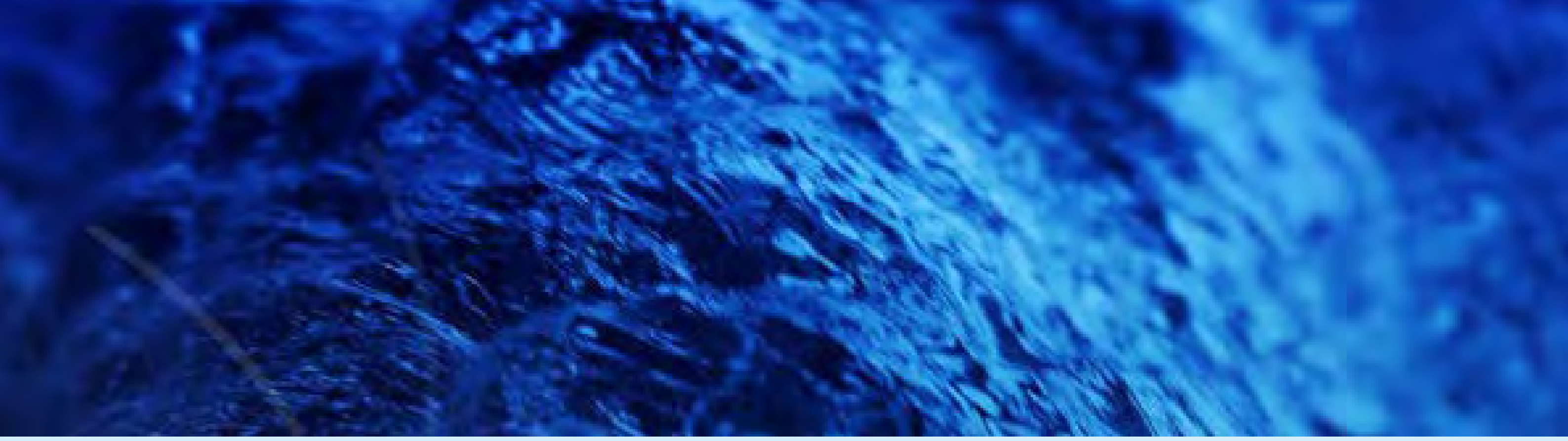
Those that are assessed as having little to no input nor output from WIN do not proceed past this step. Where a GRIO is not taken forward to step six it is included in the RACE.

6 Brief DG WIN

The definition phase ‘ends’ when GRIO have been defined in a consistent manner and the linkages and/or dependencies for RAS-AI capabilities are clearly stated. This phase concludes with a brief to DG WIN and approval of problem statements to be prioritised in Phase 3. DG WIN may reject or reinsert GRIO at this point.

PHASE 3 OF THE WAVE: PRIORITISATION & RESOURCING

This phase commences with a set of consistently described GRIOs which have been identified as having an important contribution to, or dependency on, RAS-AI capability.



7 Maturity Framework

This step begins by reviewing the list of problem statements against the RAS-AI Maturity Framework. Key questions that will be asked of each GRIO in relation to the Maturity Model are:

- **Constraints.** How will addressing this GRIO overcome a constraint along the roadmap to maturity?
- **Time.** What is the impact of time? Is the GRIO likely to be addressed through routine innovation (i.e. is the technology or concept so close to maturity that it doesn't require Discovery support)? Or is it so far in the future that, although worthy of R&D, the contribution to capability development is hard to identify or quantify?
- **Linkages and Dependencies.** How many projects, products, or programs will be impacted by resolving this GRIO (i.e. will be accelerated by its resolution, removal or amendment or are being held back by it)?

8 Preliminary Assignment of Tools

The maturity model allows the creation of a preliminary order of priority, in which problem statements are categorised into the four Discovery risk domains (People, Platforms and Products, Policy, Integration) in preparation for consideration by the NxPSG. In developing the preliminary list Director RAS-AI will recommend tools for each problem statement. The ultimate selection of the tool will be through the NxPSG and will be contingent on identifying funding.

9 Priorities, Tools, Resources

The NxPSG will determine three things.

First, the priority of problem statements where necessary.

Second, the most appropriate tools have been assigned to address the problems statements based on their priorities.

Third, resourcing for each activity. These are reported out to the NxPSG and the Fleet Command Board.

Key considerations are:

- **Synergies.** Wherever possible synergies between GRIO will be sought.
- **Sequencing.** Although the GRIO are identified in priority order they may not be addressed in order. E.g. the highest priority GRIO may be best progressed through a major fleet exercise which will be contingent on Navy's Fleet Activity Schedule whereas a lower priority problem may have an easy to deliver tool which can be conducted sooner.
- **Resourcing.** Recognising that Delivery is managed by program sponsors in partnership with delivery agencies, resources need to be identified and allocated by the capability risk owner. This will require trade-offs, acknowledging that the preferred tool may not be the most cost effective. It is better to have a lower cost tool provide a suitable answer rather than not address a GRIO at all.

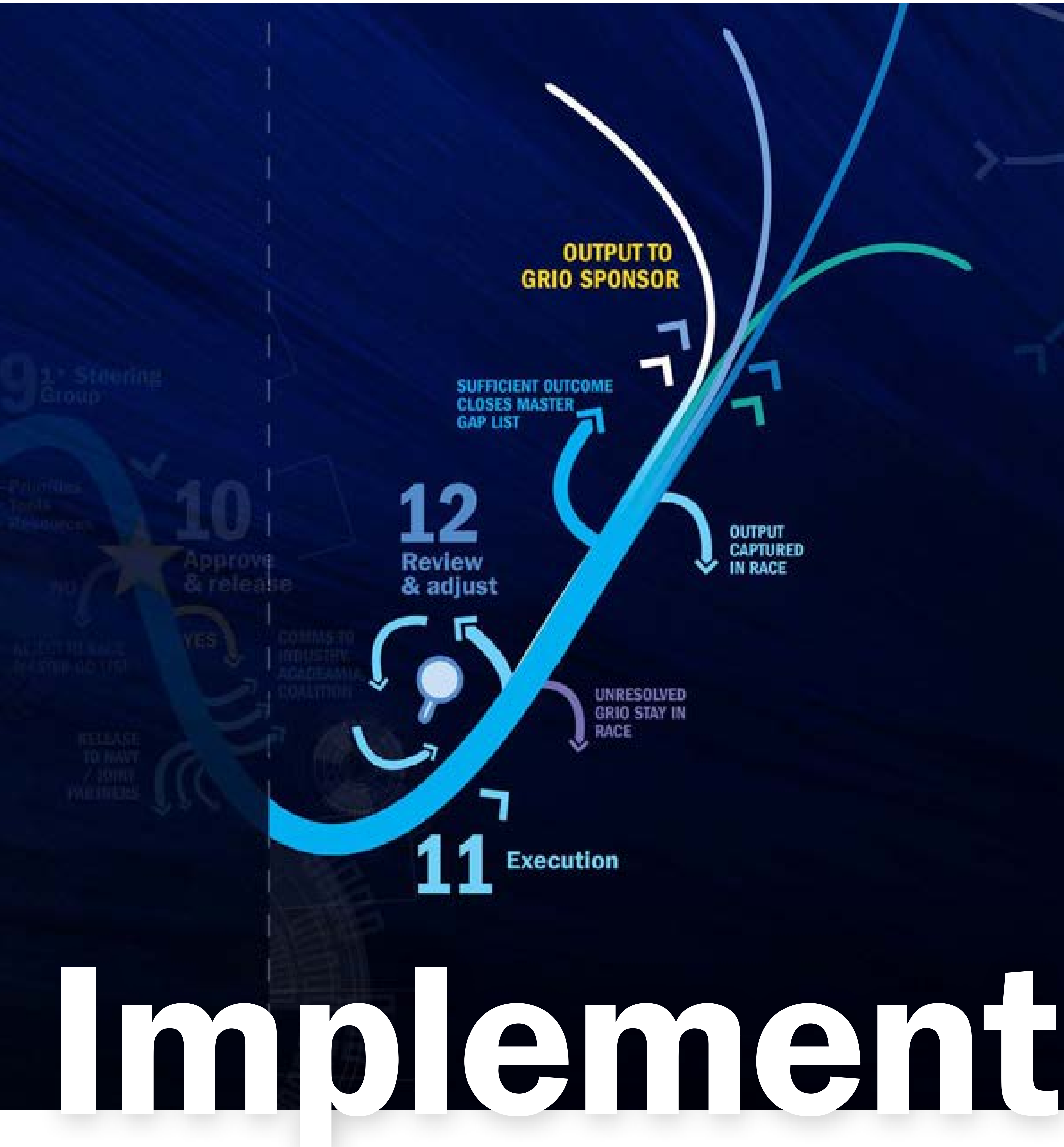
The outcome of this NxPSG is a proposed Forward Work Program that is resourced and scheduled.

10 Approve and Release

The proposed Forward Work Program is submitted to Navy Capability Committee (NCC) for approval. Any un-resourced GRIO will still be included in the prioritised list in case resourcing becomes available on short notice. On approval the Program will be released to Navy, shared with Joint partners and communicated (where ever possible) to Industry, Academia and Coalition partners.

PHASE 4 OF THE WAVE: IMPLEMENTATION

This phase is the execution of the approved forward work program and a mid-point review.



11 Execution

As Discovery activities are conducted their output is provided directly to the GRIO sponsor but is also captured in the RACE.

- Where the outcome is sufficient to either enhance capability (or inform a decision not to pursue a particular gap or opportunity) it can be closed in the master GRIO list.
- Some activities may lead directly to another, this may not need to be reinserted in the cycle and may be conducted once resources are made available. E.g. An industry workshop may determine the technical feasibility of a solution which leads directly to prototyping which may then lead to a field trial or preview T&E.
- Unresolved GRIO remain in the RACE and will be considered in the next wave.

This cycle will be conducted at least annually however can increase its frequency or amplitude dependent on resources.

12 Review and Adjust

Halfway through the execution cycle the RASAI-CG reconvenes to review progress, confirm priorities and adjust resources, potentially including identification of funding for unfunded problem statements. It also captures newly identified GRIO and sets the conditions for the next cycle of the wave.

GLOSSARY

A

Agent. A system, machine, or system of systems that is authorised to act on behalf of a human to conduct physical or non-physical (cyber), tasks.

Automatic System. A system that is pre-programmed to respond to stimuli in a rules-based, deterministic manner and achieve its function without further human input.

Autonomous System. A system that determines how to perform the tasks necessary to achieve a defined goal. Autonomous systems respond to stimuli in a probabilistic manner but can be regulated by deterministic controls so that it can perform their tasks or functions without further human input.

Autonomy. The ability of a machine, whether hardware or software, to perform a task without human input.

Artificial Intelligence (AI) is a collection of interrelated technologies used to solve problems and perform tasks that, when humans do them, requires thinking.

Algorithms are clear processes or sets of rules to be followed in calculations, data processing or other problem-solving operations.

Artificial Narrow Intelligence (ANI) is also referred to as weak AI or narrow AI, is the only type of artificial intelligence we have successfully realised to date. Narrow AI is goal-oriented, designed to perform singular tasks - i.e. facial recognition, speech recognition/voice assistants, driving a car, or searching the internet - and is highly intelligent at completing the specific task it is programmed to do

Artificial General Intelligence (AGI) also referred to as strong AI or deep AI, is the concept of a machine with general intelligence that mimics human intelligence and/or behaviours, with the ability to learn and apply its intelligence to solve any problem. AGI can think, understand, and act in a way that is indistinguishable from that of a human in any given situation. This has not yet been achieved.

Artificial Super Intelligence (ASI) is the hypothetical AI that doesn't just mimic or understand human intelligence and behaviour; ASI is where machines become self-aware and surpass the capacity of human intelligence and ability. This has not yet been achieved.

Architecture(s) a tool to describe a method for designing (information) systems in terms of a set of building blocks, and for showing how the building blocks fit together. It should contain a set of tools and provide a common vocabulary. It should also include a list of recommended standards and (potentially) compliant product that can be used to implement the building blocks.

C

COLREGS are the International Regulations for Preventing Collisions at Sea, published by the International Maritime Organization.

Combat Artificial Intelligence (Combat AI) refers to the use of AI to support mission-based outcomes aimed at improving Situational Awareness, Decision-making, and Operational Tempo. Combat AI solutions may integrate structured and unstructured data from combat and weapon systems, networks, and sensors. Combat AI solutions may interface with, or be a component of, hardware such as autonomous systems.

Command. The authority that a military member lawfully exercises through rank or appointment to determine what is to be achieved by subordinate forces.

Common Control Interface ('Interfaces'). Also known as 'bridges' CCIs provide a link between the main Control and individual Agents or UxVs. The CCIs translate the incoming and outgoing information between the propriety control system aboard the UxVs and the main Control system.

Common Control Agents ('Agents'). Systems that are capable of acting with some level of autonomy. At a minimum they execute Boyd's 'OODA loop' - observe (i.e. monitor sensory information including communications inputs, assess objects), orient (i.e. assess situations and impacts, develop and assess course of action options), decide (i.e. choose and commit to goals, choose COAs) and act (i.e. deliver effects through effectors including communications outputs). The sophistication of an agent will depend on the level of intelligence required to undertake its defined taskings.

Common Control Protocol (CCP). Common Control Protocols allow dynamic assignment of assets by the lawful, dynamic binding of (human) command orders with machine (bot/agent) control.. Agents may be human or machine. A machine agent may be embodied as the supervising controller of a robot (decision maker) or disembodied as a controller in a decision support system (decision aid).

Common C2 Language (CC2L). A language (or collection of defined terms and phrases) that permits the lawful expression of command and control actions that can be understood and acted upon by both humans and machines. The common C2 language should all necessary elements for lawful command of RAS-AI assets across the spectrum of employment.

Common Control (of Robotics and Autonomous Systems (RAS)) is the set of constraints required to ensure legal, ethical, reliable and repeatable employment of systems that can operate without continual direct human interaction (degrees of autonomy). Common Control will ensure that on receipt of a command or order to achieve a defined mission, a RAS system or element will execute the commanders intent with the same (or more rigorous) legal, moral, ethical voracity as a human agent would in the same circumstances, even though the method of achievement may be different.

Common Control Environment (CCE). The overarching governance (including laws, ethics, values and regulations), for the co-ordinated employment of RAS in the maritime environment. Although an inanimate collection of rules, the Environment is a living entity, evolving with changes in laws and societal expectations, and adapting (or changing dramatically) depending on context.

Common Spectrum Management Protocol (CSMP). Integrate and leverage Maritime EM Manoeuvre Warfare projects to provide spectrum control systems to dynamically manage, harden and trust our spectrum while attacking, jamming, sowing distrust and denying the enemy theirs. The CSMP will therefore augment current systems and any other future proprietary offerings.

Control. The act of coordinating forces towards outcomes determined by Command. Control is undertaken by elements that integrate the actions of forces necessary to achieve Command intent. Types of control:

- **Full Human Control.** A human controls every aspect of the systems function, physically or through other means of remote control.
- **Human In The Loop.** The system performs some functions independently but requires a human to perform functions that complete the systems task cycle.
- **Human On The Loop.** The system performs all functions autonomously but a human may intervene to stop or modify the outcome before the task is complete.
- **Human Starts The Loop/Human Before the Loop.** A human sets the operational parameters and initiates the systems operation; the machine requires no further human interaction to complete the task.

E

Edge (edge computing/edge robots)

Edge. The use of systems, applications, and platforms to effect the conduct of tactical operations within an area or operations. Note: 1. Systems are the primary mechanism to exercise command and control of tactical actions. 2. Edge systems include battle management systems, platform mission systems, network and communications technology and the standards used to enable the information to be available to the broader single information environment. (CIOG definition at the edge').

Edge processing. Also known as edge computing refers to the processing of data at (or close to) its source. In the RAS/AI space, this refers to conducting information processing on Agents (bots), rather than returning unprocessed information to the CMS/MMS for processing.

Edge Robot. A robot or agent (bot) that conducts edge processing, and/or a robot that operates at the military edge, potentially having been launched and controlled from another autonomous system**.**

Enterprise Artificial Intelligence (Enterprise AI). The use of AI to support insights, decision-making and analytics against business objectives or desired corporate outcomes, such as improving Force Generation and Sustainment. Enterprise AI (similar to business intelligence) can be used to gain insights into data (structured and unstructured) associated with operational efficiency and effectiveness. Enterprise AI has numerous use cases including natural language processing, self-learning models, voice recognition, predictive models, image and video analytics, deep learning, neural nets, or as an input to other hardware and software.

Evergreening. The process of ensuring Capability programs are sufficiently agile to allow hardware and software to be continually developed and upgraded. This process of 'Evergreening' means transitioning from a platform centric approach to a system-of-systems methodology. This in turn will depend upon building close, long-term teaming relationships with and between industry and academia to achieve the agility to adapt to emerging threats and technologies.

L

Legal Protocol (LP). A legally recognised and executable protocol developed to embed Defence values, laws of armed conflict, intent and trust into RAS-AI machines and systems allowing the lawful deployment and command of these systems.

GLOSSARY

M

Machine Learning (ML) uses statistical techniques to give computer systems the ability to recognise patterns in data without explicit programming. This pattern recognition can be used as a basis for an AI implementation. Machine learning can be achieved through a range of methods that may not be specific to a task.

Minimum AI (Min-AI). A discrete bounded AI agent to perform specific task and functions more effectively and safer. Min-AI is a form of narrow AI.

R

Remote Control (RC). A system that is remotely controlled by a human. Without the human RC inputs the system has limited ability to operate independently.

Remote Operated Vehicle (ROV). A vehicle that is remotely operated by a human. Often referring to an Unmanned Underwater Vehicle (UUV). Without the human inputs the system has limited ability to operate independently.

S

Software Agent (Bot). A non-physical system that is authorised to act on behalf of a human to conduct non-physical, or cyber, tasks. To differentiate between physical and non-physical robots, software agents are colloquially known as 'Bots'.

U

Unmanned/Uninhabited System. A machine that does not require or usually support a human on-board. Such as Unmanned Aerial Vehicle (UAV), small Unmanned Surface Vessel (USV), or Unmanned Underwater Vehicle (UUV). Although 'Unmanned' is in common usage in the ADF and amongst coalition partners Navy, as a part of its ongoing commitment to gender inclusive language, also uses 'uninhabited' interchangeably.

Uncrewed/Optionally Crewed System. A machine that does not require a human on-board, but can support human control from on-board. Such as an Unmanned Surface Vessel that has seats and a control station on-board for direct control.

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NAVY

ROYAL AUSTRALIAN NAVY