Data – supply item or a Fundamental Input in its own right?

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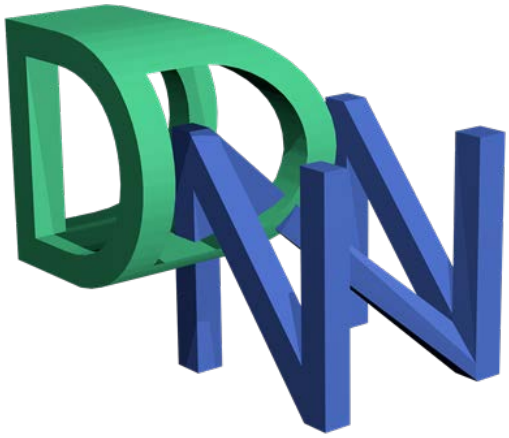

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Introduction

1. In a mid-2024 conversation with a senior Defence member, the issue of the criticality of data within the Defence environment was raised. The Defence member noted that he was thinking of creating 'Data' as another 'Fundamental Input to Capability' (FIC).

2. This white paper explores the option of setting data as a Supply Item (noting that Supply is already a FIC) rather than extending the current FIC model.

3. This white paper uses some architecture primitives to help provide a common vocabulary. These primitives are based on words that are generally understood by the wider audience (with varying concepts and definitions) but are used here with specific meaning.

   a. Effect. A desired or actual state of the environment, or a change in states.

   b. Resource. Something tangible that can be used to achieve the desired capability effects. That 'something' could be an asset (capitally acquired and managed item), a supply item (consumable or expendable item) or an actor.

   c. Process. A description of a workflow (a sequence of tasks) to achieve an effect. This is consistent with the BPMN definition of a "sequence or flow of Activities in an organization with the objective of carrying out work."

   d. Organisation. A framework of roles and their relationships.

   e. Role. An expected behaviour pattern or profile associated with participation [in a process].

4. This white paper does not look at the history of FIC. The architecture primitives are described in greater detail in a currently non-public architecture framework (3 volumes) and this white paper introduces them as a means towards a common vocabulary.

5. This white paper is important because historically Defence has not defined the FIC clearly, and the addition of another FIC element without clear definition can add to the confusion. Within this paper I:

   a. provide a foundation for understanding 'capability',

   b. provide a foundation for understanding 'FIC', and

   c. describe how 'Data' fits within the FIC construct.

6. The capability and basic FIC concepts in this white paper have already been explored in the 2020 White Paper ' Industry as a FIC' but are repeated here for completeness.

What is 'Capability'?

7. A definition of capability is 'the power to achieve a desired operational effect in a nominated environment within a specified time and to sustain that effect for a designated period.' This is the definition used by Defence[i] and is consistent with systems engineering best practice.

8. At the highest level, this could be considered 'the ability to do something' which is a common broad use of the word. Commonly, this is considered as shown in Figure 1 .

Figure 1: The simplified explanation of capability and effect

9. This simplified approach is fine when the audience has a good understanding of the context and the subtleties in the meaning of the elements drawn. For those who do not have this understanding, this simplified approach can lead the audience to think that capability means the technology that results in the effect. Figure 2 illustrates a slightly more subtle approach.

Figure 2: A simplified, but more nuanced explanation of capability and effect

10. Even this approach is simplified, because it implies that the whole of the capability is used directly in the operational activity – again potentially leading the audience to think that capability is synonymous with technology systems.

11. An additional shortfall with the simplified description is that that it describes the capability in isolation as something with absolute and clear boundaries. The power to achieve something is not only contingent on the internal configuration of the capability, but also the external drivers over which the operators have no control. As we will see later, the internal elements of the capability are all influenced by these external drivers.

12. Examining the definition of a capability in light of the non-controllable external influencers, a capability is a **probability** that an effect can be achieved in a given context and timeframe. This is consistent with the natural language approach when we describe that we may have a 'limited capability' to achieve a desired outcome.

13. The shortfalls in the simplified approach can be addressed through a capability model or framework.

What is a 'FIC'?

14. I have now identified that capability is defined in the terms of 'probability'. Until capability is tested in operations, the capability function is in an ambiguous state. Once executed in a real context, the capability function collapses to an actual outcome, which itself can be measured as a statistical degree of success.

Figure 3: Probability cloud perspective on capability and effect

15. The external factors are the obvious elements driving the final outcome. But the simplified approach to conceptualising capability described earlier ignores the large influence of the internal drivers. To describe this influence, a standard model should be used.

16. Australia has created a model for the fundamental inputs to capability - Defence describe FIC as 'those inputs that are necessarily combined to achieve capability.'[ii] The US uses a different model, and the UK a different one again – but what is important is that these models are used consistently[iii] across the range of capabilities. Defence's current formal description of FIC suggests using them as a 'checklist' to ensure all considerations have been addressed – but this ignores the utility of FIC during design to properly understand the completeness of the capability (all elements and relationships working together).

17. Defence guidance also tends to treat each element of FIC separately and largely in isolation. Defence's summary of the FIC[iv] are:

a. **Organisation** means that the capability is employed within flexible functional groupings with an appropriate balance of competency, structure, and command and control to meet the endorsed capability requirements stemming from the original need;

b. **Command and Management** includes effective command and management arrangements at all levels to safely and effectively employ the capability, including its integration across Defence;

c. **Personnel** means the role of a competent workforce component, including ADF (permanent and Reserves), APS and contractors, in the delivery, operation, sustainment and disposal of the capability;

d. **Collective Training** means that the capability is supported by a defined collective training regime to a validated performance level against the Defence planning requirements and based on the original need;

e. **Major Systems** includes significant platforms, fleets of equipment and operating systems that enable the effective generation of Defence capabilities;

f. **Facilities and Training areas** means the infrastructure requirements necessary to support the delivery, sustainment and operation of a capability system, including training areas which may mean any area of land, sea, undersea or airspace that may be designated for military manoeuvres or simulated wartime operations;

g. **Supplies** include managing all classes of supply to maintain a capability at the designated readiness state, including sustainment funding and fleet management;

h. **Support** includes engineering support; maintenance support; supply support; training support; packaging handling, storage and transportation; facilities; support and test equipment; personnel; technical data and computer support; and

i. **Industry** includes the consideration of the resilience and capacity of industry, such as the reliability and health of supply chains.

j. **Data** includes the data created, gathered, used and reused by a capability, including the capacity to integrate, secure and share data across multiple major systems and capabilities.

Figure 4: Probability cloud with multiple elements

18. For those of us that like definitions, we can immediately see that the descriptions above are very open to interpretation. Most of them do not effectively describe the "what and "why" of the FIC elements, but reword the title in a generic fashion. A key example is 'Support' which simply lists type of support.

19. The current description of FIC works well in high-level conversations but does not help in achieving a **consistent** systems engineering approach. And the FIC construct is used throughout the life of a capability for systems engineering purposes. To achieve this a deeper level of thought is required. In this paper, an architectural approach is taken, consistent with systems engineering[v].

20. Architecturally speaking:

a. *Organisation* is a framework of **roles** and their relationships. Only when roles are filled by actors can an organisation be effective.

b. *Command and Management* represents the governance **processes**, decisions and **rules** or policies that govern the effective employment of the capability.

c. *Personnel* are tangible **resources** that are further divided into classes. Key to this discussion is the workforce that operate the *Major Systems*.

d. *Collective Training* are **processes** specific to a validated performance level.

e. *Major Systems* are **resources** that are managed assets. These are normally Supply Class VII items.

f. *Facilities and Training areas* are **resources**, more specifically the same type of resources as *Major Systems* (managed assets). Some facilities are necessary to house major systems in order for those major systems to be used to achieve an effect. An example here is a ship (as a facility) that provides 'hotel services' to a weapons system.

g. *Supplies* are **resources**, as defined by the classes of supply with the exception of Supply Class VII (*Major Systems*).

h. *Support* describes **processes** (engineering; maintenance; the act of supply; training; packaging handling, storage and transportation; etc.).

i. *Industry* describes the **states** of Industry. States, and the change of states are described architecturally through **effects**.

j. *Data* can be **resources** for consumption that should be managed. This is the subject of this white paper, noting the definitional similarity with *Major Systems* and *Supplies*.

21. Resources are the only tangible aspect within FIC. Organisations and roles are empty constructs that only become viable if actors (personnel) are assigned to them. Major systems can only be used if personnel operate them[vi].

22. Processes are a glue concept. Processes are also empty constructs that only become viable when the described roles are filled with actors and the required resources are provided.

23. The architectural approach with the required relationships between the various elements creates a complex picture. But this is needed for understanding how likely a capability is going to be effective in a given context.

Figure 5: Capability cloud with direct influences indicated

24. The overall effectiveness of a capability to achieve the desired effects can be calculated through the effectiveness of the relevant FIC. Processes are only as good as the ability to resource them. Organisations are only as good as the ability to assign workforce to them. When viewed through the architecture lens, these relationships become clear.

Where does Data fit in?

Data and information

25. The Chambers Dictionary (13rd Edition) describes 'data' as facts given (quantities, values, names, etc) from which other information may be inferred; such facts, in the form of numbers or characters, which can be input into a computer.

26. Data, by itself, is not useful. It should be interpreted in context to provide information, which is then useable. Additional processing of information generates knowledge, awareness and understanding – the desired end products of data.

27. For the remainder of this discussion, I will use 'information' rather than 'data' because of the veneer of usefulness.

Classes of supply

28. The US classes of supply have been adopted by Defence, and are described in the following table:

Class	Description
Class I	Rations – Subsistence (food and drinking water), gratuitous (free) health and comfort items.
Class II	Clothing And Equipment – individual equipment, tentage, some aerial delivery equipment, organizational tool sets and kits, hand tools, unclassified maps, administrative and housekeeping supplies and equipment.
Class III	POL.– Petroleum, Oil and Lubricants (POL) (package and bulk): Petroleum, fuels, lubricants, hydraulic and insulating oils, preservatives, liquids and gases, bulk chemical products, coolants, deicer and antifreeze compounds, components, and additives of petroleum and chemical products, and coal
Class IV	Construction materials, including installed equipment and all fortification and barrier materials.
Class V	Ammunition of all types, bombs, explosives, mines, fuses, detonators, pyrotechnics, missiles, rockets, propellants, and associated items.
Class VI	Personal demand items (such as health and hygiene products, soaps and toothpaste, writing material, snack food, beverages, cigarettes, batteries, alcohol, and cameras—nonmilitary sales items).
Class VII	Major end items such as launchers, tanks, mobile machine shops, some parachute systems and vehicles.
Class VIII	Medical material (equipment and consumables) including repair parts particular to medical equipment. (Class VIIIa – Medical consumable supplies not including blood & blood products; Class VIIIb – Blood & blood components (whole blood, platelets, plasma, packed red cells, etc.).
Class IX	Repair parts and components to include kits, assemblies, and subassemblies (repairable or non-repairable) required for maintenance support of all equipment.

Class X	Material to support nonmilitary programs such as agriculture and economic development (not included in Classes I through IX).
Miscellaneous	Water, salvage, and captured material.

29. A casual observation is that the examples are all tangible, physical, items. Supply is also commonly used in a financial sense, which is intangible. This white paper is not a study into the supply ecosystem, but some key characteristics are important.

30. The Chambers Dictionary notes that the noun 'supply' is an act of supplying; that which is supplied or which supplies a need; an amount provided or in hand; the available amount of a commodity; an amount of food or money provided (used generally in plural); a source of water, electricity, etc; a parliamentary grant for expenses of government; a person who takes another's duty temporarily, a substitute (especially a teacher). With that list, electricity and expense grants are not tangible items.

31. The supply chain is another aspect to be considered.

a. Supply focusses on the activities required for obtaining raw materials and subproducts necessary for the manufacture of relevant products.

i. In this stage of the supply chain, it is important to have the availability and quantity of materials and their timescales well planned and coordinated.

b. Manufacture/production includes all processes related to the transformation of raw materials into products and their mass production (if relevant).

i. Optimisation of the processes plays a key role in the standardisation of operations and therefore in a more agile and effective cycle.

c. Storage relates to the temporary handling of goods and their quality and quantity control in a particular space so that their inflow and outflow is managed according to need.

i. Warehouses and/or distribution centres are the focal point.

ii. Correct management will anticipate any production peaks or fluctuations in demand and their effect on stock and its management.

d. Distribution and delivery address the product leaving the warehouse and distribution centre through to its delivery to the end customer.

i. An important consideration is that the product reaches the customer in good condition and within the agreed deadlines.

32. I do not think that a returns stage (where the end customer sends the product back to the company) is directly relevant to the discussion of data as a class of supply. However, a feedback loop that addresses customer satisfaction is important and would substitute for a returns stage.

Is information equivalent to a class of supply?

33. Information is not a physical, tangible, item. But it does have many similarities with supply items. This was explored in 2006 during the RPDE Task 11 (User Defined Operating Picture) and explained in the Task 11 Analysis Report. The analogy of the supermarket serving up information proxies was a complex study that covered many aspects, but the key takeaway (no pun intended) is that the acquisition, storage and vending of items is a well-understood concept whether it was baked beans or data.

a. The supply phase is relevant to the collection activities which gather the raw data that can be used either directly, or as a base for other information products.

b. The manufacture/production phase is a value-adding activity that should make sense of data in context. The operational picture or intelligence products are examples where data is value added for a contextual purpose.

c. Storage, of both data and value-added products, is well understood. Storage locations (data centres) are key, with each data centre appropriately located (power, security, ease of access, latency in the delivery of data). Data management is another discipline, ensuring that data is correct, timely and available. For this the choice of the type of storage technology will be key. Security of data at rest is important.

d. Distribution and delivery for data covers the data products being transmitted from the data centre through the appropriate communications channels and arrives at the end user in good condition in a timely manner. Again, security of data in transit is important and this is the same for any supply item in transit from the warehouse to the consumer.

34. The other analogy that I use is that information is like fuel (POL). In this analogy, the data would be like crude oil – it must be processed to become a useful information product.

a. An understanding of the quantities of fuel, for each type of fuel, is an essential element of the manufacturing. Supply should meet demand. Requests for information generate that demand.

b. Different machines require different types of fuel, and this has traditionally been a one-to-one relationship; although multi-fuel engines are available today. Engines run optimally on the right fuel. The right information is required to generate the right decisions.

c. Fuel must be transported from place of manufacture to place of mass storage, and then transported to where it can be dispensed. Security of fuel in transit, and when in storage, is a key consideration. Information must be secured at rest and in transit.

d. Dispensing devices are tailored interfaces. A refueller cannot place the nozzle of diesel pump into an ULP tank; at least not without causing damage. Interfaces between information stores and using applications are similarly designed for their purpose.

e. Fuel shortages severely impact the effective operation of a community (c.f. the fuel crises of the 1970s). The inability to provide information due to resource/organisational deficiencies have similar impact.

35. The final concept that I want to introduce was introduced in my paper on knowledge gap management in 2006[vii]. Information can be collected (hunt, gather, harvest) or created (manufacture, process). I consider the act of buying information is a form of outsourcing the collection or creation of information.

Why not just add another Fundamental Input?

36. The UK's Ministry of Defence also has a framework for capability development (Defence Lines of Development), which is known by the acronym TEPIDOIL[viii]:

a. **Training.** The provision of the means to practice, develop and validate, within constraints, the practical application of a common military doctrine to deliver a military capability.

b. **Equipment.** The provision of military systems and weapons, expendable and non-expendable (including updates to legacy systems), needed to outfit/equip an individual, group or organisation.

c. **Personnel.** The timely provision of sufficient, capable and motivated personnel to deliver defence outputs, both now and in the future.

d. **Infrastructure.** The acquisition, development, management and disposal of all fixed, permanent buildings and structures, land, utilities and facility management services in support of defence capabilities. It includes estate development and structures that support military and civilian personnel.

e. **Doctrine and Concepts.** Doctrine is an expression of the principles by which military forces guide their actions and is a codification of how activity is conducted today. It is authoritative, but requires judgment in application. A concept is an expression of the capabilities that are likely to be used to accomplish an activity in the future

f. **Organisation.** Relates to the operational and non-operational organizational relationships of people. It typically includes military force structures, MoD civilian organizational structures and defence contractors providing support.

g. **Information.** The provision of a coherent development of data, information and knowledge requirements for capabilities and all processes designed to gather and handle data, information and knowledge. Data is defined as raw facts, without inherent meaning, used by humans and systems. Information is defined as data placed in context. Knowledge is information applied to a particular situation.

h. **Logistics.** The science of planning and carrying out the operational movement and maintenance of forces. In its most comprehensive sense, it relates to the aspects of military operations which deal with: the design and development, acquisition, storage, transport, distribution, maintenance, evacuation and disposition of materiel; the transport of personnel; the acquisition, construction, maintenance, operation, and disposition of facilities; the acquisition or furnishing of services, medical and health service support.

37. The UK is the only Five Eyes member that explicitly calls out Information as an element. This demonstrates that Data as a FIC is possible. An important consideration is that the TEPIDOIL concept describes the input as the ‘requirements’ for information, and not the information itself – this is in contrast to the Australian FIC element.

38. In my description of FIC, I note the emergent complexity. The addition of another FIC adds another dimension to the complexity which makes integration within the capability lifecycle much more complicated. This is not about technical difficulty but is about policy and assurance complexity.

39. The inclusion of Data as a FIC also elevates data to a level of reverence that is not necessary, nor is necessarily helpful. This reminds me of a much earlier discussion, just after the First Principles Review, where a capability upgrade was being put through the Defence Major Projects process. This upgrade was simply putting more of the same technology on platforms that did not already have that technology installed. My argument was that this should be a sustainment program, fixing a gap in the already desired capability. The Project Director argued that this was really important and thus should remain as a Major Project [with the associated delays, costs and bureaucracy].

40. That something is important does not mean that the avenues for acquiring that something should be more complicated that absolutely necessary. Fuel is important for the operation of platforms, but does not have its own FIC. Food is important for ensuring that any deployed troops can fight and survive, but does not have its own FIC. Data is similarly important and the management of this resource mirrors those for the other supply items.

41. Unlike other FIC, where a single authority can usually be identified for assurance of delivery (e.g. Security and Estate Group for Facilities, Single Service authorities for others), data requires multiple authorities for assurance of delivery and this depends on the nature of the data. This separation of authorities is a necessary step for the security and integrity of the data. This separation of authorities for delivery of different flavours of data is another example of how data mirrors supply items.

42. The key issue becomes identifying the value proposition relative to the effort and complexity. The value lies in explicitly identifying data as a required resource in the achievement of capability effects. This is currently a gap in the Defence Capability concepts, where the use of information is assumed and implicit. I don't think this point is controversial.

43. The danger lies in the ease with which something as consumable and transient as data could be added as a FIC rather than exploring other avenues, such as becoming another class of supply. This opens the door for calls for other resources to be added as FIC because they are also important.

44. Another perspective is that data/information is a critical input or association with all the other FIC, which reduces its value as a distinct FIC within itself. In the FIC mapping (c.f. the architecture framework referred to in the introduction), each FIC has limited relationships with other FIC, creating a manageable directed graph/network. Data, on the other hand, is required by all and this means that Data would connect to all nodes in the net. This universality indicates that Data as a node in the FIC graph is improper and inefficient.

Closing notes

45. This white paper has tried to open up a conversation on a complex topic in a few pages. In doing so, some of the subtleties and nuances have been glossed over. In addition, the general text here belies the years of thinking that have gone into the concepts.

46. Can Data be added as a FIC? This is the wrong question – the real question is whether it should. This paper identifies that adding Data as a FIC introduces complexity and complications that outweigh any possible benefit from doing so. Identifying Data and Information as a Class of Supply has the similar effect of raising visibility with the advantage of well-established supply concepts that already parallel the delivery of data and information to end users.

47. In drafting the white paper, a different perspective on FIC than had previously been used in Defence had to be introduced. FIC cannot be seen as an add-on, a checklist or a number of silos to be considered separately. In a systems engineering sense, the concept of the capability and the concept of the fundamental inputs to the capability cannot be separate or separated. To describe the FIC is to describe the capability, and the capability cannot be described without using the FIC – they are the one and the same.

48. This paper has only barely scratched the surface on the concept of the capability being described as the totality of the FIC probability clouds. The impact of multiple capabilities sharing resources is yet to be discussed.

49. Additional conversations are required to address a maturing perspective on FIC and the use of FIC to quantify effects and probabilities.

[i] This definition orginally taken from Capstone Doctrine ADDP 00.2 – Command and Control.
[ii] As taken from 'Capability Life Cycle Detailed Design' document provided by Force Design at www.defence.gov.au.
[iii] This white paper does not fully address the current inconsistent used within the Australian Defence context.
[iv] A full definition of the original eight FIC was in ADDP 00.2, and the summarised definitions were in the 'Capability Life Cycle Detailed Design'. These definitions are taken from the One Defence Capability System Manual version 2.0, which are unchanged from my 2020 white paper with the exception of the addition of 'Data'.
[v] A system is a combination of interacting elements organized to achieve one or more stated purposes (ISO/IEC 15288-2015, Systems and Software Engineering—System Life Cycle Processes, 2015). At a base level, an architecture describes elements and their relationships – architecture and systems engineering are symbiotic activities.
[vi] The complex and nuanced discussion around automated systems as actors is outside the scope of this white paper. The upshot of that discussion is that personnel are still required in the operating chain.
[vii] A framework for managing knowledge gaps, Alan J. Dyer, Journal of Battlefield Technology Vol 9, No 3, November 2006.
[viii] Descriptions taken from 'A Framework For Strategic Military Capabilities In Defense Transformation' presented to the 11th International Command and Control Research and Technology Symposium in 2006.