# REAL TIME CONTROL OF A MULTIFUNCTION ELECTRONICALLY SCANNED ADAPTIVE RADAR (MESAR)

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## ABSTRACT

This paper will describe how Siemens Plessey Radar have developed a real time radar control process for MESAR, a multifunction radar test bed.

## 1. INTRODUCTION

The MESAR project has been jointly funded by Siemens Plessey Radar, formerly Plessey Radar, and the U.K Ministry of Defence (MoD) since 1982. The first phase of the project was completed with the delivery, to the ARE Funtington test range, of an adaptive antenna and data recording system in August 1988. Since then the equipment has undergone extensive and successful trials, with the emphasis being on adaptive beamforming.

The current phase of the MESAR project is to extend the hardware delivered at the end of phase 1 to provide a real time radar test bed capable of simultaneous surveillance and tracking. Additions to the phase 1 equipment are primarily a real time, software signal processor, and real time radar control software. Trials are due to begin in 1991. The system configuration is described more fully in a supplementary paper. (Manners[1])

A definition of terms used in the following description can be found in the Appendix to this text.

## 2 RADAR CONTROL REQUIREMENTS

The requirements of the radar control process can be summarised as follows:-

1) A priority structure for radar functions such that each function takes absolute priority over all other functions with lower priorities.

2) Each radar job shall exist at a priority level which matches the function it performs.

3) An algorithm that determines in real time the sequence in which radar tasks, drawn from radar jobs, must be performed. It must also permit the dynamic variation of data rates and dwell times.

4) Adaptive waveform control according to environmental and ECM conditions. The ability to select in real time, waveforms for both surveillance and tracking which match the clutter and jamming conditions, and provide the required detection performance.

5) Operating in real time the radar control process shall be able to schedule plot confirmation tasks such that the result is received within 100mS of the initial surveillance plot.

6) The radar control process shall attempt to keep the antenna fully occupied.

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## 3 REAL TIME RADAR CONTROL FOR MESAR

The following paragraphs describe the operation of the MESAR radar control sub system, which is illustrated in Figure 1.

### 3.1 Radar Job Table (RJT)

The RJT is a prioritised list of radar functions. Each level has been assigned one or more radar functions, and jobs are entered at the appropriate level. Each job which demands radar time has absolute priority over jobs in lower levels. i.e., 8>7>6 etc. The parameters of a job are:-

| | |
|---|---|
| Dwell time | Frame time (Surveillance) |
| Waveform parameters | Desired update time (Tracking) |
| Signal Processing selections | Latest update time (Tracking) |

### 3.2 Scheduler Algorithm

The unit which the algorithm schedules is a look i.e., a one or more radar activities. The scheduler algorithm will maintain a time balance for each job in the RJT. The time balance is a measure of how much radar time is owing to the job. The characteristic of each job on which the scheduler operates is occupancy, the proportion of total radar time which each job demands.

### 3.3 Radar Job Controller (RJC)

The RJC has responsibility for maintaining the RJT in a state that correctly represents the demands on the radar at any time. This includes:-

1) Creating new jobs
2) Changing priority level of jobs
3) Deleting jobs
4) Suspending jobs
5) Updating job parameters
6) Initiating Waveform Selection
7) Radar System Load Monitoring
8) Track Maintenance
9) Plot Labelling

These actions will be triggered in response to messages received from either the Main Tracker, the radar hardware, or the operator.

### 3.4 Waveform Selection

The Waveform Selection process is responsible for selecting waveform parameters for each radar task. Primarily this entails selecting the correct waveform and signal processing to match the clutter and ECM conditions defined in clutter and jamming maps.

For surveillance tasks, where beam positions and region boundaries are predefined, this process is simply the selection of one of eight predefined waveforms for each beam position, given by the possible combinations of -

1) Ground clutter present or not
2) Moving clutter present or not
3) Jamming present or not

For tracking tasks, beam positions coincide with target positions and are not the same as used in surveillance. However, the clutter and jamming maps contents for a group of surveillance beam positions close to the intended tracking beam positions can be used to determine the clutter and jamming conditions. Also determined by Waveform Selection are dwell time and PRF for each update.

## 4 THE LIFE OF A TRACK

In order to better describe the operation of the radar it is useful to describe the life of a track. This is as follows:

1) A normalized surveillance plot arrives at the RJC following plot processing (extraction). The RJC labels it with the details of the surveillance task which generated it, and passes it to the Main Tracker.

2) The surveillance plot fails to associate with any track already known to the Main Tracker. At this stage the plot may be a false alarm. Consequently the Main Tracker makes a Plot Confirmation Request to the RJC, and passes back the surveillance task details which relate to the new plot.

3) The RJC enters a new job in the Plot Confirmation Level of the RJT, using the same waveform as the surveillance task which generated the plot. The job is entered with a negative time balance and a required occupancy so that the plot confirmation task is completed within 100ms of the completion of the initial surveillance task.

4) When the plot confirmation task has completed, the RJC will delete it from the RJT.

5) All plots generated by the plot confirmation task in the region of the initial surveillance detection are passed to the RJC from the plot processing function. The RJC passes them on to the Main Tracker labelled as plots generated by plot confirmation tasks.

6) Any such plot which does not associate with a known track will generate a Track Initiation Request from the Main Tracker to the RJC, containing the desired time at which the task is required, and the latest time by which it must execute.

7) The RJC will enter a job in the initiation level of the RJT, and trigger Waveform Selection to provide waveform parameters directly to the new job in the RJT. At this stage the Main Tracker will have allocated a track number to the new track. The RJC shall maintain a record of job number against track number.

8) Track initiation aims to establish a specific track accuracy within a fixed time interval, typically one second. Throughout this interval, and following each initiation update, the RJC receives a Track Initiation Request containing desired update and latest update times. As a result the RJC modifies the update rate of the job in the RJT and triggers Waveform Selection to provide waveform parameters.

9) When initiation is complete, the Main Tracker will send a Track Initiated message to the RJC, containing the Track/Job number and the priority, low, medium or high the track is designated.

10) The RJC will remove the initiation job from the Track Initiation level of the RJC, and insert it in the priority level of the RJT which corresponds to the designated track priority. The RJC will also trigger waveform selection.

11) During the life of the track, and following each update the Main Tracker will make a Track Update Request to the RJC, containing

the track number, desired update and latest update times. The RJC will modify the contents of the appropriate job in the RJT and trigger Waveform Selection to provide the Waveform parameters for the next update.

12) During the life of a track, if due to overload a track update approaches the latest time of update, then the RJC will elevate the track update job to the Track Maintenance level of the RJT in an attempt to prevent the track from being lost. The job remains in the Track Maintenance level for only one update and is then returned to a lower update priority level by the RJC.

This process would only apply to low and medium track updates in the example shown in Figure 1, since high priority tracks have a higher priority than track maintenance.

13) A track will continue until either the operator or the Main Tracker decide to delete it. In both cases the RJC will receive a Delete Track message from the Main Tracker and consequently remove the job relating to the deleted track from the RJT.

## 5 CONCLUSIONS

A process has been described which harnesses the potential of an active phased array radar. It permits radar functions to be prioritised and for radar jobs to exist with a priority appropriate to the function they perform. Priority may be dynamic property of a job.

Automatic waveform selection permits the radar control process to adapt to environmental and ECM conditions. Also permitted is the dynamic variation of dwell time and update rate for tracking tasks.

## 6 ACKNOWLEDGEMENTS

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## 7 REFERENCES

1. Manners, D.M. "ART" : an adaptive radar testbed. IEE (PGE15) Colloquium. June 1990.

## APPENDIX A
## Definitions

The following definitions refer to terms used in the text of this paper.

FUNCTION:
A unique type of work that the radar is required to perform e.g., surveillance, track initiation, track update, plot confirmation
JOB:
A job is an ordered set of looks, which may be many tasks
TASK:
A set of radar activities non coherently integrated to provide detection in one beam position. Each activity may be at a different RF frequency.
ACTIVITY:
A single pulse or coherent burst of pulses.
LOOK:
A look is a single activity or a set of activities from one task transmitted contiguously.

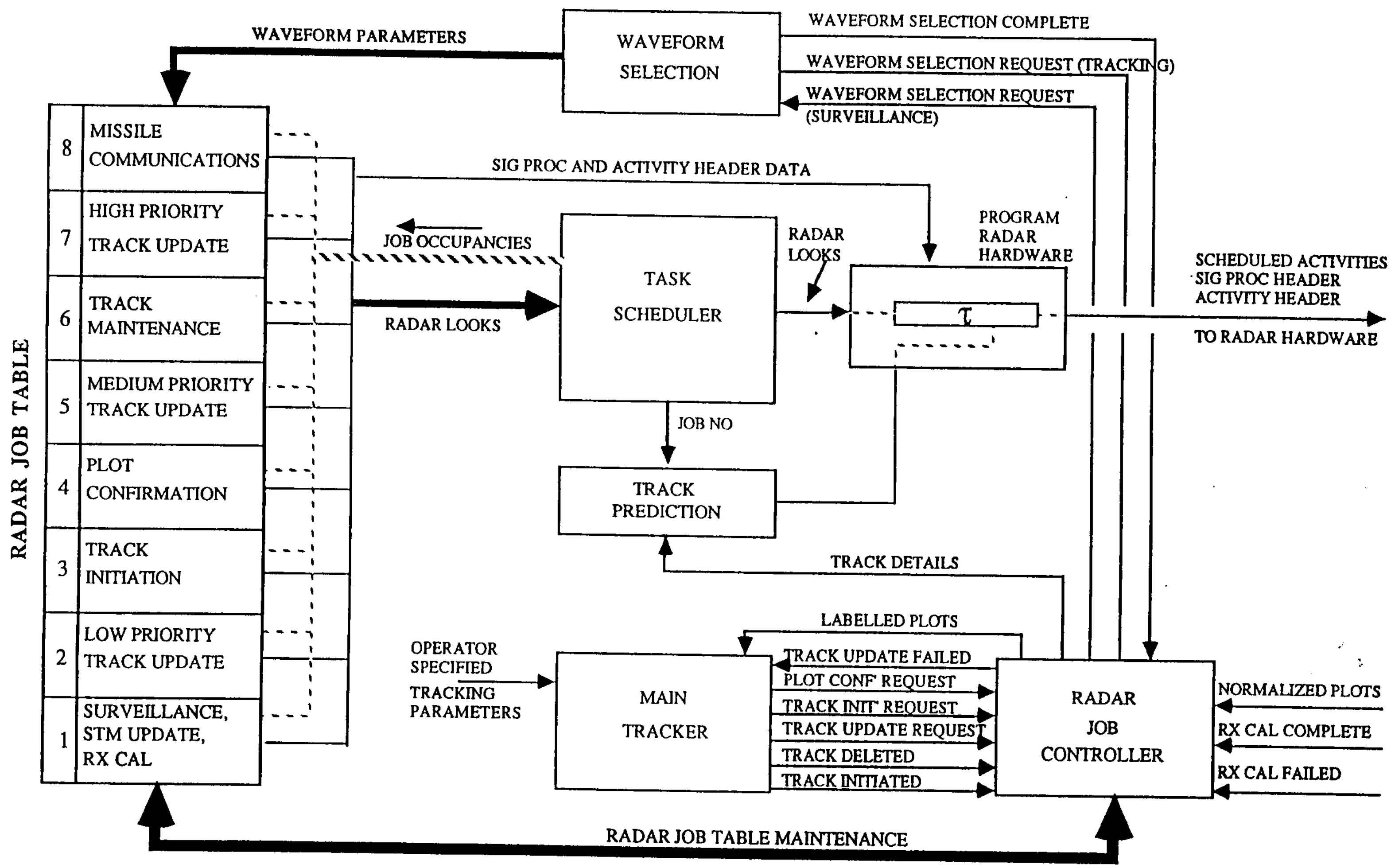


FIG 1. MESAR RADAR CONTROL SUB-SYSTEM