Technical Report

Model of the ACP Process Verbs and ACP Tool Capabilities

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Contents

1 Introduction

The aim of this report is to describe the set of verbs used to characterise the capabilities of ARPI systems and technologies which can support the ACP planning process. In addition to providing a way of describing system and technology capabilities the verbs could also be used to initially populate an ACPT process ontology which details the activities which take place in generating an air campaign plan, e.g. refine, issue, analyse, etc. This would compliment the domain ontology being defined for ACPT which describes the activities in the plan itself, e.g. interrupt, destroy, paralyse, etc.

The need for a methodology to characterise the capabilities of systems and technologies was identified in the Air Campaign Planning Tool (ACPT) being developed by ISX on behalf of the ARPI. The ACPT has been developed to aid Air Operations Centre (AOC) staff in defining the objectives, task objects and targets of an air campaign. The ACPT comprises a number of editors, viewers and reasoning systems (planners, schedulers, critiquers, etc) which are invoked by a user. At present the user is free to solve the problem in any order they wish as there is no prescriptive view imposed and the system itself does not provide any support in helping the user decide "what is the next best thing to do" from those problem solving issues outstanding.

Acting as a central focus to ACPT is the Node and Objects Manager (NOM) control panel. An aim for the mixed initiative planning framework which it is proposed be added to ACPT is for the NOM control panel systems, editors and viewers to be invoked with results written to the ACPT database and further "issues" being put onto the NOM's agenda. The NOM agenda will contain the issues which remain to be resolved before the plan is complete e.g. an objective specified at too high a level, missing steps (suppression of radars before attacking), etc. Each of these issues may be resolved by one or more tools or agents and in dealing with one issue several more issues may be added to the NOM's agenda.

The aim of describing a system's capabilities is to allow the NOM controller to determine which tool or sequence of tools should be used to resolve an issue.

In common with other representations emerging from ARPI technologies and ACP modellers at various levels it is envisaged that ACP tasks be described in the following form.

- **Verb**: describes the type of activity the tool performs, e.g. review, critique, issue, structure, etc.
- **Noun Phrase(s)**: describes what the activity acts upon, e.g. document, tool, etc.
- **Qualifier(s)**: describes additional information which restricts the tool in performing its task.

One of the outcomes of the study was to identify a set of process level verbs for ACP. The aim is that each of the systems, editors and viewers in ACPT will be have its' capabilities described using these verbs. The noun phrase(s) will be used to describe the products of the planning process which are created or modified by the planning process, e.g. documents, data files, databases, etc. Each of the process products has a series of attributes which describe its status e.g. issued, completed, updated, draft, etc approach to the process product. The process products will themselves contain the ACP plan entities, e.g. schedules, lists of objectives, ATO, MAAP, etc. The status and type of the process products will be used as "triggers" to indicate when a particular process step should be carried out.

The information in the **verb/noun(s)/qualifier(s)** description will be used to populate the fields of the agenda entries in the NOM controller. The structure of agenda entries may be follows:

- **Source agent** (always available)
- **Destination agent** (may or may not be known or constrained)
- **Verb**
- **Noun Phrase(s)**
- **Qualifier(s)**
- **Trigger(s)** (triggers are placed on the status of activities within the planning process and the process products created/modified)

This mechanism is straightforward and can be used weakly or strongly depending on how well the verbs and arguments are defined. It will allow the NOM controller to identify a tool capable of dealing with the issue and where appropriate (through the appropriate delegation of authority from the user) launch tools automatically to deal with the issue. In a number of cases there will not be a simple mapping between an issue and a tool and in these cases the NOM controller will need to create a workflow plan which transforms the issue into a series of sub-issues which can be mapped to tool capabilities. This is the aim of a study into the possible use of O-Plan as a "Planning to Plan" aid for ACPT.

The remainder of the document is as follows. Section 2 provides a description of the process used to identify a set of initial verbs for modelling ACP. Section 3 describes a top down analysis of the ACP domain (captured in a series of IDEF-3 models) and Section 4 provides a description of the process verbs used in the editors and tools in an existing version of ACPT. The analysis is Section 3 and Section 4 was used to define the initial set of process verbs. Section 5 describes how this initial model was refined by the addition of two other information sources and by the attempt to classify two existing ARPI systems, i.e. SIPE and EXPECT. Section 6 describes the methodology which will be used as a base to classify further ARPI systems and technologies. Section 7 provides a summary of the work to date and describes the ways in which the verb/noun(s)/qualifier(s) descriptions will be extended and validated by describing further ARPI technologies and systems. This work has already started with the classification of the TRAINS systems from Rochester University.

Appendix A provides a description of the initial set of verbs and Appendix B shows how the verb definitions have been used to describe the capabilities of a number of ARPI systems, i.e. EXPECT, SIPE, O-Plan and TRAINS. Appendix C contains a number of IDEF-3 models which provide an overview of the ACP process and were used as the input for Section 3.

This document is intended to evolve as new verbs are identified and previously classified verbs as split or combined as further ARPI systems and technologies are classified.

2 The Verbs in the ACP Process

The aim of this section is to describe the process used to elicit the verbs which describe the major activities in the ACP process. This will be subsequently used to classify the capabilities of ARPI systems and technologies and to form the base for an ACPT process ontology. In addition to the methodology a description of how the verbs were identified and the information sources used is also provided.

The main emphasis during the initial work on describing the ACP process has been to identify the verbs involved. This was accomplished in two phases. The first phase identified an initial set of verbs and the second phase refined the set of verbs by classifying two ARPI technologies (and using other ACP modelling sources). An overview of the verb identification process is shown in Figure 1. An outcome of the process has led to a way in which we can attempt to categorise other ARPI technologies using the ACP process verbs.

Each phase of the identification process used both top down and bottom up analysis techniques and a number of different information sources were used. It was expected from the outset that a modelling "gap" would be identified between the level at which the ACP process was modelled and level at which capabilities of the systems and technologies were described (for example in ACPT). One of the aims of the initial phase was to identify the extent of the gap and to propose a way of bridging it in terms of the `verb/noun(s)/qualifier(s)` model.

The results of phase 1 were that a modelling gap did exist and that a number of areas of the ACP process were not currently covered by editors and tools in ACPT. A set of verbs were identified and proposed as the outcome of phase 1 and these were used as the initial input to the phase 2 refinement process. The initial set of verbs was augmented and categorised by taking information from two further sources – The Joint Air Operations Force Level Planning models and the IDEF-3 models from the Theatre Battle Management Project. This refined verb model was then used to categorise two specific ARPI systems, i.e. SRI's SIPE and ISI's EXPECT. The results of the refinement process was the addition of a number of new verbs and the splitting/combining of a number of sub-verbs. The final part of the refinement phase was to take a different ARPI system and attempt to describe its capabilities with the verb model. This was successfully achieved with the TRAINS system from Rochester University. This was the first attempt to use the verbs classification on a system which was not part of the test cases, i.e. SIPE and EXPECT. Details of the capability verb descriptions and classification of a number of ARPI systems is provided in Appendix A and Appendix B respectively.

Full details of the analyses carried out in each phase of the verb identification process from both top down and bottom up perspective is described in a following sections.

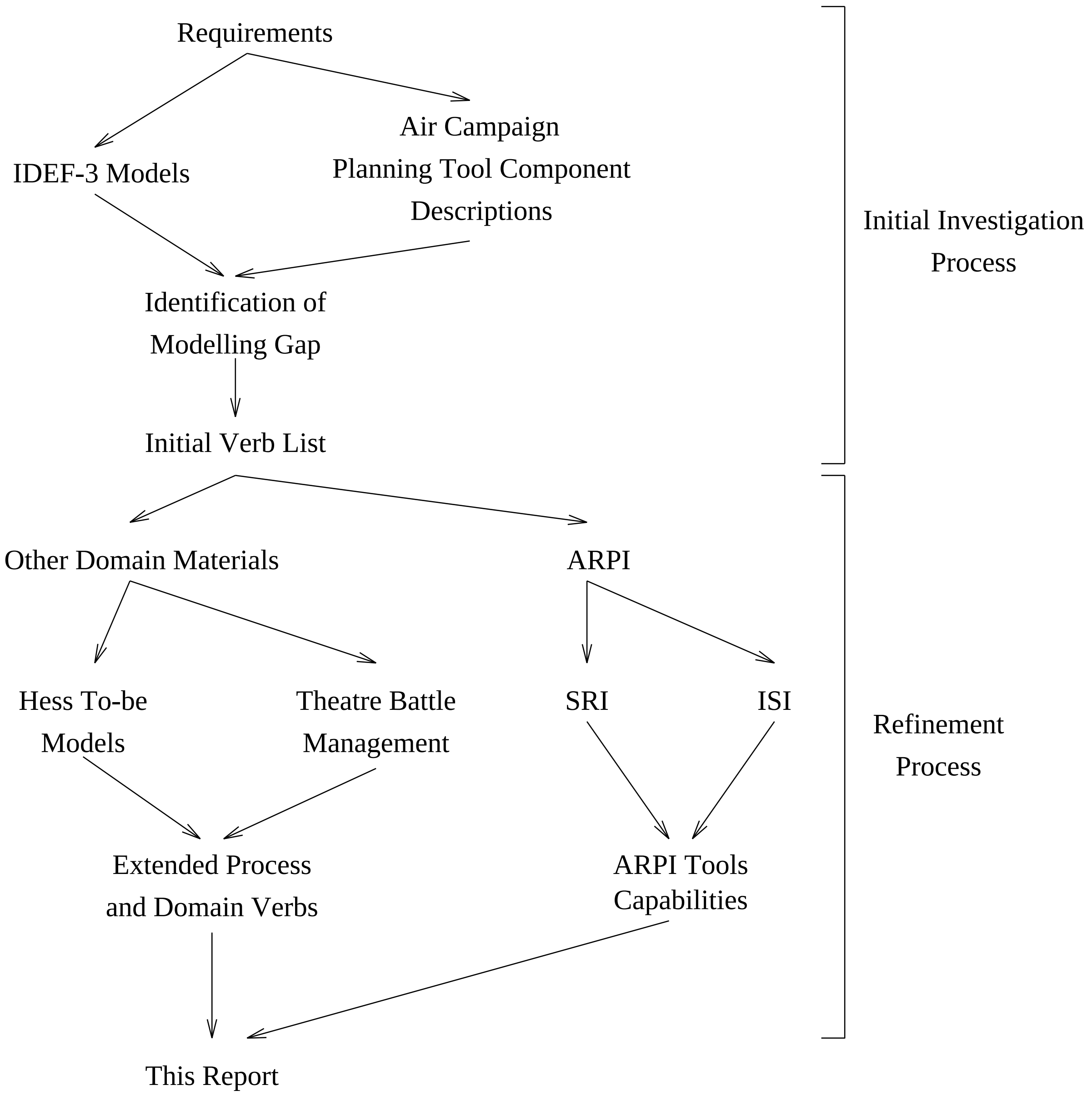

Figure 1: Overview of the Verb identification Process

3 A Top Down Analysis of the Air Campaign Planning Process

The aim of the analysis of the ACP planning process was to examine IDEF-3 models of the ACP process and to identify the verbs being used to describe the planning process. The IDEF-3 diagrams used to provide the verbs are given in Appendix C. Each verb used in the model was grouped according to its decomposition. Verbs are capitalised and where appropriate supporting nouns phrases are given.

1. **JFACC Planning**
   (a) SUPPORT developing objectives
   (b) DEVELOP recommended defense posture
   (c) DEVELOP recommended apportionment
   (d) DEVELOP recommended target objectives
   (e) APPROVE JFACC guidance
2. **JIPTL Development**
   (a) ALLOCATE CAS sorties
   (b) PERFORM target selection
   (c) PERFORM weaponeering assessment (broad)
   (d) INTEGRATE nominated targets
   (e) REVIEW current status
   (f) MATCH targets to guidance
   (g) BUILD prioritised target list
   (h) SUPPORT weaponeering/force application
3. **Mission Planning**
   (a) CONSIDER target/route threat
   (b) GROUP targets
   (c) PRIORITISE and IDENTIFY support requirements
   (d) CALCULATE sorties
   (e) DEVELOP TOT flow (rough)
   (f) CO-ORDINATE mission requirements
   (g) PROVIDE EC planning
   (h) DEVELOP tanker flow
   (i) DECONFLICT airspace
   (j) FINALISE ATO

(k) FINALISE SPINS
(l) PRODUCE ATO
(m) FINAL quality control of ATO
(n) RELEASE ATO

4 A Bottom Up Analysis of the Process Verbs used in ACPT

The aim of this analysis was to identify the verbs used by the ACPT system and the types of activity necessary to generate a series of objectives and air tasks. These are grouped according to the control panels used to represent the ACPT system as given in the Software User Guide (Version 0.1) and in Storyboard demonstration of IFD-4 prepared by ISX.

1. **ACPT - Strategy Tool Control Panel**
   (a) DEFINE campaign.
2. **Commander's Guidance and Scenario Definition**
   (a) REVIEW all commander's guidance documents relating to the current active campaign plan.
   (b) DEFINE enemy course of action.
3. **Objective Development Tools**
   (a) REVIEW objectives
   (b) DEFINE air objectives
   (c) DEFINE tasks
   (d) PRIORITISE Objectives
   (e) SEQUENCE Objectives
   (f) PRIORITISE tasks
   (g) SEQUENCE tasks
   (h) DEFINE action related to Objective
   (i) DEFINE effort related to Objective
   (j) DEFINE COG related to Objective
   (k) DEFINE location related to Objective
   (l) MODIFY measures of merit
   (m) CLASSIFY Objective in relation to doctrines.
   (n) REVIEW Objective status
   (o) REVIEW target list and status
   (p) ASSIGN targets to task
   (q) MERGE target lists
4. **Situation Analysis Tools**
   (a) ASSEMBLE indexed tree of documents
5. **Working Attack Plan Development Tools**

   (a) ASSIGN target sets to lowest level objectives
   (b) SORT targets according to priorities
   (c) ANALYSE sorted target list (CTEMS)
   (d) ASSIGN various attributes to targets

6. **Briefing Tool**
   (a) GENERATE standard briefing slides

This list of ACPT process verbs was used to identify those parts of the ACP process which are currently supported by the ACPT system. The aim was to try and identify the tools which could be used to support the different parts of the ACP process. This would provide pointers to the type of capabilities description the required tool would need. As expected there was a modelling gap between the way in which the ACP process was being described and the capabilities of the ACPT system. In addition, the ACPT system provides only limited support in a number of ACP areas at present.

The ACP model described in Section 3 is used to provide the comparison framework. The aim was to identify against each sub-activity of the model from Section 3 which tools support the activity in ACPT. The result of the s is as follows:

1. **JFACC Planning** With the exception of 1.b this process is supported by the Objective Development Tools of ACPT.
2. **JIPTL Development**: ACPT provides the following support:
   - 2.a not supported within ACPT
   - 2.b supported by Objective Development Tool.
   - 2.c not supported within ACPT.
   - 2.d supported by the Working Attack Plan Development Tools.
   - 2.e supported by the Working Attack Plan Development Tools.
   - 2.f supported by the Working Attack Plan Development Tools.
   - 2.g supported by the Working Attack Plan Development Tools.
   - 2.h supported through CTEMS/RAAP.
3. **Mission Planning** This part of the process is not supported by ACPT.

5 Air Campaign Planning Process Verb Refinement

The analyses carried out during this phase were as follows:

- A top down analysis of the process verbs used the Joint Air Operations Force-Level Planning and those for Theatre Battle Management.
- A bottom up analysis of the verbs needed to describe the capabilities of two ARPI capabilities: SIPE and EXPECT.

5.1 Process Verbs used in the Joint Air Operations Force-Level Planning and Theatre Battle Management

The aim of this analysis was to ensure that the verbs covered a number of different but related domains. These additional domains were:

- Joint Air Operations Force Level Planning description developed by David Hess of SAIC.
- Theatre Battle Management Activity Model Functional Decomposition Chapter 5 of the Air Operation Centre Plans.

In both cases it was possible to match all verbs against an already existing major or sub-verb in the initial model or to suggest a possible refinement to the model. Each of the comparisons is described in Table 1 and Table 2 respectively. The column headings are as follows:

- Major Verb: This indicates whether the verb matches a major verb in the initial model or not.
- Sub Verb: This indicates whether the verb matches a sub-verb of the initial model or not. If it does then the relevant major verb is shown. For example, in the Joint Air Operations Force Level Planning domain the verb **allocate** was identified as a sub-verb of **assign**.
- Suggestion: This indicates that the verb was not in the initial model or was identified as being mis-classified against the initial model i.e. the usage of the term was not consistent the definition given. The suggestion is either to make the verb a new major verb or to insert it as a sub-verb of and already existing major verb.

5.2 Classification of the SIPE and EXPECT

The aim of this analysis was to take the refined verb set and to use it to describe two ARPI technologies, i.e. SIPE and EXPECT. The initial set of verbs was used to initiate a series of discussions during which further verbs were added and others refined. For example, in the case of the EXPECT system it was necessary to split the major verb **Review** into a series of sub-verbs

JAOC Verb	Major Verb	Sub Verb	Suggested Placing
allocate	N	assign	
analyze	Y		
approve	N	decide, review, support	
assess	Y		
assign	Y		
build	N	develop	
compare	N	identify	
complete	N	decide	
co-ordinate	N	organise	
deconflict	N	N	
determine	N	N	analyse, assess
develop	Y		
evaluate	N	N	assess
formalise	N	N	organise
identify	Y		
integrate	N	identify	modify as new major verb
link	N	N	modify
plan	N	decide	make sub-verb of develop
prepare	N	N	develop
prioritise	Y		
provide	Y		
publish	N	N	issue
receive	N	N	obtain as new major verb
review	Y		
select	N	identify	
staff	N	N	assign

Table 1: Joint Air Operations Force Level Planning

which more accurately described the type of reviewing EXPECT was carrying out. The sub-verbs of **Review** reflect a range of reviewing activities from "reviewing to learn" to "reviewing to critique". However, a number of domain experts were unhappy with the choice of sub-verbs, in particular the choice of "review to critique" which they deemed to have a negative emphasis. One of the outcomes of the analysis was that certain verbs may be acceptable to the technology providers may be unacceptable to the domain experts.

The capabilities of the SIPE system were easier to categorise as they were similar to those of the O-Plan system being developed at Edinburgh which the authors of the report therefore understand. The main problem was understanding the meaning of the term "plan" and the different ways it could be interpreted as a capability in the domain. Plan could be interpreted in a range of ways such as "allocation of resources", "build by construction" or "modify in a prescribed way" . One outcome of the analysis was that it was easier to describe the capabilities of the individual components of a planner than the capabilities of the entire system. A future aim of the study is to identify the major components of ARPI systems and technologies and to categorise their capabilities as well. For example, the temporal network manager of the O-Plan system has the ability to manage temporal constraints which could be an advertised capability independent of O-Plan's capabilities as a planner.

Full details of the final set of verbs used to describe SIPE and EXPECT can be found in Appendix B.

TBM Verb	Major Verb	Sub Verb	Suggested Placing
acquire	N	N	obtain
calculate	N	decide	
consider	N	assess, review	assess
create	N	N	develop
modify	N	N	develop
detect	N	N	identify
establish	N	N	obtain, analyse
finalise	N	decide	
group	N	identify	
input	N	N	provide
match	N	identify	
monitor	N	N	analyse
perform	Y		
produce	N	develop	
refine	N	N	modify
release	N	issue	
transmit	N	N	issue

Table 2: Theatre Battle Management Activity Model Decomposition

6 Component Capabilities Characterisation

An outcome of this work has been to suggest an initial approach to categorising ARPI tools and technologies in terms of the ACP process model (principally using the ACP process verbs at this stage).

The main parts of the approach are as follows:

- Classifying an ARPI system or technology
- Refining the verb model

Each of these will be dealt with in a separate subsection.

6.1 Classifying an ARPI system or technology

The aim of this section is to describe the process which should be followed to classify a new ARPI system or technology. The steps involved are as follows:

- **Verb Matching**:
  Attempt to match the capabilities of the ARPI system against each of the major verbs in the model. If a match is found ensure that each of the sub-verbs also matches the capabilities of the ARPI system.
  - If all sub-verbs match then the system should be classified as having the capability of the major verb(s).
  - If some of the sub-verbs do not match then the systems should be classified as having the capability of those sub-verbs which match.
- **Noun Phrase Specification**:
  Specify one or more noun phrases which describe the object(s) on which the verb related activity may be carried out.
- **Qualifier Phrase Specification**
  Specify one or more qualifier phrases which describe additional information i.e. the agent(s) who specify the input, type of document used e.g. draft, final or issued, the situations where the activity is applicable, etc.

In addition to classifying the capabilities of an entire system or technology it may also be possible to categorise one or more of its sub-components, e.g. a knowledge acquisition tool kit, constraint manager in a planner/scheduler, etc. The same classification process should be followed to identify an appropriate **verb/noun(s)/qualifier(s)** description for each sub-component of the system,

One of the future aims of the work is to extend the model to include classes of noun and qualifier phrases which should be used. However, at present the scheme allows for any number of free format phrases to be specified.

6.2 Refining the Verb Model

The aim of this section is to describe the process which should be followed to add new verbs to the model. A new verb should only be added when no suitable major or sub-verb can be identified in the existing model. The changes to the model which are permitted are as follows:

- **Adding a new verb**:
  Attempt to associate the verb with one or more of the major verbs.
  - If an association can be found then add the verb to the major verb class.
  - If no association can be found then add the verb as a new major verb class and seek to define any sub-verbs which are appropriate.
- **Merging existing verbs under a major new verb heading**:
  If it is found that several verbs are always related in all tools categorised then it may be that too detailed a verb model has been defined or that the categorisations are inappropriate. In this case the sub-verbs should be merged under a new major verb heading and any sub-verbs which can be treated as synonyms should be merged as well.
- **Splitting a major verb heading into two or more distinct groups**:
  If it is found that two distinct classes of ARPI systems e.g. schedulers, knowledge acquisition tools, plan critiquers, etc. consistently choose the same subset of sub-verbs from a major verb heading there may be a need to split the major verb. This should be done by choosing new major verb headings and then regrouping the sub-verbs as appropriate.

7 Summary and Further Work

The aim of this section is to summarise the results of the work to date and to provide pointers to further work and related areas of research.

The model of agent capabilities in terms of a `verb/noun(s)/qualifier(s)` description was developed in two phases. The first phase was used to define an initial set of verbs which were obtained from IDEF-3 models of the ACP process and from process planning verbs associated with technologies and tools in ACPT. As expected a modelling gap was identified between the level as which the activities in the ACP process were being described and that used within ACPT. The aim was therefore to close the gap by identifying a more suitable set of verbs and sub-verbs which could more accurately describe the capabilities of the ARPI systems and technologies used to support the ACP process. During phase 2 the initial set of proposed verbs was "tested" on two example ARPI systems, i.e. SIPE and EXPECT and additional information sources were examined to identify further verbs and to refine the existing set. The outcome of the refinement phase was an updated set of verbs which were successfully used to describe the capabilities of the TRAINS system from the University of Rochester. This was the first time the verbs were used on an ARPI system which was not part of the original test set. Details of the verbs to be used in the capability model are described in Appendix A and the classification of the capabilities of ARPI systems is provided in Appendix B.

The future aims of this work are to categorise further ARPI technologies and to refine the verb set as new capabilities are identified. The verb model will also be extended to describe the types of noun phrases and qualifiers which can be associated with the verbs. A number of examples of these have already been identified while classifying the capabilities of SIPE, EXPECT and TRAINS.

The aim is to classify and group the types of noun phrases and qualifiers used and to amend the verb model to take these into account.

The current verb model will be provided to the Process Ontology Construction Group (POCG) as a possible base for an ACP process ontology for the ARPI. This will complement the ACP plan ontology being developed for ARPI and will be grounded in the SENSUS ACP domain lexicon being developed at ISI. As further refinements and additions are made to the verb model these will be fed through to the discussions of the POCG.

Appendix A: Verb Definitions

The aim of this appendix is to describe the proposed set of verbs which can be used to describe the capabilities of the tools, editors and viewers of the ACPT system. Each major verb is split into a number of sub-verbs which describe a specific aspect of the major verb. In a number of occasions a number of major verbs share one or more sub-verbs and this is indicated by a pointer to the other major verb. For example establish is a sub-verb of both **Analyse** and **Obtain**. Associated with each major verb are a series of notes which indicate the type of activity it should be associated with. Where two or more sub-verbs are separated by commas this indicates that the verbs are synonyms of each other.

The information sources for this work have been the Oxford Dictionary, Roget's Thesaurus, and CommonKADS.

Major Verb: Analyse

- **Notes**: ANALYSE has notion of quantitative investigation
- **Sub-Verbs**
  - predict – foretell a future state of situation
  - determine – resolve or define an outcome
  - monitor – watch, check or supervise
  - diagnose – ascertain from symptoms
  - establish (see OBTAIN) – set up a situation
  - measure – to ascertain dimensions or amount

Major Verb: Assess

- **Notes**: Assess has a notion of qualitative investigation and is similar to "grade" in CommonKADS.
- **Sub-Verb**
  - estimate – judge the worth of, reckon the value of by rough estimation
  - expect – to suppose or wait
  - consider – to take into account or deliberate on
  - ascertain – to prove
  - determine (see ANALYSE)

Major Verb: Assign

- **Notes**: This has the notion of both authority and the "handing over" of a resource or responsibility.
- **Sub-Verbs**
  - allocate, staff – assign one or more objects to an item
  - apportion – share out amongst one or more groups
  - delegate – commit authority to a group or person

Major Verb: Communicate

- **Notes**: This is the communications which takes place agents (user or systems) within the planning process.
- **Sub-Verbs**
  - request – petition or ask a third person or group
  - acknowledge – announce receipt of an object
  - reject – put aside or return object

Major Verb: Decide

- **Notes**: some of the meanings of DECIDE imply finality (finalise, terminate), others seem to imply select by consideration (approve, calculate). Not sure how make certain fits in (confirm/match/compare ?)
- **Sub-Verb**
  - complete, finalise – finish of define as having maximal extent
  - approve (see REVIEW) – sanction or commit
  - terminate bring to an end (not necessarily complete)
  - choose – select from a greater set

Major Verb: Develop

- **Notes:** This has the sense of growth or production of an artifact. The term "plan" is used in the JOAC model. On analysis of the JOAC model it was found that it was being used in that particular context as a creation activity and could therefore be replaced by produce or create.
- **Sub-Verb**
  - build, construct – construct by putting parts together

  - produce, create – bring or cause to come into existance
  - compose – arrange in a specified or understood order
  - prepare – make ready to a required point

Major Verb: Identify

- **Notes**: IDENTIFY has notion of set manipulation, all the meanings given could be further defined in terms of set manipulation;
  - select by consideration – pick from a set according to various criteria
  - compare – match ?
  - resemble– match/compare?
  - detect – merge/combine items to form a set
- **Sub-Verb**
  - classify, group – to fall into harmonious combinations
  - match – to be equal to or comparable with
  - select by consideration – to pick from a set by preference
  - compare, resemble – to liken or represent as similar to
  - detect – to discover to find our

Major Verb: Issue

- **Notes**: There are various types of response implicit in the type of issue raised:
  - ISSUE (circulate) has notion of report-back
  - ISSUE (emerge/flow/be driven from/supply) has notion of create
  - ISSUE (publish) has notion of making available
  - ISSUE (release)
  - ISSUE (give out orders to subordinates)
- **Sub-Verb**
  - release – to make available (has less formal meaning that publish and distribution is controlled)
  - deliver – to give up or discharge
  - publish – to send forth to the public
  - transmit – to send on, communicate
  - circulate – to move around and spread further

Major Verb: Modify

- **Notes**: Modify has the notion that one or more objects should be changed in a prescribed way.
- **Sub-Verb**
  - combine, join, link – unite or be brought together for a common purpose
  - refine – remove defects and clarify
  - integrate – complete by the addition of parts
  - evolve – deduce further information or extent
  - augment – make or become greater than original

Major Verb: Obtain

- **Notes**
- **Sub-Verb**
  - receive – accept delivery of
  - acquire – gain possession of
  - establish – secure permanent acceptance of

Major Verb: Organise

- **Notes**: ORGANISE has notion of managing and or creating a structure:
  - co-ordinate – one or more parts together
  - regularise – put objects into a regular structure
  - formalise – ensure objects adhere to a formal structure
  - deconflict – remove unwanted interactions
- **Sub-Verb**
  - co-ordinate – cause to function together or in proper order
  - regularise – put into a consistent structure
  - formalise – give definite shape to
  - deconflict – remove constraint violations between one or more objects

Major Verb: Perform

- **Notes**: PERFORM has the notion that the activity or role is carried out.
- **Sub-Verb**
  - execute – carry out required activity

Major Verb: Prioritise

- **Notes**: PRIORITISE has the notion that you are ordering objects in relation to some criteria: precedence, time, seniority, importance, rank.
- **Sub-Verb**
  - order – put into a prescribed sequence
  - rank – associate to a prescribed grade

Major Verb: Provide

- **Notes**: PROVIDE has the notion that you are giving something to a third party which may be physical or not.
- **Sub-Verb**
  - supply, furnish – provide a needed resource (occurring over an extended period)
  - equip – provide requirements needed (start up. setting up a position)
  - offer – readiness to provide assistance
  - give – transfer to a third party usually as a gift
  - input – make a contribution to

Major Verb: Review

- **Notes**: (see ASSESS/evaluate). This has a notion of finding out information which is then used for a number of other activities, e.g. review to learn, review to critique, etc.
- **Sub-Verb**
  - learn – gain understanding of situation or artifact
  - appraise – estimate the value of
  - summarise – ascertain the key elements of an object or situation
  - critique – identify major flaws and suggest remedies

Major Verb: SUPPORT

- **Notes**: This has the notion that you are providing some level of effort to improve the position of a third party.
- **Sub-Verb**:
  - sustain – provide resources over an extended period
  - strengthen – make a position or situation stronger
  - approve – confirm or show satisfaction with an approach

Appendix B: ARPI Technology Classifications

The aim of the Appendix is to show how the verbs described in Appendix A can be used to describe the capabilities of different ARPI systems and technologies. A small number of systems have already been described using the proposed framework, with the final aim of describing all ARPI systems and technologies. Each of the systems and technologies is described in a separate section. At present only the capabilities of the main system have been described with a future aim of adding descriptions for each of their major components.

7.1 Expect

The EXPECT tool being developed at USC/ISI is a knowledge acquisition framework which can be used acquire knowledge concerning a problem or domain. This knowledge can then be used to review plans and to highlight "issues" which may need to be addressed.

The capabilities of the Expect systems can be described by the class of verbs associated with `Review` in the verb classification described in Appendix A. The EXPECT tool can be described using the following verb/noun/qualifier descriptions:

Verb	Noun Phrase(s)	Qualifier(s)
Appraise	the situation	produce a report/briefing
Summarise	the situation	produce a report/briefing
Critique	the situation	report issues
Suggest	fixes to issues identified	

7.2 Sipe

The Sipe tool being developed at SRI is a planning system which aids the user in decomposing a specified task into a sequence of activities which can be enacted.

The capabilities of the Sipe system can be described by the class of verbs associated with Develop and Modify in the verb classification described in Appendix A. The SIPE system can be described using the following verb/noun/qualifier descriptions:

Verb	Noun Phrase(s)	Qualifier(s)
Produce	course of action	from a task input
Modify	course of action	due to environment and tasking

7.3 O-Plan

The O-Plan tool being developed at AIAI is a planning system which aids the user in decomposing a specified task into a sequence of activities which can be enacted.

The capabilities of the O-Plan system can be described by the class of verbs associated with Modify in the verb classification described in Appendix A. O-Plan always takes a partial plan and modifies it. The O-Plan system can be described using the following verb/noun/qualifier descriptions:

Verb	**Noun Phrase(s)**	**Qualifier(s)**
Modify	course of action	due to environment and tasking

7.4 TRAINS

The TRAINS system being developed at the University of Rochester is a user dialogue tasking and planning system which aids the user in decomposing a specified task into a sequence of activities which can be enacted.

The capabilities of the TRAINS system can be described by the class of verbs associated with **Assess**, **Communcate** and **Develop**. This indicate a mixture of different capabilities which is reflected in it mixed initiative approach to problem solving. The TRAINS system can be described using the following verb/noun/qualifier descriptions:

Verb	**Noun Phrase(s)**	**Qualifier(s)**
Describe	situation to system	(from user)
Modify	of changes in the situation	(from system)
Suggest	action, course of action, or constraint	(from system or user)
Request	action or course of action	(from system or user)
Acknowledge or Reject	suggestion/request	(from system or user)
Correct, Clarify or Elaborate	something	(from system or user)
Summarise or Describe	situation or plan	to user (via system)
Authorise	action by system	(from user)

Appendix C: IDEF Models of the ACP Process

The aim of the Appendix is to described the IDEF models of the ACP process which were used to generate the verbs described in Appendix A. The models were generated from diagrams rovided by Mitre to AIAI during the ISAT project meeting in Washington in April 1996.

The top level IDEF-3 model provides an overview of the activities involved in Joint Air Operations Planning process and is shown in Figure 2. The activities are represented by rectangular boxes, linked together by precedence arcs. Shown within the activity box is the name of the activity (central panel), its unique number (bottom left-hand corner) and a reference number to an activity on an associated diagram (bottom right-hand corner).

For the Joint Air Operations Planning model, three parent activities were identified at the highest level of abstraction. These are:

- JFACC **Planning**: which includes activities involved in developing the JFACC Guidance is shown in Figure 3. This activity is further decomposed into 5 further activities.
- JIPTL **Development** which includes activities involved in developing the target list is shown in Figure 4. This activity is further decomposed into 5 further activities.
- **Mission Planning**: which includes the activities involved in developing the Master Attack Plan until the release of the Air Tasking Order is shown in Figure 5. This activity is further decomposed into 10 sub-activities with the first of these "develop master attack plan" is decomposed into a further 5 activities. These decompositions are shown in Figure 6, Figure 7 and Figure 8.

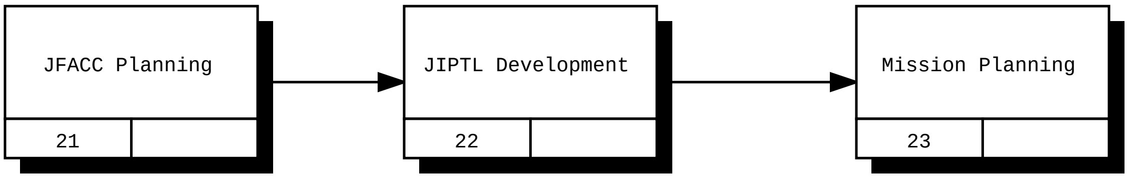

Figure 2: Overview of the Joint Air Operations Planning Process

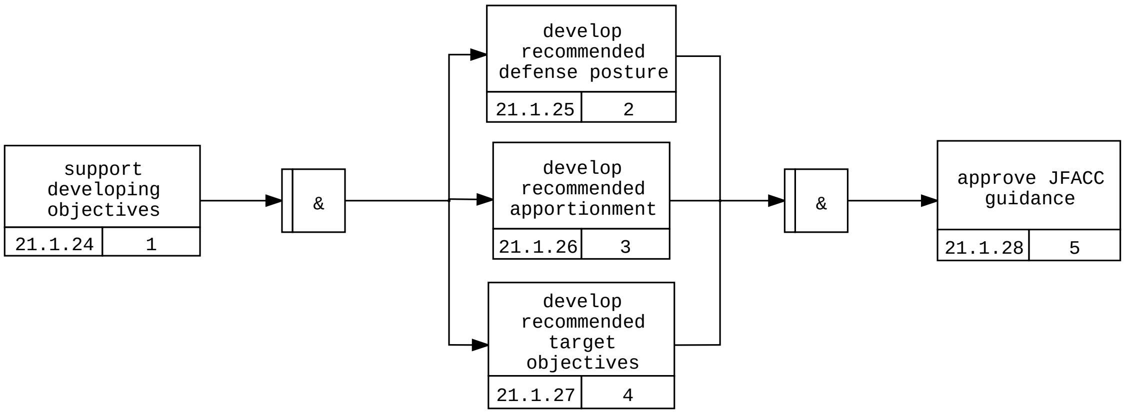

Figure 3: JFACC Planning Process

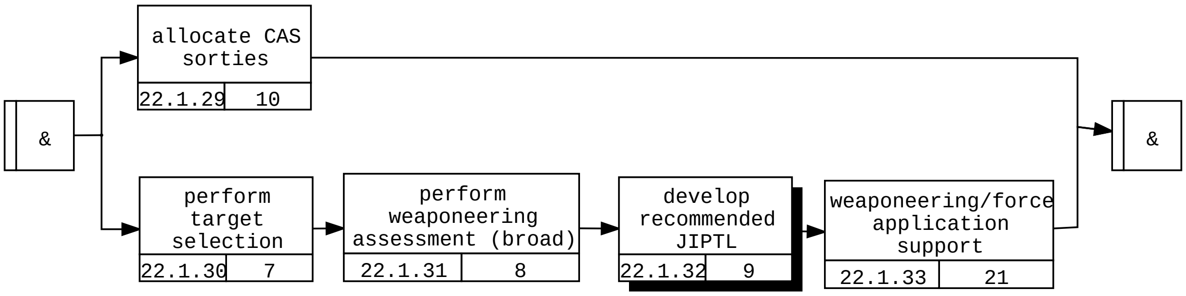

Figure 4: JIPTL Development Process

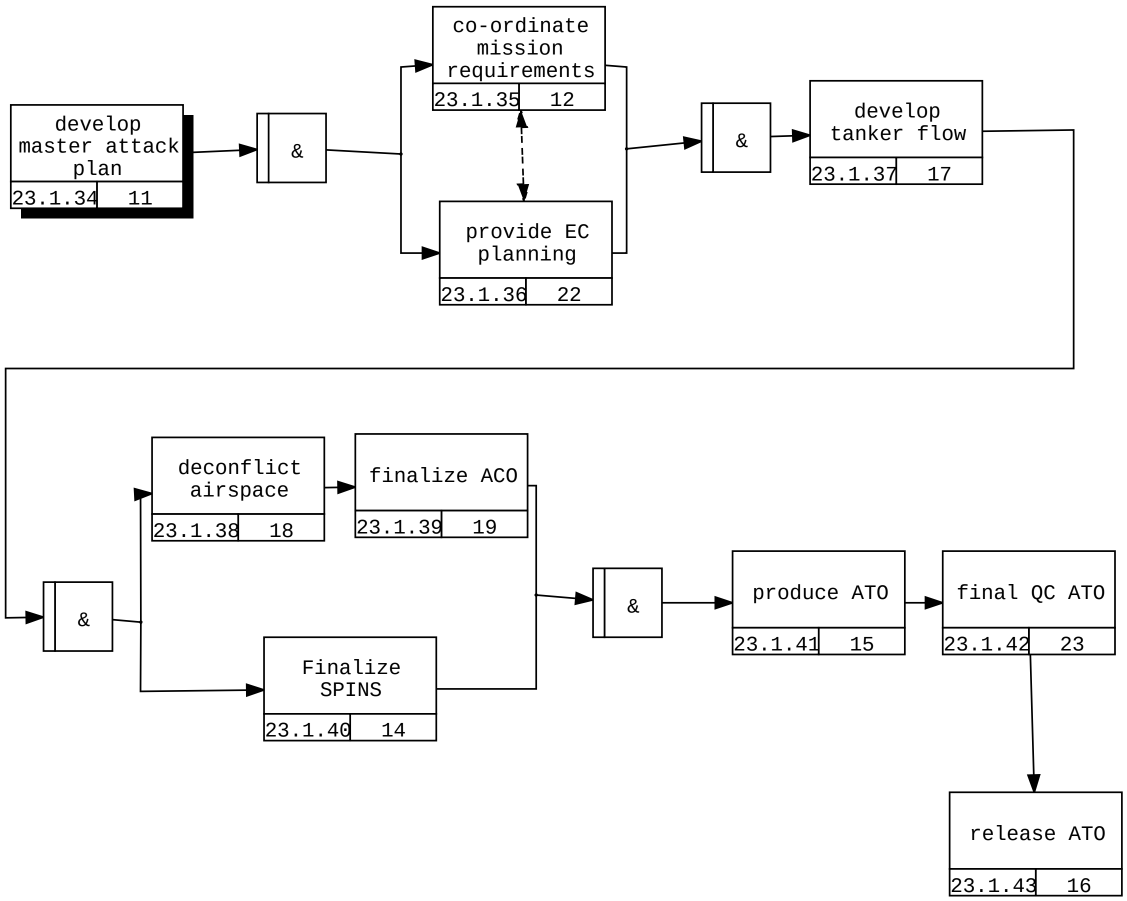

Figure 5: Mission Planning Process

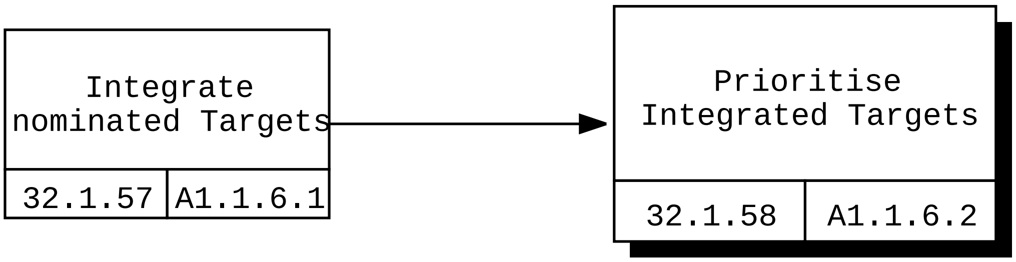

Figure 6: Develop Recommended JIPTL Process

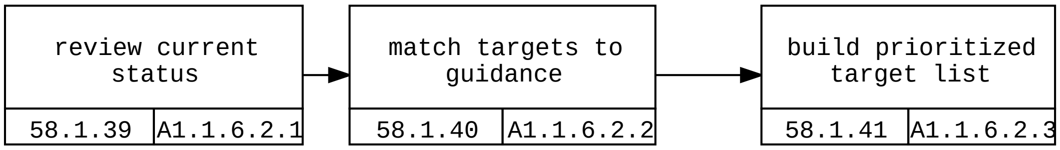

Figure 7: Prioritise Integrated Targets Process

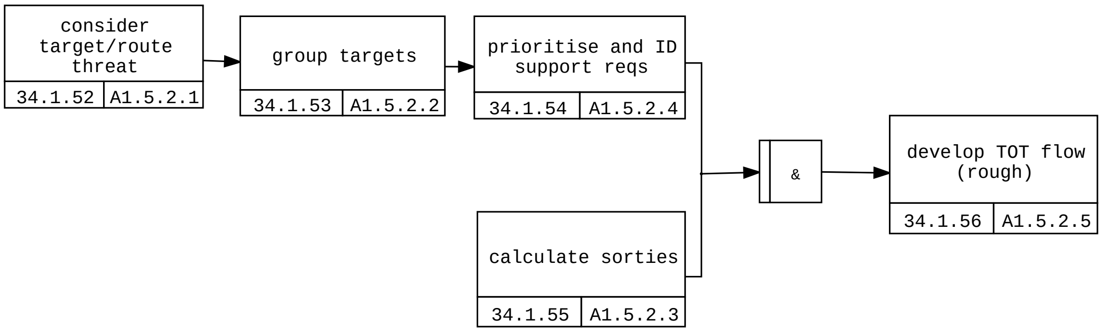

Figure 8: Develop Master Attack Plan Process