FFI RAPPORT

TALUS - Users Guide

GLÆRUM Sigurd, HOVIK Lars

FFI/RAPPORT-2000/02733

FFISYS/723/161.3

Approved
Kjeller May 24 2000

Jan Erik Torp
Director of Research

TALUS - Users Guide

GLÆRUM Sigurd, HOVIK Lars

FFI/RAPPORT-2000/02733

FORSVARETS FORSKNINGSINSTITUTT
Norwegian Defence Research Establishment
P O Box 25, NO-2027 Kjeller, Norway

FORSVARETS FORSKNINGSINSTITUTT (FFI)
Norwegian Defence Research Establishment

P O BOX 25
N0-2027 KJELLER, NORWAY

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE
(when data entered)

REPORT DOCUMENTATION PAGE

1) PUBL/REPORT NUMBER	2) SECURITY CLASSIFICATION	3) NUMBER OF PAGES
FFI/RAPPORT-2000/02733	UNCLASSIFIED	81
1a) PROJECT REFERENCE	**2a) DECLASSIFICATION/DOWNGRADING SCHEDULE**	
FFISYS/723/161.3	-	

4) TITLE

TALUS - Users Guide

5) NAMES OF AUTHOR(S) IN FULL (surname first)

GLÆRUM Sigurd, HOVIK Lars

6) DISTRIBUTION STATEMENT

Approved for public release. Distribution unlimited. (Offentlig tilgjengelig)

7) INDEXING TERMS

IN ENGLISH:	IN NORWEGIAN:
a) TALUS	a) TALUS
b) Simulation	b) Simulering
c) Air-to-air combat	c) Luftkamp
d)	d)
e)	e)

THESAURUS REFERENCE:

8) ABSTRACT

This document is a Users Guide to the TALUS tactical air combat simulation model. It describes how to install and run the model. It also describes in a quite detailed manner how to define a scenario. The Users Guide is not a reference manual for developers, it is primarily intended for the end user who wishes to analyse the performance of combat aircraft and/or their subsystems over a range of scenarios.

9) DATE	AUTHORIZED BY	POSITION
	This page only	
May 24 2000	Jan Erik Torp	Director of Research

ISBN-82-464-0416-4

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE
(when data entered)

CONTENTS

TALUS - Users Guide

1 INTRODUCTION

TALUS is a discrete event, Monte Carlo based simulation model for engagement level air-to-air combat developed at the Norwegian Defence Research Establishment (FFI). This manual will describe how to install the model and how to use the model in creating and running scenarios.

2 INSTALLATION

The TALUS executable will run on a Windows 98 or Windows NT system with at least 32 Mb (64 Mb recommended) RAM. To install TALUS from the CD-ROM, simply copy the file structure from the CD-ROM to a hard drive and make the PATH environment variable include a reference to the \bin directory. TALUS is now ready to run.

To modify and recompile the TALUS source code additional steps are required. It is necessary to install the MODSIM III compiler which again requires the presence of the Microsoft Visual C++ compiler. To install these compilers, please refer to the accompanying instructions. At the time of writing the current versions are: MODSIM III Release 2.1 Professional Edition and Microsoft Visual C++ version 6.0.

3 RUNNING TALUS

TALUS may be executed either from the command line or through the graphical user interface. The command line syntax is:

```
>talus [input dir]
```

TALUS will then initialise and run the scenario which must be defined in an input file named «input.dat» in the input directory. The resulting data files, named «output.ftn15» and «res.f15» will be put in the same directory. If no argument is given the current directory is used. Note also that, when running TALUS from the graphical user interface, trace that would normally go to standard out will be put in (a selectable) file in the selected directory.

Alternatively, TALUS may be run through the graphical user interface (GUI). To do this, execute «talusinterface.exe» found in the \bin directory. From the user interface it is possible to load an input file (of any name) and modify it if so desired, or to create an input file from scratch. TALUS itself is then executed through the «Run» command found in the GUI, with output produced in a directory specified by the user. Detailed instructions on how to use the interface is the main theme of this document and can be found in the following chapters. It should be noted here, however, that the interface will create a temporary input file by the name

of «input.dat». Consequently, any input file that the user wishes to keep, should be stored using any name but «input.dat».

4 THE GRAPHICAL USER INTERFACE – AN INTRODUCTION

In this and following chapters all elements of the GUI will be studied in detail. Before doing this, however, a quick guide on how to get TALUS up and running is given below. There are three main ways to use the interface to create a scenario. The first is to open and run an existing input file, the second is to create a scenario from scratch and the third is to modify an existing input file. The first method is obviously the simplest one, an example is outlined in the next section. First, however, a word of warning: Neither the interface nor TALUS itself is what might be considered a «shrink-wrapped» product. They are tools more or less under continuos development and used by scientists for analytical purposes. It is eminently possible to create scenarios through the user interface that will make TALUS crash. It is likewise possible to define scenarios that contain errors which make them impossible to reload into the user interface. The user interface *will* check the consistency of scenarios, but not in an exhaustive manner. Keeping this in mind, the user should maintain backup copies of any scenario that are subjected to modifications in the user interface.

4.1 Running a Scenario

After starting the interface, select File→Open from the menu. To load an example scenario select the file «generic.dat» located in the ..\database\scenarios directory. The interface will read the input file, the result looking something like Figure 4.1.

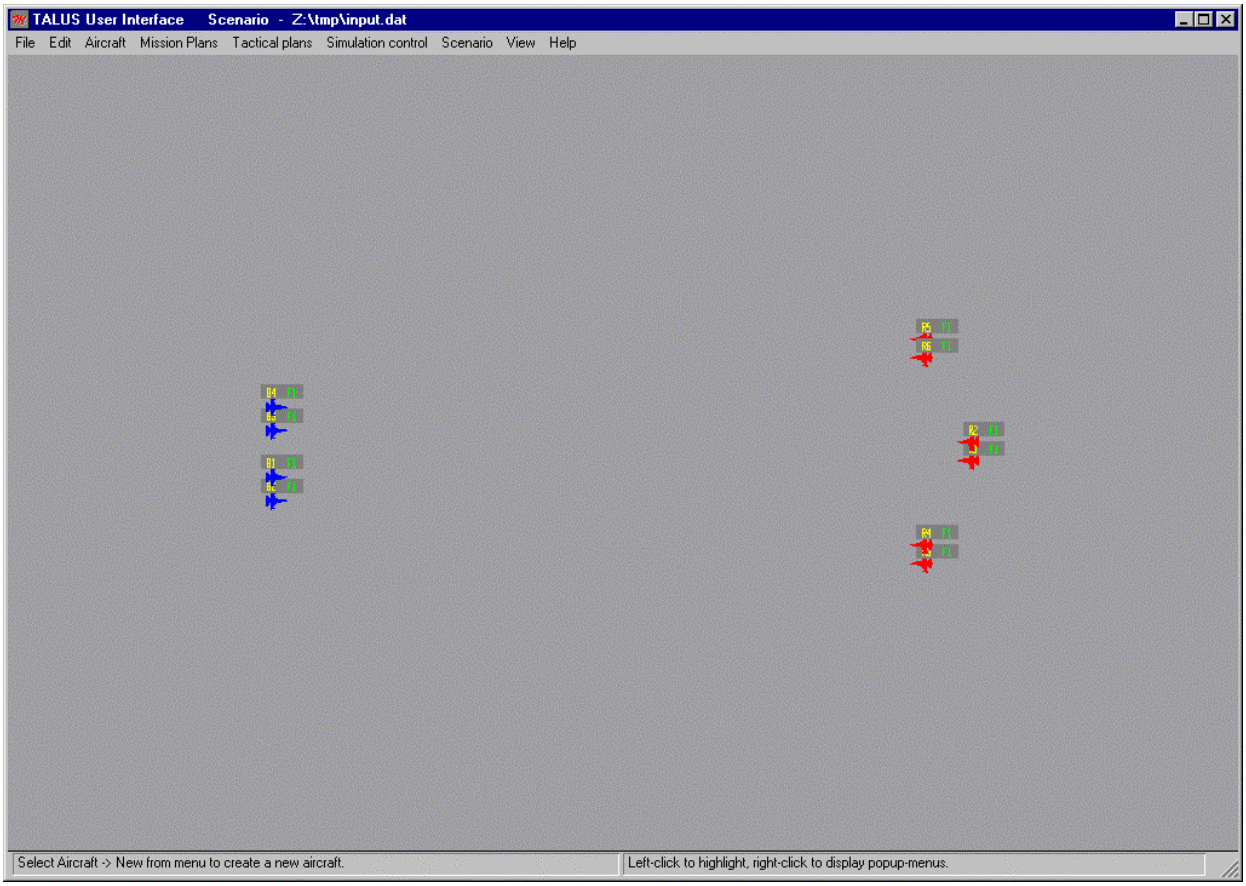

Figure 4.1 User interface with scenario loaded

To run this scenario, simply choose Scenario→Run from the menu bar. When asked to select a directory for output, choose a suitable one. Now TALUS itself will initialise and run, displaying the events through its own graphical animation. When the simulation terminates (or is terminated by the user) the user will be returned to the interface. The interface can then be terminated by selecting the menu item File→Exit. A good idea at this stage would, however, be to explore the interface by examining the different menus, double-clicking on a given aircraft to see its definition etc. Only make sure to have a backup copy of the «generic.dat» input file for future reference.

4.2 How the Application Reads Data

Data is collected either from the available database, from text files copied into the same directory as the executable, or from an opened file (if the scenario has been previously saved). The extensions used to indicate where data is collected from are; «database», «current» and «file» respectively. This applies to all kinds of data throughout the application. If the same name is used for data from «database» and from «file» or «current», and the user chooses to use the data from «database», this would overwrite any data previously selected from «file» or «current». A warning will be given if this applies, see Figure 4.2. Data from «current» will in the same way overwrite data from «file». The files in the database itself will, however, never be overwritten (with the exception of the sample input files in the ..\database\scenarios directory).

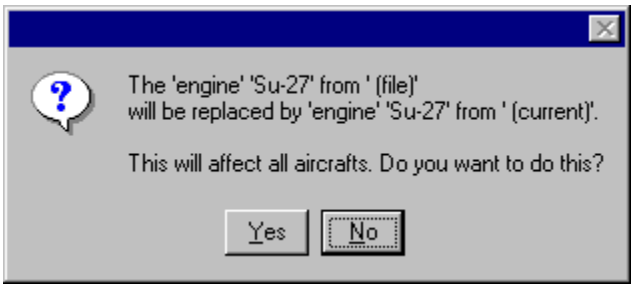

Figure 4.2 Example on warning given when data is to be overwritten

As an example consider the case where a user has opened a file containing a scenario (in Talus User Interface) and this scenario includes several aircraft named «Su27». Their subtype name would appear as «Su27 (file)» in the application. The subtype «Su27» may also exist in the database, and would then appear as «Su27 (database)» in the application. If the user then adds a new aircraft and specifies its subtype to be «Su27 (database)», then the data for all «Su27»s would be gathered from the database. If for some reason the data for the «Su27» is different in the database from that in the file, the results achieved by running the scenario may be different. If the database is not updated, and the opened scenario file has not been changed using an text editor, the data for the «Su27» in the database and in the file would be exactly the same.

4.3 Windows, Working Area and Dialog Boxes

Before moving on to the specifics of the TALUS interface, a general introduction to the kinds of windows and controls employed by the interface is given below.

4.3.1 Windows and Working Area

Figure 4.3 shows a window with menus, working area and status bar (in this case the main window of «Talus User Interface»). Menus are contained within the menu bar at the top of the application window. Each menu may contain one or more menu items, which can be activated by clicking on them. The working area is a large grey area of the window. A status bar is shown at the bottom of the window. A short help text is displayed in it depending on what menu item or icons that are highlighted.

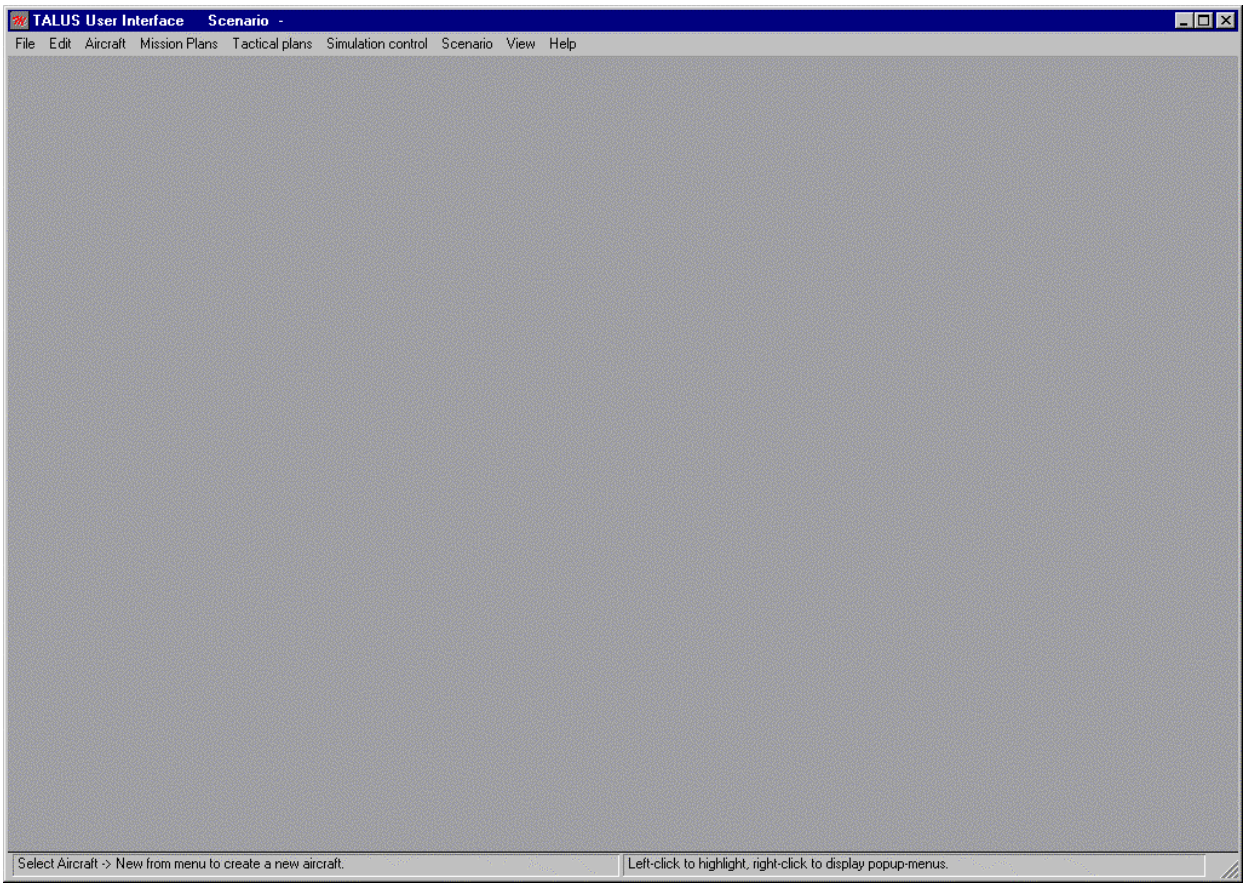

Figure 4.3 Window with menus, working area and status bar

4.3.2 Dialog Boxes

Figure 4.4 is an example of a dialog box. These will appear on top of the window that invoked them. Interaction with that window will not be possible until the dialog box is terminated (usually by clicking on an «OK» or «Cancel» button). A dialog box can contain buttons, text boxes, combo boxes, value boxes, radio boxes and text labels. Certain dialog boxes may only contain text and one or more buttons. They are then usually referred to as «message dialog boxes».

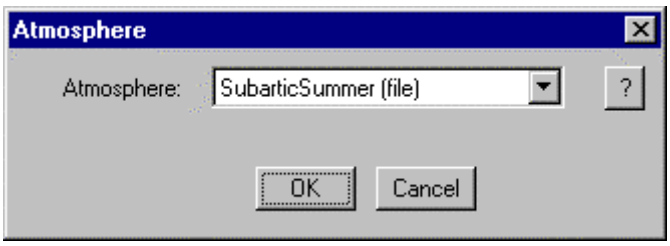

Figure 4.4 Example of a dialog box

4.3.3 Tabbed Dialog Boxes

Figure 4.5 gives an example of a tabbed dialog box.

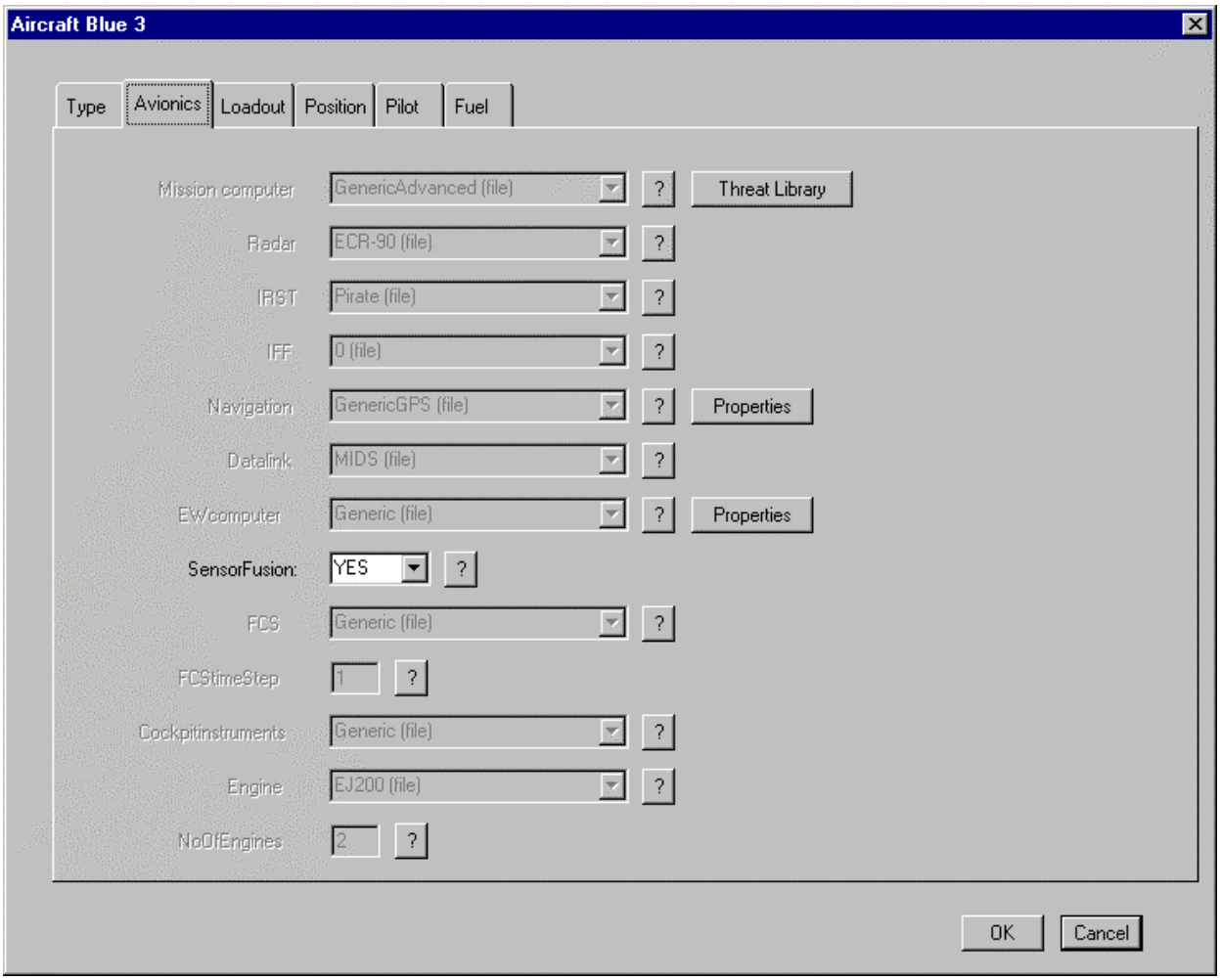

Figure 4.5 Example of tabs

A dialog box may have several tabs. Each tab can have several controls (combo boxes, value boxes etc) attached to it. Only the top tab field can be seen; all other tab fields and attached controls remain hidden underneath. The only visible portion of a tab field is a small rectangular area containing its name, or a tab. Clicking on the tab will bring the tab field to the top of the tab area and show all controls attached to it. Tabs are usually used where there is not enough space in a dialog box to display all controls or they may be used where there is a logical reason to separate different types of data. Items contained in a dialog box or a dialog box tab are called controls.

4.4 Commonly Used Items in Dialog Boxes (Controls)

4.4.1 Combo Boxes

A combo (combination) box is a text box containing a small «drop down» button, as in Figure 4.6. When that button is pressed, a scrollable list of choices for the text field is displayed. The combo box may be defined to allow only those alternatives shown in the list to be entered (most common), or to be fully editable like a text box.

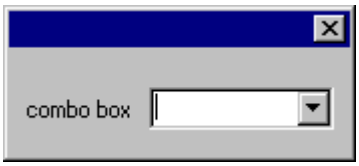

Figure 4.6 Example of a combo box

4.4.2 Value Boxes

A value box is used to receive or show a single numerical value to the user, as in Figure 4.7. The value may have to be within a certain range. If a value typed into the box is out of range, the user will be informed whenever a verifying button (e.g. «OK» button) is pressed.

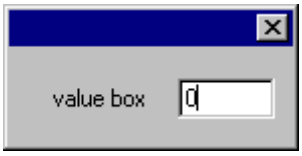

Figure 4.7 Example of a value box

4.4.3 Radio Boxes

The radio box, an example is shown in Figure 4.8, accepts input from a fixed list of alternatives. It contains a set of radio buttons. One can only select one radio button at a time; when one select a new button, the previously selected button pops up automatically.

Figure 4.8 Example of radio box

4.4.4 Buttons

A button receives simple input and contains no data from the user. A special type of button is the help button, see Figure 4.9.

Figure 4.9 Example of buttons

When the help button is pressed a help text pops up next to it, as in Figure 4.10

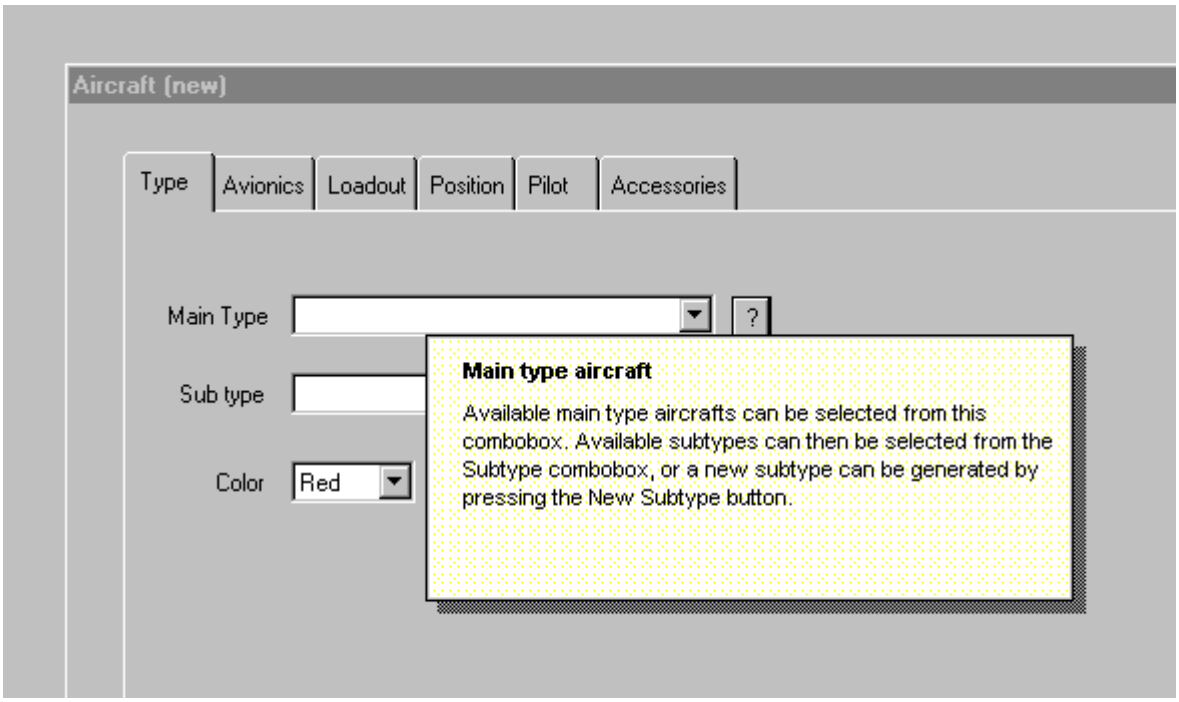

Figure 4.10 Example of a help-button

5 MAIN WINDOW

The window that is displayed when the application is started was shown in Figure 4.3. Menus are activated by left-clicking the mouse. They can also be activated using shortcut keys (pressing <Alt> key, then the key for the underscored letter, or using the arrow keys). Menu items available under each menu/submenu are illustrated below. A status bar is shown at the bottom of the window, displaying text describing more information about the highlighted menu item. The text being displayed depends on what menu item or aircraft icon(s) that are highlighted.

5.1 Popup Menu in Window Canvas

By right clicking the mouse in the window canvas (outside of any aircraft images), a popup menu is displayed (shown in Figure 5.1).

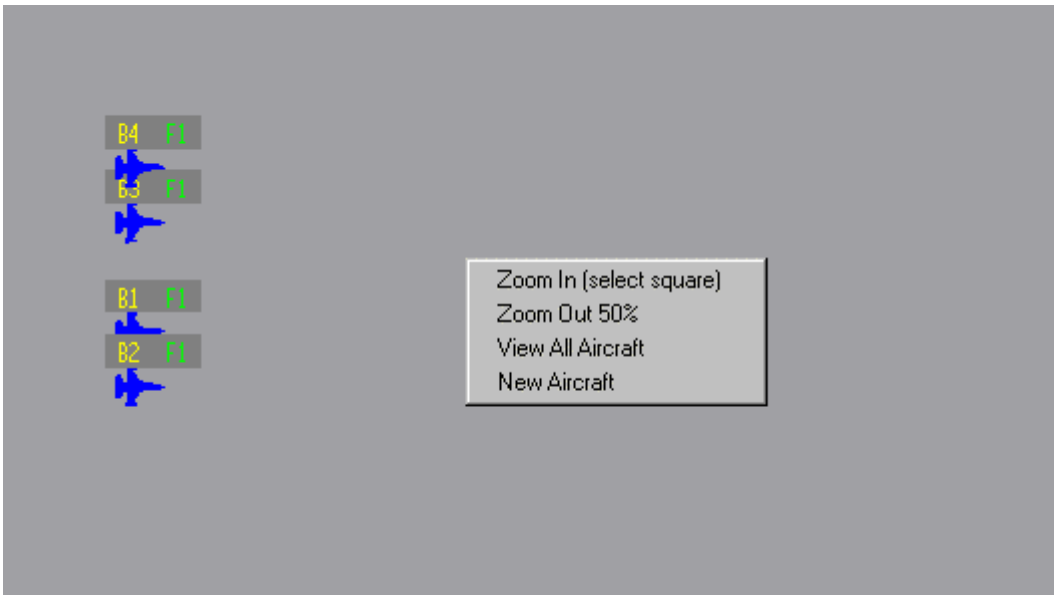

Figure 5.1 Popup menu displayed when right-clicking in window canvas

The popup menu contains 4 items, described below.

5.1.1 Zoom In (selected square).

After this item is selected, one must left-click the mouse in the window canvas to select the first corner of the area to be viewed. Then one must move the mouse (a rubber square indicating the area to be zoomed is displayed) and left-click the mouse again to actually zoom in the selected area.

5.1.2 Zoom Out.

Zooms out 50% around the current window centre point.

5.1.3 View All Aircraft.

The view is changed so that all aircraft are shown within the window borders.

5.1.4 New Aircraft.

Displays a dialog box in which the user can create a new aircraft and set some specific attributes (see Chapter 8, «Defining and Editing Aircraft»).

5.2 Popup Menu on Aircraft Icons

The user can select an aircraft by left-clicking on its icon in the working area. If the aircraft is member of a formation, only one aircraft may be selected. If several aircraft are not member of any formation, more than one (of the same side) may be selected by holding down the Ctrl-key while left-clicking on the icons. By right-clicking on an aircraft image that is highlighted, a popup menu is displayed (shown in Figure 5.2, Figure 5.3 and Figure 5.4).

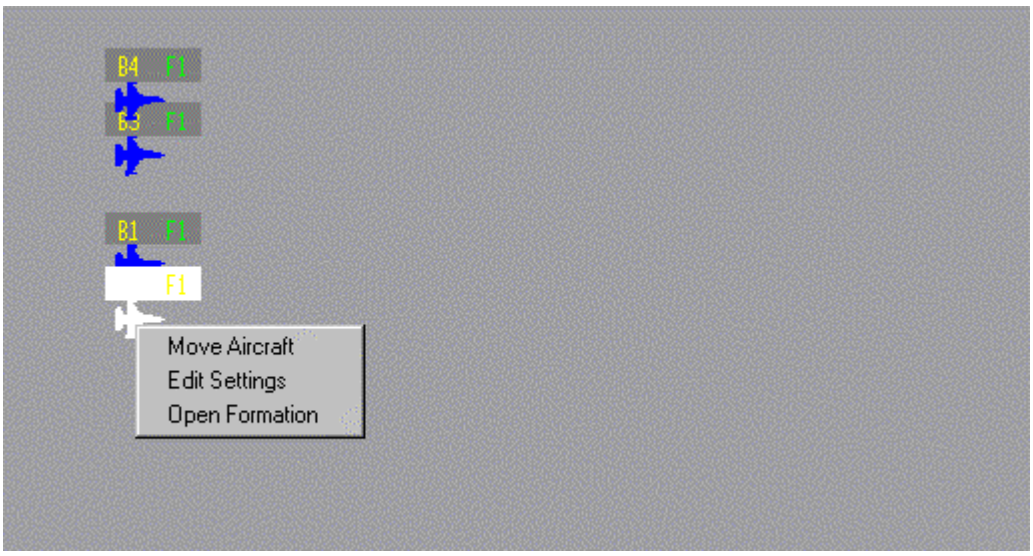

Figure 5.2 Popup menu displayed when right-clicking on an aircraft icon when the aircraft is member of a formation

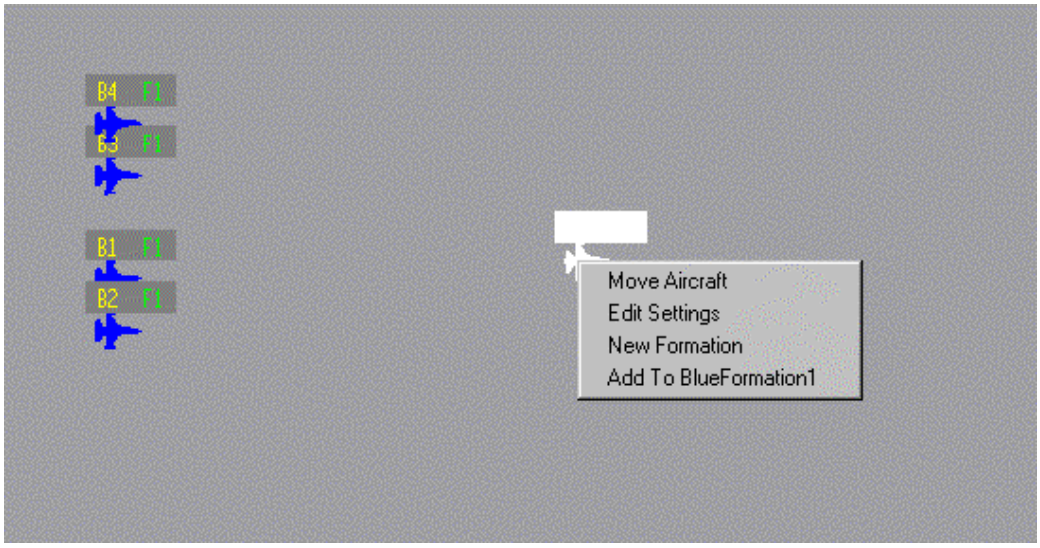

Figure 5.3 Popup menu displayed when right-clicking on an aircraft icon when the aircraft is not member of a formation

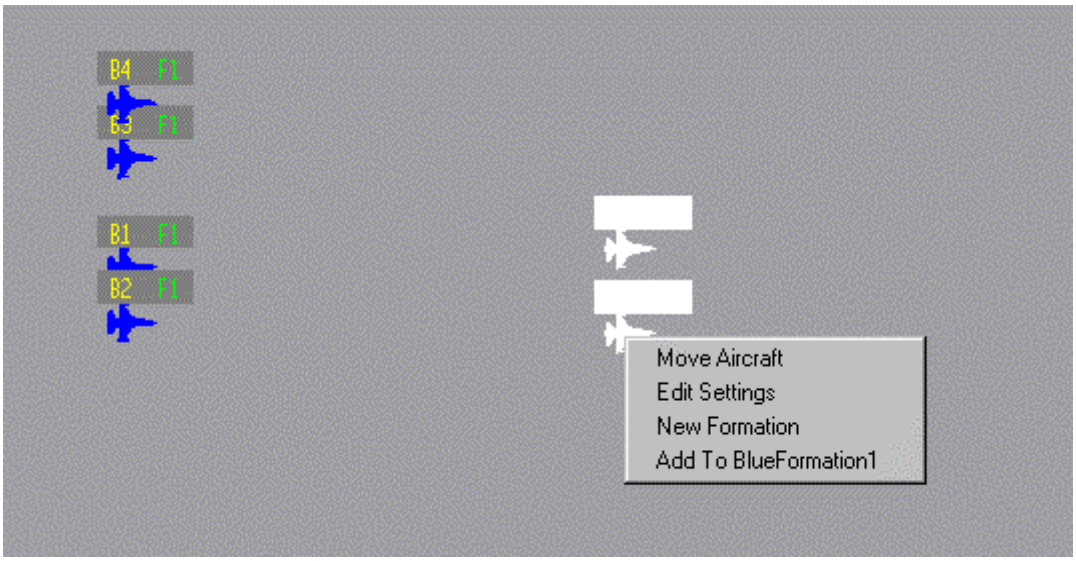

Figure 5.4 Popup menu displayed when right-clicking on an aircraft icon when more than one icon is highlighted

The popup menu contains 3 or more items, described below.

5.2.1 Move Aircraft

One can move the aircraft to a desired position within the displayed area, positioning it by left clicking the mouse on the desired position. If it is desired to move it to a position outside the displayed area, one must first zoom out to include the desired position, or type in the exact position by selecting «Edit Settings».

5.2.2 Edit settings

Displays a dialog box in which the user can set some specific attributes of the aircraft. This dialog box is similar to that displayed when configuring a new aircraft, see Chapter 8, «Defining and Editing Aircraft».

5.2.3 Open Formation

This menu item is displayed if the selected aircraft is member of a formation. If selected, the «Command Structure» window for that formation is displayed, see Chapter 9, «Defining the Command & Control Structure».

5.2.4 Add to *Color*Formation*Number*

These menu item(s) is/are displayed if the selected aircraft is/are not member(s) of a formation. One menu item for each formation on the appropriate side is displayed. If one item is selected, the «Command Structure Window» for the according formation is displayed, see Chapter 9 «Defining the Command & Control Structure». The highlighted aircraft is/are displayed together with those that are already members of the formation.

5.2.5 New Formation

This menu item is displayed when the selected aircraft are not member of a formation. If the item is selected, a «Command Structure Window» for a new formation is displayed, see Chapter 9 «Defining the Command & Control Structure». The highlighted aircraft are

displayed in this window. A formation may consist of any number of aircraft, it may also consist of only one.

6 MENU STRUCTURE IN MAIN WINDOW

The application has eight menus in the main menu; File, Edit, Aircraft, Command structure, Tactical plans, Simulation control, Scenario and Help. Each menu may contain one or more menu items. This chapter describes the purpose of each menu item.

6.1 File Menu

The file menu contains the items shown in Figure 6.1.

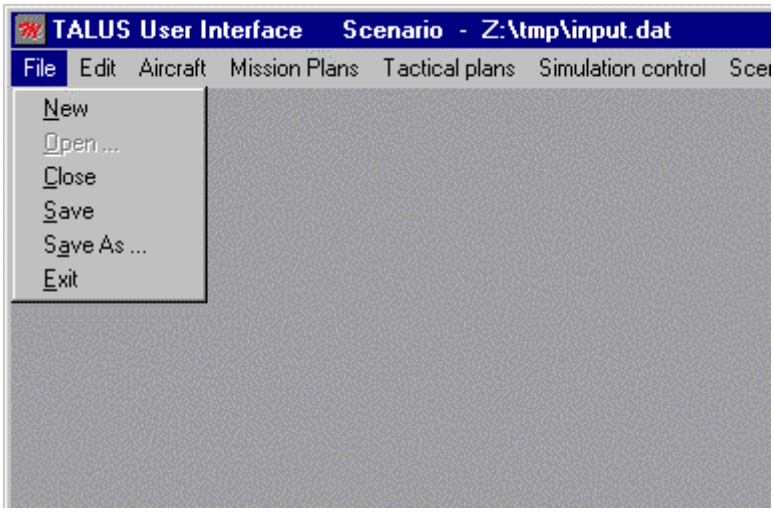

Figure 6.1 File menu

6.1.1 File - New

This action should be used when a new scenario is to be generated. If a scenario is already open and changes have been made to it, the dialog box in Figure 6.2 is displayed. Choosing the «OK« button would save and close the scenario, displaying an empty working area. Choosing the «Cancel« button would cancel the operation and close the dialog box.

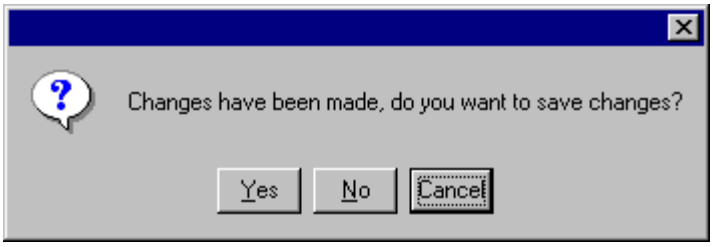

Figure 6.2 «Ok to close?» dialog box

6.1.2 File - Open

This action should be used when it is desired to open a previously saved scenario. A standard “File Open” dialog box prompts the user for a name of the scenario.

6.1.3 File - Close

This action should be used to close a scenario. A dialog box will be displayed prompting the user to save it if that has not already been done. An empty working area will be the result of this action.

6.1.4 File - Save

This option saves the updated scenario information to a previously specified file.

6.1.5 File - Save as

This option displays a standard dialog box prompting the user to specify a filename.

6.1.6 File - Exit

When this option is selected, the application is terminated. However, if the open scenario has had changes made to it after it was last saved, the user will be asked whether to save these changes.

6.2 Edit Menu

The file menu contains the items shown in Figure 6.3.

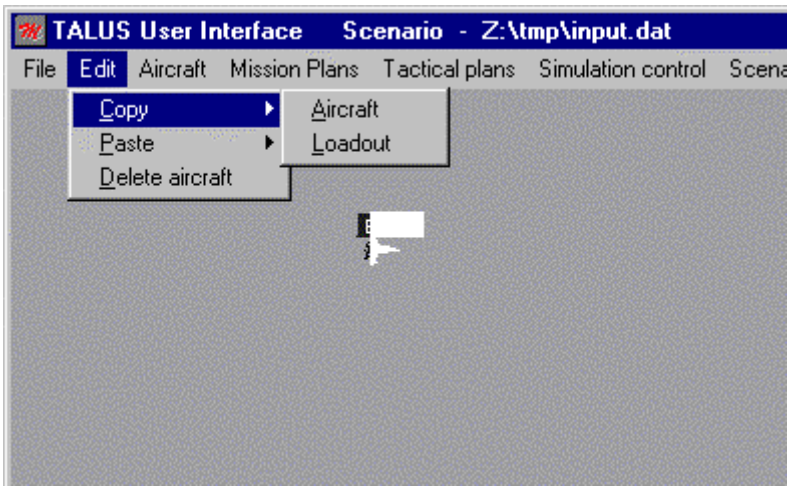

Figure 6.3 Edit menu

6.2.1 Edit - Copy Aircraft

An aircraft, including its subsystems, can be copied to the «clipboard». The aircraft that is to be copied must be selected first by highlighting it. All parameters for the aircraft are copied, except for the position and formation information. One and only one aircraft must be highlighted before this menu item is available.

6.2.2 Edit - Copy Loadout

The loadout information (weapons and stores) of an aircraft can be copied to the clipboard. One, and only one, aircraft must be highlighted before this menu item is available.

6.2.3 Edit - Paste Aircraft

If an aircraft has been copied, a new aircraft can be created by pasting it to the workspace. The pasted aircraft would be displayed with a new number (for its colour). The pasted aircraft would be placed at position 0.0 (middle of workspace). The aircraft can then be moved in the same way as any aircraft. One can also specify its position by entering the position information into its position fields, see Section 8.5. Note that this menu item will be unavailable if any aircraft is selected - the aircraft that was copied must be deselected before the paste operation. Note that, for some reason, the copy operation often has to be repeated once before the Edit→Paste menu item becomes available.

6.2.4 Edit - Paste Loadout

Loadout information (that has previously been copied to the «clipboard») can be pasted onto one or more existing aircraft. The aircraft must have the same number of loadout points as the one that the loadout information was copied from. If not, a dialog box informing the user that pasting cannot be done, is displayed. One or more aircraft must be highlighted before this option can be selected.

6.2.5 Edit - Delete Aircraft

When this item is chosen the aircraft that is highlighted is deleted. A dialog box asking for confirmation is displayed first, see Figure 6.4.

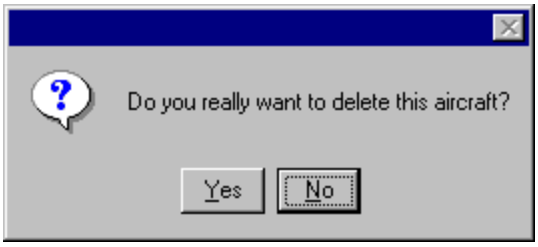

Figure 6.4 Confirmation dialog box

6.3 Aircraft Menu

The aircraft menu contains the single item shown in Figure 6.5.

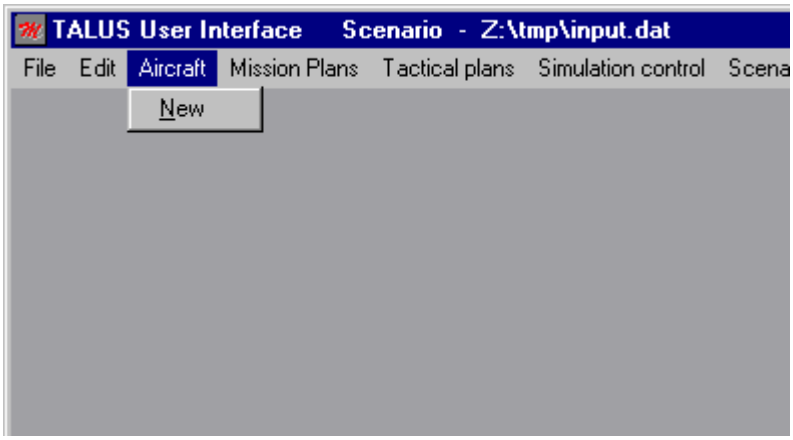

Figure 6.5 Aircraft menu

6.3.1 Aircraft - New

Selecting this menu item, an aircraft properties dialog box is displayed. How this is used to define a new aircraft is described separately in Chapter 8. The end result is, however, that a new aircraft is added to the main window with properties defined by the selections made by the user.

6.4 Mission Plans Menu

The Mission Plans menu (Figure 6.6) is used to define the overall mission for each of the participating formations in the scenario.

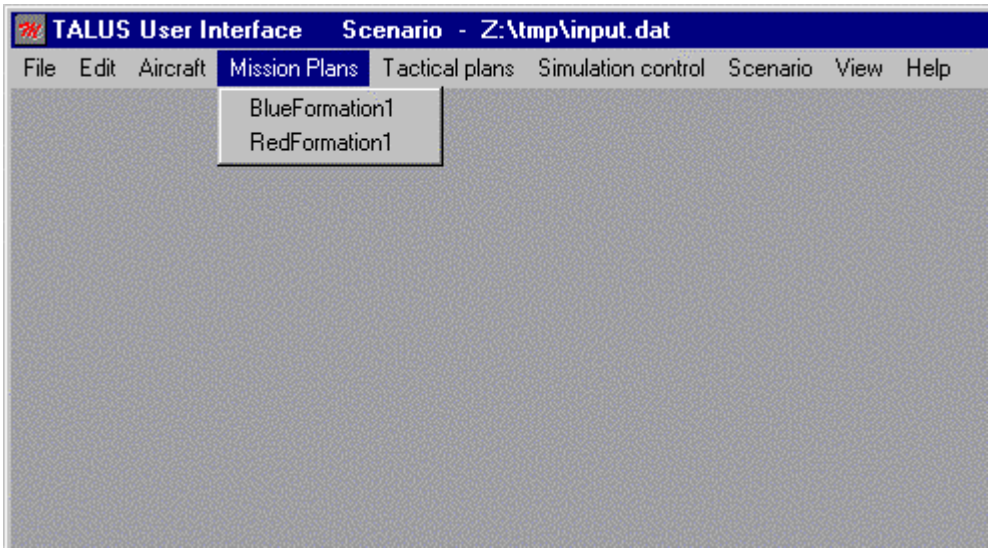

Figure 6.6 Mission Plans menu

The menu contains zero or more menu items. Menu items are added/removed when formations are added/removed, see Chapter 9, «Defining the Command Structure». One mission menu item is available for each formation within the scenario. Figure 6.6 Mission Plans menu shows an example where there are only one formation on each side. Chapter 10 describes how the mission plan for a given formation may be defined and modified.

6.5 Tactical Plans Menu

The Tactical Plans menu contains the items shown in Figure 6.7

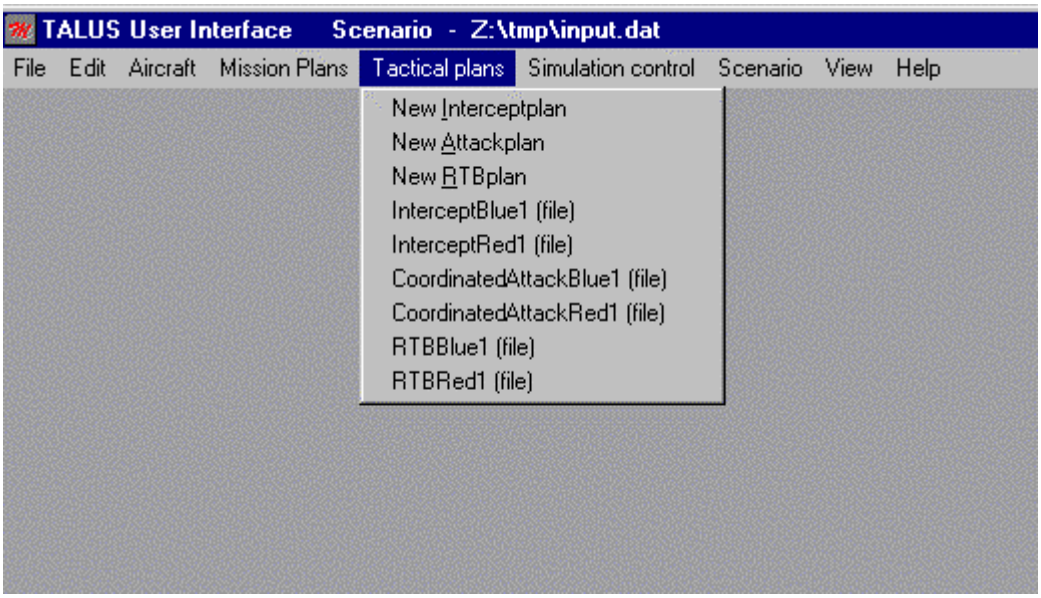

Figure 6.7 Tactical plans menu

In addition to the three first items, this menu contains as many items as there are tactical plans defined. With regard to the three first items, the user can define a new plan from scratch, or use an existing one as a template. These items are: «New Interceptplan», «New Attackplan» and «New RTBplan». New tactical plans may use existing ones as templates, the dialog box in Figure 6.8 will ask the user to select such a template. Selecting an existing tactical plan allows the user to review and modify it. Chapter 11 describes how tactical plans are defined in detail.

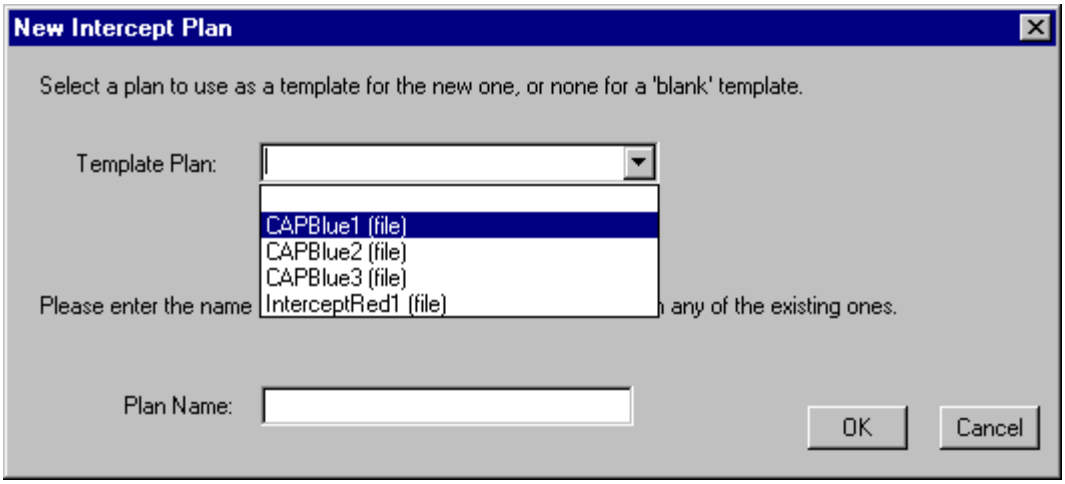

Figure 6.8 New Tactical plan dialog box

6.6 Simulation Control Menu

The Simulation Control menu contains the items shown in Figure 6.9.

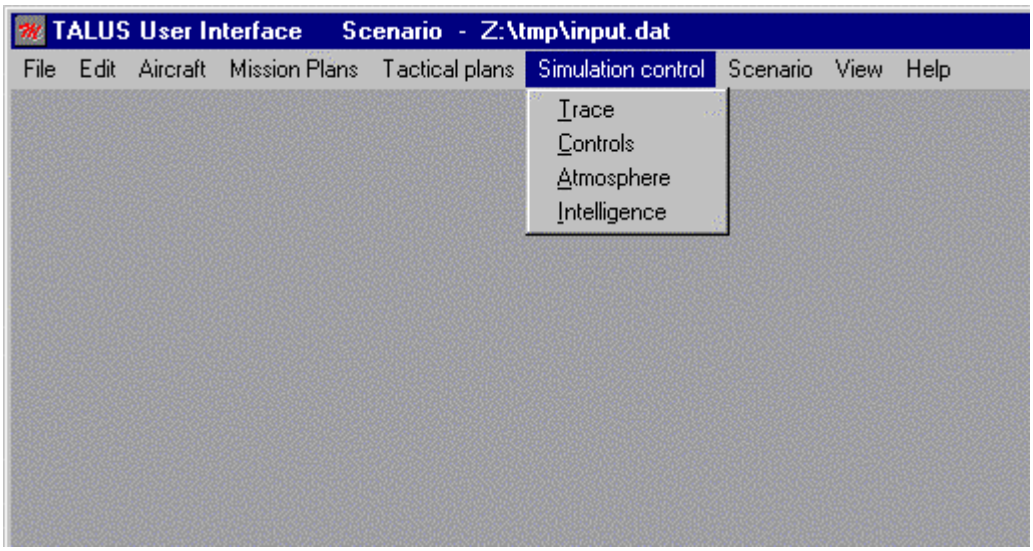

Figure 6.9 Simulation control menu

6.6.1 Simulation Control - Trace

The trace dialog box, depicted in Figure 6.10, enables the user to specify subsystems for which detailed information should be traced during a simulation. If, for instance, the user wants to study the performance of a specific radar type, the name of the aircraft carrying such a radar can specified in the appropriate box. As the scenario unfolds, TALUS will then output detection attempts, signal-to-noise, single scan probability of detection etc to standard out. Likewise, a trace on «Planner» for a specific aircraft will produce a trace of most of the decisions taken by the corresponding pilot. If the user wants to save this trace to a file, TALUS should be executed from the command line with a redirect of the output, e.g.:

```
talus > trace.dat
```

Another way to achieve the redirect is to launch the batch file created by the interface, see Section 6.7.1.

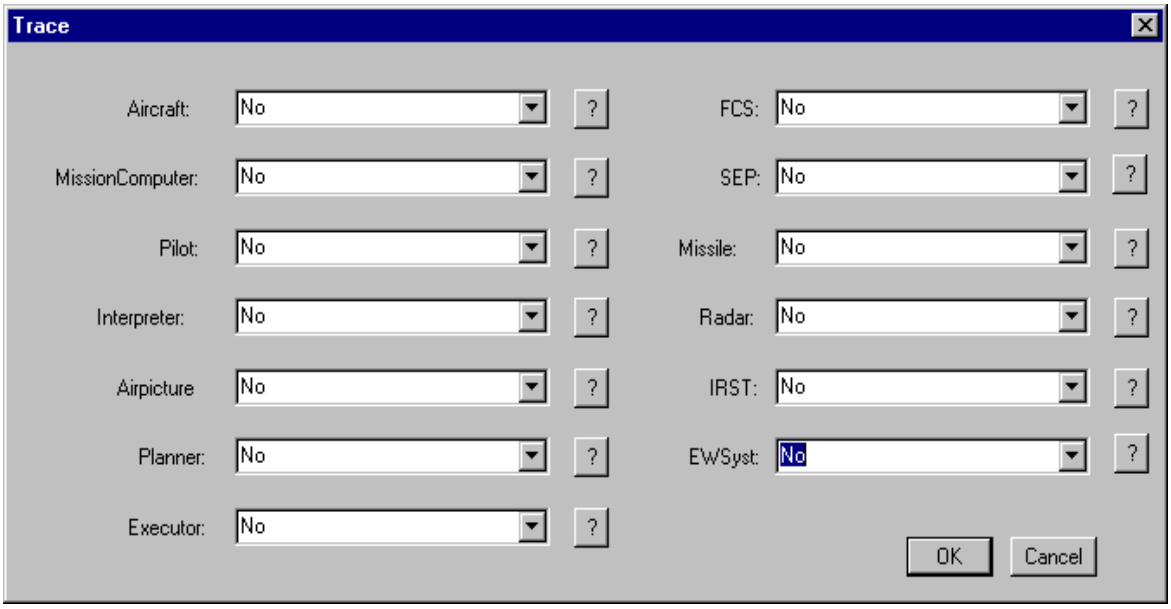

Figure 6.10 Trace dialog box.

6.6.1.1 Aircraft

Will give a trace of the aircraft velocity, orientation, position etc.

6.6.1.2 Missioncomputer

Will give a trace of all sensor tracks reported to the mission computer of the specified aircraft, the sensor fusing process, subsystem management events etc.

6.6.1.3 Pilot

Will produce a trace of the initial command and control structure of which the pilot of the specified aircraft is a part.

6.6.1.4 Interpreter

Will give a trace of the interpreter module of the pilot of the specified aircraft. This module is responsible for the reception and pre-processing of sensor information.

6.6.1.5 Airpicture

Will give a trace of the airpicture module of the pilot of the specified aircraft. This module is responsible for building and maintaining an airpicture based on available information and to give an assessment of this airpicture on demand.

6.6.1.6 Planner

Will give a trace of the planning modules of the pilot of the specified aircraft. These modules are responsible for the long- and short-term planning of the pilot, taking into account pre-laid plans, current airpicture and orders received.

6.6.1.7 Executor

Will give a trace of the executor module of the pilot of the specified aircraft. This module is responsible for the execution of plans through an interface to the aircraft.

6.6.1.8 FCS

Will give a detailed trace of the flight control system (FCS).

6.6.1.9 SEP

The «SEP» box is somewhat special. If this is specified, the Mach-altitude diagram of the specific excess power (SEP) of the specified aircraft is produced and saved in the file «SEP.dat». This is needed to specify optimal climb profiles for new aircraft types, and should be used for the detailed definition of the aircraft type.

6.6.1.10 Missile

Will give a trace of the fly-out of the given missile. The missile name is given by the launch aircraft and the designation of the store the missile is/was attached to, for instance «Blue1-3L».

6.6.1.11 Radar

Will trace the events for the specified radar. The name specified should be that of the radar platform, i.e. the aircraft name or the name of a specific radar missile.

6.6.1.12 IRST

Will trace the events for the specified IRST. The name specified should be that of the IRST platform, i.e. the aircraft name or the name of a specific IR-missile.

6.6.1.13 EWSystem

Will trace the events for the EW-system of the specified aircraft. At the moment this includes the missile approach warning system (MAWS) and the radar warning receiver (RWR).

6.6.2 Simulation Control - Controls

The “Controls” item in the Simulation Control menu will bring up the dialog box shown in Figure 6.11.

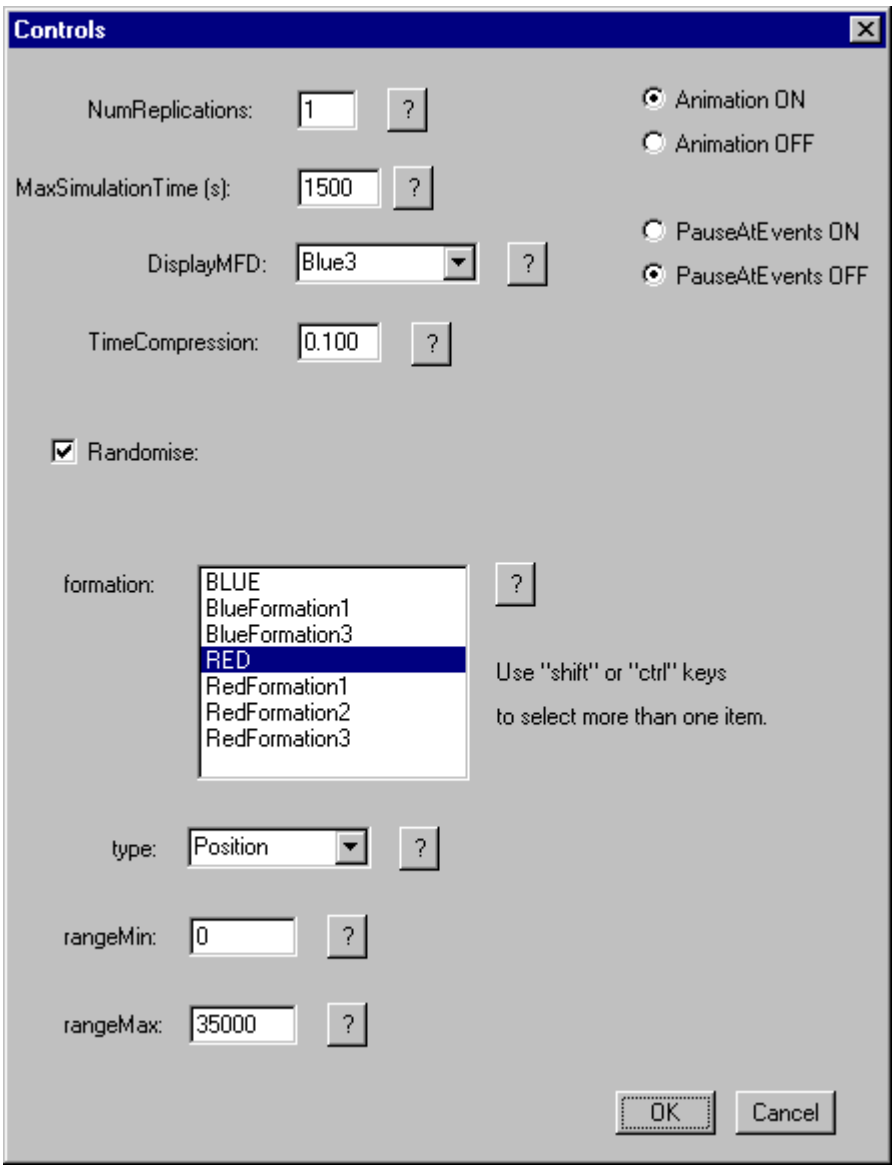

Figure 6.11 Controls dialog box

6.6.2.1 NumReplications

This will specify the number of Monte Carlo runs for the current scenario. If this is set greater than 1 while animation is turned on or trace is set for an aircraft, a dialog box shown in Figure 6.12, is displayed, asking the user if he really want to do this.

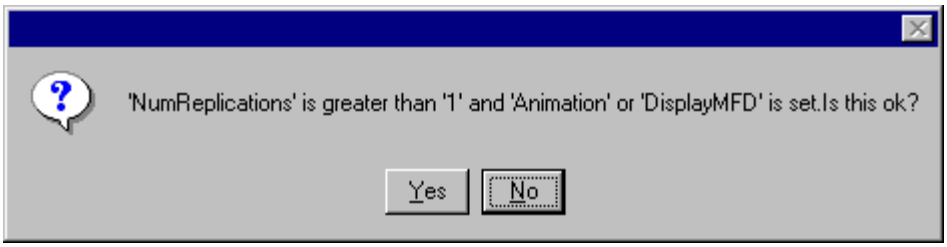

Figure 6.12 Numreplication greater than one dialog box

Events should normally not be traced in this case, since the amount of data produced could potentially be huge. Likewise, it is usually not desirable to animate several replications.

6.6.2.2 MaxSimulationTime

A simulation run (or Monte Carlo iteration) is usually terminated when on side is obliterated or all aircraft are returning to base. If it is desirable to terminate the simulation before this happens, the maximum simulated time can be specified here (seconds). If no such fixed limit is desired, a large number should be specified.

6.6.2.3 DisplayMFD

Will, if Animation is turned on, do an animated trace of the cockpit displays and pilot airpicture of the specified aircraft. If Animation is not turned on, selecting DisplayMFD will have no effect and a warning of this will appear, as depicted in Figure 6.13.

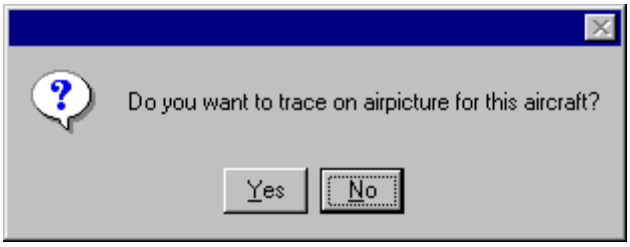

Figure 6.13 Trace airpicture dialog box

6.6.2.4 TimeCompression

If set to 1, will make the simulation run in real-time - if the computer is fast enough and the scenario small enough. The normal setting is 0.1 or smaller, making the system do the simulation as fast as possible.

6.6.2.5 AnimationON/AnimationOFF

Will make TALUS produce a graphical animation of the scenario as it unfolds, see Chapter 12 for a description of the run-time interface.

6.6.2.6 PauseAtEventsON/PauseAtEventsOFF

If turned on, will make TALUS pause its execution each time the pilot of the tagged aircraft (designated by the DisplayMFD box) makes a decision of some importance.

6.6.2.7 Randomise

If this box is checked, a randomisation of the starting positions for the specified formation or side will take place between Monte Carlo iterations.

6.6.2.8 Formation

Specifies for which formation or side the randomisation should be applied to.

6.6.2.9 Type

Specifies the type of randomisation, either position along the initial course, or the initial course itself. Note that only «Position» is currently implemented.

6.6.2.10 rangeMin

Minimum value for randomisation range (delta), in meters for position, degrees for course.

6.6.2.11 rangeMax

Maximum value for randomisation range (delta), in meters for position, degrees for course.

6.6.3 Simulation Control - Atmosphere

This box (Figure 6.14) will enable the user to choose the type of atmosphere model that should be employed in the scenario. This choice will mostly influence the detection ranges of IR-sensors.

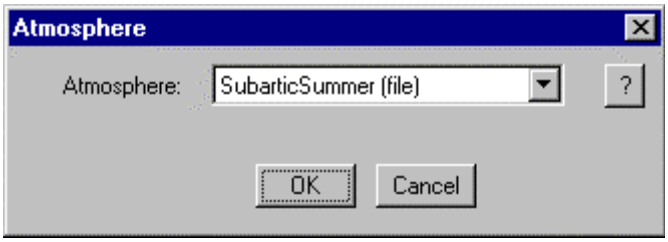

Figure 6.14 Atmosphere dialog box

6.6.3.1 Atmosphere

Select an atmosphere model to use in the scenario, usually a standard atmosphere is selected.

6.6.4 Simulation Control - Intelligence

The box in Figure 6.15 will equip the two sides with a rough initial intelligence estimate with regard to the main threat axis.

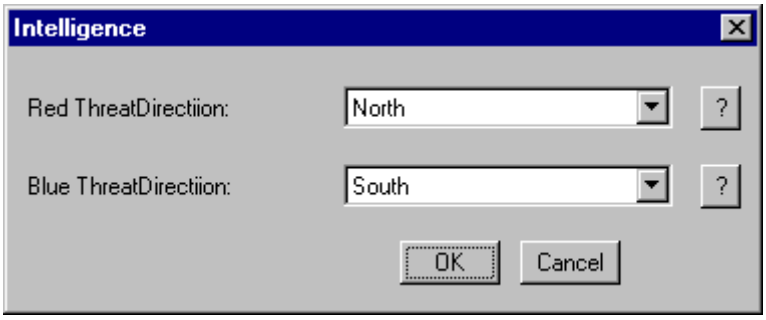

Figure 6.15 Intelligence dialog box

6.6.4.1 RedThreatDirection

The initial threat axis as seen from the Red side.

6.6.4.2 BlueThreatDirection

The initial threat axis as seen from the Blue side.

6.7 Scenario Menu

The single item in the Scenario menu is shown in Figure 6.16.

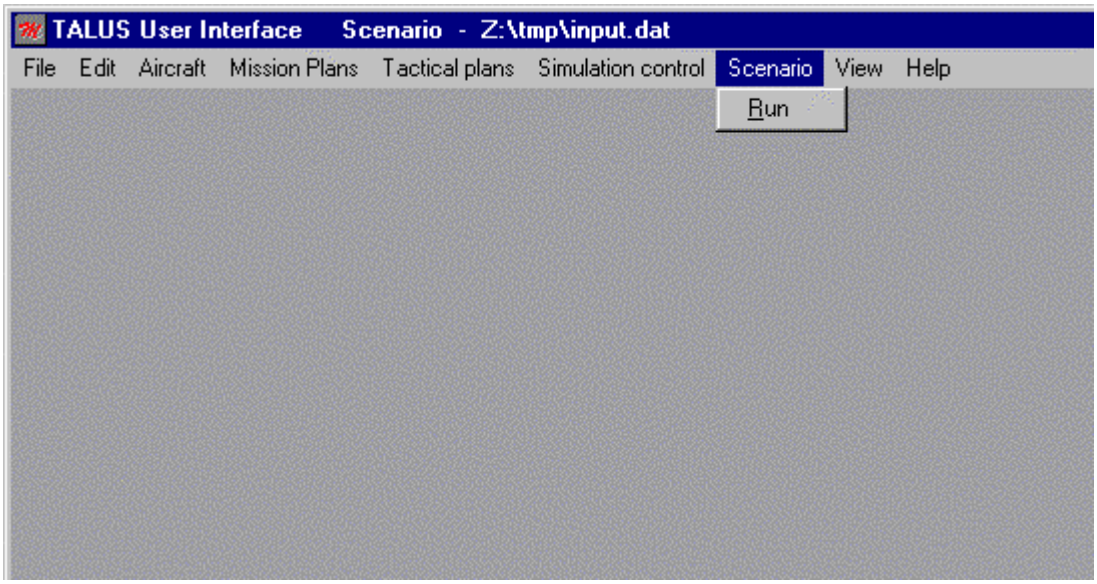

Figure 6.16 Scenario menu

6.7.1 Scenario - Run

When this item is chosen, the simulation, using the TALUS model, is executed. A temporary file named «input.dat» is generated by the «TALUS User Interface» and is used as input for TALUS. The TALUS executable must reside in the same directory as the «TALUS User Interface». If animation is set to «Off», TALUS will be executed in the background and nothing will seem to happen. The simulation will, however, run its course and the result will be output to main output file «output.ftn15». If animation is set to «On», the scenario will be animated. See Chapter 12 for a description of this interface.

When selecting Scenario > Run, a dialog box will appear and the user asked to select a file where trace information will be stored. The directory in which this file is located will also be used to store the other output files, namely «res.f15» and «output.ftn15». Furthermore, a copy of the input file, named «input.dat» will be put in this directory.

Due to some peculiarity of the Windows operating system, however, the trace file «res.dat» (or whatever name the user has selected), will not actually be produced. To account for this, a batch file - «run.bat» - will be created in the specified directory. Executing this batch file (outside the user interface) *will* produce the «res.dat» trace file, as well as the other output files. Note that this only applies to the trace file – the main output file, «output.ftn15», is created at the right location, also when running TALUS from the user interface.

6.8 View Menu

This menu (Figure 6.17) is similar to the popup menu displayed when right-clicking in the window canvas.

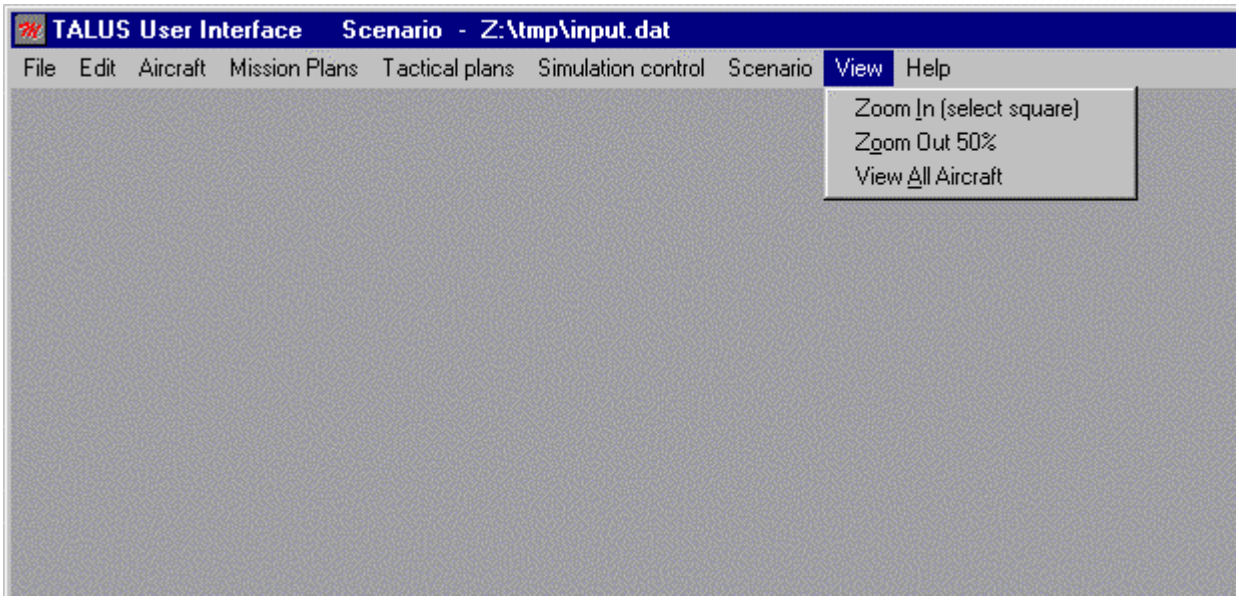

Figure 6.17 View menu

6.8.1 View - Zoom In (selected square)

After this item is selected, one must left-click the mouse in the window canvas to select the first corner of the area to be viewed. Then one must move the mouse (a rubber square indicating the area to be zoomed is displayed) and left-click the mouse again to actually zoom in the selected area.

6.8.2 View - Zoom Out

Zooms out 50% around the current window centre point.

6.8.3 View - View All Aircraft

The view is changed so that all aircraft are shown within the window borders.

6.9 Help Menu

The help menu is depicted in

Figure 6.18 and contains two items.

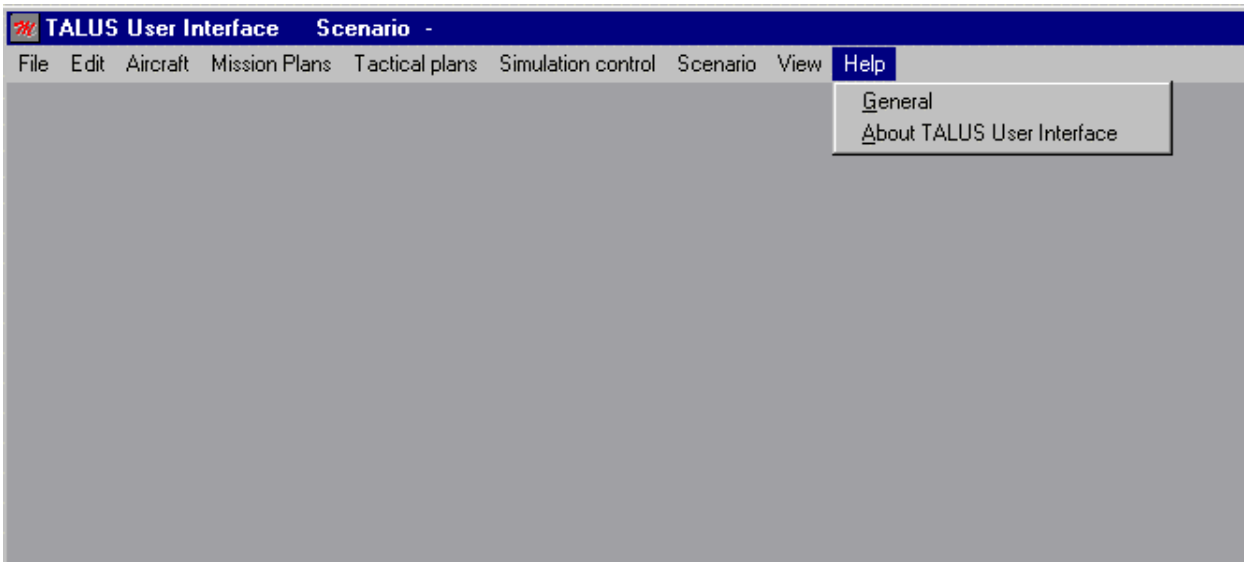

Figure 6.18 Help menu

6.9.1 Help - General

Gives access to the help system for the program, including this manual. The index is shown in Figure 6.19.

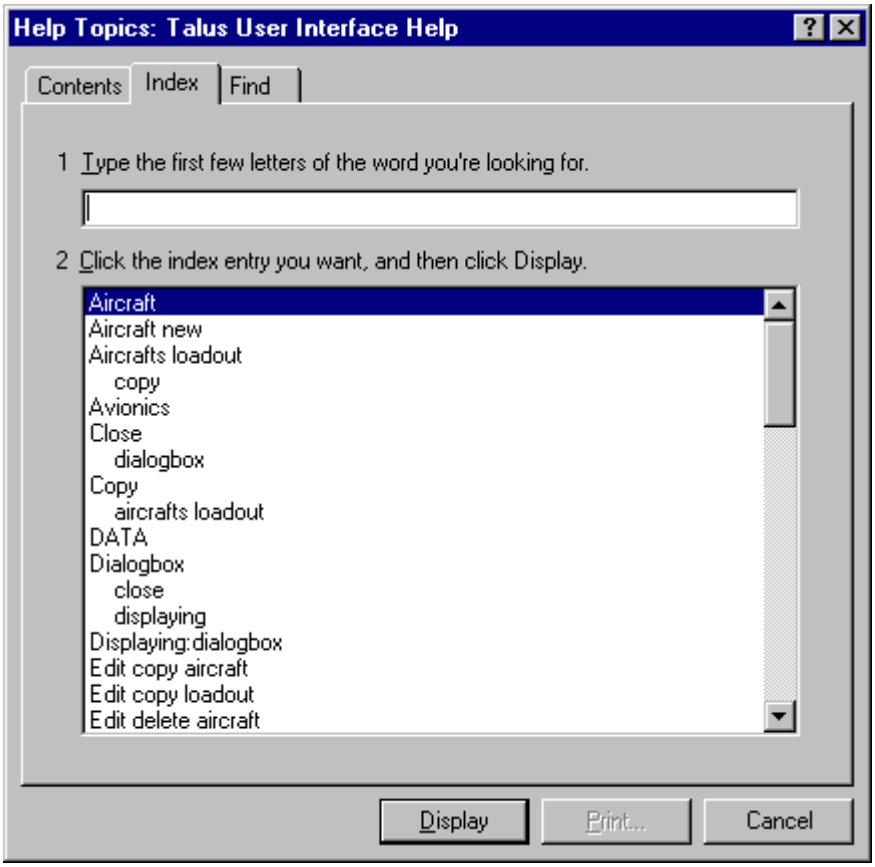

Figure 6.19 Help General

6.9.2 Help - About TALUS User Interface

Displays version information etc, as shown in Figure 6.20.

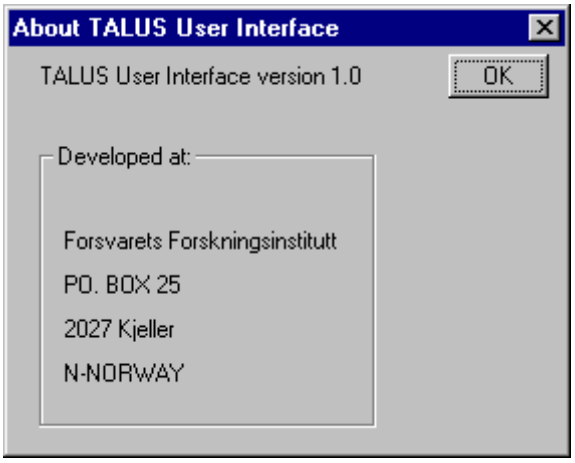

Figure 6.20 About TALUS User Interface

7 THE DATABASE

The database is a directory structure, depicted in Figure 7.1, which contains data files for different types of aircraft, aircraft configurations, subsystems, missiles, tactical plans etc. These are available to the user through the user interface for definition of aircraft configuration and loadout, reuse of tactical plans (usually as a basis for modifications) etc.

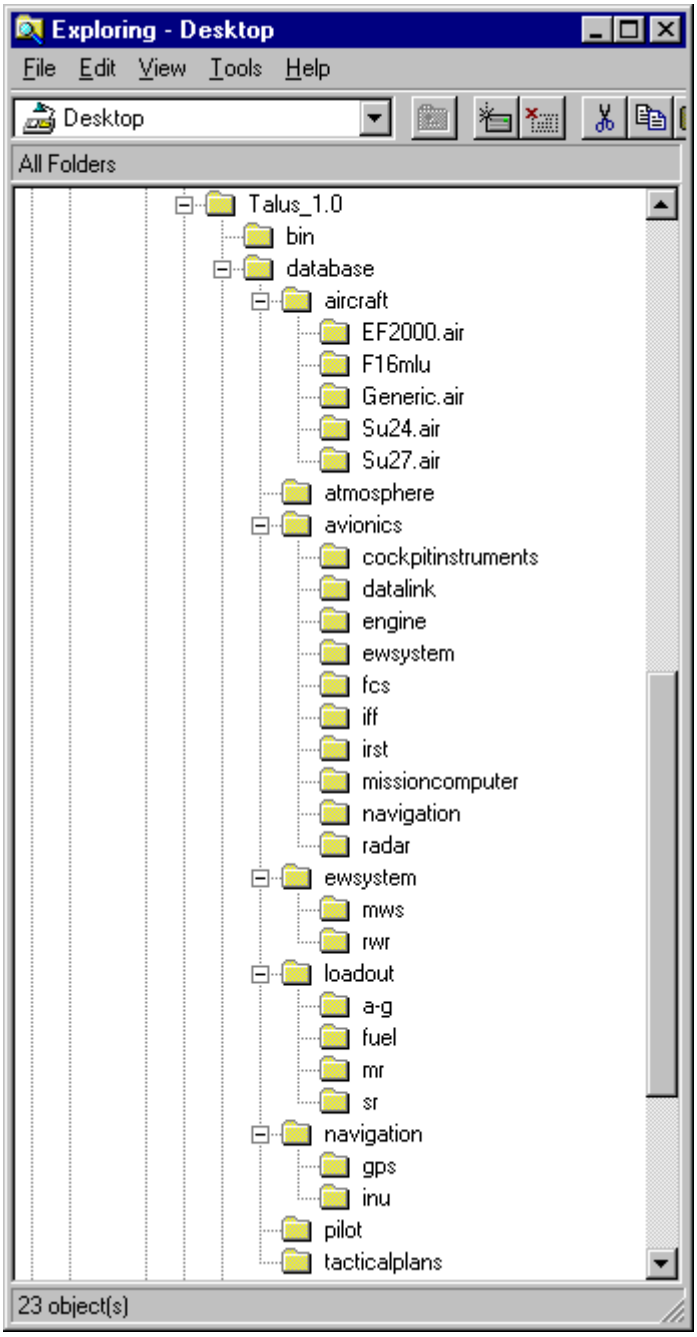

Figure 7.1 Directory structure of database

Seen from the user interface, the database is static - at least at present. It is not possible to define, say, a new radar and download it to the database. To make additions and modifications, use a text editor and enter the data manually, saving the result in the database using the proper file extension. The user should employ the existing data files as templates for new entries.
A special note is needed for the definition of aircraft types. Figure 7.2 exemplifies the data structure associated with an aircraft. Each aircraft type must have its own directory below the \aircraft directory, named «<type name>.air». In this directory there must be at least two files, one, called «<type name>.main», containing weight, wingspan, aerodynamic constants etc. Additionally, there must be one or more «*.sub» files that define the configuration of the aircraft, with respect to engine type, sensor types, data link etc. In this way it is possible configure an aircraft with a number of avionics options, without having to re-enter the airframe data for each configuration.

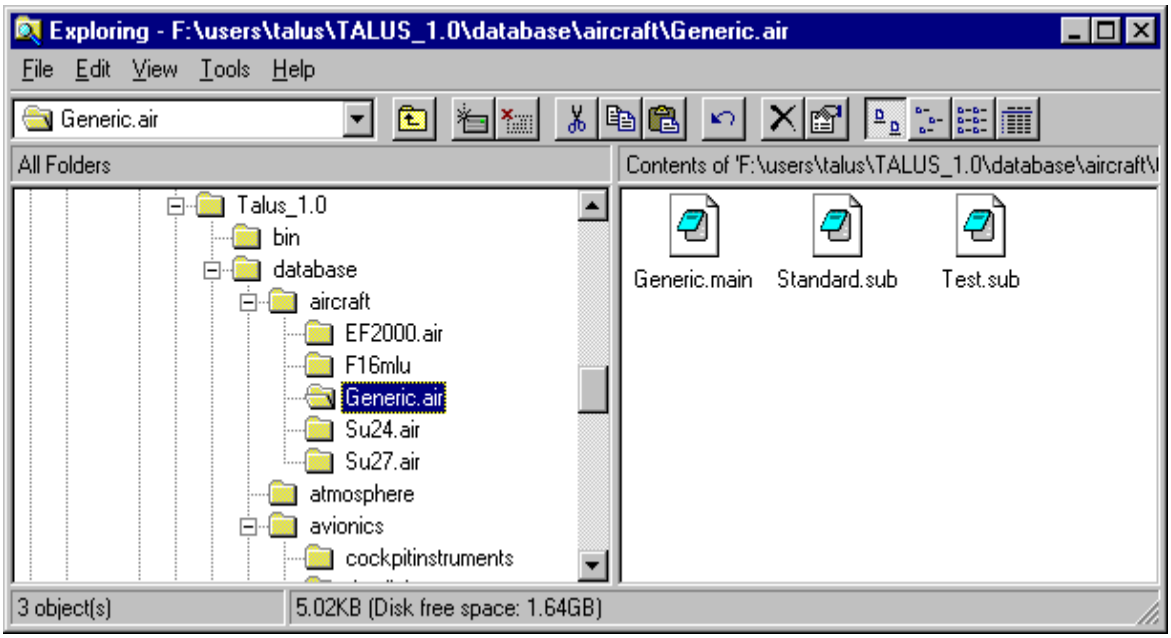

Figure 7.2 Database files for aircraft

8 DEFINING AND EDITING AIRCRAFT

When Aircraft → New is chosen from the main menu, an aircraft properties dialog box, as in Figure 8.1, is displayed for a new aircraft. This dialog box is the same as for an existing aircraft, (see Section 5.2.2, «Edit settings») except that no values are set in the controls. Some exceptions to this are in controls where default values are used. The different controls in the different tabs are explained in the following sections.

8.1 Type Tab

This tab contains four controls, as shown in Figure 8.1.

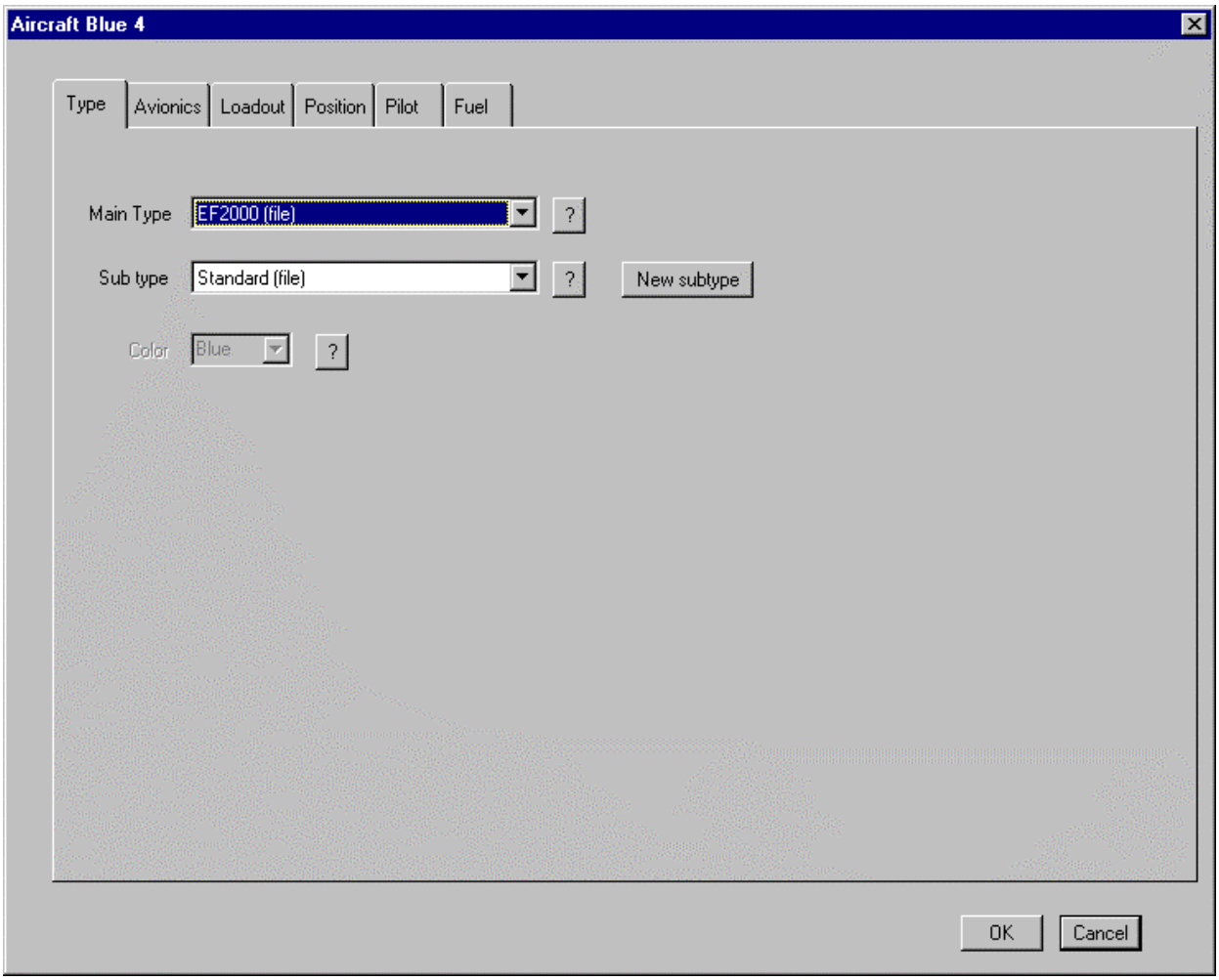

Figure 8.1 Type tab

8.1.1 Main Type

One main type must be selected from the options list before a subtype can be selected. New main types cannot be defined by the user, they must be entered into the database manually, as described in Chapter 7.

8.1.2 Subtype

A subtype may either be selected from the options list or a new type may be defined by pressing the «New subtype» button. When an existing one is selected, the controls underneath the «Avionics» tab are set to the values for that subtype. They cannot be edited, except for «Sensor Fusion», «Threat Library», «Navigation Properties» and «EWcomputer Properties», see Section 8.2, «Avionics tab for existing subtype».

8.1.3 New Subtype

When this button is pressed, the user is allowed (and must) type in a name in the «Subtype» field (combo box). The user must then set appropriate values for the controls underneath the «Avionics» tab, see Section 8.3 «Avionics tab for new subtype». The new subtype being defined will be available throughout the session, (until the scenario is closed) and may be used in creating new aircraft or editing existing ones. It will have the extension «(created)» after its name.

8.1.4 Colour

This combo box specifies to which side this aircraft belongs. One cannot change side (colour) of an existing aircraft.

8.2 Avionics Tab for Existing Subtype

If the user has selected an existing subtype from the «Subtype» options list, an «Avionics» tab similar to that shown in Figure 8.2 is displayed (when the «Avionics» tab is selected). Only «SensorFusion», «Threat Library», «Navigation Properties» and «EWcomputer Properties» may be changed. These are explained in the next section. The controls underneath the «Avionics» tab are what actually defines a subtype.

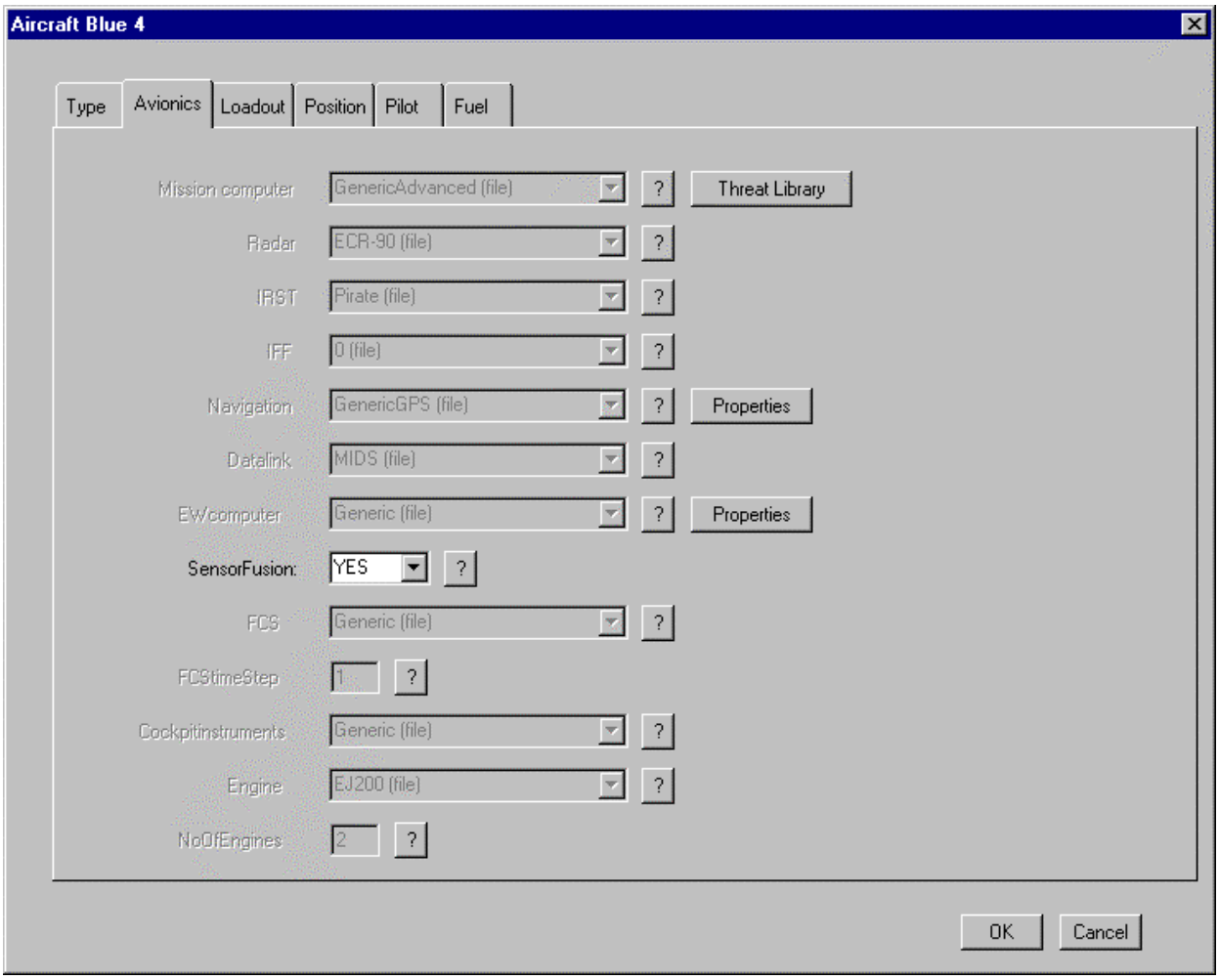

Figure 8.2 Avionics tab for existing subtype

8.3 Avionics Tab for New Subtype

If the user has selected the «New subtype» button, and has typed in a name in the «Subtype» combo box, the appearance of the «Avionics» tab will be something like that shown in Figure 8.3. The new subtype must be defined by setting the appropriate values in the different controls. The controls are explained below.

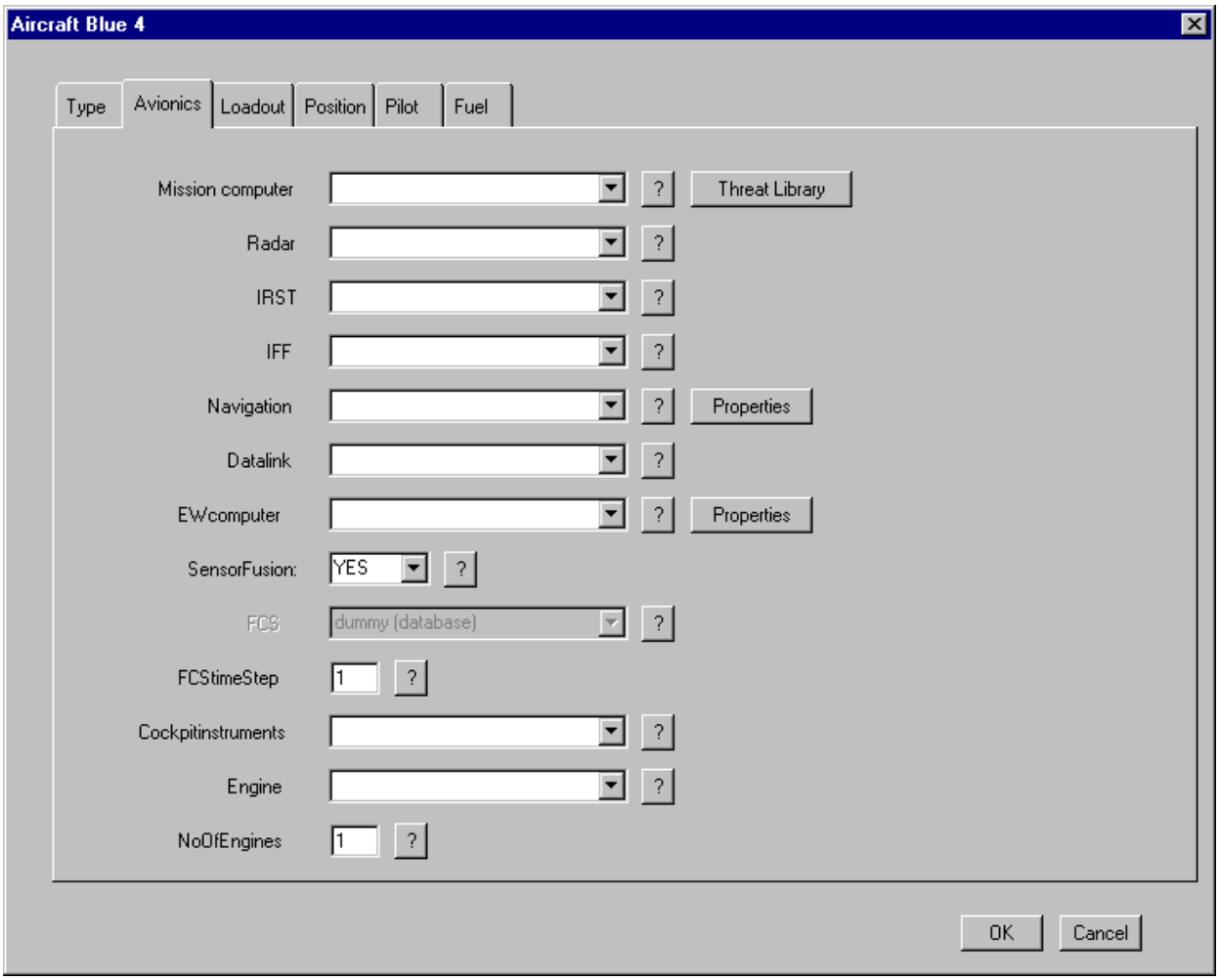

Figure 8.3 Avionics tab for new subtype

8.3.1 Missioncomputer

This box identifies the central (tactical) computer of the aircraft. The mission computer contains the threat library and a few parameters concerning the tracking capacity of the mission computer. It is important to note that two aircraft having the same type of mission computer will have identical threat libraries, even if this has been modified (see below). In particular, aircraft on different sides should *not* use the same mission computer - they will be thoroughly confused with regard to who is friend and who is foe!

Note also that whether the mission computer is of the advanced, sensor fusing kind is not decided by the entry in this box, but rather by the selection between «YES» or «NO» in the sensor fusion box described below.

8.3.2 Threat Library

The threat library of the selected mission computer can be modified by pressing this button, resulting in the dialog box seen in Figure 8.4. Sensors that have an ID capability will - if they are successful - report the type name of the target to the mission computer. If the mission computer have this type in its threat library, the identity of the target will be tagged on to the track. If it does not, the track will be presented as an «unknown» to the pilot. If the user wants

each aircraft to have a complete threat library, these must be updated each time a new (main) type of aircraft or missile is introduced to the scenario.

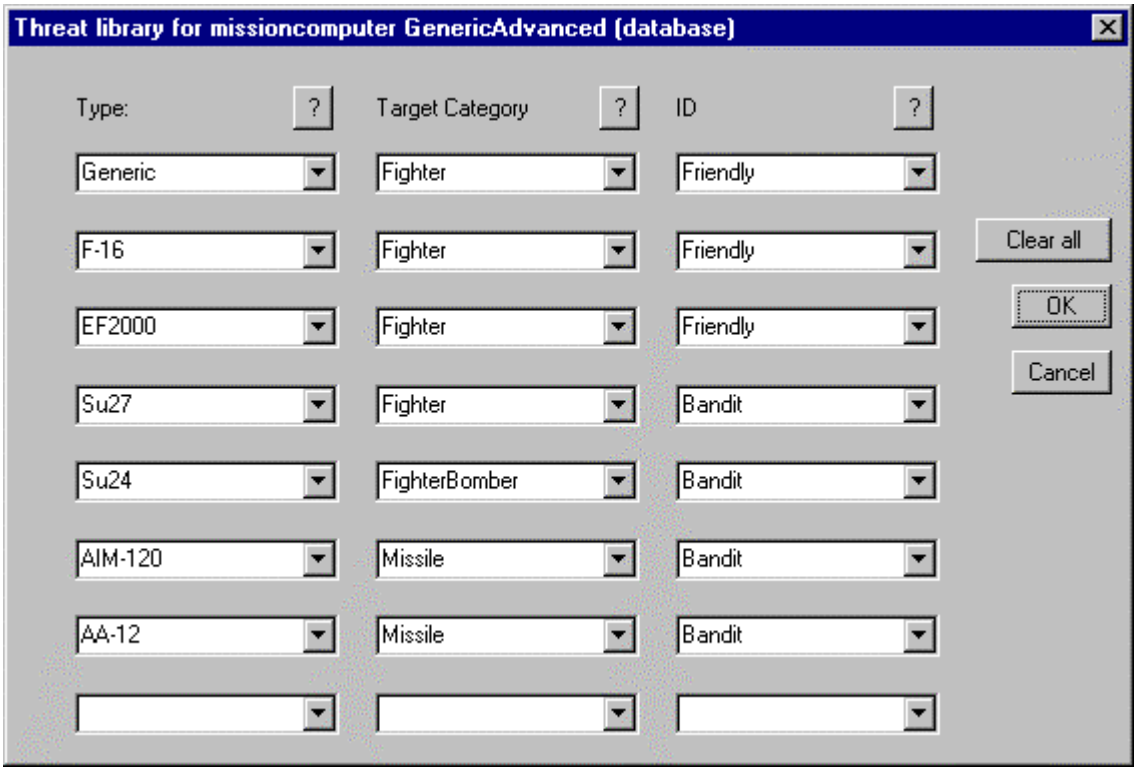

Figure 8.4 Threat library dialog box

Note that a missile should not be given a friendly ID! An airborne missile is always a danger to nearby aircraft and TALUS does allow Blue-on-Blue situations.

8.3.2.1 Type

Select the type of aircraft or missile that should have an entry in this threat library.

8.3.2.2 Target Category

Specify whether – given an ID – also the more specific target category should be known.

8.3.3 Radar

Select the Radar from the available list for the new subtype or leave it empty if it is not to be equipped with one.

8.3.4 IRST

Select the infrared search and track from the available list for the new subtype or leave it empty if it is not to be equipped with one.

8.3.5 IFF

Select the IFF from the available list for the new subtype or leave it empty if it is not to be equipped with one. At present though, the IFF is not functional in TALUS.

8.3.6 Navigation

Select the navigation system from the available list for the new subtype. The navigation system consists of a inertial navigation system (INS) and an optional GPS receiver.

8.3.7 Navigation Properties

The navigation subsystem can be modified by specifying the type of INU and GPS that should be included in it, see Figure 8.5. An INU must be included, but a GPS need not. A navigation system without GPS will be subjected to uncorrected drift errors.

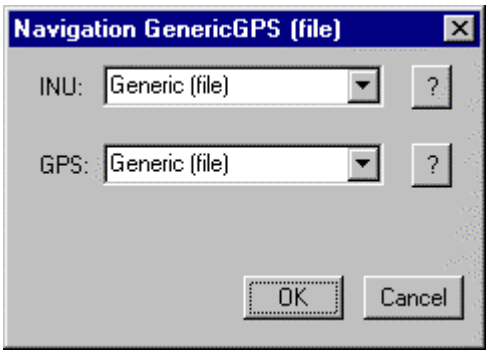

Figure 8.5 Navigation properties dialog box

8.3.7.1 INU

Specify the type of inertial navigation unit.

8.3.7.2 GPS

Specify the type of global positioning system (or leave it empty).

8.3.8 Datalink

If the aircraft is to be equipped with a tactical data link, its type is specified here. Note that if a data link is selected, the aircraft (or rather, the mission computer) *should* be made capable of sensor fusion, see below.

8.3.9 EWComputer

Select the electronic warfare system from the available list for the new subtype or leave it empty if it is not to be equipped with one.

8.3.10 EWComputer Properties

The EW system is presently made up of a missile approach warning system (MAWS or MWS) and a radar warning receiver (RWR). These are selectable through the dialog box in Figure 8.6. Note that one or both of these may be left blank if the aircraft does not carry that subsystem.

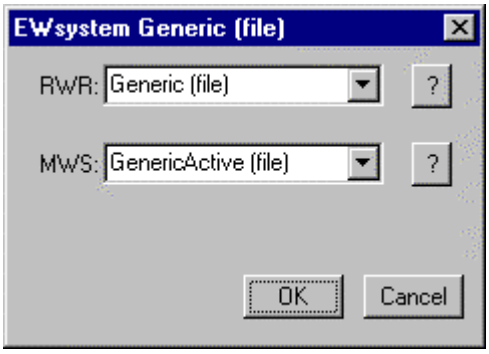

Figure 8.6 EWComputer properties dialog box

8.3.10.1 RWR

Specify the type of radar warning receiver (or leave it empty).

8.3.10.2 MWS

Specify the type of missile warning system (or leave it empty).

8.3.11 Sensor Fusion

Whether the mission computer of the aircraft is able to perform sensor fusion is decided by selecting ’YES’ or ’NO’ in this box. If ’YES’, both track correlation and information fusion will take place, but the process will not be instant and perfect. Rather, a continuous checking and double-checking of hypothesis is taking place, hopefully resulting in a progressively simpler airpicture. The next version of TALUS will probably include a parameter that the user can adjust to control the speed and accuracy of the sensor fusion process.

8.3.12 FCS

At the moment, only one selection is available for the flight control system. If, in the future, say a 6-DOF model should be implemented, the selection between flight models can be made here.

8.3.13 FCSTimeStep

Specifies the time step (in seconds) of the flight control and simulation system (FCS). A normal choice here is a time step of 1 second and TALUS is not extensively tested for other values.

8.3.14 Cockpitinstruments

Select the type of cockpit instruments from the available list for the new subtype. The main difference between the types is the amount of time it would take for a pilot to assimilate the sensor information displayed on them, modelling the quality of the man-machine interface.

8.3.15 Engine

Selects the engine type for the new subtype. Different subtypes of a main aircraft type may have different engines.

8.3.16 NoOfEngines

Selects the number of engines of the new subtype. Note that 2 engines would double the thrust and fuel consumption of the aircraft with respect to the data given for its engine type. Note also that the number does not need to be an integer. A selection of e.g. 1.3 would increase thrust and fuel consumption by 30% compared to a selection of 1.0.

8.4 Loadout Tab

What type of loadout that is applied to each loadout point can be set in this tab, depicted in Figure 8.7. A combo box is displayed for each loadout point (number depends on the «Main Type» of aircraft). The different loadouts available are shown in the dropdown list for each point. The following five parameters must be set for each loadout. If loadout for a point is set to «empty», then all five parameters are set to «0».

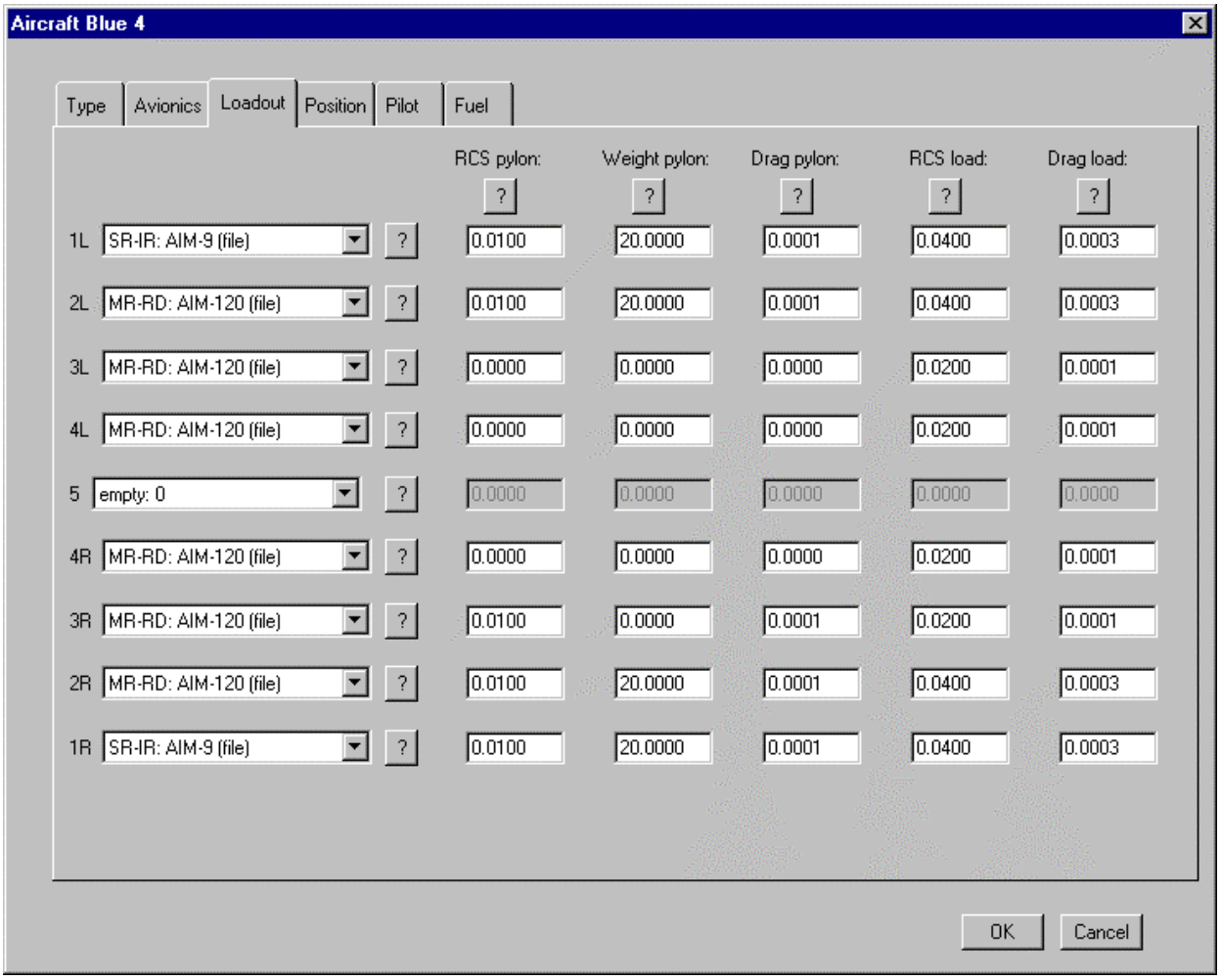

Figure 8.7 Loadout tab

8.4.1 Load Specification

Specify a weapon or fuel tank (or leave it empty).

8.4.2 RCS Pylon

The radar cross section (in m^2) contribution of the pylon. This is given as a delta, constant for all aspect angles.

8.4.3 Weight Pylon.

The weight contribution of the pylon in kg.

8.4.4 Drag Pylon

The drag contribution of the pylon. This is given as the zero drag coefficient delta (C_{D0}). Note that this should be a small number, in the order of 0.0001, or the aircraft will not be able to fly! Double check by adding the zero drag of all pylons and weapons/tanks and compare it to the zero drag given for the aircraft itself, found in the «<aircraft>.main» file in the database. This sum should at least not be orders of magnitude larger than the zero drag of the clean aircraft.

8.4.5 RCS Load

The radar cross section (in m^2) contribution of the actual weapon/tank. This is given as a delta, constant for all aspect angles. Note that this number may vary for a given load, depending on the hard point it is attached to. A missile will have different RCS (and drag) contributions if it is on the wing, semi-recessed or carried internally.

8.4.6 Drag Load

The drag contribution of the weapon/tank. This is given as the zero drag coefficient delta (C_{D0}). Again, take care that the sum of drag deltas do not become to big. The weight contribution of the load is defined in the weapon/tank data and need not be specified in the loadout section.

8.5 Position Tab

The initial position, speed and course for the aircraft is defined in the tab in Figure 8.8. Note that there should usually be some sort of coherence between these initial values and the manoeuvre data of the initial tactical plan.

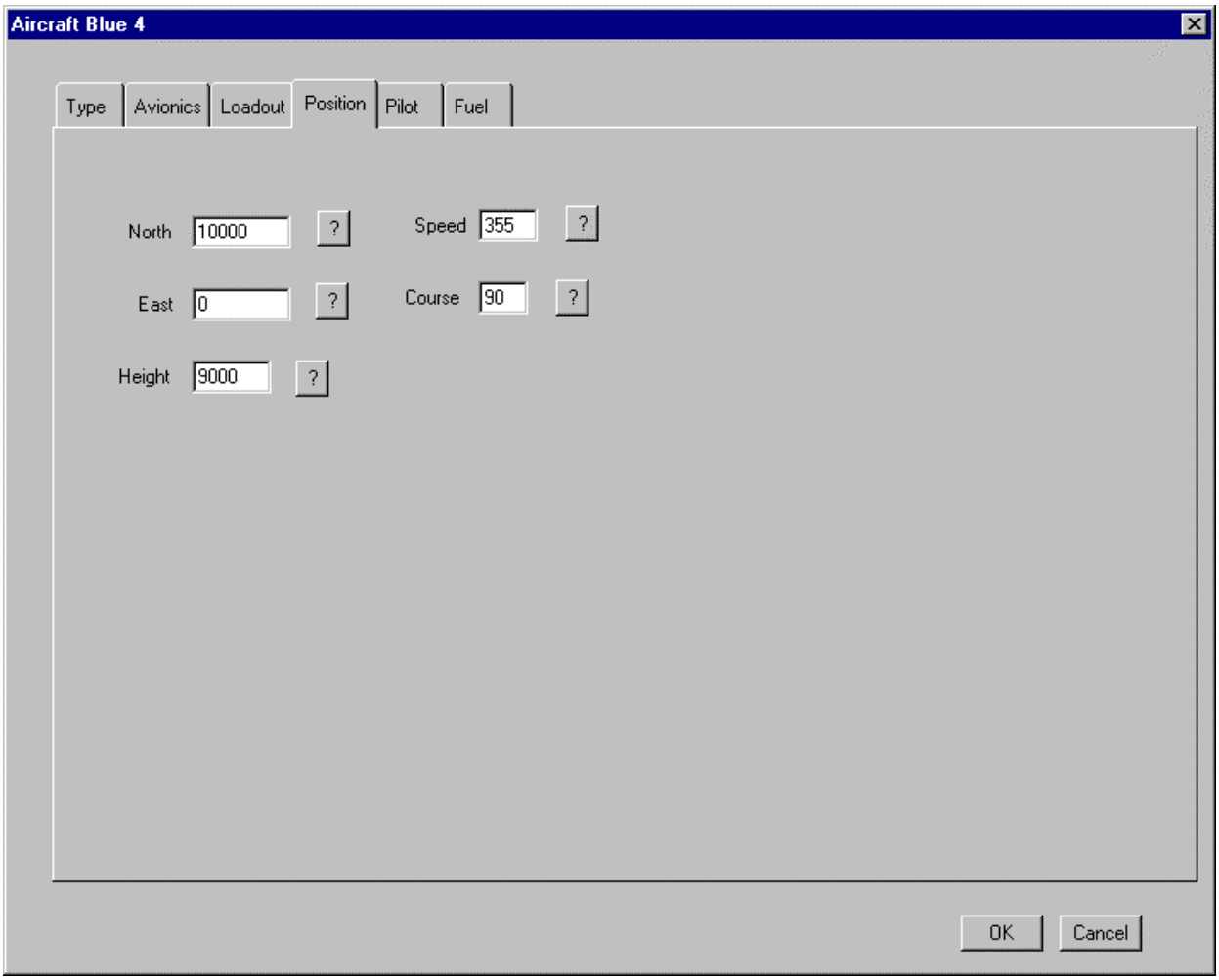

Figure 8.8 Position tab

8.5.1 North

Specifies the initial north/south position of the aircraft in metres. Centre of the working area is initially set to 0.0.

8.5.2 East

Specifies the initial east/west position of the aircraft in metres. Centre of the working area is initially set to 0.0.

8.5.3 Height

Specifies the initial height of the aircraft in metres. If not specified, it is set to 0.0!

8.5.4 Speed

Specifies the initial speed of the aircraft in m/s. If not specified, it is set to 0.0!

8.5.5 Course

Specifies the initial course of the aircraft in degrees, 0 degrees being north, 90 degrees being east, and so forth. If not specified, it is set to 0.0!

8.6 Pilot Tab

The pilot can be specified for individual aircraft, see Figure 8.9.

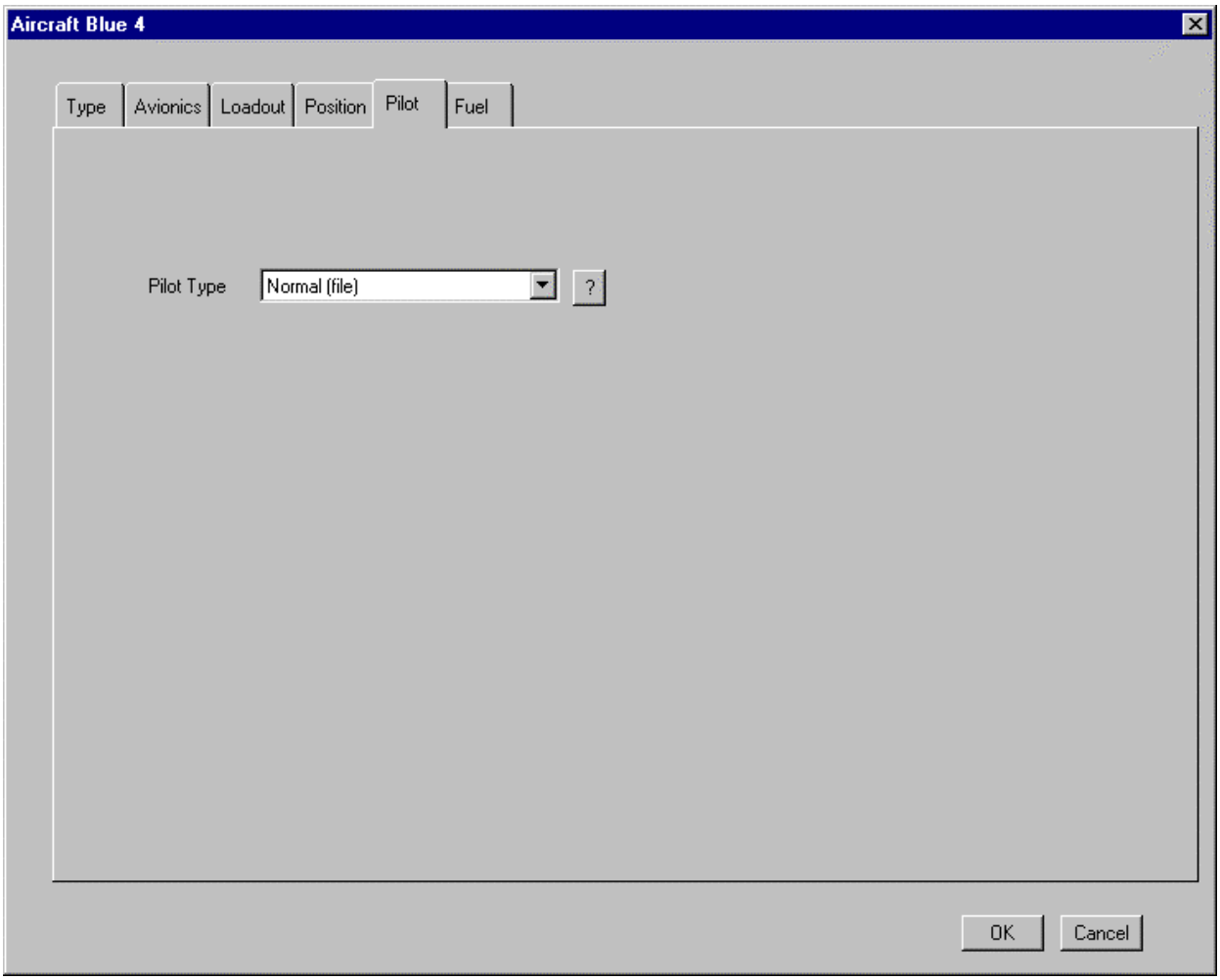

Figure 8.9 Pilot tab

8.6.1 Pilot Type

How experienced the pilot is can be specified here. There are three available levels of experience; «experienced», «normal» and «inexperienced». The default value is «normal». The difference between the types is given by their ability to quickly assimilate sensor information and to maintain a complex airpicture. A future upgrade will probably include a selection of pilot aggressiveness.

8.7 Fuel Tab

The fuel levels can be adjusted for aircraft on an individual basis, as seen in Figure 8.10.

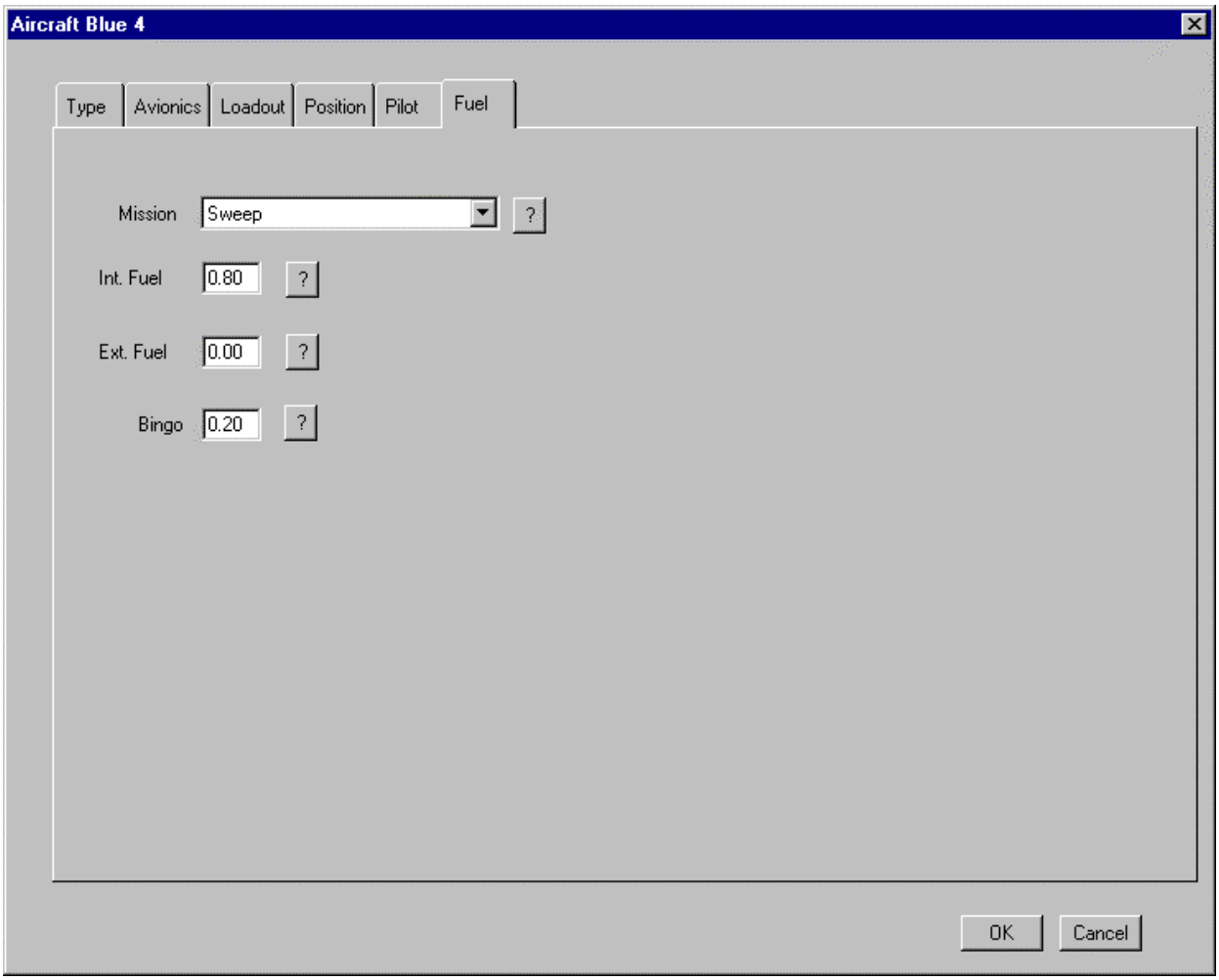

Figure 8.10 Fuel tab

8.7.1 Mission

The mission of this particular aircraft – a bit misplaced. The choice here is not very significant, except for «AirToGround». If this is specified, particular rules come into play regarding mission abort criteria, see Section 11.6.2.5.

8.7.2 Int. Fuel

Initial fuel, as a fraction of maximum internal fuel capacity. This value should be between 0.0 and 1.0.

8.7.3 Ext. Fuel

External fuel, as a fraction of maximum external fuel capacity. The external fuel capacity is given by the capacity and number of wing tanks actually carried by this aircraft, as defined under the loadout tab. This value should be between 0.0 and 1.0.

8.7.4 Bingo

When the fuel level reaches the fraction of maximum internal fuel capacity given here, it is time to abort and head for home. This value should be between 0.0 and 1.0.

9 DEFINING THE COMMAND & CONTROL STRUCTURE

All aircraft in a scenario must be integrated into the command and control structure of its side before the scenario can be run. The hierarchy has three levels - mission, formation and section. The section consists of one or two aircraft - a Section Leader and an optional wingman. Any number of sections can be used to form a formation - with one of the section leaders designated to double as Formation Leader. Likewise, any number of formations can be used to form a mission - with one of the formation leaders designated to be also the Mission Commander. All aircraft on one side usually belongs to the same mission, though there are provisions to have more than one.

The command and control structure is employed for co-ordination and communications between aircraft on the same side. A Mission Commander may, for instance, allocate his own forces by ordering his formation leaders to attack different enemy formations, while a Section Leader will co-ordinate a target sort with his wingman. How extensive - and at which level - this co-ordination is, depends on the definition of the tactical plans, see Chapter 11, «Defining Tactics». Neither the extent of co-ordination nor the command and control structure itself are static throughout the duration of an engagement. Each pilot will update his perception of the command structure when he learns about other pilots either being shot down or returning to base, while the command authority in general will move down in the hierarchy as the engagement evolves and (possibly) becomes more chaotic.

9.1 How to Create a Command Structure.

The command structure is established by creating and modifying the formations. The Mission Commander is nominated when the first formation is created and will be identical to this formation's Formation Leader. The sections are defined as part of defining the formation. The creation of new, or editing of existing, formations can be initiated in two ways:

a) By selecting one or more previously unassigned (no formation name next to the aircraft name) aircraft, right-clicking, and selecting either «New Formation» or «Add to <existing formation>».

b) By selecting an aircraft that is already part of a formation, right-click and select «Open Formation».

When either of the popup menu items «Open Formation», «Add To Formation» or «New Formation» are selected, a new window named «Command Structure» is displayed, similar to that shown in Figure 9.1. If the aircraft drawn are previously members of a formation, a line is drawn from each aircraft to another, indicating a relationship between those aircraft. Also, next to the text showing the aircraft's id, a text indicates the aircraft's role in the command structure. There are four possibilities, MC-Mission Commander, FL-Formation Leader, SL-Section Leader and WM-wingman, see above.

Any aircraft that have not previously been member of the formation does not have a line drawn between itself and another aircraft, nor does it have any text drawn next to it indicating its role.

To add an aircraft (not previously member) to the formation, right-click on the aircraft that is to be its «leader» in the command structure, move the mouse to point on top of the aircraft that is to be added (a rubber line will be drawn between the aircraft clicked upon and the mouse position). Then right-click on the aircraft to be added and select its role from the available items in the popup menu. Which items that are available depends on the role of the «leader».

To reconfigure the whole command structure of a formation, select the menu item «Command Structure→Reset All». All lines and text indicating roles will be removed. Then right-click on the aircraft that is going to be the highest (leader) in the command structure. A popup menu item is displayed, either «Mission Commander» (if none exist in any formation on that side), or «Formation Leader» if a «Mission Commander» already has been set. Then move the mouse to the next aircraft in the command structure, right-click on it and choose its role from the popup menu. A line will be drawn between the two aircraft. Now, right-click on any of those two aircraft to continue to define the command structure. When finished, save the command structure, see Section 9.2.1.1 «File Save» later in this chapter. Any aircraft not being connected to another one with a line will not be added to this formation. When a new formation is opened one must follow the same procedure as when «Command Structure→Reset All» has been selected.

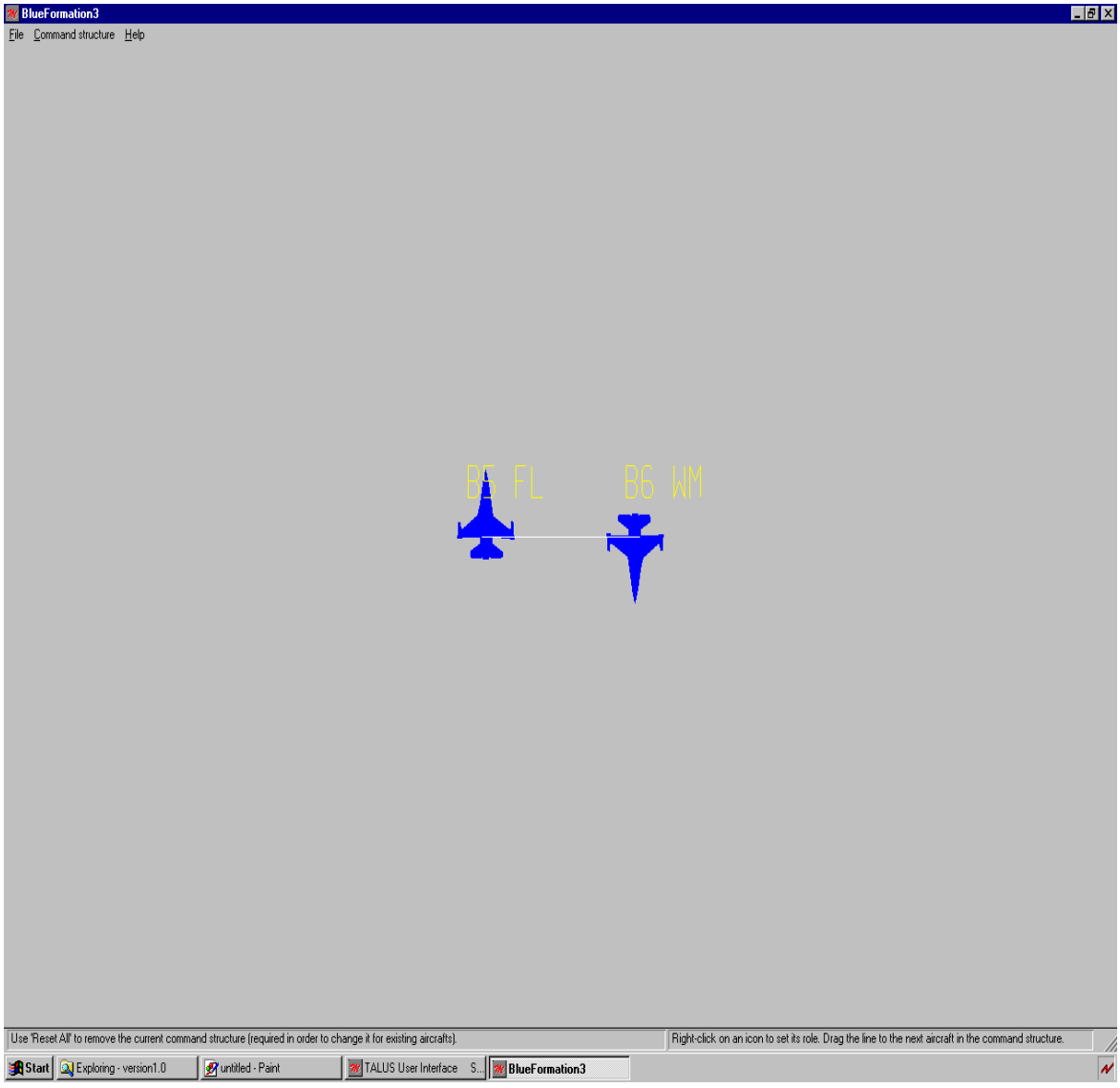

Figure 9.1 Command structure window

9.2 Menu Structure in Command Structure Window

An explanation of each of the available menu items in the command structure window is given below.

9.2.1 File Menu

The File menu is depicted in Figure 9.2 below.

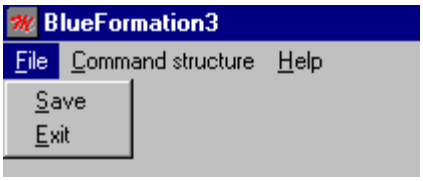

Figure 9.2 File menu in command structure window

9.2.1.1 File - Save

Saves the current state of the command structure, including changes that have been implemented to the current formation.

9.2.1.2 File - Exit

Exits the «Command Structure» window and returns the control to the «Main» window. If changes have been made to the command structure since it was last saved, a dialog box shown in Figure 9.3 is displayed, prompting the user to save these changes.

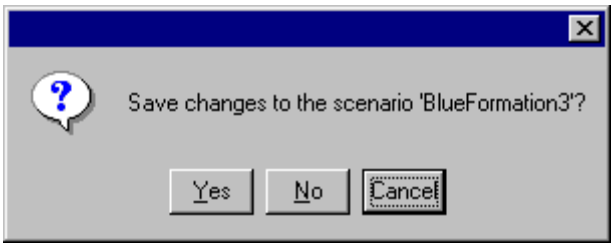

Figure 9.3 Message dialog displayed when changes have not been saved

9.2.2 Command Structure Menu

The Command Structure menu is depicted in Figure 9.4 below.

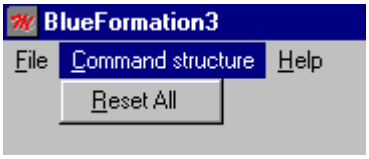

Figure 9.4 Command structure menu in Command structure window

9.2.2.1 Command Structure - Reset All

When this item is chosen, the whole command structure of the current formation is removed. Changes will not take effect until the command structure is saved. This option must also be used to remove a formation completely. Choose «Reset All», and then save the command structure.

9.2.3 Help Menu

The Help menu is depicted in Figure 9.5 below.

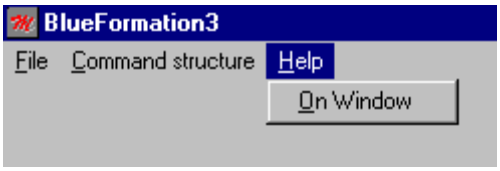

Figure 9.5 Help menu in Command structure window

9.2.3.1 Help - On Window

Displays help for this window.

10 DEFINING A MISSION

For each formation in a scenario, a mission needs to be defined. Selecting a formation from the menu Mission Plans in the main window will open the dialog box, displayed in Figure 10.1, where a mission is specified. A mission plan is essentially a script of lower-level tactical plans. An intercept mission may, for instance, specify that the formation should employ a tactical plan of the type ’Intercept’ first, then, if nothing happens, a tactical plan of the type ’RTB’ (Return To Base). The transition between these plans are governed by the interrupt criteria of the actual plans involved. Note that the third type of available tactical plans - ’Attack’ - is usually not specified in the script. This plan will be executed when an interrupt criterion of one of the other plans suggests it. The mechanism of transition between tactical plans allows for extensive excursions from the script, see Chapter 11 - «Defining Tactics».

When defining a mission plan, there are only three types of tactical plans available - ’Intercept’, ’Attack’ and ’RTB’. These plans are, however, quite flexible and each formation will typically have its own flavour of each of them. The ’Intercept’ plan may, for instance, be implemented as a standard vectored intercept, a CAP (racetrack) or bomber escort. The common denominator being that it is employed pre-engagement, while its execution may be quite different from one formation to another.

Every aspect concerning the execution of a mission plan is handled by the pilots. Although aircraft behaviour may be described below, it is in fact the pilot model which will implement the plan.

10.1 Mission Tab in Mission Plans Dialog Box

One «mission» menu item is available for each formation that has a command structure defined. The text displayed on the menu item is of the format «*color*Formation# mission», where *colour* is the side, usually «Red» or «Blue» and # is the number of the formation. Numbers (which are unique for each formation) are generated automatically by the application. When one of the «mission» menu items is selected, a dialog box of the format shown in Figure 10.1 is displayed. The elements are described below.

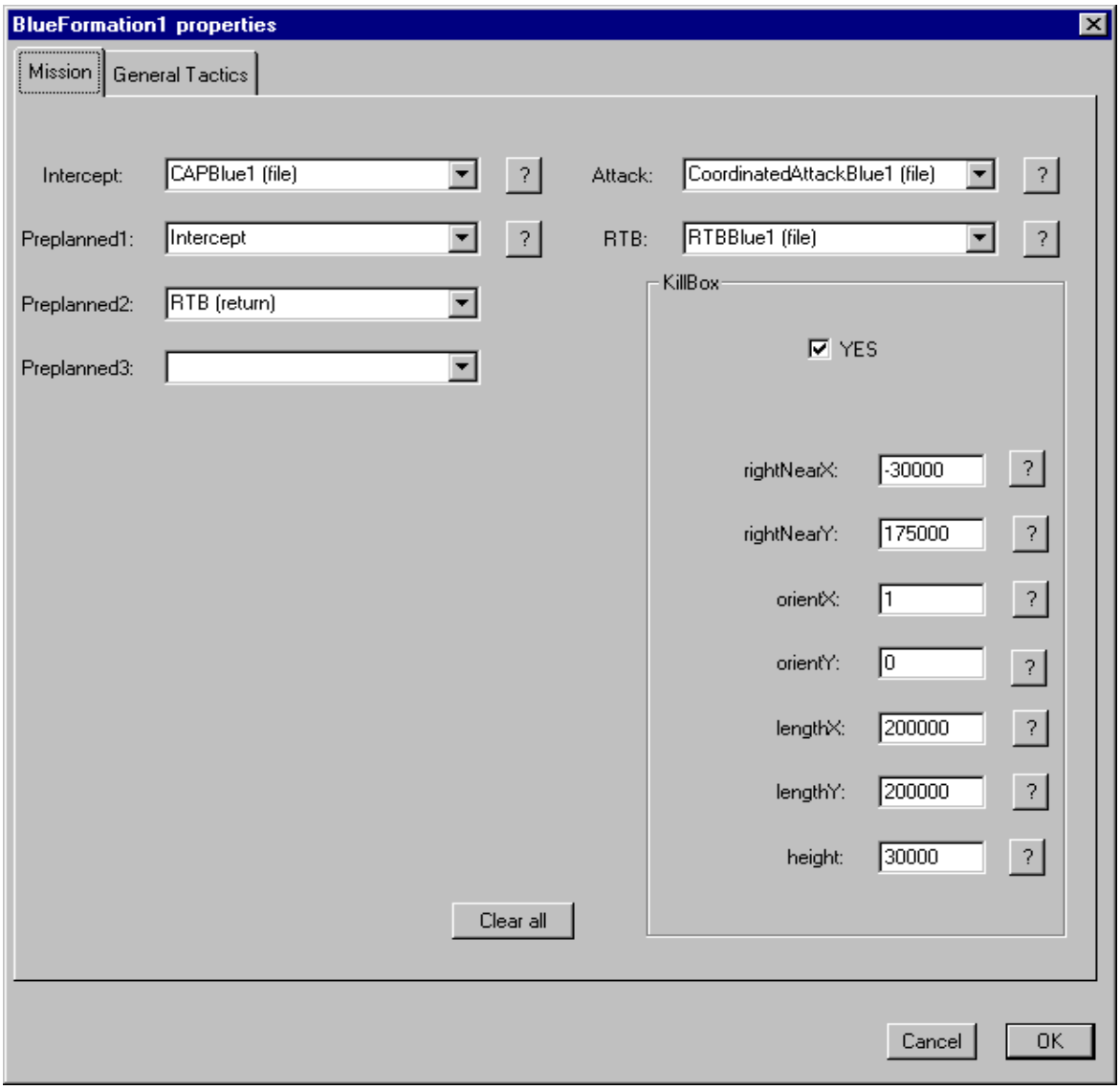

Figure 10.1 Mission Plans dialog box, mission tab

The «Clear All» button removes all the pre-planned combo boxes, except for the first one, and also clears the content of the «Intercept», «Attack» and «RTB» combo boxes.

10.1.1 Preplanned#

The script of tactical plans that constitutes the mission plan is specified using the boxes *preplanned#*. The list should be composed to fulfil the mission *without regard to enemy interference*. The actions required in case of contact with the enemy are specified at the tactical level - see the next chapter.

One can have as many «preplanned» fields as desired (as many as space within dialog box allows). When a value is chosen in the lowest one (highest number), a new empty pre-planned field pops up below it.

The ’(return)’ option that can be added to a tactical plan means that at the termination of any excursion from the script, control will be returned to the plan that was active when the excursion was initiated - *if* this plan had the ’(return)’ option. If not, control will move on to the next tactical plan in the list.

It should be noted here that this structure is somewhat lacking in flexibility. It would be desirable to allow one formation to use different versions of, say, the ’Intercept’ plan at different phases of the mission. At the moment only one specific ’Intercept’ plan may be defined. This may then be used repeatedly by the formation, but the tactical parameters will be identical from one invocation to the next. The implementation of full flexibility is, however, not technically difficult and will almost certainly be included in the next version of TALUS.

10.1.2 Intercept

This box is used to specify the name of the ’Intercept’ plan that is to be employed by the current formation. The detailed nature of this plan is defined using the Tactical Plans menu.

10.1.3 Attack

This box is used to specify the name of the ’Attack’ plan that is to be employed by the current formation. The detailed nature of this plan is defined using the Tactical Plans menu.

10.1.4 RTB

This box is used to specify the name of the ’RTB’ (Return To Base) plan that is to be employed by the current formation. The detailed nature of this plan is defined using the Tactical Plans menu.

10.1.5 Killbox

Each formation may be given an area of responsibility - or kill box. Aircraft belonging to this formation will then only engage targets within the kill box, except in the case of dire crisis. The kill box is defined as a rectangular box with a specified corner, orientation and extent. If the orientation of the box is South-North (orientation (1, 0) in the (North, East) co-ordinate system), the corner in question will be the Northeastern corner, while the length given for the X-direction will be the extent of the box to the South, and the length given for the Y-direction will be the extent of the box to the West. If another orientation is given, the effect will be that of a rotation of the kill box.

10.1.5.1 rightNearX

The North co-ordinate (meters) of the fixed corner of the kill box. If the orientation of the box is South-North (orientation (1, 0) in the (North, East) co-ordinate system), the corner in question will be the Northeastern corner.

10.1.5.2 rightNearY

The East co-ordinate (meters) of the fixed corner of the kill box. If the orientation of the box is South-North (orientation (1, 0) in the (North, East) co-ordinate system), the corner in question will be the Northeastern corner.

10.1.5.3 orientX

The North co-ordinate of orientation vector of the kill box, in the (North, East) co-ordinate system, in meters.

10.1.5.4 orientY

The East co-ordinate of orientation vector of the kill box, in the (North, East) co-ordinate system, in meters.

10.1.5.5 lengthX

The width of the kill box (meters) in the negative x-direction. For a South-North oriented kill box this corresponds to the extent in the West-direction from the Northeastern corner.

10.1.5.6 lengthY

The width of the kill box (meters) in the negative y-direction. For a South-North oriented kill box this corresponds to the extent in the South-direction from the Northeastern corner.

10.1.5.7 Height

Maximum altitude extent (meters) of the kill box, from zero altitude.

10.2 General Tactics Tab in Mission Plans Dialog Box

The second tab in the Mission Plans dialog box, see Figure 10.2, enables the user to set a few tactical parameters for aircraft in individual formations. These parameters will remain constant throughout a scenario, regardless of which tactical plan that is currently executing. Note that the parameters are *tactical*, the actual properties of a given aircraft and its subsystems may impose limits on its performance so that the given values are not attainable.

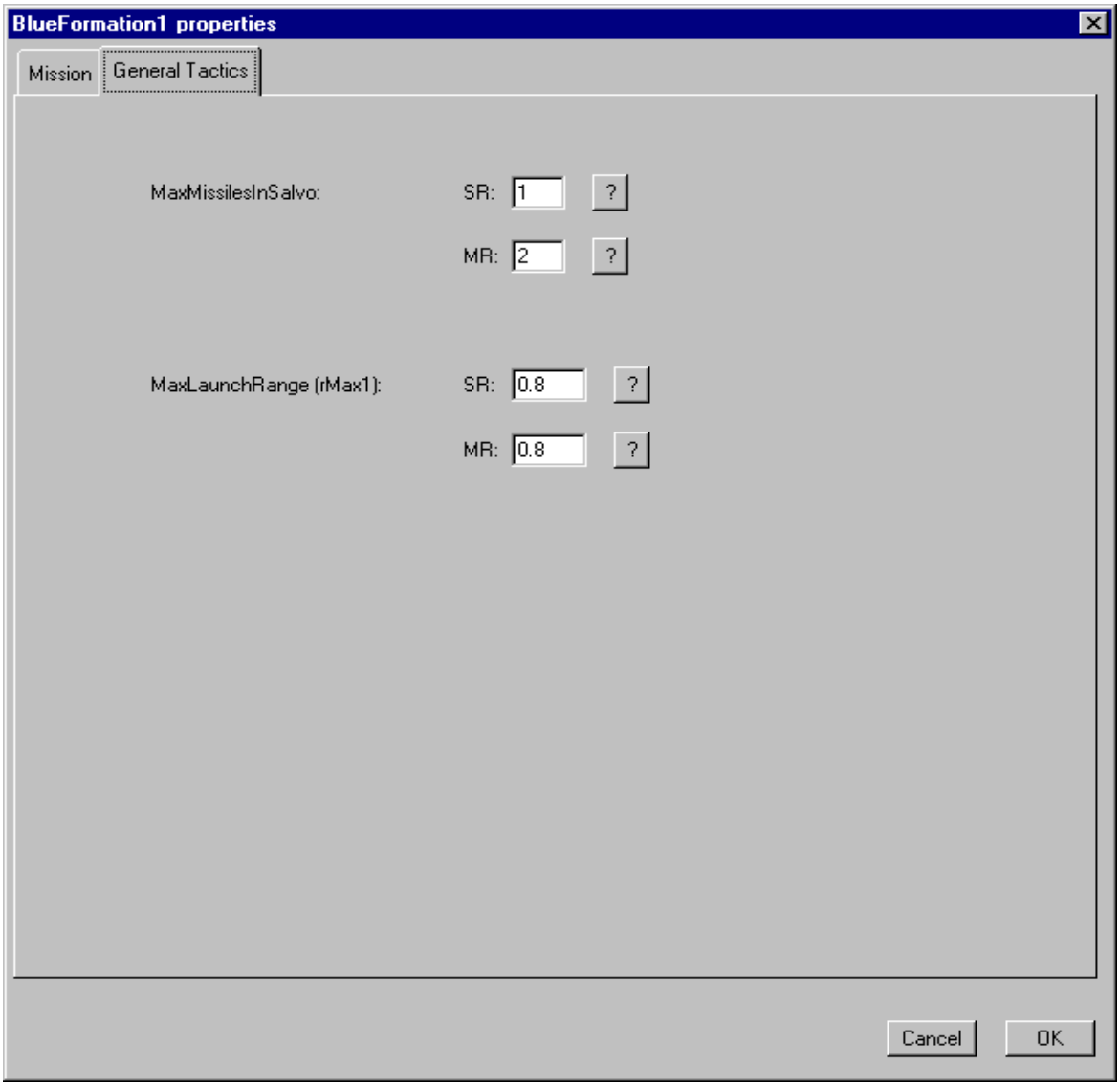

Figure 10.2 Formation dialog box, general tactics tab

10.2.1 MaxMissilesInSalvo SR

This box defines the maximum number of short-range missiles that an aircraft belonging to the current formation will launch in one salvo.

10.2.2 MaxMissilesInSalvo MR

This box defines the maximum number of medium-range missiles that an aircraft belonging to the current formation will launch in one salvo.

10.2.3 MaxLauncheRange(rmax1) SR

This box defines the range to target at which an aircraft will seek to launch its missiles. It is given as a fraction of r_{max1} and is generally a number between 0 and 1, although values greater than 1 are permitted. r_{max1} is computed dynamically with regard to the launcher-target geometry and represents the maximum kinematic range of the missile in question.

10.2.4 MaxLauncheRange(rmax1) MR

This box defines the range to target at which an aircraft will seek to launch its missiles. It is given as a fraction of r_{max1} and is generally a number between 0 and 1, although values greater than 1 are permitted. r_{max1} is computed dynamically with regard to the launcher-target geometry and represents the maximum kinematic range of the missile in question. Prior to the undertaking of serious analysis, the user should do a sensitivity analysis with regard to the effect of varying this value for the medium-range missiles, as it may have a great impact on the effectiveness of the missiles as well as on the extent to which an aircraft will put itself in a vulnerable position. If the value given is too big, the missiles may not (or rarely) reach their target. If it is too small, the launch range will be so short that it puts the launcher in excessive peril.

11 DEFINING TACTICS

Each formation in a scenario has at its disposal three types of tactical plans - ’Intercept’, ’Attack’ and ’RTB’ (Return To Base). The previous chapter explains how these are used to build a mission. In this chapter, the aim is to explain how the tactical plans themselves are defined in detail. All choices made here will affect the tactical behaviour of the affected pilots. Below, references will be made to both pilot and aircraft behaviour, but all actions will in fact be taken by the pilot.

The dialog box that is used in specifying a tactical plan is accessible through the Tactical Plans menu in the main scenario window. From this menu, one may select an existing tactical plan and bring it up for editing, or one may choose to create a new plan - selecting one of the three generic types. If a new plan is selected, the user is asked to supply a specific name for the plan and also if an existing plan should be used as a template for the new one. The result is in all cases a dialog box, similar to the one depicted in Figure 11.1.

Each of the formations will in general have their own versions of the three types of tactical plans, although often only small modifications need to made for formations on the same side. Defining and modifying tactical plans nevertheless constitute the major effort in creating new scenarios and must be resolved through a trial-and-error approach. The user will have to judge the behaviour of individual aircraft and formations, using the scenario animation and trace options, until it is decided that events unfold in a reasonable way.

11.1 General Tab in Tactical Plans Dialog Box

The first tab, shown in Figure 11.1, defines the general structure of the tactical plan and some miscellaneous parameters. A plan is defined by a script of low-level action plans and criteria for moving from one action plan to the next. A brief overview of the available action plans is given below.

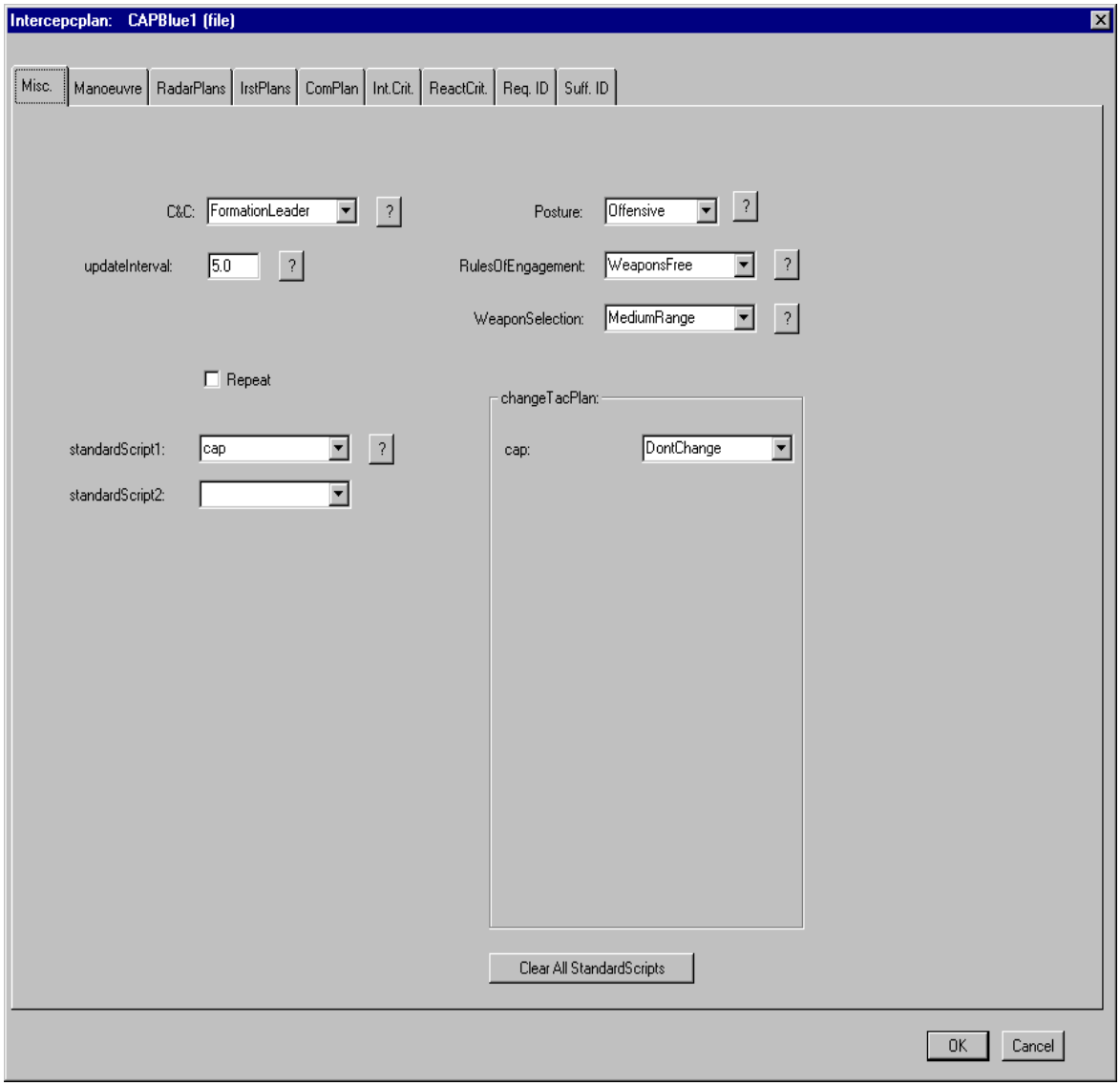

Figure 11.1 General. tab in Tactical plans dialog box

11.1.1 Action Plans

The available action plans can be used in scripts making up any type of tactical plan, although not all of them would make sense in all tactical plans. A tactical plan of the ’Attack’ type, for instance, would in general not employ the action plan ’Land’.

11.1.1.1 Action Plan ’Cruise’

This action plan represents a straight and level flight, generally used pre- or post-engagement. Height, speed and course will be adjusted according to the manoeuvre data of the tactical plan (see Section 11.2).

11.1.1.2 Action Plan ’CAP’

This action plan represents a combat air patrol, generally used pre-engagement. The orientation and position of the racetrack will be adjusted according to the manoeuvre data of the tactical plan (see Section 11.2). The centre of the racetrack will be at the position given here, while its orientation is given by the vector. The user should make sure that the initial positions of the aircraft on CAP should be compatible with the geometry of the racetrack, since there are no

method in TALUS for actually establishing a racetrack as yet. For the same reason, a CAP should only be used as the first action plan of the first tactical plan of any given formation.

11.1.1.3 Action Plan ’Accelerate’

This action plan will implement a max-energy climb more or less head-on towards enemy targets. This manoeuvre is usually co-ordinated by either a Formation Leader or Mission Commander, at least for an initial attack. This action plan represents the first phase of an attack, prior to force allocation and target selection. To make the acceleration optimal, the SEP-curves of the aircraft should be specified, see Section 6.6.1.9.

11.1.1.4 Action Plan ’Commit’

This action plan represents the pre-launch phase of an attack. The aircraft will perform a max-energy climb and missiles will be launched according to the tactical parameters defined in Section 10.2. There will typically be extensive co-ordination between aircraft on the same side in the execution of this plan.

11.1.1.5 Action Plan ’fPoleManoeuvre’

This action plan represents a defensive manoeuvre during the mid-course phase of own missiles. Medium-range missiles typically need to be fed updated target data for most of the flight towards the target, only being autonomous when their own sensors have detected the target - within the 10 last kilometres or so. This action plan will keep the targets at the edge of the search volume of the launcher’s radar, to maximise the offset and minimise exposure to enemy missiles.

11.1.1.6 Action Plan ’aPoleManoeuvre’

When own missiles have entered the active phase, or at any other time it is deemed necessary, this action plan will make the aircraft turn and run from the source of danger.

11.1.1.7 Action Plan ’Land’

This plan will, as the name implies, make the aircraft land on a - hopefully - nearby airfield. The landing itself is not simulated, the effect will be that the aircraft is removed from the simulation, without being counted as a kill.

11.1.2 C&C

This box specifies on which level the command authority rests during the execution of this tactical plan. The commander named here, will be responsible for co-ordinating both the execution and termination of the plan. Subordinate pilots will wait for orders before undertaking decisive action, at least until the tactical situation requires them to take action on their own. If ’Mission Commander’ is specified here, co-ordination will take place between formations. If ’Formation Leader’ is specified, co-ordination will be internal to formations only. Lastly, if ’Section Leader’ is specified, co-ordination will only take place between the Section Leader - wingman pair of aircraft.

Note that although a certain high level of co-ordination may be specified by the input, the co-ordination authority will generally move to lower levels as the engagement evolves and becomes more complex.

11.1.3 updateInterval

Specifies how often a pilot will re-evaluate the situation at the tactical level. A reasonable update interval will be between 1-5 seconds, where an ’Attack’ plan normally gets a higher update frequency than, say, an ’RTB’ plan. Note that the lower level action plans will have a higher update frequency, but these are not selectable by the user.

11.1.4 Posture

This box will specify the aggressiveness of the pilot, but this is not implemented in the current version of TALUS.

11.1.5 RulesOfEngagement

If rules of engagement (ROE) are ’Weapons Tight’, only targets that are identified as hostile will be fired upon during the execution of this tactical plan. ’Weapons Free’ will mean that all targets not identified as friendly are considered legitimate.

11.1.6 WeaponSelection

This box defines the default weapon selection during the execution of this tactical plan.

11.1.7 standardScript#

Here the user can define a script of action plans which effectively defines the tactical plan. For an ’Intercept’ or ’RTB’ type of plan, the script will usually be quite simple, e.g. a single ’Cruise’ or ’CAP’ for an ’Intercept’ plan or a ’Cruise’ + ’Land’ for an ’RTB’ plan. An ’Attack’ plan may, however, be constructed in a number of ways, depending on how offensive its should be. The F- and A-pole manoeuvres are essentially defensive and one or both may either be included or omitted from the script. For each of the action plans specified, an interrupt criterion must be given in the corresponding box to the right of it.

One can have as many «standardScript» fields as desired (as many as space within dialog box allows). When a value is chosen in the lowest «standardScript» combo box (highest number), a new empty «standardScript» combo box pops up below it. A «changeActionPlan» combo box with a label equal to the value of the «standardScript» pops up to the right. The «Clear All StandardScripts» button removes all «changeActionPlan» combo boxes and all but one «standardScript» combo boxes, allowing the user to redefine the number of scripts.

11.1.8 changeTacPlan#

For each action plan in the script, there must be specified a termination criterion. When this criterion is satisfied the tactical planner will move on to the next action plan in the script. There are several termination criteria to choose from, all listed below.

11.1.8.1 DontChange

This criterion means that the action plan should not be terminated. If no critical events occur, it will therefore be kept active until the tactical plan itself is terminated.

11.1.8.2 CriticalRange

This criterion means that the action plan will be terminated if there appears a threat that is considered to be critical. This is useful in a situation where the pilot is waiting for orders before committing. If a critical threat appears, this criterion would make the pilot act without waiting for orders.

11.1.8.3 FirstShot

This criterion means that the action plan is terminated when a missile is launched. It (or the next) is usually used to terminate a ’Commit’ plan in order to activate e.g. the F-pole manoeuvre.

11.1.8.4 FirstSalvo

This criterion is essentially identical to ’FirstShot’, but it will not activate until all missiles in the first salvo has been launched.

11.1.8.5 FirstActive

This criterion means that the action plan will be terminated when the first missile (launched by own aircraft) is estimated to have entered the active phase and consequently does not need updates from the launch platform any longer. This (or the next) is usually used to terminate a ’Commit’ or ’fPoleManoeuvre’ and enter into the ’aPoleManoeuvre’.

11.1.8.6 AllActive

This criterion is essentially identical to ’FirstActive’, but it will not activate until all missiles in the salvo are estimated to have entered into the terminal phase.

11.1.8.7 AtPosition

This criterion will activate when the aircraft have reached the position given by the manoeuvre data of the tactical plan, see Section 11.2.2. This is typically used to terminate a ’Cruise’.

11.1.8.8 AllClear

This criterion will activate when all hostile or unknown targets have disappeared from the airpicture. Typically used to terminate an ’aPoleManoeuvre’.

11.1.9 Repeat

If the ’Repeat’ option is selected, the tactical planner will, when the last action plan in the script has terminated, repeat the script, starting with the first action plan. This is typically used in an ’Attack’ plan to enable reengagements. If it is not selected, the current tactical plan itself will be terminated upon termination of the last action plan. The mission planner will then move ahead to the next pre-planned *tactical* plan. If, for instance, an ’Attack’ plan does not

have the ’Repeat’ option selected, the result will be that the pilot does not reengage, but in effect executes a «hit-and-run».

11.2 Manoeuvre Tab in Tactical Plans Dialog Box

The manoeuvre tab is used to specify default manoeuvre parameters for a given tactical plan. Figure 11.2 shows the contents of this tab. Note that not all values are necessarily relevant. This depends on the selection of ’ManoeuvreGuide’.

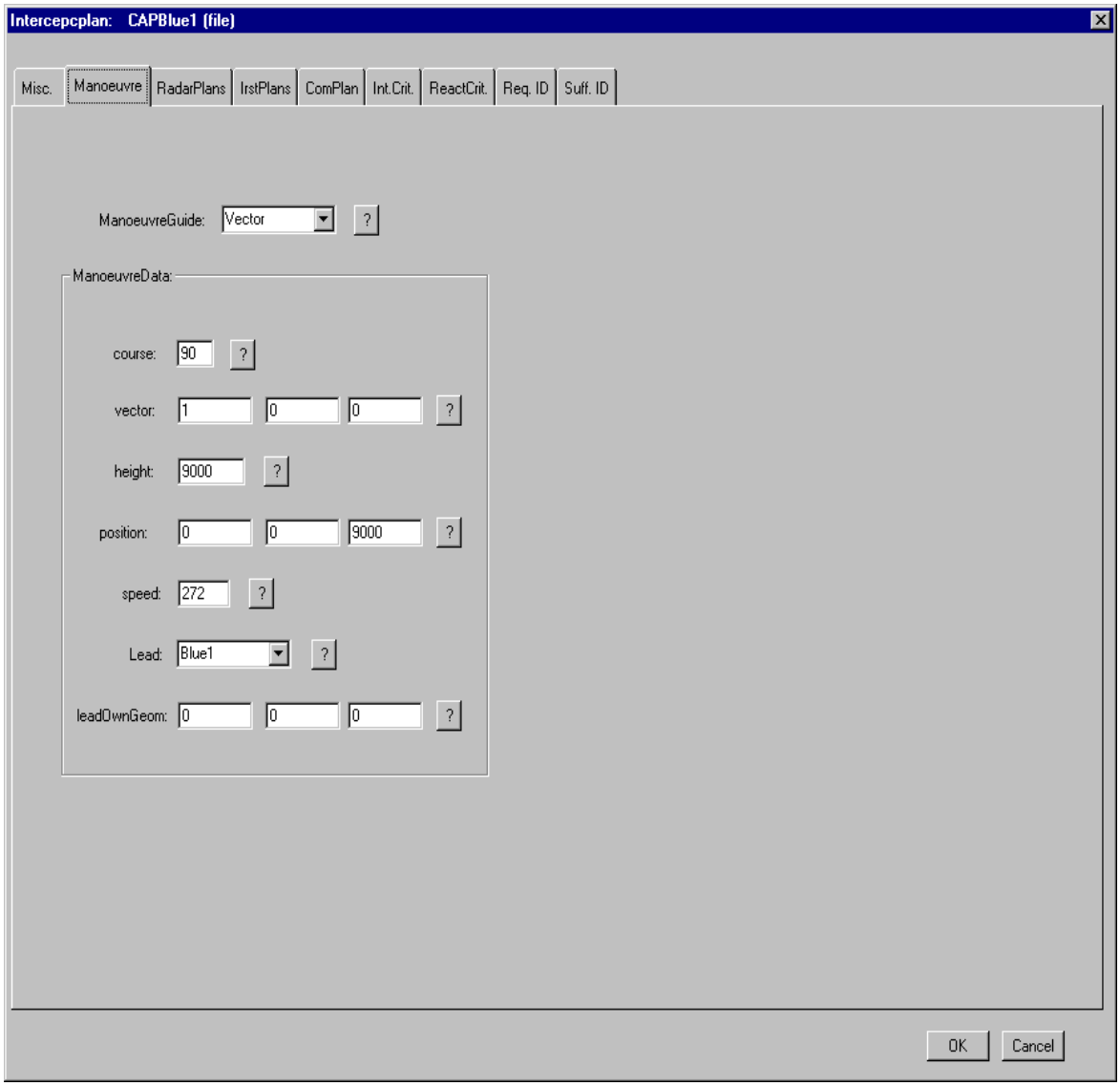

Figure 11.2 Manoeuvre tab in Tactical plans dialog box

11.2.1 ManoeuvreGuide

The selection made here defines the type of manoeuvre that the pilot will perform during the execution of the current plan. The choices are described below.

11.2.1.1 Course

The pilot will seek to establish a course given by the ’Course’ field in the ’ManoeuvreData’ section.

11.2.1.2 Position

The pilot will seek to establish a course towards the position specified in the ’Position’ field in the ’ManoeuvreData’ section.

11.2.1.3 Target

The pilot will manoeuvre with respect to enemy targets. The fields in the ’ManoeuvreData’ section will not be relevant. This choice should be made for an ’Attack’ plan.

11.2.1.4 Vector

The pilot will seek to establish a course corresponding to the direction vector specified in the ’Vector’ field in the ’ManoeuvreData’ section.

11.2.2 ManoeuvreData

Specific numerical values for the manoeuvre type are specified in this section. Only values required by the the selected ’ManoeuvreGuide’ need to be entered.

11.2.2.1 Course

Desired course in degrees, 0 is North, 90 is East.

11.2.2.2 Vector

Desired direction vector in the (North, East, down) co-ordinate system, the ’down’ component is ignored.

11.2.2.3 Height

The altitude in meters that the aircraft should try to establish.

11.2.2.4 Position

The position in the (North, East, down) coordinate system (coordinates in meters) that the aircraft should fly towards.

11.2.2.5 Speed

The speed in m/s that the aircraft should seek to establish.

11.2.2.6 Lead

Ignored, not presently implemented.

11.2.2.7 leadOwnGeom

Ignored, not presently implemented.

11.3 RadarPlans Tab in Tactical Plans Dialog Box

Each tactical plan can have one or two standard radar modes defined. The first mode is selected by the pilot upon activating the tactical plan, the second is selected when a specified

change criterion is satisfied. If only one mode is specified, this will be selected at all times during the execution of the tactical plan. If the aircraft is equipped with radar, at least one mode must be specified - though it may be given as ’Off’ or ’Standby’. Figure 11.3 shows the tab in which the modes are specified.

Note that it is the responsibility of the user to specify a mode that the radar in question actually supports the given mode. This can be checked by looking at the actual radar data in the database and/or the current input file, where all the available modes are listed and specified.

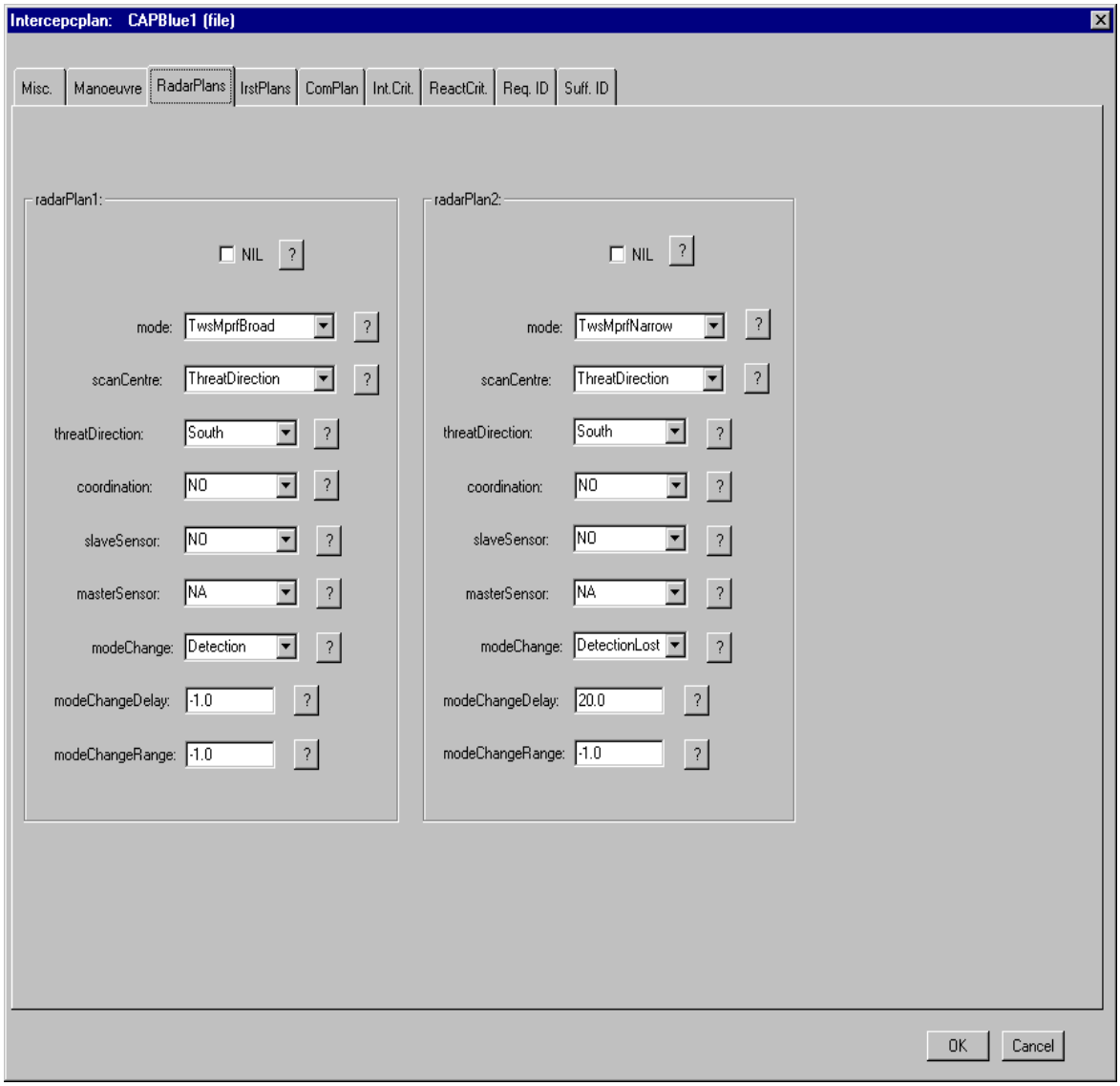

Figure 11.3 RadarPlans tab in Tactical plans dialog box

11.3.1 NIL

If this is selected, the fields below have no impact. Note that at least one sensor plan should be selected if the aircraft is equipped with a sensor of this type.

11.3.2 Mode

Specifies the name of the sensor mode. It is the responsibility of the user to select a mode that the sensor actually supports!

11.3.3 scanCentre

Specifies the principle that governs the steering of the sensor's scan centre. Note that it is not always possible to obtain the desired scan centre - it may be outside the field of regard. In this case the sensor will be slewed as far as it goes in the desired direction. The choices are explained below.

11.3.3.1 Boresight

The scan centre will be aligned with the long axis of the aircraft. The sensor will be pitch stabilised. That is, it will be pointing horizontally.

11.3.3.2 SelectedTarget

The scan centre will be pointed at the currently selected target. If no target is currently selected, the sensor will be pointed towards the last known target position.

11.3.3.3 ThreatDirection

The scan centre will be pointed towards the specified threat direction, see 11.3.4.

11.3.4 ThreatDirection

Specifies a default threat direction that may be used to point the sensor in the absence of any other threat indicators.

11.3.5 Coordination

Ignored, not currently implemented.

11.3.6 slaveSensor

Ignored, not currently implemented. Different sensors will, however, per default take cues from each other (controlled by the pilot).

11.3.7 masterSensor

Ignored, not currently implemented. Different sensors will, however, per default take cues from each other (controlled by the pilot).

11.3.8 modeChange

If there are two sensor plans, this selection will govern the switching between the respective sensor modes. The alternatives are described below.

11.3.8.1 NoChange

This selection means that the current sensor plan should be kept for the duration of the current tactical plan.

11.3.8.2 Detection

This selection means that the other sensor plan should be selected once a (unknown or hostile) target has been detected.

11.3.8.3 TargetSelected

This selection means that the other sensor plan should be selected once a target has been selected.

11.3.8.4 TargetLost

This selection means that the other sensor plan should be selected if the currently selected target is lost.

11.3.8.5 DetectionLost

This selection means that the other sensor plan should be selected if all (unknown or hostile) detections are lost.

11.3.8.6 Range

This selection means that the other sensor plan should be selected if the minimum range to a unknown or hostile target is less than the given value, see 11.3.10.

11.3.9 modeChangeDelay.

The value given here will impose a delay (in seconds) on the change of sensor plans, counted from the time the change criterion was satisfied.

11.3.10 modeChangeRange.

If the mode change criterion is given as ’Range’, the value in this box specifies the numerical value (in meters) of that range.

11.4 IrstPlans Tab in Tactical Plans Dialog Box

If the aircraft is equipped with an IRST, the tab depicted in Figure 11.4 is used to specify sensor plans for that sensor. The fields of this tab are exactly parallel to the one described for the radar in the previous section and will not be repeated here. Note that while an IRST is not in general a ranging sensor, the ’Range’ box is still meaningful since the pilot will get ranging information from other sensors. That range information is applied in the management of the IRST as well.

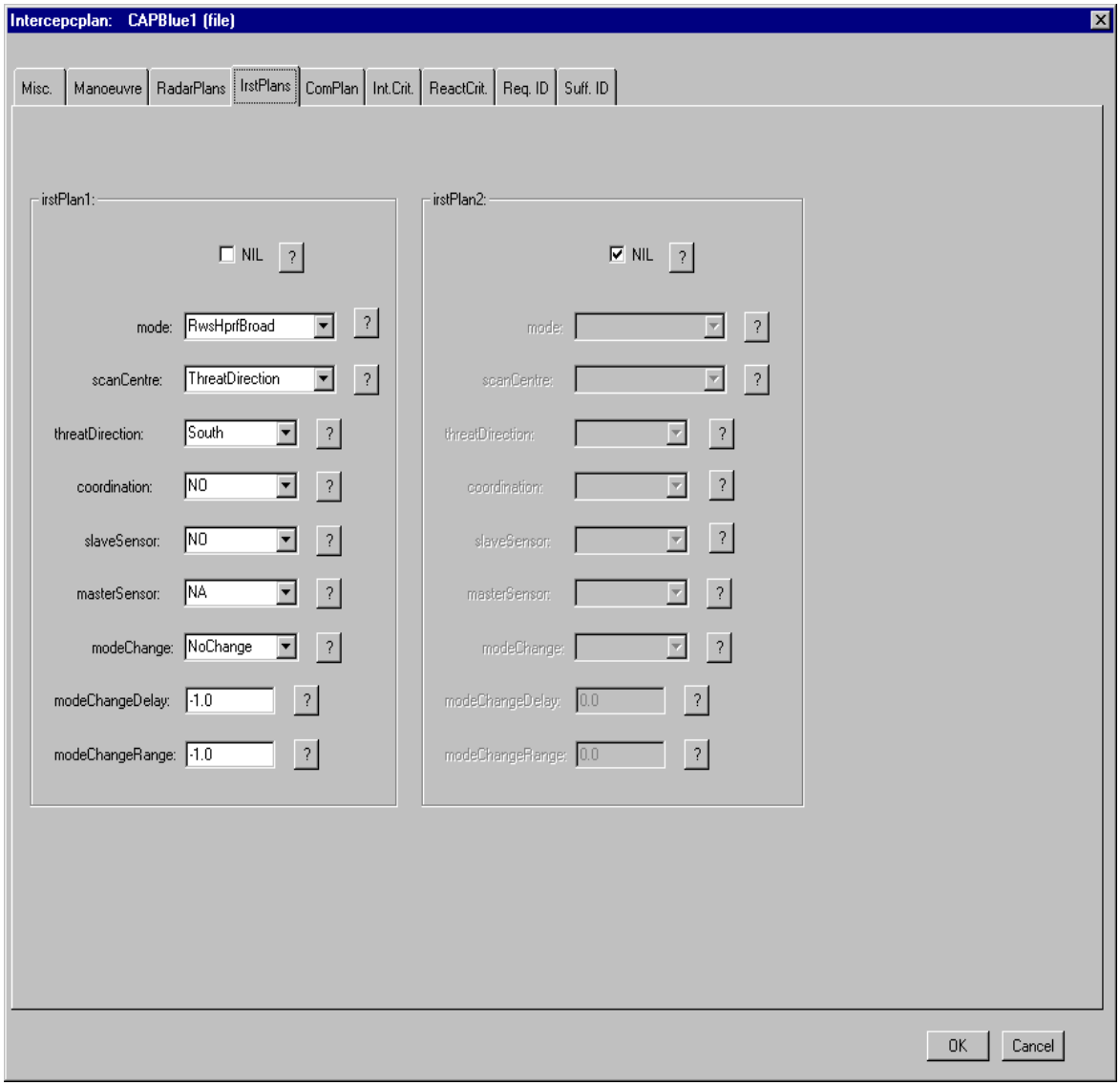

Figure 11.4 IrstPlans tab in Tactical plans dialog box

11.5 ComPlan Tab in Tactical Plans Dialog Box

The communication plans tab, depicted in Figure 11.5, is used to specify the extent and in which situations the pilots should use their radios. Since the need for radio communication depends on the tactical situation - and the presence of other means of communication, notably data link - the user can specify different procedures for each tactical plan.

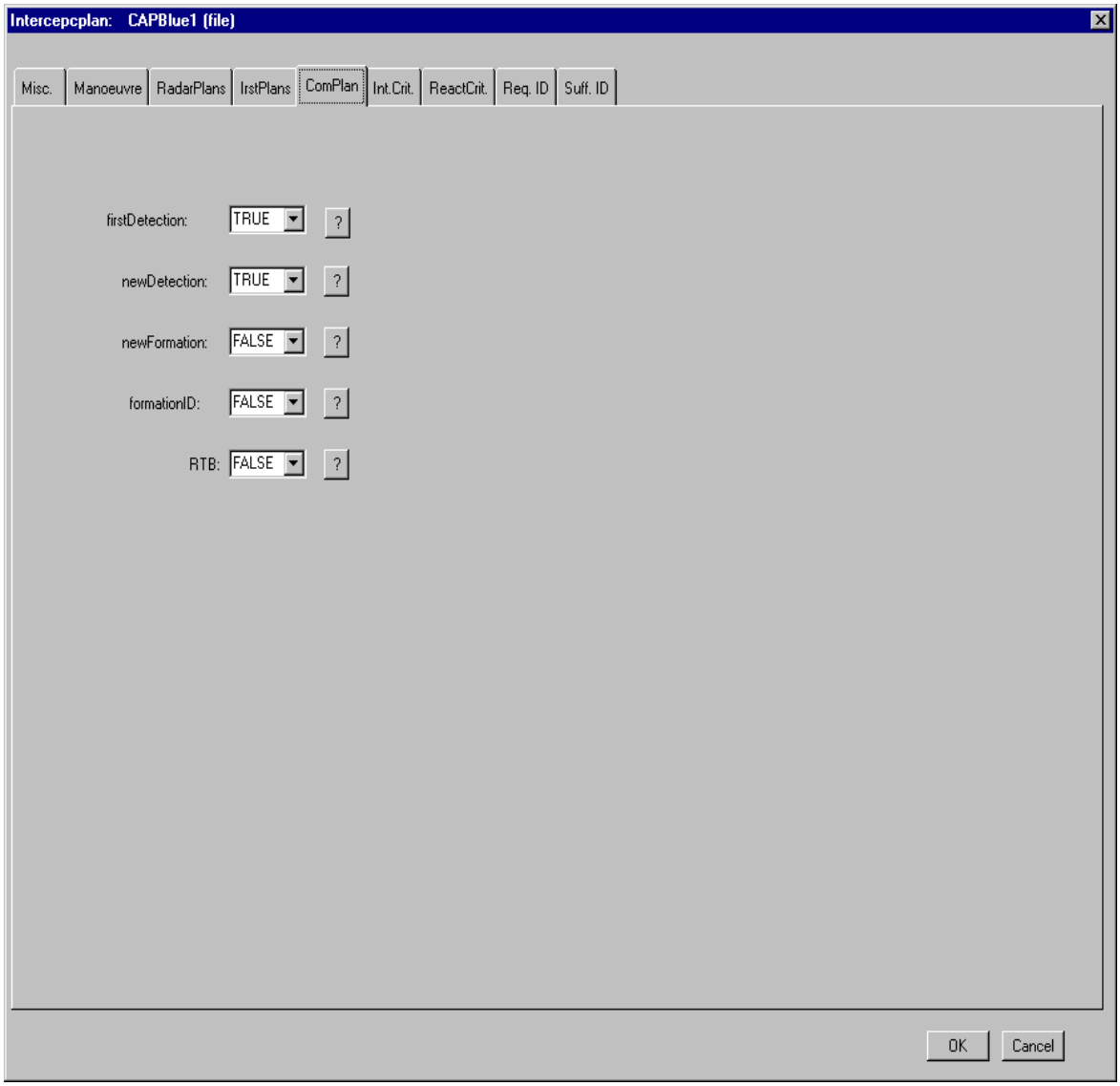

Figure 11.5 ComPlan tab in Tactical plans dialog box

11.5.1 firstDetection

If TRUE, a pilot will broadcast the first detection made by his own sensors on the radio.

11.5.2 newDetection

If TRUE, a pilot will broadcast *all* detections made by his own sensors on the radio. Should only be used (if at all) for aircraft without data link and then only pre-engagement.

11.5.3 newFormation

If TRUE, a pilot will broadcast all detections that result in the creation of new formations in his airpicture. That is, detections which are clearly set apart from existing ones, either by space, course or type.

11.5.4 formationID

If TRUE, a pilot will broadcast the fact that an identification has been made for a formation of previously unknown identity.

11.5.5 RTB

If TRUE, a pilot will broadcast the fact that he has to abort the mission, either because he has to make a premature (not ordered by a superior or part of the mission plan) return to base, or because he has to bail out. Pilots receiving this message will update their command & control data to reflect that the pilot in question will no longer play a part.

11.6 Int.Crit. Tab in Tactical Plans Dialog Box

This tab, shown in Figure 11.6, specifies the termination criteria for the current tactical plan. The choices made here can potentially have a major impact on how an engagement is played out, in that it determines how pilots (and formations) transit from one phase of their mission to another. Since there are a lot of criteria that has to be considered, the user should devote enough time and effort to ensure that the settings are reasonably robust with respect to the given scenario. Furthermore, it is not to be expected that one set of choices can be reused for another scenario without at least some modification. The best way to approach the problem is by trial and error - taking one set of interrupt criteria, run the scenario, modify, try again and so on.

The interrupt criteria are either based on the pilot's current situational assessment of the airpicture or on status flags raised by various aircraft subsystems. Note that a tactical plan may be interrupted for other reasons than the triggering of an interrupt criterion - usually as a result of an order from a superior pilot.

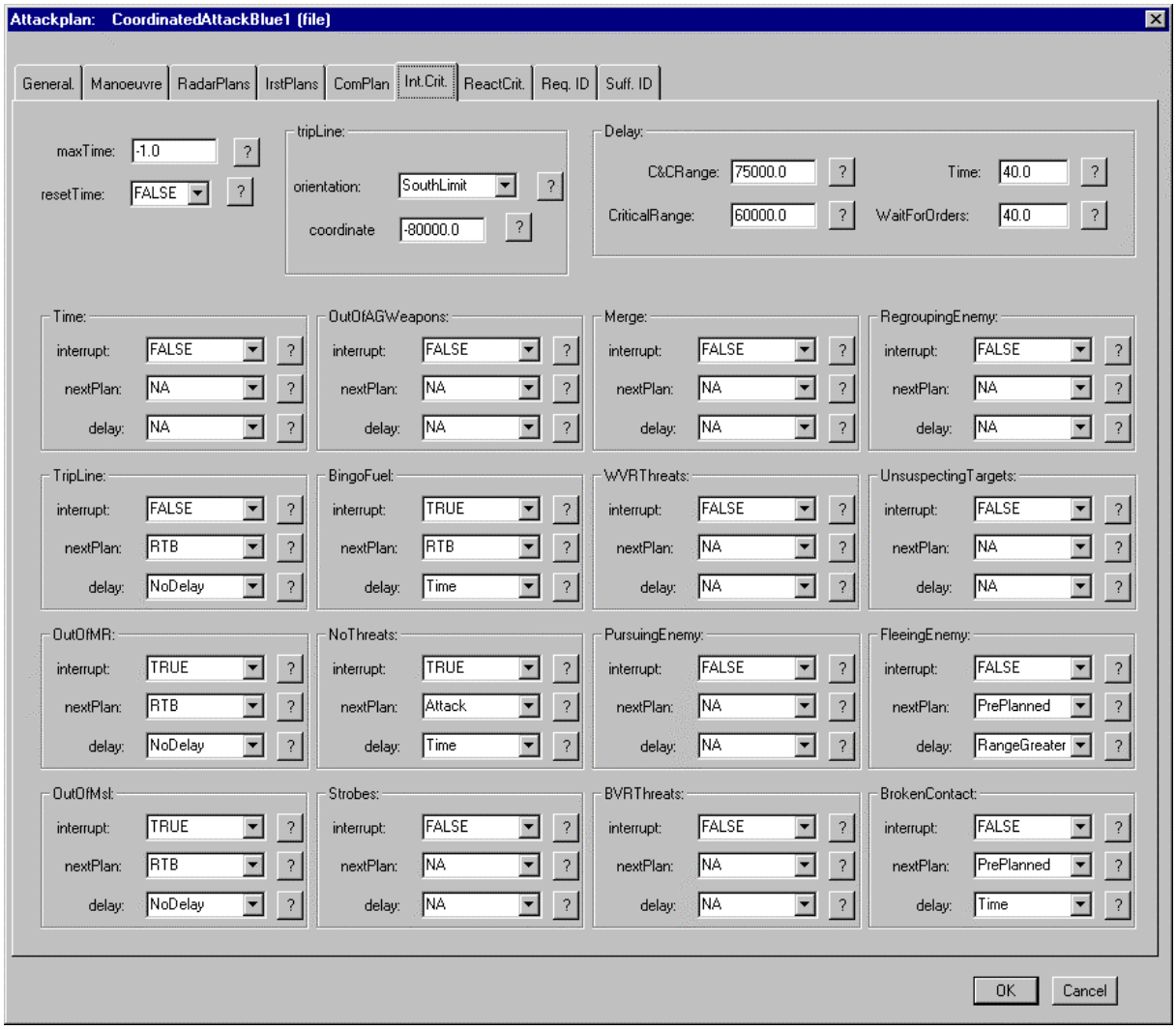

Figure 11.6 Int.Crit. tab in Tactical plans dialog box

11.6.1 General Parameters

The top section of the tab is used to specify some parameters that are used by some or all of the interrupt criteria.

11.6.1.1 maxTime

The maximum time (seconds) that the current tactical plan is allowed to execute. This value will only be relevant if the interrupt criterion ‘Time’ is TRUE.

11.6.1.2 resetTime

If this is TRUE, the maximum allowed time for the current plan is reset each time the pilot first terminates and then later reactivates it.

11.6.1.3 tripLine

Defines the orientation and position of a trip line. If the ’TripLine’ interrupt criterion is TRUE, the pilot will terminate the current tactical plan when he crosses this line.

’Orientation’ defines which side of a given line that represents the ’forbidden’ area, e.g. ’NorthLimit’ which would activate the interrupt if the pilot finds himself north of the given co-ordinate.

’Coordinate’ gives the numerical co-ordinate of the trip line (in meters) in the (North, East, down) coordinate system. If the line is a ’NorthLimit’ or ’SouthLimit’, the number represents the North component, while for a ’WestLimit’ or ’EastLimit’ the number represents the East component.

11.6.1.4 Delay

These entries supply numerical values to any delays which may be specified for the individual interrupt criteria.

’C&C Range’ gives the range (to the enemy) at which a pilot with the proper command authority would initiate a co-ordinated interrupt of the current tactical plan - if such a delay was specified for the interrupt that triggered.

’CriticalRange’ gives the range (to the enemy) at which a subordinate pilot will no longer wait for a co-ordinated interrupt of the current tactical plan.

’Time’ gives a numerical value (in seconds) to any time delays imposed on the individual interrupt criteria.

’WaitForOrders’ gives the maximum time (in seconds) that a subordinate pilot will ignore his own interrupts and wait for a co-ordinated transition.

11.6.2 Interrupt Criteria

If a given situation - that matches one of the criteria below - should lead to the termination of the current tactical plan and the execution of another, the criterion’s interrupt field should be set to TRUE.

If a criterion is set to TRUE, a suggestion for the next tactical plan must be specified for that criterion. This may be either «PrePlanned» - in which case the pilot would move on to the next tactical plan of the mission - or the specific type name of one of the three tactical plans.

A delay may be specified for a given interrupt criterion. ’RangeLessThan’ will postpone the interrupt until the minimum range to an unknown or hostile target is less than the value given above, ’RangGreaterThan’ will postpone interrupt until the minimum range is *greater* than that value, while’TimeDelay’ will postpone the interrupt for a fixed time period, defined above. ’NoDelay’ will obviously not postpone the interrupt.

11.6.2.1 Time

IF TRUE, the interrupt will activate when the current tactical plan has been executing for the length of time prescribed in the ‘maxTime’ box.

11.6.2.2 Tripline

If TRUE, the interrupt will activate when the aircraft crosses the trip line defined above.

11.6.2.3 OutOfMR

If TRUE, the interrupt will activate when the aircraft has expended all its medium-range missiles.

11.6.2.4 OutOfMsl

If TRUE, the interrupt will activate when the aircraft has expended all its medium-range *and* short-range missiles.

11.6.2.5 OutOfAgWeapons

If TRUE, the interrupt will activate if the pilot has executed an emergency drop of all air-to-ground weapons. Usually employed to abort an air-to-ground mission, see Section 8.7.1.

11.6.2.6 BingoFuel

If TRUE, the interrupt will activate when the aircraft has reached its defined bingo fuel level.

11.6.2.7 NoThreats

If TRUE, the interrupt will activate when the pilot's airpicture no longer contain any threats, often used to terminate an 'Attack' plan (perhaps combined with the 'Repeat' option - see Section 11.1.9 - to make the pilot reengage).

11.6.2.8 Strobes

If TRUE, the interrupt will activate when unknown or hostile targets are detected, even when the detections are just strobes, i.e. without range information. Regardless of the entry in the 'Delay' field the pilot *will* wait for some time until the airpicture has settled down a bit.

11.6.2.9 Merge

If TRUE, the interrupt will activate when the pilot's assessment of the airpicture indicates a «merge», i.e. hostile or unknown targets at very close range - a «fur-ball».

11.6.2.10 WVRThreats

If TRUE, the interrupt will activate when the pilot's assessment of the airpicture indicates threats within visual range - typically 20-25 km.

11.6.2.11 PersuingEnemy

Ignored, assessment type not yet implemented.

11.6.2.12 BVRThreats

If TRUE, the interrupt will activate when targets are detected at long range (beyond visual range). Typically used to execute an 'Attack' plan, often in combination with a 'RangeLessThan' type of delay.

11.6.2.13 RegroupingEnemy

Ignored, assessment type not yet implemented.

11.6.2.14 UnsuspectingTargets

Ignored, assessment type not yet implemented.

11.6.2.15 FleeingEnemy

Ignored, assessment type not yet implemented.

11.6.2.16 BrokenContact

Ignored, assessment type not yet implemented. Use ’NoThreats’ instead.

11.7 React.Crit. Tab in Tactical Plans Dialog Box

Some situations require immediate action, without going through the somewhat long-winded process of the previous section. The reaction criteria can be turned on or off using the fields depicted in Figure 11.7.

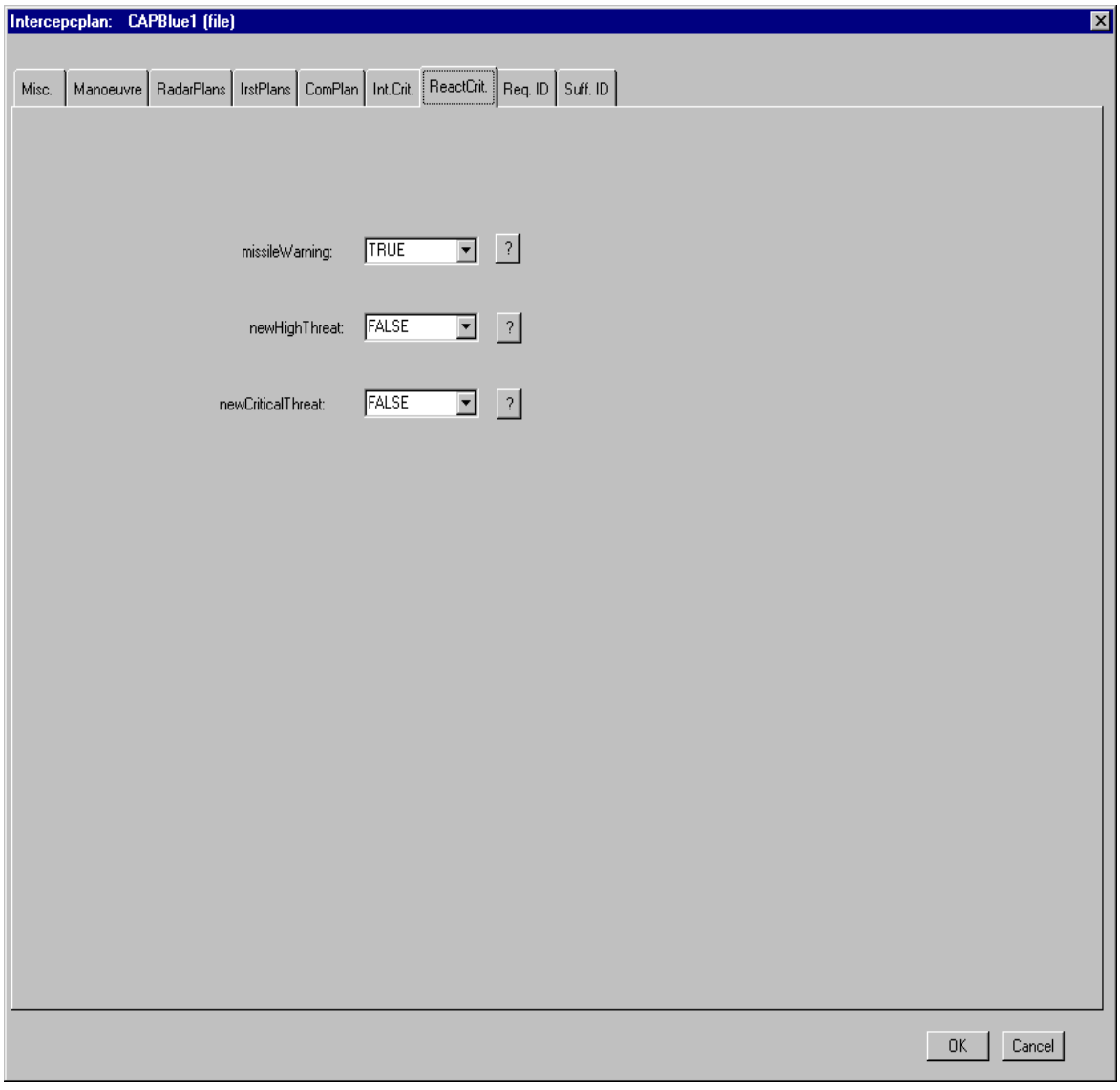

Figure 11.7 React.Crit. tab in Tactical plans dialog box

11.7.1 missileWarning

If TRUE, the pilot will react immediately if he detects an incoming missile. A missile avoidance manoeuvre will be executed and maintained as long as the threat persists. There is usually no reason to turn this option off, except maybe for calibration purposes - e.g. testing a new missile model.

11.7.2 newHighThreat.

This option is presently ignored - the emergence of a new high threat is handled through the standard target sorting procedures and interrupts.

11.7.3 newCriticalThreat.

This option is presently ignored - the emergence of a new critical threat is handled through the standard target sorting procedures and interrupts.

11.8 Required and Sufficient ID Tabs in Tactical Plans Dialog Box

The tabs, one of them depicted in Figure 11.8, are supposed to allow the user to qualify any ID requirements. At present however, this is not implemented. The pilot will obey the rules of engagement (ROEs), but the identity of the targets are taken at face value. If a sensor has obtained an ID on a target, the pilot will use this information without reservation. In a future version of TALUS this will surely be refined to include specific ID requirement, for instance that a visual ID is required, or that a failure to respond to an IFF enquiry is sufficient, for weapon launch.

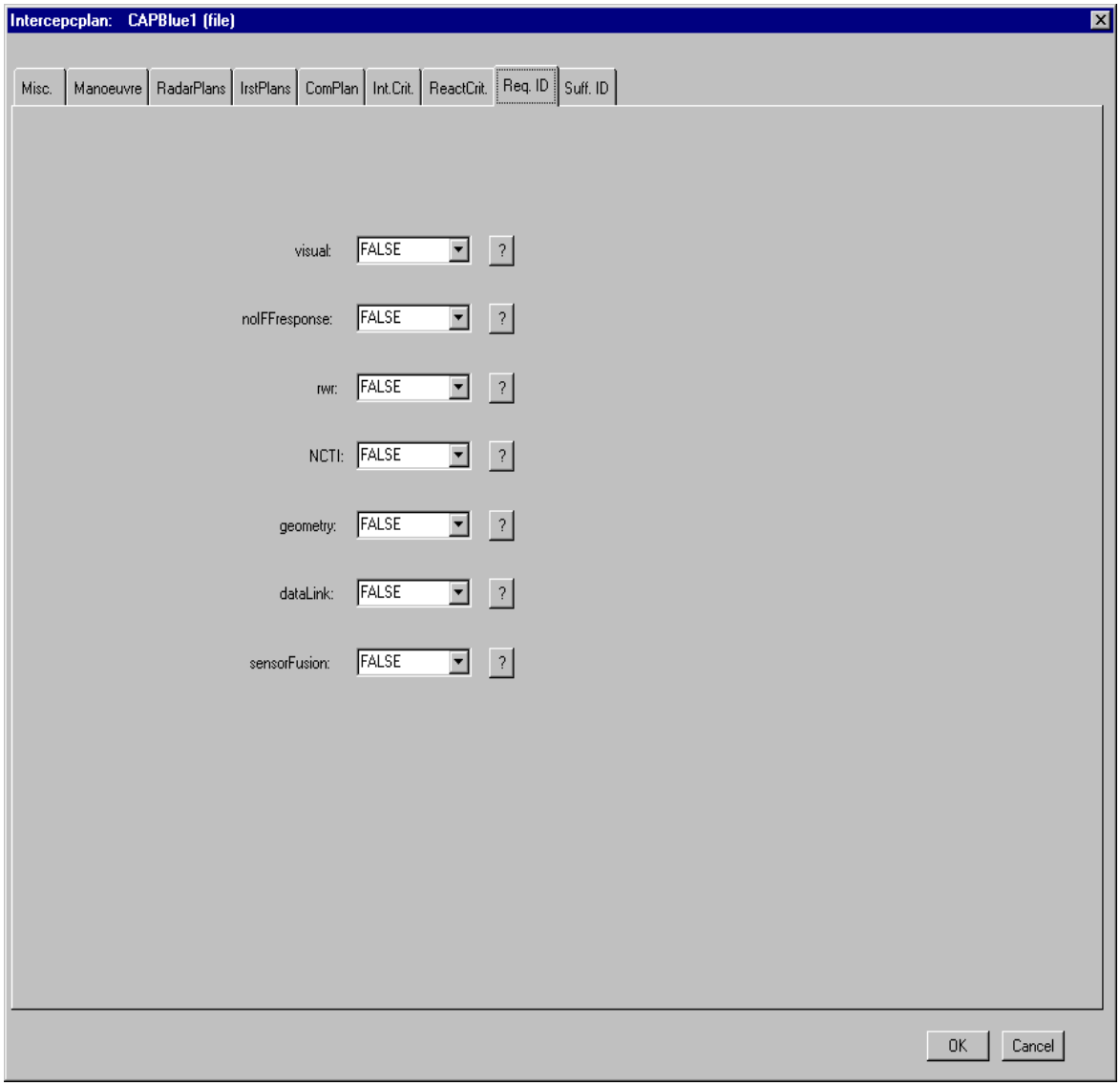

Figure 11.8 Req. Id tab in Tactical plans dialog box

12 TALUS RUN-TIME INTERFACE

Selecting Scenario → Run from the main window will launch the TALUS executable. If animation is turned off (see Section 6.6.2), the program will execute in the background and the user is free to return to the interface and either exit or create another input file. If animation is turned on, TALUS will bring up its own run-time interface -depicted in Figure 12.1 below - where the simulation is animated.

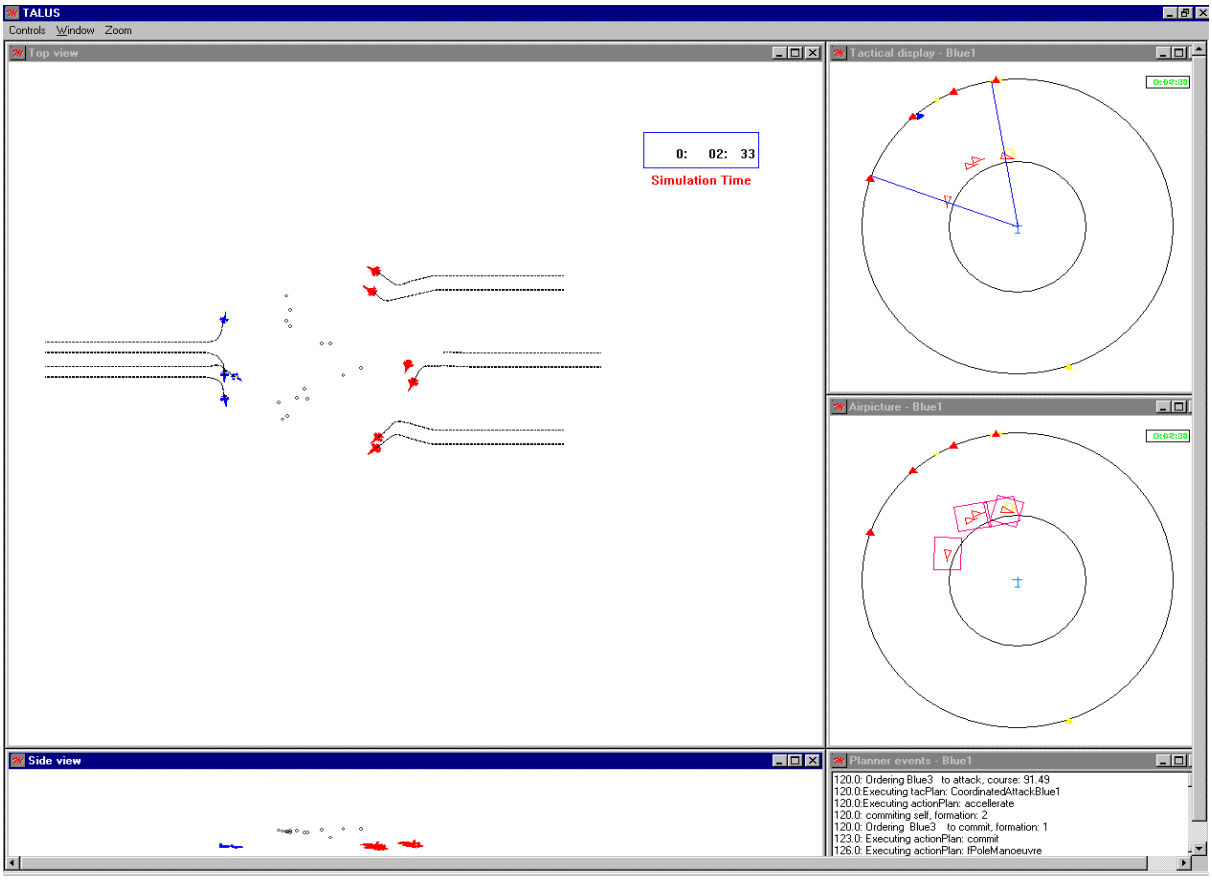

Figure 12.1 TALUS application

The run-time interface consists of five windows. They are, from top left:

1) A birds-eye view of the scenario, with animation of aircraft and missiles. One aircraft will be tagged (yellow dot) if the 'DisplayMFD' option is selected (see Section 6.6.2).

2) A view of the tactical display in the cockpit of the tagged aircraft, with all current sensor (plus data link) detections. Green symbols signify friendly aircraft, yellow are unknown and red are hostile. Lines represent strobes, with the dotted lines resulting from the radar warning system and dashed lines from the IRST. Open-ended symbols represent tracks from the data link, while closed symbols are from the onboard radar. Filled symbols (solid lines) represent tracks which have been fused, while unfilled symbols represent single sensor tracks. There are also special symbols representing missile warnings, either from the RWR or the MWS.

3) A view of the pilot's airpicture. The symbology is identical to the tactical display, with a few additions. «R»s represent tracks reported on the radio, either a single letter, or an «R» with a line through it, signifying a reported vector to a target (unknown range). The airpicture display also reflects how the pilot classifies targets into formations by putting boxes around them. As the situation evolves, these boxes may merge or split according to the pilot's continuous reevaluation of the airpicture. The pilot will also 'remember' targets that have been lost, keeping the formation boxes for some time after the actual tracks have disappeared.

4) A window tracing some of the decisions of the pilot in the tagged aircraft. Most of the important actions of this pilot will be output in textual form as they happen, but the list will in no way be complete.

5) A side view of the scenario.

The run-time interface has a few menus that allow the user to pause the simulation and to set the scale of the tactical and airpicture displays. The default range to the outer ring of these windows is 90 km, to the inner ring 45 km.

13 OUTPUT

The main output file of TALUS is «output.ftn15». When performing an analysis, the basis will be statistics from this file. At FFI a legacy Unix program is used to produce the statistics, the user therefore needs to either develop his own or, maybe simpler, to import it into a spreadsheet and define the necessary macros to extract the required statistics. Apart from losses to each side, previous experience at FFI suggests that - especially when doing sensitivity analysis - the most important data are the data concerning range, speed and height at missile launch. A study of how these average values change as a function of the input parameter in question will, together with the development of losses to each side, often lead to important insights with regard to both the given parameter, but also with regard to the potential and limitations of the weapon system (aircraft) as a whole.

The output file contains a trace, in the form of a single line of text, for each missile launch, missile hit and missile miss. The output is arranged in blocks, one block for each Monte Carlo iteration of the scenario. An example is shown in Table 13.1.

time	l	t	bs	k	nfk		ota	sigp	r,ra	del	ml,mf	hl,rp	nl,nf	mt	ht	nt	u	rsk,rfk	rmx,pk	rmin	tum	fehlw	tmsl	ifk	kz	nufk
110	B1	R4	2	3	5	trig	180	0	63.3369	0	1.31	9.16	1	1.21	8.86	1	1	0	81.37	37.7	0	0	0	2	0	8
112	B3	R6	2	3	5	trig	180	0	61.653	0	1.29	9.1	1	1.25	8.46	1	1	0	79.4	36.7	0	0	0	2	0	26
112	B4	R6	2	3	5	trig	178	0	61.0585	0	1.29	9.11	1	1.1	8.5	1	1	0	79.39	36.8	0	0	0	2	0	35
116	B2	R4	2	3	5	trig	172	0	58.1119	1	1.32	9.23	1	1.2	9.05	1	1	0	82.92	38.3	0	0	0	2	0	17
130	R5	B3	2	1	5	trig	128	0	50.9593	1	1.29	8.96	1	1.07	9.27	1	1	0	70.58	38.3	0	0	0	2	0	188
132	R4	B2	2	1	5	trig	124	0	47.7601	2	1.29	8.99	1	1.19	9.13	1	1	0	69.82	37.4	0	0	0	2	0	179
149	R3	B1	2	1	5	trig	126	0	40.3741	6	1.33	9.3	1	0.95	8.82	1	1	0	67.29	37	0	0	0	2	0	170
152	R1	B4	2	1	5	trig	101	0	48.5147	0	1.35	9.35	1	0.97	8.5	1	1	0	61.57	37.7	0	0	0	2	0	152
152	R2	B4	2	1	5	trig	115	0	48.3798	31	1.38	9.31	1	1.01	8.88	1	1	0	62.15	38.2	0	0	0	2	0	161
154	R6	B3	2	1	5	trig	152	0	38.7381	33	1.33	9.1	1	0.95	8.27	1	1	0	61.96	34.9	0	0	0	2	0	197
160	B4	R6	2	1	0	hit	163	0	0.0033	5	1.95	-205	1	1.17	9.24	1	1	0	0.34	0	0	0	48.1	-3	30	35
161	B3	R6	2	3	0	miss	0	0	0.2	0	1.93	0	1	0	0	1	1	0	0	0	0	0	48.9	-2	6	26

Table 13.1 Content of the «output.ftn15» file

The columns are explained below. Note that some of the columns contain only dummy variables. They are included because of format requirements of the mentioned legacy software.

1) Simulation time of event.

2) Name of launch aircraft.

3) Name of (intended) target aircraft.

4) Specification of fire control sensor, 1 = IRST, 2 = radar, 3 = RWR, 4 = eyes.

5) Type of missile, 1 = Red medium-range, 2 = Red short-range, 3 = Blue medium-range, 4 = Blue short-range.

6) Number of missiles left of the given type for the given launch aircraft.

7) Type of event, trig = missile launch, hit = missile hit, miss = missile miss.

8) Aspect angle (off-tail angle) from launcher to target (trig) or missile to target (hit or miss) - in degrees.

9) Dummy value.

10) Range to target at launch (trig) or miss distance (miss or hit), all in km. If unknown the value is given as 0.2000.

11) Off-boresight angle to target (degrees) with respect to launch aircraft (trig) or missile long axis (hit or miss).

12) Speed of launch aircraft (trig) or missile (hit or miss) - Mach.

13) Height of launch aircraft (trig) in km or closing velocity missile - target (hit or miss) in m/s.

14) Dummy value

15) Speed of target aircraft - Mach

16) Height of target aircraft - km.

17) Dummy value.

18) Dummy value.

19) Dummy value.

20) r_{max1} in km (trig) or random number draw (hit or miss). If missile is outside fusing range this will be a dummy value (miss).

21) r_{max2} in km (trig) or dummy value (hit or miss).

22) Dummy value.

23) Dummy value.

24) Missile flyout time (hit or miss) in seconds or dummy value (trig).

25) Dummy value.

26) Cause of miss, 30 = target hit and kill, 13 = target killed by other missile, 11 = no target data at launch, 6 = miss distance greater than fusing range, 5 = closing velocity too low, 2 = max fly-out time (battery), 0 = explosion, but p_k too low, -4 = target outside missile sensor gimbal, -5 = no target illumination (semi-active missiles).

27) Number that uniquely identifies each missile.

A ABBREVIATIONS

BVR	Beyond Visual Range
C&C	Command & Control
CAP	Combat Air Patrol
EW	Electronic Warfare
FCS	Flight Control System
FFI	Forsvarets forskningsinstitutt (Norwegian Defence Research Establishment)
FL	Formation Leader
GPS	Global Positioning System
GUI	Graphical User Interface
ID	Identity
IFF	Identification Friend or Foe
INU	Inertial Navigation Unit
IR	Infrared
IRST	Infrared Search and Track
MAWS	Missile Approach Warning System
Mb	Megabyte
MC	Mission Commander
MFD	Multi-Function Display
MR	Medium Range
MWS	Missile Warning System
RAM	Random Access Memory
RCS	Radar Cross Section
ROE	Rules of Engagement
RTB	Return To Base
RWR	Radar Warning Receiver
SEP	Specific Excess Power
SL	Section Leader
SR	Short Range
TALUS	TAktisk LUftkampSimulering (Tactical Air Combat Simulation)
WM	Wingman
WVR	Within Visual Range

DISTRIBUTION LIST

FFISYS **Dato:** May 24 2000

RAPPORTTYPE (KRYSS AV)	RAPPORT NR.	REFERANSE	RAPPORTENS DATO
X RAPP ☐ NOTAT ☐ RR	2000/02733	FFISYS/723/161.3	May 24 2000
RAPPORTENS BESKYTTELSESGRAD		ANTALL EKS UTSTEDT	ANTALL SIDER
Unclassified		32	81
RAPPORTENS TITTEL		FORFATTER(E)	
TALUS - Users Guide		GLÆRUM Sigurd, HOVIK Lars	
FORDELING GODKJENT AV FORSKNINGSSJEF:		FORDELING GODKJENT AV AVDELINGSSJEF:	

EKSTERN FORDELING

ANTALL	EKS NR	TIL

INTERN FORDELING

ANTALL	EKS NR	TIL
14		FFI-Bibl
1		Adm direktør/stabssjef
1		FFIE
5		FFISYS
1		FFIBM
1		Ragnvald Solstrand, FFISYS
1		Bent Erik Bakken, FFISYS
1		Jan Erik Torp, FFISYS
1		Ingunn Mari Skaaden, FFISYS
1		Ottar Graasvoll, FFISYS
1		Aanund Storhaug, FFISYS
1		Ove Undheim, FFISYS
1		Ole Martin Halck, FFISYS
1		Stian Betten, FFISYS
1		Hans Olav Sundfør, FFISYS

FFI-K1 Retningslinjer for fordeling og forsendelse er gitt i Oraklet, Bind I, Bestemmelser om publikasjoner for Forsvarets forskningsinstitutt, pkt 2 og 5. Benytt ny side om nødvendig.