Challenges Involved in Developing Intelligent Automatic Command and Control Systems

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Abstract- Command and Control systems are the key components of defence arena. In today's world there is a need for automating these systems with intelligence. The paper below describes in brief the challenges faced during the development of such systems along with benchmarking of a prototyped application.

Index Terms- Prototyping, initialization, benchmarking, sources and sensor data

I. Introduction

All defence systems require a command and control system to receive information process it and generate a common operational picture. The input can be in the form of data from sensors, sources, intelligent reports and images. The inputs are required to be processed, linked with the historical database and generated outputs are shown as military symbols on map background or as entities on electronic charts. There are innumerable number of design challenges during the development of these systems. Hence prototyping shall be required. For selecting the hardware benchmarking shall be done. Based on the performance results, the architecture decisions shall be made.

II. Design and Development Challenges

While designing a system it is desirable to benchmark the hardware using prototyped application in order to select small form factor.The algorithms can also be benchmarked for resource utilization namely CPU and RAM.The maps used are not intelligent enough to provide information about the terrain like roads,railwaystations and areas. Hence provisioning has to be done so that the user can draw these geometries.The knowledge base or rule base for fusion,situation and threat assessment is built into the system with the domain expertise.Additions and modifications to it is an ongoing process.The library of keywords and images is also an ongoing process.During peace time, the system is configured and is started on reaching its mobilized location.A lot of initialization data is retrieved from the persistent database to the applications residing in the system for real time response.During the data loading process,there are chances of data loss.Hence the data structure and communication design of the applications have to cater for these conditions.Fault tolerance of the hardware is done by providing dual nodes.There is also a requirement, to build the fault tolerance of software and quickly switchover without disrupting the processed infromation supply for the generation of Common Operational Picture(COP). The sensors and sources which provide inputs to command and control systems are limited in number.Also,their ranges and types of entities detected automatically also exists.Therefore ,the received inputs have to be assigned weights or probability and processed accordingly.Information about the built up of battlefield scenario in the enemy depth areas is challenging and not available at many times. Systems depend on historical data which is data mined and utilized but the availability of war data is limited.Uncertainity in predicting the behaviour of enemy and enemy course of movement exists.The terrain where the systems are operated is difficult and weather unpredictable.A number of legacy systems exist in the defence forces and interfacing with them is also a challenge for automation.The communication media has its own bandwidth limitations.

There is a need to analyse and develop video transfer and utilization schemes as most of the video output are analog in nature.Hardwares used have large form factors and there is demand of the small form factor needs.There is also a lack of requirements clarity at domain level and difference in opinion among the users of the domain.The doctrines are not fixed .The time duration of systems from the point of inception to fielding is large.Hence there is always a manual override or manual intervention included in an automated system.

III. Prototyping of Algorithms

Prototyping of various algorithms for situation and threat assessment has been done in a quad core server with 4 GB RAM. The input to the prototyped application has been fed in using recorded data from various inputs and sources or Test Driver. The inputs have been collected ,correlated in real time ,undergone a cycle of situation assessment (SA) and threat assessment (TA) to provide the output for generation of Common Operational Picture (COP).The setup is as given in the Fig 1.

After the targets have been generated in the system, the CPU and memory utilization measured has been done .The measurement data is in Table 1.Graphs have been plotted for CPU and RAM utilization with respect to the number of targets generated in the system .The graphs are in Fig 2 and Fig 3.

Number of Targets	CPU Utilization in % with 4 core	% RAM utilization (RAM is 4GB)
550	0	2.4
1000	0	2.4
2100	0	2.4
2500	0	2.4
5050	156.8	2.7
10150	100.9	4.6
15000	107.9	4.8
20000	101	5.1
25000	187	5.5
30000	94.9	5.9
35000	202.6	6.2
40000	97.6	6.9
45000	173.8	8.4
50000	143	9.2
55000	106	9.8
60000	96.8	10.8

Table 1: Performance Measurement of Targets

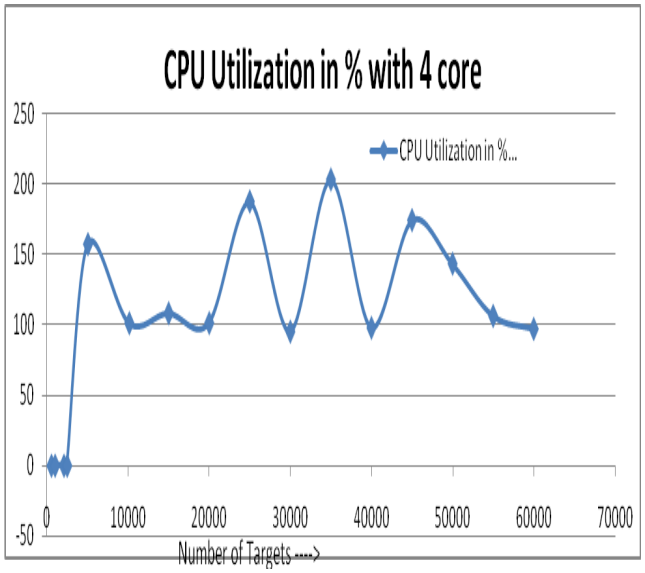

Fig 2: CPU utilization with respect to number of targets

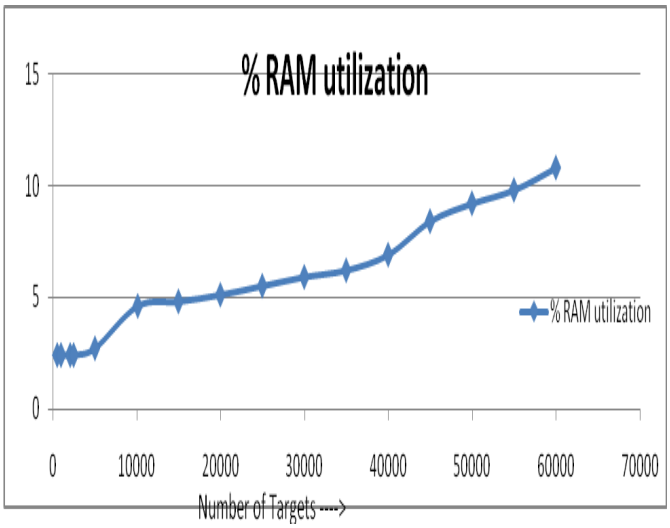

Fig 3: RAM utilization with respect to number of targets

IV. Enhanced Setup for Command and Control Systems

The hierarchical setup for command and control systems is as indicated in the Fig 4. Every node shall receive the information from various sensors and sources.COP shall be generated at every level and transferred to peer level as well as higher levels. The highest level shall resolve all the information and generate the COP of the entire region. Duplicate information shall be filtered out, old information shall be given less weightage and situation report shall be generated. Enemy threat shall be indicated with prioritized list of threats. Alerts shall be generated to attract the operator attention. Conflicts in the system shall also be indicated and resolved by the system.

V. Conclusion

A prototyped application for surveillance of symmetric and asymmetric warfare has been designed and implemented. The CPU and RAM utilization has been measured with maximum capacity tests. The same concept has been extended to a hierarchical architecture for analysis of sensor inputs, processed information, textual analysis, image interpretation and link it with the knowledge base to generate the output at the Ops room.

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