Presentation

# Deployment of SAR and GMTI Signal Processing on a Boeing 707 Aircraft using pMatlab and a Bladed Linux Cluster

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***Abstract***
The Lincoln Multifunction Intelligence, Surveillance and Reconnaissance Testbed (LiMIT) is an airborne research laboratory for development, testing, and evaluation of sensors and processing algorithms. During flight tests it is desirable to process the sensor data to validate the sensors and to provide targets and images for use in other on board applications. Matlab is used for this processing because of the rapidly changing nature of the algorithms, but requires hours to process the required data on a single workstation. The pMatlab and MatlabMPI libraries allow these algorithms to be parallelized quickly without porting the code to a new language. The availability of inexpensive bladed Linux clusters provides the necessary parallel hardware in a reasonable form factor. We have integrated pMatlab and a 28 processor IBM Blade system to implement Ground Moving Target Indicator (GMTI) processing and Synthetic Aperture Radar (SAR) processing on board the LiMIT Boeing 707 aircraft. GMTI processing uses a simple round robin approach and is able to achieve a speedup of 18x. SAR processing uses a more complex data parallel approach, which involves multiple "corner turns" and is able to achieve a speedup of 12x. In each case, the required detections and images are produced in under five minutes (as opposed to one hour), which is sufficient for in flight action to be taken.

## 1. Introduction
Airborne sensor research platforms traditionally record data in the air and process it later on the ground. On board processing has been prohibited because of rapidly changing algorithms, the cost of parallel processing hardware, and the time to implement the algorithms in a real-time programming environment. This situation has changed with the advent of several new technologies: parallel Matlab (e.g. pMatlab and MatlabMPI), inexpensive bladed Linux clusters, high-speed disk recording systems, and on board high bandwidth networks. Integrating these technologies on board the aircraft (Figure 1) allows processing in a sufficiently rapid manner for in flight action to be taken. This talk presents the overall architecture for such a system as demonstrated on the Lincoln Multifunction Intelligence, Surveillance and Reconnaissance Testbed (LiMIT).

## 2. Approach
The LiMIT signal processor goal is to provide in flight assessment of the overall performance of the radar system, and to provide targets and images for use in other on board applications. Four technologies are the foundation of the LiMIT on board processing system: parallel Matlab (e.g. pMatlab and MatlabMPI), inexpensive bladed Linux clusters, high-speed disk recording systems, and an on board high bandwidth network. The pMatlab parallel Matlab toolbox implements

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Global Array Semantics in the Matlab environment, which provides parallel data abstractions that allow the analyst to write parallel code with minor modifications to their serial code. pMatlab is built on top of the MatlabMPI point-to-point communications library. The 14 node 28 CPU bladed Linux cluster provides inexpensive parallel processing, memory, local storage and local interconnect, in a 7U form factor, that supports Matlab and all its libraries. The disk based recording system can be mounted via a conventional network, providing a simple file system between the recording system and the signal processor. A rich conventional LAN based interconnect allows the signal processor to use standard COTS based communication protocols for reading the record system (e.g. NFS, FTP, ...), sending displays back to the operator (e.g. X-windows), and sending output products to the rest of the system.

## 3. Results

The above four technologies were used to implement Ground Moving Target Indicator (GMTI) and Synthetic Aperture Radar (SAR) processing on board the aircraft. The speedup as a function of number of processors is shown in Figure 2. GMTI processing uses a simple round robin approach and is able to achieve a speedup of ~18x. SAR processing uses a more complex data parallel approach which involving multiple "corner turns" and is able to achieve a speedup of ~12x. In each case, the required detections and images are produced in under five, which is sufficient for in flight action to be taken. Using parallel Matlab on a cluster allows this capability to be deployed at lower cost in terms of hardware and software when compared to traditional approaches.

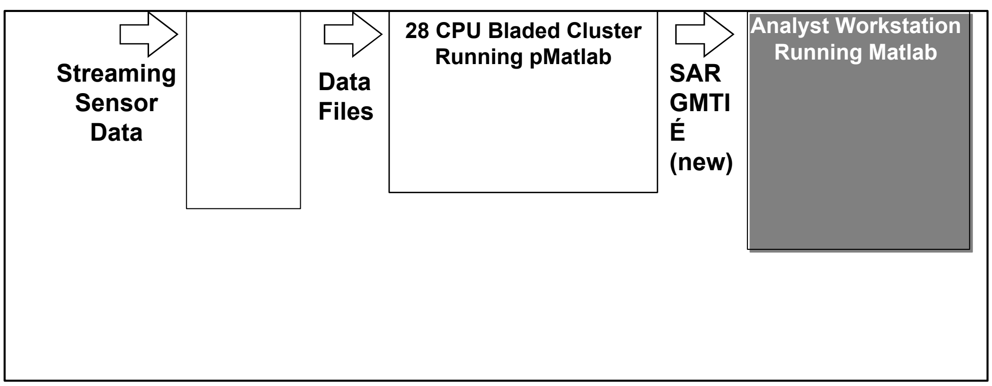


**Figure 1: LiMIT Signal Processing Architecture.**

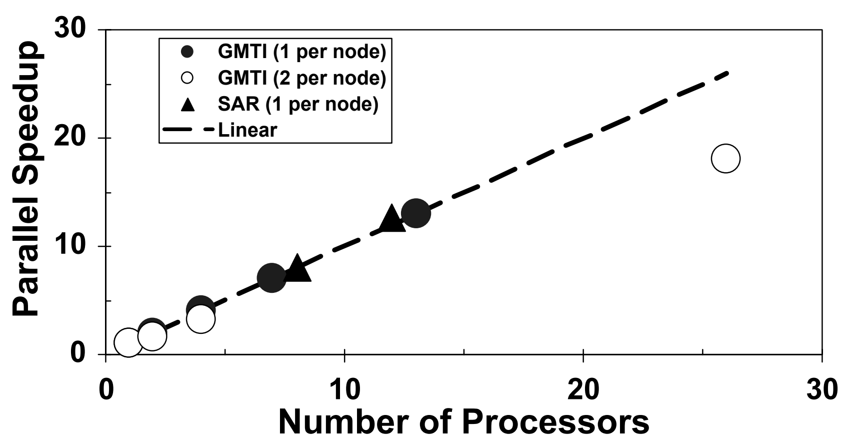


**Figure 2: GMTI and SAR parallel processing performance.**