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Searching for the ISR Holy Grail

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Background

ISR (Intelligence, Surveillance and Reconnaissance) is an essential enabler for current and future operations. There is a demand from decision makers to understand what fulfilling differing levels of ISR tasks means in terms of military campaign success and risks. ISR tasks, being enablers, are necessary to provide sufficient understanding by commanders to allow them to plan and execute a military campaign. Consequently, identifying how the extent to which the fulfilment of ISR tasks contributes to the final probability of success of a military campaign has been an enduring challenge for the analysis community.

Over the last year, two methods have now been developed which seek to ameliorate this situation. The focus of the development of both approaches was to re-use information readily available. Collectively they provide means to identify the strengths and weaknesses of alternative ISR force mixes in terms of the wider military effects that they enable, thereby illuminating the illusive “Better ISR: so what?” question.

Both methods have been developed to answer the “so what?” question with regards to the outputs generated by Dstl’s Joint Intelligence Model (J2M), but could also be applied to other models and methods.

J2M, a stochastic simulation, is a key tool in assessing scenario specific ISR tasks. Through modelling ISR tasks within the full Direction, Collection, Processing and Dissemination (DCPD) cycle (see Figure 1), J2M identifies the extent to which Commanders’ Intelligence Requirements[1] are met.

[1] An Intelligence Requirement is a military commander’s request for information, for example “Conduct battle damage assessment”. In a typical scenario there are 50 requests per day.

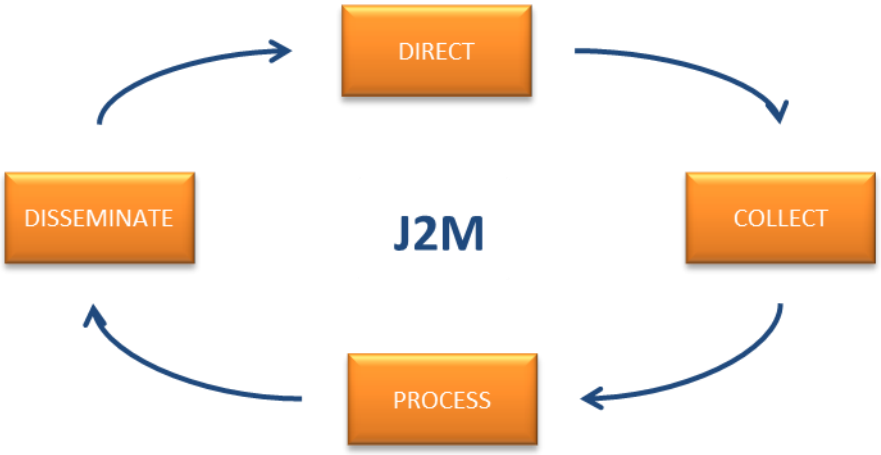

Figure 1: DCPD cycle

J2M outputs include the percentage of satisfied (and failed) Intelligence Requirements together with the reasons for failure which could be due to constraints relating to Intelligence analysts, collectors or communications bearer. However, J2M outputs do not include any information as to the importance of particular Intelligence Requirements within the context of the military campaign. Consequently, it can be difficult to discriminate between ISR fleet mix options tested in J2M that result in differing numbers of Intelligence Requirements met as it is difficult for the analyst to weight any difference in outputs in terms of importance or impact.

The two methods focus on relating the Intelligence Requirements outputs of J2M to high level campaign outcome metrics. The key difference between the two methods is the high level metrics they focus on. Method 1 focuses on linking the Intelligence Requirements to Defence Tasks; method 2 focuses on linking Intelligence Requirements to Campaign End-state.

Method 1: Linking Intelligence Requirements to Defence Tasks

The first method, linking Intelligence Requirements to Defence Tasks[2], can be applied to any scenario or vignette with a developed Intelligence Requirement set.

The approach consists of six steps:

1. The analyst generates a Microsoft Excel spreadsheet linking scenario specific Intelligence Requirements to the Defence Tasks, highlighting where Intelligence Requirements are thought to support the relevant Defence Task. For example, does meeting the Intelligence Requirement “Conduct battle damage assessment” support the Defence Task “Prosecute, or constrain the movement of, targets". Each link is marked as either essential to the successful completion of the Defence Task, beneficial to the conduct of the Task but not essential to complete the Task successfully or has no bearing on the Task.

2. This framework is validated through engagement with military advisors who review these links and adjust existing information, or identify any missing links.

[2] The 26 Defence Tasks are tasks that “differentiate defence from other government departments” (DIRM), for example “Prosecute, or constrain the movement of, targets” as opposed to “Manage data” which is common across government departments.

3. In order to reduce the complexity for visualisation purposes the results are grouped into broad categories of Intelligence Requirement. For example, the “Conduct battle damage assessment” Intelligence Requirement is part of the “Measurement of Effects” grouping.

   The Defence Tasks are similarly grouped, for example, “Prosecute, or constrain the movement of, targets” Defence Task is part of the “Operate” grouping.

4. A diagram is generated illustrating the links between the groups of Intelligence Requirements and Defence Tasks in order to identify whether or not there are any obvious gaps, Figure 2.

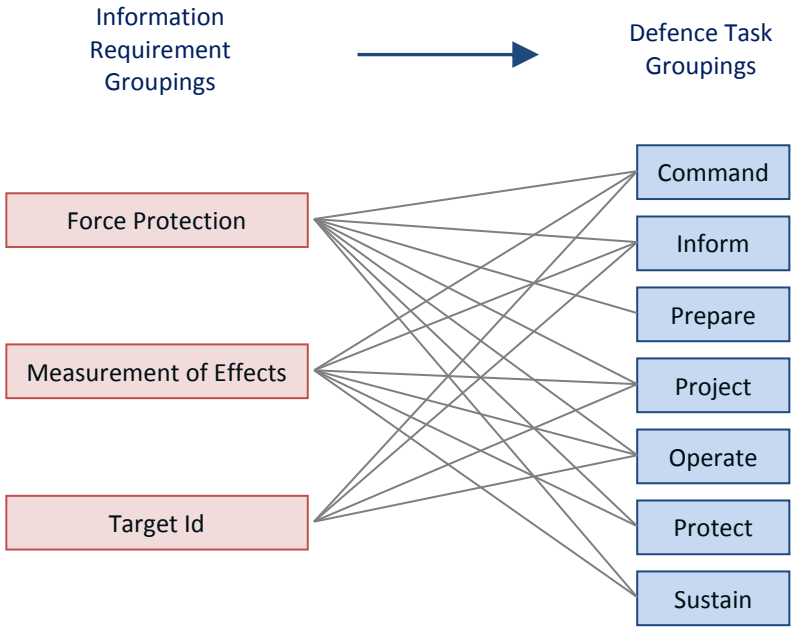

Figure 2: Intelligence Requirements linking to Defence Task Groupings

5. Using the Intelligence Requirement and Defence Task groups generate two tables illustrating how many Intelligence Requirements are essential to the successful completion of the Defence Task and how many are beneficial to the conduct of the Task.

   For example, in Table 1 there are 21 essential links between the “Measurement of Effects” Intelligence Requirement grouping and the “Operate” Defence Task grouping.

	Force Protection	Measurement of Effects	Target Id
Command	4	10	4
.	.	.	.
.	.	.	.
.	.	.	.
Operate	10	**21**	7
.	.	.	.
Sustain	4	7	0

Table 1: How many Intelligence Requirements are essential

6. This table can then be used to add fidelity to J2M outputs, highlighting the proportion of essential Intelligence Requirements completed, see for example, Table 2. This allows the analyst some ability to weight potential difference between the outputs of alternative ISR force mixes tested in J2M.

	Force Protection	Measurement of Effects	Target Id
Command	95%	29%	32%
.	.	.	.
.	.	.	.
.	.	.	.
Operate	95%	**37%**	46%
.	.	.	.
Sustain	95%	49%	-

Table 2: How many essential Intelligence Requirements are met

In our example scenario, the 21 essential links between "Measurement of Effects" Intelligence Requirement grouping and the "Operate" Defence Task grouping are met 37% of the time in the example J2M run.

The example force mix is very strong on "Force protection" but weak in the "Measurement of Effects" and "Target Id". Another force mix might be slightly weaker on the "Force Protection" Intelligence Requirements but better at "Target Id" and the "Measurement of Effects".

Utility of Method 1

The process has turned a single linear scale of "Intelligence Requirements satisfied" into a multi-dimensional scale which allows analysts to rank outputs based on the importance in the campaign.

It is necessarily manpower intensive requiring as a minimum: military advisors, a facilitator and a scribe. When testing the approach a day long workshop was required to link 51 Intelligence Requirements to 26 tasks. Workshops would be required for each scenario; however the workshops have added benefits as discussion aids understanding and ensures that potential links are correctly scored.

Method 1 provides a means to identify some strengths and weaknesses of alternative ISR force mixes in terms of the wider effects that they enable, thereby illuminating the illusive "Better ISR: so what?" question. It can be applied to any scenario or vignette with a developed Intelligence Requirement set and can also be used to identify whether or not there are any obvious gaps in the Intelligence Requirement set.

Method 2: Linking Intelligence Requirements to Campaign End-state

The second method links the Intelligence Requirements to the Campaign End-state. For example, what is the impact of achieving 90% of the "Battle damage assessment" Intelligence Requirements on the End-state rather than only achieving 50% of them? The method utilises linked doctrinal planning tools and concepts to generate a Benefits Map. The key concepts used are:

- Supporting Effects: "The intended consequences of actions" (JDP 01).
- Decisive Conditions: "A specific combination of circumstances deemed necessary to achieve a campaign objective" (JDP 01).
- Campaign Objectives: "A goal, expressed in terms of one or more decisive conditions, that needs to be achieved in order to meet the national strategic aim" (JDP 01).
- Campaign End-state: "The campaign end-state is reached when all the campaign objectives have been achieved. It therefore represents the extent of the Joint Task Force Commander's contribution to meeting the national strategic aim" (JDP 01).

The approach consists of nine steps. As with the previous approach it also focuses on the Intelligence Requirement set developed for the J2M model.

1. Identify the Supporting Effects from the campaign plan documentation, which are scenario specific; for example, "Control of the sea achieved" and "Blue ports and airfields protected".
2. Identify the scenario specific Decisive Conditions from the campaign plan documentation; for example, "Access to region secured" and "Red aggression defeated".
3. Identify the Campaign Objectives from the campaign plan documentation; for example "Red defeated" and "Freedom of action maintained".
4. Identify the Campaign End-state from the campaign plan documentation, for example "Pre-crisis territorial boundaries restored".
5. Link the Supporting Effects to the Decisive Conditions. For example, the Supporting Effect "Control of the sea achieved" supports the Decisive Condition "Red aggression defeated". These links may have been generated during the development of the scenario or vignette, if not then a military judgement panel will be required.
6. Link the Decisive Conditions to the Campaign Objectives. For example, the Decisive Condition "Red aggression defeated" supports the Campaign Objective "Red defeated". If these links have not been generated during scenario development then military judgement will be required.
7. Hold a military judgement panel to link the Intelligence Requirements to the Supporting Effects. For example, the Intelligence Requirement "Identify targets" informs several of the Supporting Effects including "Control of the sea achieved" and "Blue ports and airfields protected".

8. This linked structure can be used to generate a Benefits Map using Banxia Decision Explorer (see example in Figure 3). The nodes within the map are the Intelligence Requirements (IRs), the Supporting Effects (SEs), the Decisive Conditions (DCs), the Campaign Objectives (COs) and the Campaign End-state. The links between the nodes are those identified/generated in steps 5 to 7. All of the Campaign Objectives necessarily feed into the Campaign End-state.

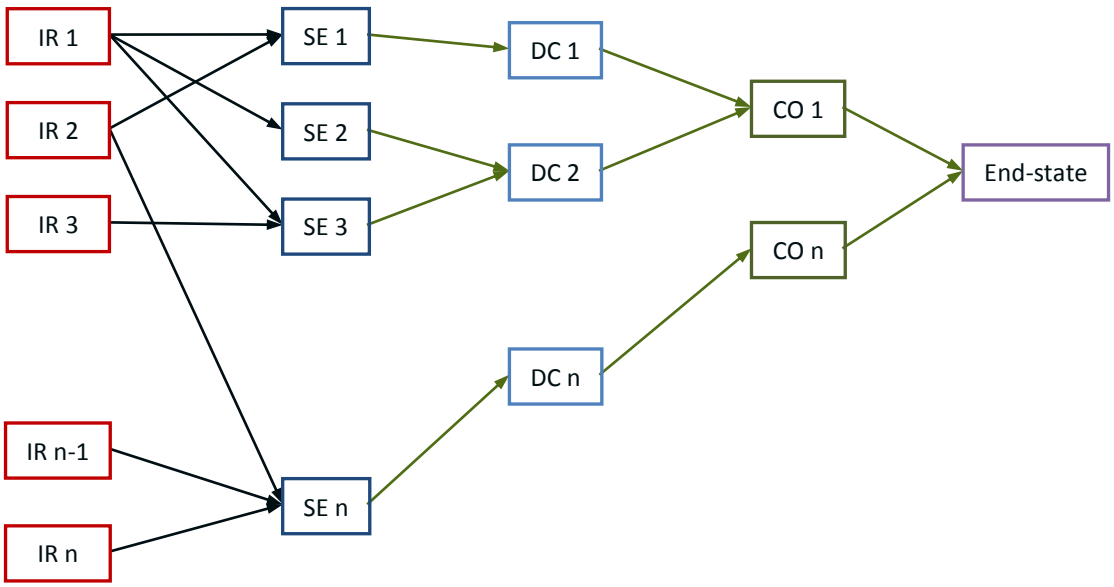

Figure 3: Example Intelligence Requirement to Campaign End-state Benefits Map

9. After applying the J2M outputs of the number of Intelligence Requirements successfully achieved to the left hand end of the Benefits Map, the map can therefore be used to generate a Measure of Merit based on contribution to Campaign End-state that can be useful to the analyst in providing discrimination between ISR force mixes.

For calculating weighting factors within the Benefits Map, Banxia Decision Explorer defines three link types, with the mathematical interpretation of them based on logical interactions. Two of these are applicable when linking Intelligence Requirements across to the Campaign End-state.

1. Contingent Relationships (drawn as black links) - where the value of the parent is equal to the average value of the children.

$$V^{3}_{parent} = (V_1 + V_2 + \ldots V_n)/n$$

This is applicable when linking Intelligence Requirements to Supporting Effects as a work around would always be found if one Intelligence Requirement performed badly.

Figure 4 illustrates a sub-set of the Intelligence Requirements that inform the “Control of the sea achieved” Supporting Effect. The value of the Supporting Effect, “Control of the sea achieved”, is equal to 0.9 + 0.8 + 0.7 + 0.6 divided by 4 which is 0.75.

[3] V = Value

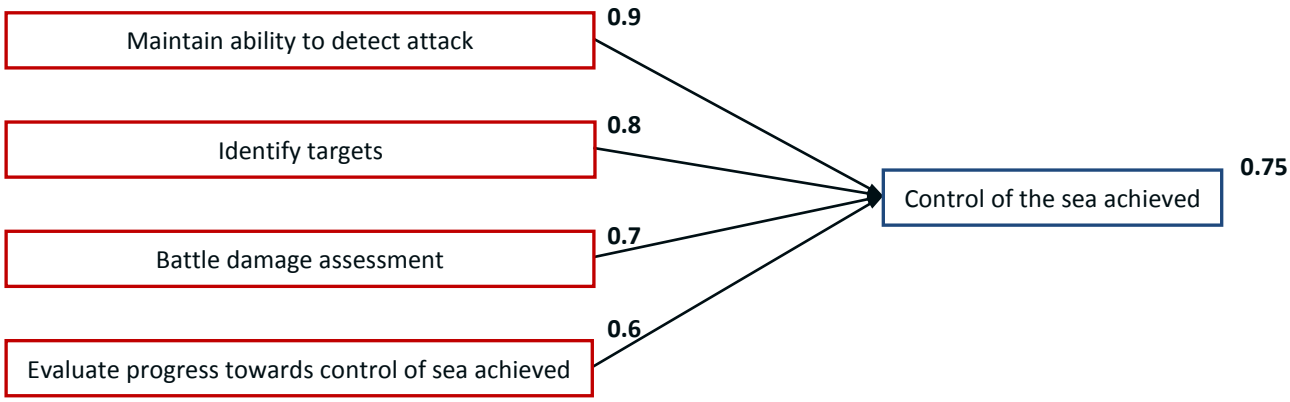

Figure 4: Continent Relationships

2. Compounding Relationships (drawn as green links) - where all children are necessary to achieve the parent, i.e. the value of the parent is equal to the value of the lowest performing child.

$$V_{parent} = \min (V_1 + V_2 + \ldots V_n)$$

This type of relationship is applicable for links between Supporting Effects, Decisive Conditions, Campaign Objectives and the Campaign End-state.

Figure 5 illustrates the supporting effects that inform the “Red aggression defeated” Decisive Condition. The value of the Decisive Condition, “Red aggression defeated”, is 0.65 which is the minimum of the supporting effect values 0.75, 0.9 and 0.65.

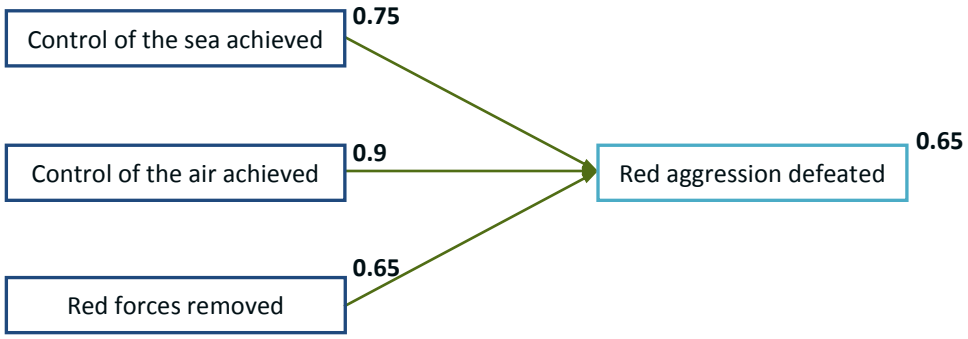

Figure 5: Compounding Relationships

The third Decision Explorer link type, not used in this approach as it is not applicable to the problem, is Mitigating Relationships where the value of the parent is the maximum value of the children, so the highest performing child would be the driver rather than the lowest.

$$V_{parent} = \max (V_1 + V_2 + \ldots V_n)$$

The Benefits Maps produced can either be a hierarchical linking of the Intelligence Requirements to the Campaign End-state (see Figure 3) or follow the Campaign Schematic[4], (see Figure 6). In both maps the links between the Intelligence Requirements and the Supporting Effects are black Contingent Relationships; and the other links are green Compounding Relationships.

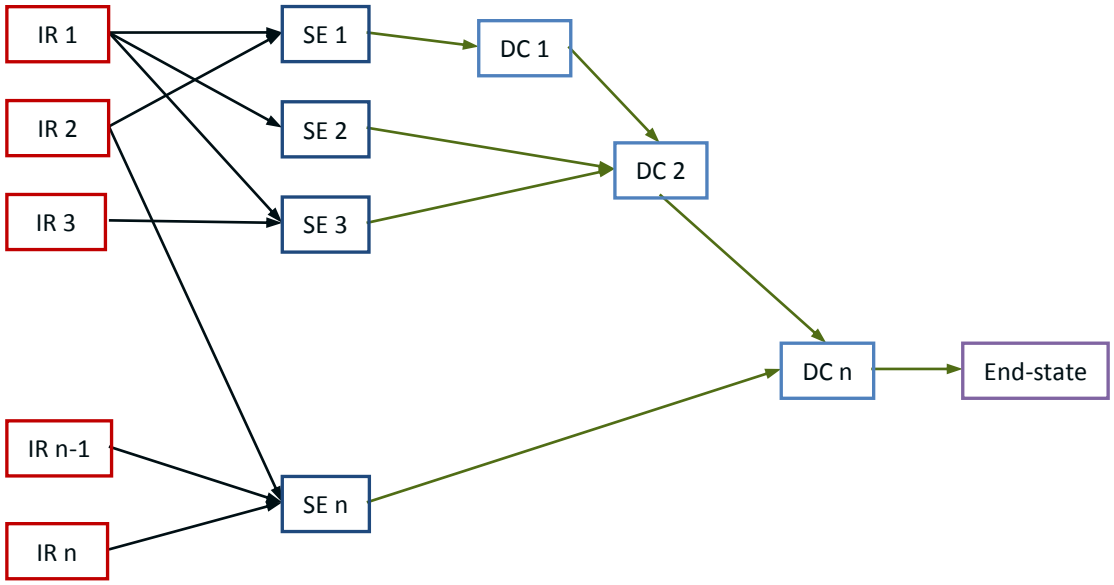

Figure 6: Campaign Schematic Benefits Map

In both the hierarchical and the Campaign Schematic Benefits Maps the Campaign End-state values are the same. This is due to them being equal to the value of the lowest performing supporting effect as the links are green Compounding Relationships, i.e. V_{parent} = min (V_1 + V_2 + … V_n). This is illustrated in Figures 7 and 8 where the values in red are the critical path for the example ISR force mix. In both of these maps the value of the Campaign End-state is 0.5 which is the value of SE 3.

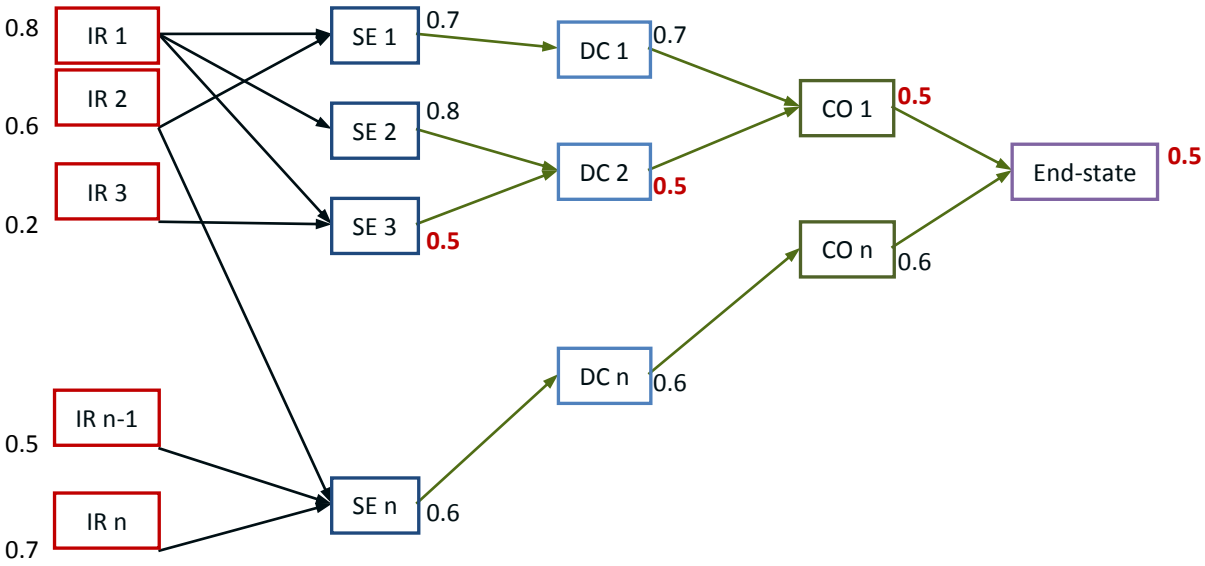

Figure 7: Hierarchical Benefits Map values

[4] The Campaign Schematic is a visualisation of the logical lines of an operation which describes "the course of action (or plan) through a series of decisive conditions that will achieve the campaign objectives (and hence the campaign end-state)" (JDP 5-00).

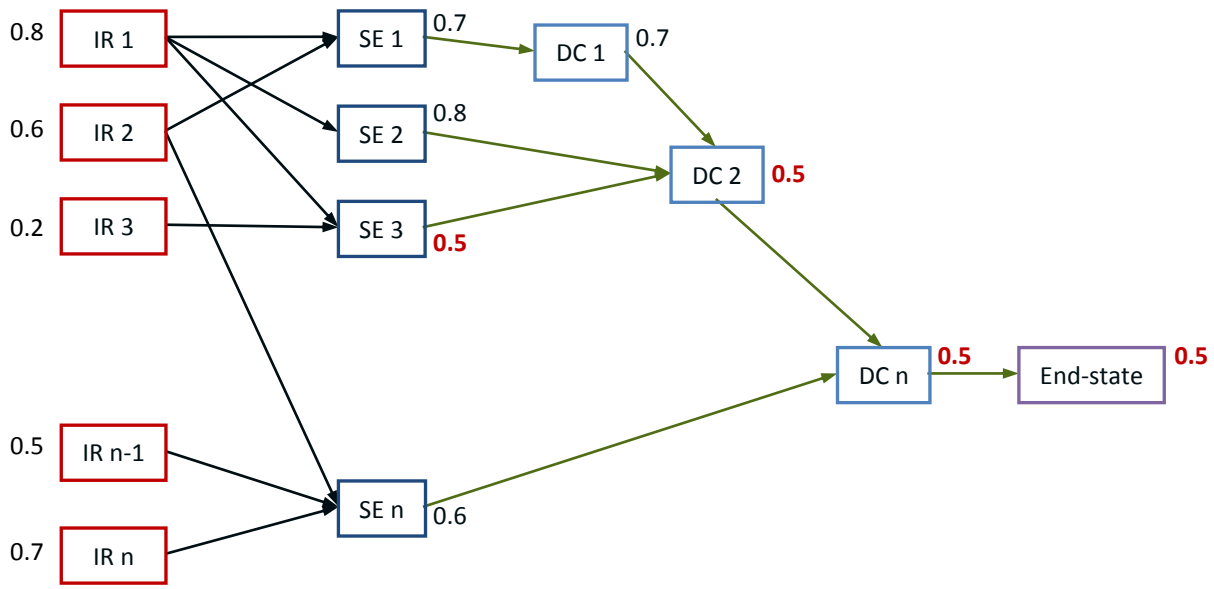

Figure 8: Campaign Schematic Benefits Map values

The outputs from the maps can be used to indicate if one force mix is better than another and where its strengths and weaknesses lie. However, since the results are on an ordinal scale it is not possible to say how much better, i.e. a 0.4 is better than a 0.2 but not necessarily twice as good.

Utility of Method 2

The second method, linking Intelligence Requirements to the Campaign End-state, can only be applied to scenarios or vignettes where Intelligence Requirements, Supporting Effects, Decisive Conditions and Campaign Objectives have been defined. However in this approach, as the majority of the Intelligence Requirements were developed from the Supporting Effects, military advisors are only required for a couple of hours rather than day long workshops as the links are more intuitive.

The Benefits Mapping approach illuminates the illusive “Better ISR: so what?” question by identifying the impact of achieving more of the Intelligence Requirements, for example what is the effect on the Campaign End-state of meeting 90% of the “Battle damage assessment” Intelligence Requirements rather than only achieving 50% of them. Does it matter? This method can provide the analyst with a means to answer this sort of question within the context of the campaign details.

As with the first method it can also be used to identify whether or not there any obvious gaps in the Intelligence Requirement set.

Is this the ISR holy grail?

The two methods developed identify the relative strengths and weaknesses of alternative ISR force mixes in terms of the wider effects that they enable. The first links Intelligence Requirements to the Defence Tasks and the second links Intelligence Requirements to the Campaign End-state. Both methods use existing information and well understood methods (e.g. Benefits Mapping) rather than requiring expensive and lengthy tool development.

Linking Intelligence Requirements to the Campaign End-state is the preferred method to answer the “Better ISR: so what” question, because:

- Military advisors are only required for a couple of hours rather than a day long workshop.
- The approach uses existing campaign plans; therefore there is less need for analytical judgment.
- It also provides better discrimination between options so it better at answering the “so what?” question.

However, when all of the campaign details are not available, the analyst can utilise the first method and link the Intelligence Requirements to the Defence Tasks in order to answer the “so what?” question albeit at a lesser degree of fidelity.

The next stage is for decision support to use the benefits maps produced in order to identify the impact of achieving more of the Intelligence Requirements, i.e. answer the ‘so what’ if ISR force mix A is better at targeting than ISR force mix B.

It is also planned to develop mappings for more scenarios and campaigns and potential for reusable vignettes within them.