# Secure and Faster Clustering Environment for Advanced Image Compression

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**-------------------------------------------------------------------ABSTRACT---------------------------------------------------------------**
Cloud computing provides ample opportunity in many areas such as fastest image transmission, secure and efficient imaging as a service. In general users needs faster and secure service. Usually Image Compression Algorithms are not working faster. In spite of several ongoing researches, Conventional Compression and its Algorithms might not be able to run faster. So, we perform comparative study of three image compression algorithm and their variety of features and factors to choose best among them for cluster processing. After choosing a best one it can be applied for a cluster computing environment to run parallel image compression for faster processing. This paper is the real time implementation of a Distributed Image Compression in Clustering of Nodes. In cluster computing, security is also more important factor. So, we propose a Distributed Intrusion Detection System to monitors all the nodes in cluster . If an intrusion occur in node processing then take an prevention step based on RIC (Robust Intrusion Control) Method. We demonstrate the effectiveness and feasibility of our method on a set of satellite images for defense forces. The efficiency ratio of this computation process is 91.20.

**Keywords** - Compression, Cluster, JPEG, Distributed Computing, Security.
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## I. INTRODUCTION

In recent years the interest in distributed image compression techniques has been steadily grown. The trend is firstly to store and transmit images and video clips digitally and secondly to add multimedia properties to wireless mobile devices. The capacity of the long distance wireless networks is limited, which causes need for more efficient multimedia compression methods. The problem is to achieve sufficient compression ratio with acceptable degradation in low cost embedded consumer devices.

The basic JPEG standard for still image compression is the most commonly used intra-image compression method at the moment, but wavelet based methods have promising features for the future needs. JPEG is based on the discrete cosine transformation (DCT) of the 8x8 blocks JPEG2000, which is a recent compression standard, utilizes wavelet transformations. Wavelets normally require more computation power than DCT. The benefit is that they also retain spatial domain characteristics, which can be utilized for other purposes easier than DCT results.

Image-based applications the resource constraints are particularly severe because representing visual data requires a large amount of information, which in turn leads to high data rate (as opposed to low data rate sensing like temperature or pressure). Typically, images are compressed in order to save communication energy. However, the algorithms required to compress the image data are often very computationally expensive for the resource- constrained nodes. The resource constraint problem for networks can be alleviated with the use of distributed image compression. We argue that the use of distributed image compression in resource- constrained networks is essential mainly due to two reasons.

The first reason is that enabling image compression in networks with extremely limited computational power, where an individual node does not have sufficient computational power to completely compress a large raw image to meet the application requirements, is not possible unless the node distributes the computational task among other nodes. In this case, a distributed method to share the processing task is necessary. The second reason is that even when battery operated nodes are not extremely limited in computational power, distributing the computational load among otherwise idle processors of other nodes extends the overall lifetime of the network. By reducing the workload on a processor, other techniques like dynamic voltage selection can be integrated to further save energy. The introduction of the paper should explain the nature of the problem, previous work, purpose, and the contribution of the paper. The contents of each section may be provided to understand easily about the paper.

## II. CLUSTER ENVIRONMENT

In our proposed Image Compression Scheme, all the free processor are grouped to form a Cluster Environment based on Master Node. Depending on the Modern Distribution Scheme (MDS) the job is to be divided, processed and merged to produce the final result.

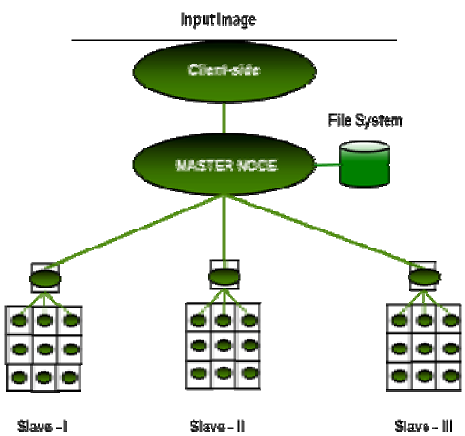


Figure 1 - Java Clusteing Enviroment

Figure 1 shows that the Java Clustering Environment having group of nodes and an Master Node. It addtionaly having an file System for Image Storage .

## III. IMAGE COMPRESSION

In this method, we compared the following Image Compression Algorithms using Matlab and verified the effective performance of all Algorithms.

1. Discrete Cosine Transform.
2. Biorthogonal Wavelets.
3. JPEG Wavelet Transform.

### *A. DISCRETE COSINE TRANSFORM*

The idea of compressing an image is not new. The discovery of DCT in 1974 [1] is an important achievement for the research community working on image compression. The DCT can be regarded as a discrete-time version of the Fourier-Cosine series. It is a close relative of DFT, a technique for converting a signal into elementary frequency components. Thus DCT can be computed with a Fast Fourier Transform (FFT) like algorithm in **O(nlogn)** operations. Unlike DFT, DCT is real-valued and provides a better approximation of a signal with fewer coefficients. The DCT of a discrete signal **x(n), n=0, 1, .. , N-1** is defined as:

$$X(u) = \sqrt{\frac{2}{N}}C(u)\sum_{n=0}^{N-1} x(n)\cos\left(\frac{(2n+1)u\pi}{2N}\right)$$

where, **C(u) = 0.707** for **u = 0** and
= **1** otherwise.

### ***B.*** BIORTHOGONAL WAVELETS

The steps needed to compress an image are as follows:

1. Digitize the source image into a signal s, which is a string of numbers.
2. Decompose the signal into a sequence of wavelet coefficients w.
3. Use thresholding to modify the wavelet coefficients from w to another sequence w'.
4. Use quantization to convert w' to a sequence q.
5. Apply entropy coding to compress q into a sequence e.

### *C. JPEG WAVELET ALGORITHM*

A common characteristic of most images is that the neighboring pixels are correlated and therefore contain redundant information. Image compression aims at reducing the number of bits needed to represent an image by removing the spatial and spectral redundancies as much as possible. Among a variety of image compression algorithms, JPEG [3] is a commonly used standard for still image compression. More recently, the wavelet transform has gained widespread acceptance in signal processing in general, and in image compression research in particular. In many applications, wavelet-based schemes (also referred to as subband coding) outperform other coding schemes.

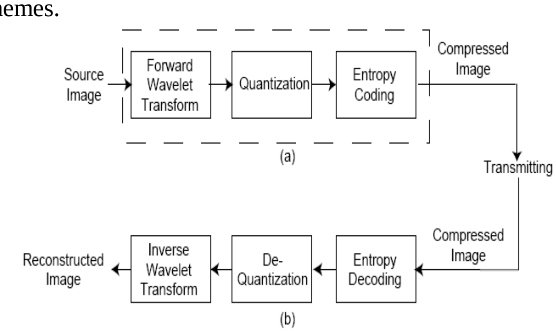


Figure. 2- A typical wavelet-based image compression (a) encoder (b) decoder.

Wavelet-based coding is more robust under transmission and decoding errors, and also facilitates progressive transmission of images. Because of their inherent multiresolution nature, wavelet coding schemes are especially suitable for applications where scalability and tolerable degradation are important. Thus, we choose the new wavelet-based image compression standard JPEG2000 [4] as the image compression scheme in this study.

## IV. IMAGE COMPRESSION MEASUREMENT

The Compressed Image status is measured using the following methods

### A. *Measures*

The 8 kind of performance measures are

Mean Square Error $MSE = \frac{1}{N}\sum_{j=1}^{M}\sum_{k=1}^{N}(x_{j,k} - x'_{j,k})^2$

Peak Signal to Noise Ratio $PSNR = 10\log\frac{(2^n-1)^2}{MSE} = 10\log\frac{255^2}{MSE}$

Normalised Cross-Correlation $NK = \sum_{j=1}^{M}\sum_{k=1}^{N} x_{j,k} \cdot x'_{j,k} / \sum_{j=1}^{M}\sum_{k=1}^{N} x_{j,k}^2$

Average Difference $AD = \sum_{j=1}^{M}\sum_{k=1}^{N}(x_{j,k} - x'_{j,k}) / MN$

Structural Content $SC = \sum_{j=1}^{M}\sum_{k=1}^{N} x_{j,k}^2 / \sum_{j=1}^{M}\sum_{k=1}^{N} x'^2_{j,k}$

Maximum Difference $MD = Max(|x_{j,k} - x'_{j,k}|)$

Laplacian Mean Square Error $LMSE = \sum_{j=1}^{M}\sum_{k=1}^{N}[O(x_{j,k}) - O(x'_{j,k})]^2 / \sum_{j=1}^{M}\sum_{k=1}^{N}[O(x_{j,k})]^2$

$O(x_{j,k}) = x_{j+1,k} + x_{j-1,k} + x_{j,k+1} + x_{j,k-1} - 4x_{j,k}$

Normalised Absolute Error $NAE = \sum_{j=1}^{M}\sum_{k=1}^{N}|x_{j,k} - x'_{j,k}| / \sum_{j=1}^{M}\sum_{k=1}^{N}|x_{j,k}|$

### B. *Factors*

The 4 kind of performance factors are

If there are n kinds of color in a digital image,

1. Entropy:

$$H = \sum_{i=1}^{n} H_i = -\sum_{i=1}^{n} p_i \log_2 p_i$$

Where pi is the probability of the ith color and

$$\sum_{i=1}^{n} p_i = 1 \quad 0 \le p_i \le 1$$

2. Quotient compression=File Size1/File Size2;
3. Compress Ratio = 1/Quotient_compression1;
4. Compress Gain = (1-Compress_Ratio1);

## V. COMPARATIVE STUDY

We perform comparative analysis of Three image compression algorithms[10] with 8 different measures and 4 different factors. This Compression Techniques are tested for some images and best method is selected for cluster Computing.

TABLE 1 : AVERAGE PERFORMANCE MEASURES

| Method | MSE | PSNR | AD | SC | NK | MD | LMSE | NAE |
|---|---|---|---|---|---|---|---|---|
| DCT | 573.20 | 21.92 | 0.11 | 1.03 | 0.97 | 147.67 | 0.98 | 0.12 |
| Wavelet biorthogonal | 206.90 | 25.38 | 0.02 | 1.01 | 0.99 | 62.82 | 0.94 | 0.08 |
| JPEG method | 134.14 | 27.33 | 0.10 | 1.00 | 1.00 | 115.00 | 0.96 | 0.06 |

TABLE 2 : Average Performance Factors

| Method | Entropy | QC | CR | CG |
|---|---|---|---|---|
| DCT | 7.62 | 1.67 | 0.64 | 0.36 |
| Wavelet Biorthogonal | 7.64 | 1.55 | 0.71 | 0.29 |
| JPEG Method | 7.53 | 2.23 | 0.54 | 0.46 |

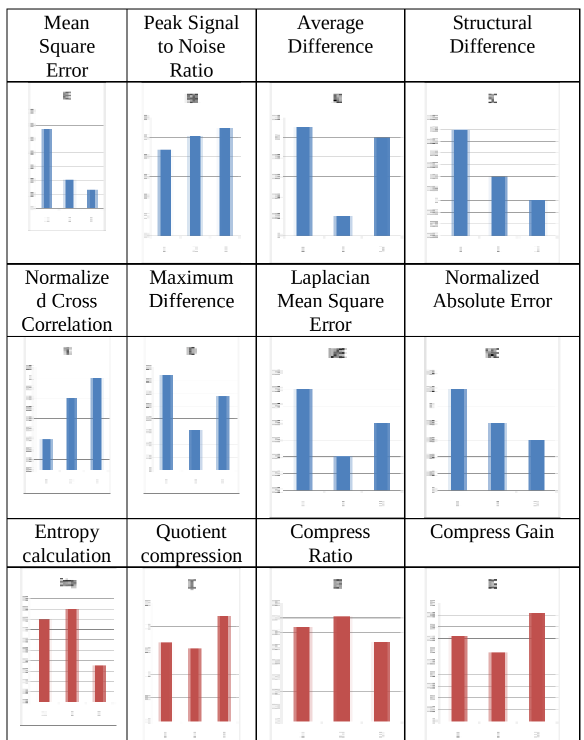


Figure 3 : Average Performance Measures

Based on the Result of measurements, we Choose JPEG Algorithm for Distributed Image Compression.

## VI. YSTEM DESIGN

### A. Overall Design

The over all System named as Secure and Faster Compression Engine [SFCE], It consists of Three Major Processes for Satisfy its main goal such as Security , Speed, Accuracy , Scalability and Reliability.

Three Major Processes Are

1. Modern Distribution Scheme (MDS)
2. Safe Cluster Grouping (SCG)
3. Robust Intrusion Control ( RIC)

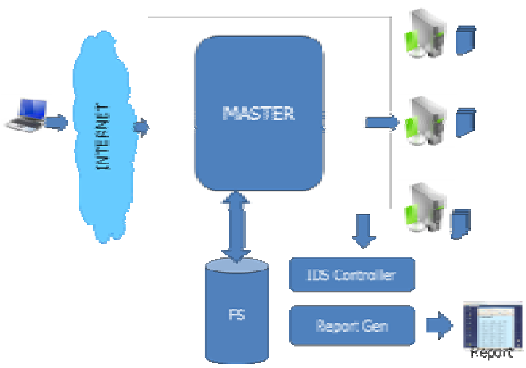


Figure 4 : Architecture of Secure and Faster Compression Engine [SFCE]

Fig 4 Describes the Architecture of Secure and Faster Compression Engine [SFCE] and its main the models such as Modern Distribution Scheme (MDS) , Safe Cluster Grouping (SCG) and Robust Intrusion Control ( RIC).

### B. Modern Distribution Scheme (MDS)

Based on the Algorithm the Process will run on the server .

```
Check The Number of Processor Available in Cluster and
Find its 2^n Value negate remaining based on priority
If 2^n is fit then
    If Check Availabity of Matlab and Alg Then
            Spilt Image into 2^n pieces
            Perform Image Compression
             using 2^n Nodes in secure way
            Merge 2^n pieces into Output Image
     End
End
```

**Algorithm Modern Distribution Scheme**

This Cluster Algorithm is used to perform faster cluster processing in our domain.

### C. Safe Cluster Grouping (SCG)

```
Begin
Establish Connection
Create a Cluster Server for Master
2^n Slave Client Nodes
If a Authorized trigger signal send to client
        it read a file from File System
        Perform Fast Image Compression
        Write the file to File System
else
            Wait for Connection
End
End
```

**Algorithm Safe Cluster Grouping Scheme**

Based on the Algorithm the Process will run on the server .

### D. Robust Intrusion Control ( RIC)

Robust Intrusion Control Monitors the activity of Virtual Controller and performs the following operations

1) *Activity Analysis*
2) *Alarm Generation*
3) *Primary Sub Server Selection*
4) *Pictorial Status Representation*

The Intrusion Manager includes the following steps:

A process monitor receives an alert “Sub Server S is corrupted” and sends a vote request to the AP module. The vote finishes with a consensus on the corruption of S. The vote result is broadcast to all Sub Servers.

The module sends a request to the Server manager to generate the list of countermeasures to react to this intrusion. The countermeasures list is broadcast to all Sub Servers. The Virtual Controller sends to the specific module the orders to isolate S and to change the current regime. The Virtual Controller also changes the frequency.

The Alarm generator receives the alert notification sent by S after its regime change.

*1) Activity Analysis*

The RIC records the information for various activities taking place in the server and analyses this information to provide an activity analysis .Some of the activities that are monitored are as follows

| HTTP Request: | Intrusion Activity: |
|---|---|
| Date of Request | Infected Sub Server |
| Time of Request | Infected Web Page |
| Content Type | Frequency of Attacks |
| Web Page Requested | Reliability of Server |
| Session Time | |
| Status of Request | |
| Status of Response | |

*2) Alarm Generation*

Based upon the activity analysis the status of alarm is decided and corresponding alarm is aroused.

Example:

If the Failure rate <THL higher level alarm is raised to intimate the administrator for necessary actions.

*3) Primary Sub Server Selection*

The Activity Analysis Process rates the Sub Servers into the following types

Trust worthy – High Priority
Suspected - Medium Priority
Corrupted - Low Priority

The Primary Sub Server Selector selects the Primary Sub Server based on the priority and Load balance .The Priority of a server is decided based upon the following formula

Initial State of Sub Servers

AS(X) =0 - Trust Worthy ----- (1)

When the first Alert occurs the system moves to the suspected states

AS(X)+=Awi(x) –Suspected -----(2)

It remains in the suspected state until the following condition satisfies

AS(X) =Awi(X) > TC- Corrupted ----- (3)

When the condition fails the system moves to the corrupted state and the system is rebooted after which it moves back to trust worthy state.

AS(X) : alert level of Sub Server X

Awi : weight of alert i for

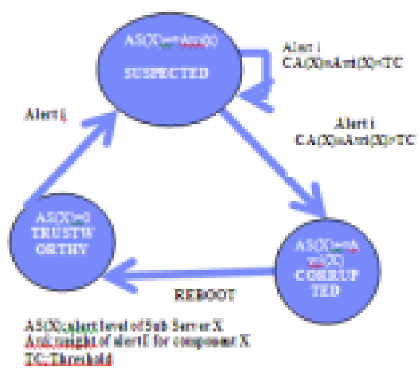


Fig 5– State Management

Fig. 5 shows the transformation of a sub server to various states.

*4) Pictorial Status Representation*

With the Activity Analysis information, that is stored in the database, a Graph is generated which helps them.

### VII. EXPERIMENTAL RESULTS

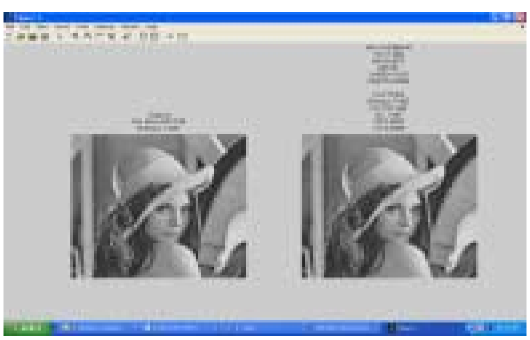

Figure 6: Image Comparison of Clustered Image


Figure 7: Intrusion Detection System

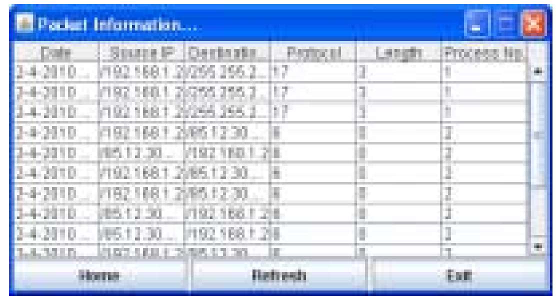


Figure 8: Packet Capturing

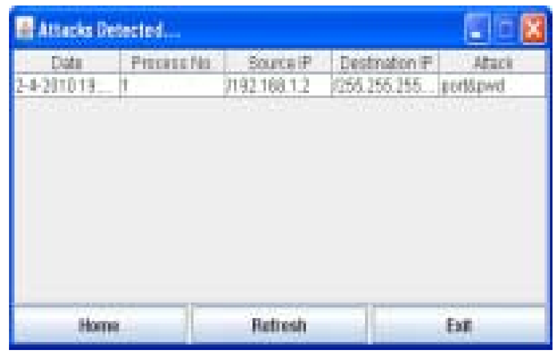


Figure 9: Attacks Detected

### VIII. PERFOMANCE ANALYSIS

We perform comparative analysis of conventional method and clustering methodology using following schemes.

***1) Single Stage Cluster Computing***

TABLE 3: Comparison of Processing Time taken by Conventional Computing and Cluster Computing Environment

| Slno | Process(Time Taken ) | Conv.Computing PT msec | CPT msec |
|---|---|---|---|
| 1 | Split Operation | 223.46 | 223.46 |
| 2 | Compression(Block-I,II,III,IV) Operation | 463.49 | 117.86 |
| 3 | Merge Operation (Seconds) | 143.96 | 143.96 |
| 4 | Show Operation (Seconds) | 153.95 | 153.95 |
| | Total Time | 984.89 | 639.24 |

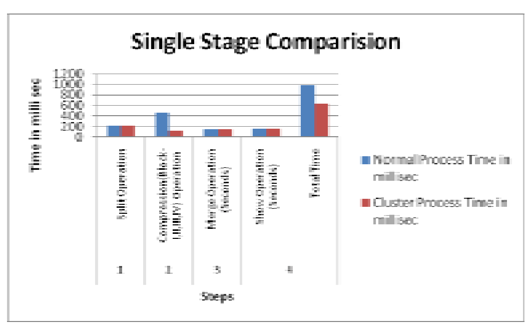


Figure 10: Graphical Output of Processing Time Taken by Conventional Processor and Single Stage Cluster Computing Environment.

### *2) Single Node with Quad Core Processor*

TABLE 4: Single Node comparison of Conventioal & Cluster Computing

| SlNo | Process(Time Taken ) | Conv. Computing PT msec | CPT msec |
|---|---|---|---|
| **1** | Split Operation | 223.46 | 223.46 |
| **2** | Compression(Block-I) Operation | 117.86 | 117.86 |
| **3** | Compression(Block-II) Operation | 117.86 | - |
| **4** | Compression(Block-III) Operation | 112.96 | - |
| **5** | Compression(Block-IV) Operation | 114.81 | - |
| **6** | Merge Operation (Seconds) | 143.96 | 143.96 |
| **7** | Show Operation (Seconds) | 153.95 | 153.95 |
| | Total Time | 984.89 | 639.24 |

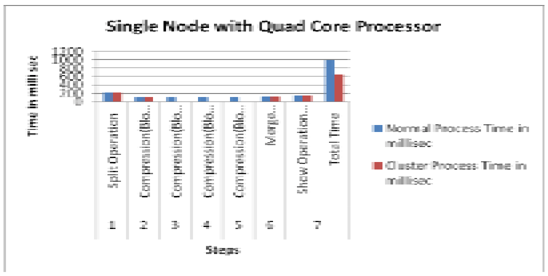


Figure 11: Graphical Output of Processing Time taken by Quad Core Processor under Conventional & Cluster Computing Environment.

### *3) Conventional Processor with Four Nodes Connected in Cluster Computing Environment.*

TABLE 5: Comparative Analysis of Processing Time of Conventional Processor with Four Nodes connected using Cluster Computing Environment.

| Sl. No | Process(Time Taken ) | Con. Comp. PT msec | CPT msec |
|---|---|---|---|
| **1** | Split Operation | 223.46 | 223.46 |
| **2** | Compression(Block-I) Operation | 117.86 | 117.82 |
| **3** | Compression(Block-II) Operation | 117.83 | - |
| **4** | Compression(Block-III) Operation | 112.96 | - |
| **5** | Compression(Block-IV) Operation | 114.81 | - |
| **6** | Merge Operation (Seconds) | 143.96 | 143.96 |
| **7** | Show Operation (Seconds) | 153.92 | 153.95 |
| | Total Time | 984.82 | 639.20 |

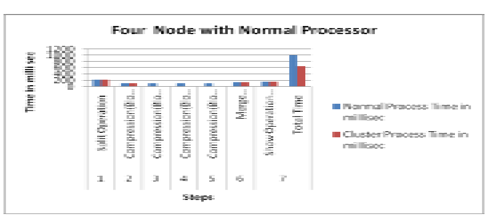


Figure 12: Graphical Output of Processing Time taken by Conventioal Processor and Four Nodes connected in Cluster Computing Environment.

We found that when we use Four Nodes with Cluster Computing Environment, its performance ratio is 1:3.

### *4) Conventional Processor with Sixteen Nodes connected in Cluster Computing Environment*

TABLE 6: Comparison Analysis of Processing Time of Conventional Processor with Sixteen Nodes connected using Cluster Computing Environment.

| Sl. No | Process(Time Taken ) | Con. Process Time in msec | Cluster Process Time in msec |
|---|---|---|---|
| **1** | Split Operation | 223.46 | 223.46 |
| **2** | Compression(Block-AI) Operation | 47.86 | 51.86 |
| **3** | Compression(Block-AII) Operation | 47.86 | - |
| **4** | Compression(Block-AIII) Operation | 42.96 | - |
| **5** | Compression(Block-AIV) Operation | 44.81 | - |
| **6** | Compression(Block-BI) Operation | 47.86 | - |
| **7** | Compression(Block-BII) Operation | 47.86 | - |
| **8** | Compression(Block-BIII) Operation | 42.96 | - |
| **9** | Compression(Block-BIV) Operation | 44.81 | - |
| **10** | Compression(Block-CI) Operation | 47.86 | - |
| **11** | Compression(Block-CII) Operation | 47.86 | - |
| **12** | Compression(Block-CIII) Operation | 42.96 | - |
| **13** | Compression(Block-CIV) Operation | 44.81 | - |
| **14** | Compression(Block-DI) Operation | 47.86 | - |
| **15** | Compression(Block-DII) Operation | 47.86 | - |
| **16** | Compression(Block-DIII) Operation | 42.96 | - |
| **17** | Compression(Block-DIV) Operation | 44.81 | - |
| **18** | Merge Operation (Seconds) | 143.96 | 143.96 |
| **19** | Show Operation (Seconds) | 153.95 | 153.95 |
| | Total Time | 1101.38 | 573.23 |

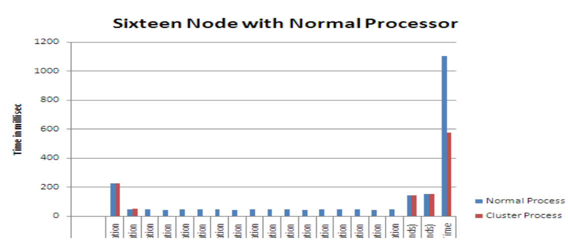


Figure 13 : Graphical Output of Processing Time taken by Conventioal Processor and Sixteen Nodes connected in Cluster Computing Environment.

We found that when we use Sixteen Nodes with Cluster Computing Environment, its performance ratio is 1:4.

The performance metric in this paper is system lifetime, which is defined as the time duration from the time instant when the network starts working until the first node in the network fails due to depleted energy.

## IX. APPLICATIONS

Application areas include Defence forces where spy images from satellites have to be stored securely and also efficiently since a lot of images flow during time of criticalities. It can also be applied in the Weather forecasting, Institution Secret Information, where images are transferred in a very fast and secure manner.

Handling of high resolution images in Mobile phones have been complex due to minimal storage available. This System solves this problem efficiently.
The trend is firstly to store and transmit images and video clips digitally and secondly to add multimedia properties to wireless mobile devices.

A recent survey during November 2009 predicts that around 698 websites have vanished due to improper security features. Using this server, the security provided increases in large fold.

## X. CONCLUSION

This Proposed methodology was tested against Standard Image Compression Methods in order to rate it. From the analysis result, it has been found that Cluster Image Compression stands unique in providing secure service to the user compared to the other Services. Our proposed method is implemented using Matlab & Java Cluster-based Environment. Several set of Images are tested based on this approach and its Execution Time is measured. This method gives higher efficiency rate than other schemes. The Security Level is high on this Java Cluster and Intrusion Scheme. Our Project is efficient to a mark of 91.20% comparing others.

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