Calculating & Maximizing The Accuracy of Remote Infrastructure Management using Layers in ANN System

Satinder Pal, Dr. Sanjay P. Sood, Dr. Dharm Bir Singh
1Dept. of CSE, Singhania University, Rajasthan, India
2State eGovernance Mission, Chandigarh Administration, Chandigarh, India
3Lord krishna Colleges, Ghaziabad, India

Abstract
Matching IT infrastructure with the needs of a business is a CIO’s biggest challenge. The increasing complexity of IT infrastructure and the constant pressure to reduce its costs, forces CIOs to maximize the use of existing resources and to enhance productivity of key technical people. Downtime, however brief, can result in revenue losses, unhappy customers and a loss of productivity. Instead of using productive time to making strategic decisions, key personnel are forced to spend it in routine operations management of IT infrastructure. Remote Infrastructure Management (RIM) involves a combination of near-shore and offshore delivery models. RIM can reduce the costs of operations, thus enabling IT managers to consider investing in new technology. The objective of this paper is focused on Artificial Neural Networks (ANN) based system to verify whether a RIM will ultimately lead to improvement in Software Process. Predicting success or failure of RIM & achieving maximum accuracy by changing number of layers in ANN system is one of the main conclusion.

Keywords
Artificial Neural Networks (ANN), Remote Infrastructure Management (RIM), Network operations centers (NOC), Classification Matrix (CM) etc.

I. Introduction
Remote Infrastructure Management (RIM) is defined by analysts as the remote support and management of various IT services that are related to infrastructure support from global delivery sites. The service offering encompasses remote monitoring and management, which includes support, administration, maintenance, and troubleshooting and performance enhancement. These services include the remote system monitoring of the following: data center, networks (WAN and/or LAN including switches, routers, and hubs), database administration, desktops, servers and related peripherals and e-mail systems. Service providers who deliver RIM services must make substantial investments in highly skilled professionals with vertical competencies in selected technology segments and subsystems. In addition, they need to provide robust enterprise tools together with voice and data-grade bandwidth for managing these enterprise environments from afar. RIM services are poised for strong sector growth as companies look to leverage a global delivery model to support their businesses. Savings can be as high as 50% because service providers can leverage automation, state-of-the-art facilities and highly trained personnel to deliver these services 24/7/365.

II. Operational Issues in RIM
Following are the issues observed in RIM process.

- People related issues
- Poorly defined roles and responsibilities
- Every team does administration, development & support
- No clear responsibility matrix / SLAs. Outsourced support
- Technology related issues

- When there is no evidence of architecture documents for network, systems and security
- When there are no tools for monitoring & managing the infrastructure
- When there is poor metrics measurement
- When there are single points of failure in Internet connectivity, Load Balancers, Firewalls
- When there is weak security
- When redundancy for applications at the system/ server/ database level is unavailable
- Since actual Implementation of RIM involves large costs and time investments there is a need to develop a system for predicting the success or failure of RIM

III. Key Action Steps in RIM Outsourcing
1. RIM outsourcing begins with an infrastructure assessment to determine the current state of IT environment. The assessment will give you and the service provider a realistic view of the environment and allow for the creation of a solid transition plan. This allows the service provider to transition services efficiently and without problems and will keep end-user satisfaction and performance high while driving down costs. Beyond pure cost savings, your organization will experience improved service delivery and security by leveraging the wealth of knowledge and resources. This assessment will give.

2. Service Level Agreements (SLAs) are the fundamental methods for measuring the performance of any group responsible for delivering services—whether local or remote. Developing the right SLA is important. And, having the right baseline measures in place before negotiating the handoff is critically important. You cannot expect the service provider to deliver on something your organization was incapable of delivering unless they have the same degree of opportunity.

3. Problem management and event escalation, the concepts of escalation, security, governance and collaboration must be discussed and determined in advance of the handoff.

4. Team collaboration via the service provider’s Web portal is essential, not only in gaining a big picture view of the network, but also in sharing metrics and business intelligence information. Setting realistic and attainable goals and objectives at the outset are also very important.

5. Develop strong sourcing competency - Organizations that use outsourcing as a pillar in their business strategy must invest in advanced competencies to manage multiple providers. For example, even with a sound sourcing strategy and best-in-class sourcing management, contracts will be hard to manage without the right people who understand outsourcing dynamics.

6. Face-to-Face communications and interactions of this newly formed strategic partnership. Building trust early is vital to both the short- and long-term success of the relationship. Delivering professional services today is really all about
people. Reviewing goals and objectives, and issues and concerns on a quarterly basis is extremely important, especially in the beginning of the new relationship. More important is the need to get to know one another—that is when trust is formed. You cannot build and sustain relationships when you do not have the opportunity to meet frequently. Again, these are the important factors you should consider in the selection process of a service provider and in the scope and range of services you are comfortable in outsourcing.

7. Retaining your intellectual property - One of the basic fears in outsourcing is that over time you lose a great deal of intellectual capital. Knowledge of networks and systems is important to every enterprise. Just because you outsource does not mean that the knowledge should go with the transaction. Make governance a deliberate process and ensure that everything is well documented. Appoint a single point of contact from your side and make sure that person is working very closely with your service provider’s single point of contact.

IV. Objective

The objective of this work is to develop an ANN based system to verify whether a RIM will ultimately lead to improvement in Software Process. Our objective is to achieve maximum accuracy of RIM by using ANN system. The benefit of this work will be that it will save cost, time & other resources in actual implementation of RIM.

V. Literature Survey

While IT management services represent a mature subject in the IT business arena, the emerging cloud generation of management services require critical enhancements to the current processes and technologies in order to deliver IT management remotely with rapid on boarding and minimal labor involvement from experts, to be affordable and scale up to the promise of the cloud. Traditional Remote Infrastructure Management (RIM) service providers use their own Network Operations Centers (NOC) to remotely monitor and manage customers’ IT infrastructure. The primary business value for RIM services is that it helps global enterprises to small and medium businesses (SMB) to outsource the burden of managing their IT infrastructure. Although the IT management service itself delivered this way is more affordable, the RIM customer on-boarding process particularly is not, taking between one to two months of expensive labor. Management services represent a mature subject in the IT business arena. According to Gartner Dataquest, Remote Infrastructure Management (RIM) is a rapidly growing market growing at a Compound Annual Growth Rate of 36%, and projected to grow from USD $14.3B to $30B by 2010 [8]. Typical RIM service providers use their own Network Operations Centers to remotely monitor and manage customers’ IT infrastructure elements such as networks, systems’ hardware and operating systems, and applications. The primary business value for RIM services is that it helps global enterprises and SMBs to outsource the burden of managing their IT infrastructure, thus, cutting down costs for infrastructure management and gaining access to expert skills. The customers can focus then on their core business, shifting the responsibility for IT management to RIM, while maintaining ownership of their assets. A RIM solution generally involves monitoring services comprising of NOC support, reporting, incident notification and escalation, while management services cover problem management and root cause analysis, configuration management, change and release management, maintenance and updates installation. Prior to providing any of these RIM services, the customer has first to select what services to subscribe to during a procedure that is called “on-boarding”. Although the IT management itself is rendered more affordable when provided remotely as a service, the RIM customer on-boarding process particularly is not, taking between one to two months of expensive labor. The current process for RIM customer on boarding consists of multiple interviews and interactions with customers to ‘discover’ their IT environment identify the resources to be managed and guide the enablement of the environment for remote management. This labor intensive approach (measured in weeks) proves to be unscalable when RIM is to be delivered as Management-as-a-Service from an IT infrastructure management cloud. Cloud computing is an emerging paradigm whereby services and computing resources are delivered to customers over the internet (or intranet) from a service provider who owns and operates the cloud. Cloud-based services characteristically can scale up promptly to meet growing demand. The benefit of this will remain unrealized if RIM on-boarding takes weeks as is the standard today. Since the duration to traditionally provision resources for new RIM customers is comparable to the current on-boarding duration, there is little incentive to motivate change to the current on-boarding approach. However, RIM’s goal for delivery from the cloud is ‘on-boarding in minutes’, which means radical revision of the current approach. To this end, we have identified the following on-boarding problems: (1) lack of a standardized approach or automation for the on-boarding operation flow, (2) inaccuracies in manually assessing the environment from the customer’s descriptions or semi-updated inventory files, (3) missing configuration data (e.g., credentials, directory paths, key performance indicators -- KPIs) necessary to setup the monitoring systems, (4) overhead for the SMB customer who is expected to perform complex configurations in their environment (e.g., VPN setup, monitoring data agent/collector installations), (5) evaluated price is not commensurate with the cost of the service expected to be provided. There are many managed services providers in the marketplace. Some are local providers, others regional, and still others global. It is largely the regional and global providers that utilize RIM techniques. They are recruiting IT professionals and making them available to client projects through the use of Global Delivery centers. For the client on-boarding process, these IT professionals have to identify the client’s IT environment either manually during multiple interviews with the customer or by providing a template for exchanging inventory information (e.g., a spreadsheet). Sometimes the customer may provide one by filling out his own questionnaire. However, a better option is programmatic discovery using dedicated discovery software. The inventory information and additional configuration details are then used to configure the monitoring and management toolset. Manual information gathering methods are notoriously error-prone – some of these errors are caught during the tool configuration step which engenders more interactions with the same customer. Other causes that drive the inaccuracy of the manual environment assessment are existing inventory out of date, incomplete or invalid data, and untracked configuration changes (e.g., for the credentials, directory paths, KPIs), that may jeopardize the quality of the RIM service. We will use the manual data gathering performances in the comparison of our experimental results. When the IT environment discovery is done programatically, the typical approaches are via stand-alone products, e.g., TADDM [1] or via services that make use of remote product download, e.g., Paglo [2]. Although more accurate in terms of discovery quality compared to the manual approach, the stand-alone products are not suitable for small
and medium business or SMBs, which have tens to few hundreds of servers. These customers cannot afford nor need sophisticated tools oriented towards large IT enterprises with thousands of IT elements. SMBs prefer to use a streamlined asset discovery service to get the inventory of their IT environment, without the hassle of installing, configuring and managing a discovery product. However, the current remote discovery service providers still require software to be installed and configured by the SMBs in their environment.

Fig. 1: Enhanced on-boarding process for RIM delivered from an IT management cloud

In [2] the provider offers the discovery tool for free in the context of their monitoring service and the customer has to take care of the discovery tool installation. This is due to the fact that the discovery must take place from a node in the network to be probed, to circumvent firewalls, Network Address Translation (NAT), and other impediments. Many users, especially in the SMB space, prefer not to face the burden of this administrative overhead and may lack the necessary skills required. After the discovery is completed, the IT professionals have typically to manually collect additional configuration details since the discovery provides partial detection of the environment. We call this approach manual onboarding with automated discovery and will compare in Section 5 its characteristics to our approach presented in this paper as well as to the manual approach. Other related solutions that involve remote discovery include [3] which uses a browser to control a discovery process, however, it is unclear whether the provider intends for the “NDM Agent” to be running on the web server or some other machine (or whether it should or could be located in the browser). They also provide “passive discovery” which involves packet sniffing to discover applications running on client machines. JLocator [4] describes a Java applet based network discovery tool. They discover the network topology, but do not examine applications either on the identified elements. XAssets [5] is a service comparable to SNAPPiMON [6], where the management tool is also browser based. In [5], the discovery process uses a wide variety of discovery techniques to collect hardware items details, while unrecognized software items lists from customers are sent on a regular basis to the provider staff and these items are manually investigated and added to the discovery database. In [6] the discovery is also a combination of manual discovery, for network and server level items and credentials, and automatic look-up for OS and application configuration. Once the inventory has been discovered and validated, and the additional information on the resources to be managed gathered, the IT professionals proceed to or guide the customer through the enablement of the environment for remote management. This step consists of the installation of data collector or agents into the customer’s premises, firewall configuration for site-to-site VPN set-up and NATing of endpoints. Finally, upon performing all necessary data collection and setup for monitoring and managing the selected items in the customer’s environment, the RIM provider prices the offering and starts delivering the IT management service. Artificial Neural Networks have emerged as a major paradigm for Data Mining applications. Neural nets have gone through two major development periods - the early 60’s and the mid 80’s. They were a key development in the field of machine learning. Artificial Neural Networks were inspired by biological findings relating to the behavior of the brain as a network of units called neurons. The human brain is estimated to have around 10 billion neurons each connected on average to 10,000 other neurons. Each neuron receives signals through synapses that control the effects of the signal on the neuron. These synaptic connections are believed to play a key role in the behavior of the brain.

Neural networks take a different approach to problem solving than that of conventional computers. Conventional computers use an algorithmic approach i.e. the computer follows a set of instructions in order to solve a problem. Unless the specific steps that the computer needs to follow are known the computer cannot solve the problem. That restricts the problem solving capability of conventional computers to problems that we already understand and know how to solve. But computers would be so much more useful if they could do things that we don’t exactly know how to do. Neural networks process information in a similar way the human brain does. They cannot be programmed to perform a specific task. The examples must be selected carefully otherwise useful time is wasted or even worse the network might be functioning incorrectly. The disadvantage is The network is composed of a large number of highly interconnected processing elements (neurons) working in parallel to solve a specific problem. Neural networks learn by example. That because the network finds out how to solve the problem by itself, its operation can be unpredictable. On the other hand, conventional computers use a cognitive approach to problem solving; the way the problem is to solved must be known and stated in small unambiguous instructions. These instructions are then converted to a high level language program and then into machine code that the computer can understand. These machines are totally predictable; if anything goes wrong is due to a software or hardware fault. Neural networks and conventional algorithmic
computers are not in competition but complement each other. There are tasks are more suited to an algorithmic approach like arithmetic operations and tasks that are more suited to neural networks. Even more, a large number of tasks, require systems that use a combination of the two approaches (normally a conventional computer is used to supervise the neural network) in order to perform at maximum efficiency.

VI. Methodology

Neural networks have proved themselves as proficient classifiers and are particularly well suited for addressing non-linear problems. Given the non-linear nature of real world phenomena, like predicting success of RIM, neural networks is certainly a good candidate for solving the problem. In this problem, MATLAB will be used as the simulation tool. Attempt will be made to build a classifier that can predict the success or failure of implementation of RIM. Six parameters of the RIM will be considered. The six characteristics will act as inputs to a neural network and the prediction of success will be the target. Given an input, which constitutes the six measured values for the parameters of the matrix, the neural network is expected to identify if the RIM process will produce success or not. This is achieved by presenting previously recorded RIM parameters to a neural network and then tuning it to produce the desired target outputs. This process is called neural network training. The samples will be divided into training, validation and test sets. The training set is used to teach the network. Training continues as long as the network continues improving on the validation set. The test set provides a completely Independent measure of network accuracy. The trained neural network will be tested with the testing samples. The network response will be compared against the desired target response to build the classification matrix which will provide a comprehensive picture of a system performance. The training data set includes a number of cases, each containing values for a range of input and output variables. The first decisions you will need to make are: which variables to use, and how many (and which) cases to gather. The choice of variables (at least initially) is guided by intuition. Expertise in the problem domain will give you some idea of which input variables are likely to be influential. As a first pass, you should include any variables that you think could have an influence - part of the design process will be to whittle this set down.

VII. Results

The results of this work are in the form of graphs of performance vs number of epochs by changing the number of layers

A. Percentage accuracy using single Layer used to construct ANN

The first graph plots the percentage accuracy achieved when one layer was used to construct the artificial neural network

It can be seen from the graph that ANN characteristics are:

TRAINLM-calcjx, Epoch 0/100, MSE 2.29141/0, Gradient 5.01065/1e-010
TRAINLM-calcjx, Epoch 17/100, MSE 0.001359/0, Gradient 0.00514123/1e-010
TRAINLM, Validation stop.
Total testing samples: 113

\[ \text{cm} \text{ (classification matrix)} = \begin{pmatrix} 70 & 6 \\ 2 & 35 \end{pmatrix} \]

\[ \text{cm}_p = 61.9469 \ 5.3097 \\
1.7699 \ 30.9735 \]

Percentage Correct Failure Detection : 92.920354%
Percentage Incorrect Failure Detection : 7.079646%

B. Percentage accuracy using 2 layers used to construct ANN

Following graph plots the percentage accuracy achieved when 2 layers were used to construct the artificial neural network

It can be seen from the graph that ANN characteristics are:

TRAINLM-calcjx, Epoch 0/100, MSE 1.84577/0, Gradient 4.5495/1e-010
TRAINLM-calcjx, Epoch 13/100, MSE 0.00320523/0, Gradient 0.0078773/1e-010
TRAINLM, Validation stop.
Total testing samples: 113

\[ \text{cm} \text{ (classification matrix)} = \begin{pmatrix} 74 & 0 \\ 2 & 37 \end{pmatrix} \]

\[ \text{cm}_p = 65.4867 \ 0.17699 \ 32.7434 \]

Percentage Correct Failure Detection : 98.230088%
Percentage Incorrect Failure Detection : 1.769912%
C. Percentage accuracy using 3 layers used to construct ANN
Following graph plots the percentage accuracy achieved when 3 layers were used to construct the artificial neural network.

It can be seen from the graph that ANN characteristics are:
TRAINLM-calcjx, Epoch 0/100, MSE 0.331589/0, Gradient 1.24963/1e-010
TRAINLM-calcjx, Epoch 11/100, MSE 0.00068622/0, Gradient 0.0433198/1e-010
TRAINLM, Validation stop.
Total testing samples: 113
\[ \text{cm} = 66.2 \]
\[ \text{cm}_p = 58.4071 \ 1.7699 \]
Percentage Correct Failure Detection : 98.230088%

D. Percentage accuracy using 4 layers used to construct ANN
Following graph plots the percentage accuracy achieved when 4 layers were used to construct the artificial neural network.

It can be seen from the graph that ANN characteristic:
TRAINLM-calcjx, Epoch 0/100, MSE 0.454978/0, Gradient 2.07929/1e-010
TRAINLM-calcjx, Epoch 12/100, MSE 0.000325555/0, Gradient 0.00963222/1e-010
TRAINLM, Validation stop.
Total testing samples: 113
\[ \text{cm} = 71.1 \]
\[ \text{cm}_p = 62.8319 \ 0.8850 \]
Percentage Correct Failure Detection : 95.575221%
Percentage Incorrect Failure Detection : 4.424779%

E. Percentage accuracy using 5 layers used to construct ANN
Following graph plots the percentage accuracy achieved when 5 layers were used to construct the artificial neural network.

It can be seen from the graph that ANN characteristics are:
TRAINLM-calcjx, Epoch 0/100, MSE 0.953917/0, Gradient 2.67875/1e-010
TRAINLM-calcjx, Epoch 15/100, MSE 0.000325555/0, Gradient 0.000963222/1e-010
TRAINLM, Validation stop.
Total testing samples: 113
\[ \text{cm} = 71.1 \]
\[ \text{cm}_p = 62.8319 \ 0.8850 \]
Percentage Correct Failure Detection : 95.575221%
Percentage Incorrect Failure Detection : 4.424779%

F. Percentage accuracy using 6 layers used to construct ANN
Following graph plots the percentage accuracy achieved when 6 layers were used to construct the artificial neural network.

It can be seen from the graph that ANN characteristics are:
TRAINLM-calcjx, Epoch 0/100, MSE 0.522056/0, Gradient 1.83581/1e-010
TRAINLM-calcjx, Epoch 16/100, MSE 0.0040275/0, Gradient 0.0865535/1e-010
TRAINLM, Validation stop.
Total testing samples: 113
\[ cm = 75.2 \]
\[ 1 \]
\[ 3 \]
\[ 5 \]
\[ cm_p = 66.3717 \]
\[ 1.7699 \]
\[ 0.8850 \]
\[ 30.9735 \]
Percentage Correct Failure Detection: 97.345133%
Percentage Incorrect Failure Detection: 2.654867%

**G. Percentage accuracy using 7 layers used to construct ANN**

Following graph plots the percentage accuracy achieved when 7 layers were used to construct the artificial neural network.

It can be seen from the graph that ANN characteristics are:
TRAINLM-calcjx, Epoch 0/100, MSE 1.83033/0, and Gradient 6.50093/1e-010
TRAINLM-calcjx, Epoch 17/100, MSE 0.004567/0, Gradient 0.00942413/1e-010
TRAINLM, Validation stop.
Total testing samples: 113
\[ cm = 66.3 \]
\[ 3 \]
\[ 4 \]
\[ 1 \]
\[ 4 \]
\[ cm_p = 58.4071 \]
\[ 2.6549 \]
\[ 2.6549 \]
\[ 36.2832 \]
Percentage Correct Failure Detection: 94.690265%
Percentage Incorrect Failure Detection: 5.309735%

**H. Percentage accuracy using 8 layers used to construct ANN**

Following graph plots the percentage accuracy achieved when 8 layers were used to construct the artificial neural network.

It can be seen from the graph that ANN characteristics are:
TRAINLM-calcjx, Epoch 0/100, MSE 3.4252/0, Gradient 6.20134/1e-010
TRAINLM-calcjx, Epoch 14/100, MSE 5.51221e-005/0, Gradient 0.010845/1e-010
TRAINLM, Validation stop.
Total testing samples: 113
\[ cm = 64.2 \]
\[ 1 \]
\[ 4 \]
\[ 6 \]
\[ cm_p = 56.6372 \]
\[ 1.7699 \]
\[ 0.8850 \]
\[ 40.7080 \]
Percentage Correct Failure Detection: 97.345133%
Percentage Incorrect Failure Detection: 2.654867%

**I. Percentage accuracy using 9 layers used to construct ANN**

Following graph plots the percentage accuracy achieved when 9 layers were used to construct the artificial neural network.

It can be seen from the graph that ANN characteristics were:
TRAINLM-calcjx, Epoch 0/100, MSE 0.877436/0, Gradient 3.07186/1e-010
TRAINLM-calcjx, Epoch 14/100, MSE 4.93003e-005/0, Gradient 0.000833949/1e-010
TRAINLM, Validation stop.
Total testing samples: 113
\[ cm = 69.7 \]
\[ 4 \]
\[ 3 \]
\[ 3 \]
\[ cm_p = 61.0619 \]
\[ 6.1947 \]
\[ 3.5398 \]
\[ 29.2035 \]
Percentage Correct Failure Detection: 90.265487%
Percentage Incorrect Failure Detection: 9.734513%
Following graph plots the percentage accuracy achieved by varying number of layers used to construct the artificial neural network. It can be seen that best result & accuracy was obtained when 9 layers were used to construct the neural network.
VIII. Conclusion

Thus it can be concluded from this paper that ANN with 9 layers is ideally suitable for predicting failure of RIM & it can achieve 98% accuracy. Due to vast changes in IT Infrastructure & technologies, ANN is useful to predict success or failure of RIM. Neural networks have proved themselves as proficient classifiers and are particularly well suited for addressing non-linear problems. Given the non-linear nature of real world phenomena, like predicting success of RIM, neural networks is certainly a good candidate for solving the problem.

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Er. Satinder Pal received his Master of Engineering from Punjab Engineering College, Chandigarh. He is having around 12 years of experience in Academia & Industry on senior positions. His research interests include Computer networks, Network security, ANN & Infrastructure Managed services with more than 20 publications – National & International.

Sanjay P. Sood has a Ph.D. in Information Technology and his rich experience (17+ years) spans various geographies. Sood has pioneered eHealth / telemedicine in India, Benin and Mauritius. He has been a Consultant to the World Health Organisation. For over two years he was the healthcare technology consultant for World Bank’s Punjab Healthcare Systems project (USD 95 million) at Chandigarh, India. He has been an eHealth specialist on the panel of United Nations (UN Office for Outer Space Affairs, Vienna). He was the project manager / investigator for a USD 1.5 million India’s national pilot project (1999-2004) that lead to the first ever implementation of Telemedicine in India’s government owned hospitals. Sood set up C-DAC’s operations in Mauritius and was the Director, C-DAC’s operations in Mauritius for over four years (2004-2008). Till March 2011, Sood was working as the program manager (Healthcare IT) and was also heading Academic and Consulting Services Division at Centre for Development of Advanced Computing (C-DAC) Mohali and has also been the Project Manager/Co-investigator for three Govt. funded telemedicine Implementation Projects (amounting to over USD 3million) at Mohali in India. He managed and implemented large scale projects (implementation of two State-wide telemedicine networks) in Punjab & Himachal Pradesh. He has authored over sixty world-class articles and academic publications including five book chapters on cutting edge applications of IT in healthcare, he is serving on the editorial boards of six international journals on health informatics and technology management and is a technical reviewer for leading international journals, organizations and publishers (like IEEE, Wiley-USA, Elsevier-Netherlands). He is also a member of Healthcare Information & Management Systems Society’s (HIMSS) Global Task Force on Electronic Health Records, he also been a member of the Executive Council of International Society for Telemedicine and eHealth. Sood is a Life Member of Computer Society of India (CSI) and is the Management Committee member at the Chandigarh Chapter of CSI. Sood is a recipient of international scholarships (like Young Investigator Scholarship by University of Michigan, SIDA Scholarship), he has traveled to around 20 countries and his network includes global pioneers and leading international experts in the domain of IT. Presently, Sood is working as Head & Principal Consultant, State eGovernance Mission for National eGovernance Plan of Govt. of India in Chandigarh.