perfSONAR NSF Proposal

We propose to work with the National University of Sciences and Technology (NUST) / Institute of Information Technology[1] in Pakistan to collaborate closely with the perfSONAR collaboration to extend the perfSONAR framework[2] and deploy it in Pakistan. perfSONAR offers an open source, open community solution to the problem of gathering network performance statistics over a multitide of different administrative domains and technological barriers. It is currently being rolled out across both the United States of America (through Internet2 and ES-net) and Europe (Geant2, Surfnet, RedClara, Pioneer etc).

The perfSONAR framework allows transparency in the gathering and storage of network related data. It also provides the means by which network diagnostic tools[3] can be included in the collection of network metrics. It therefore provides a mechanism whereby both the backbone properties and the end-to-end capabilities of the network can be interrogated and the results archived for later analysis. This bringing together of end sites with regional and backbone network providers is critical to obtaining a pervasive view of the network and ensures that the networks and monitoring tools are really serving their purpose.

perfSONAR extends the measuring and sharing of information across a wider range of autonomous domains. Through the use of authentication, authorization and auditing, sensitive information about the network can also be protected. Projects that are built around the perfSONAR framework therefore enables network engineers, system administrators and users to dramatically reduce the extraordinary amount of time they utilize today coordinating debugging efforts across multiple domains and in building up flexible, coherent monitoring infrastructures. With increased international coverage to help debugging of network related problems, perfSONAR will also aid the worldwide health of the Internet.

In particular this collaboration between NUST and Stanford Linear Accelerator Center (SLAC) will focus their efforts on mining the vast amounts of network data to aid not only the gathering and storage of network performance information, but to develop production quality, useful tools. This will provide an extensive suite that will exploit the potential of the perfSONAR framework and make it an increasingly attractive and useful suite for both networker engineers and network users and facilitate dramatically in the understanding and debugging network problems.

- Network Visualization: Today perfSONAR is more of a middleware architecture, it needs useful visualization tools to enable users to understand the network and rich information available from perfSONAR. This may involve mining for useful information, and or presenting the following areas in more accessible forms.
- Topology: With the growing push towards dynamically allocated circuits, it will become increasing more important to monitor and determine network topologies at multiple network layers in order to guarantee connectivity and performance for network users. Although users and networkers today have traceroute, one also needs more complex network topology tools to discover layer 1 and 2 paths, and to interrogate devices along the path.
- Performance Forecasting: As network applications demand more from the network, it will become important for applications (such as grid data replication) to determine when the best time to conduct transfers and or backups without affecting normal operations.
- Event Detection: Network administrators cannot review thousands of graphs each morning (e.g. multiple sites, interfaces, metrics, paths etc.) looking for anomalies/events. They need automated detection and alerting of significant, persistent changes. Today the network adminsitrators mainly detect whether a link is up or not. As network performance increases and one approaches high reliability this will need to change to not just on/off but to more subtle performance changes. As we have shown elsewhere [5] changes in IP routes, though important, often occur without impact on the performance of a path, and many serious performance changes occur without route changes.
- Network Diagnostics: Having found a network event, our experience has shown that are many steps that must be conducted by seasoned professionals and network engineers to determine the cause of the event. Many of these can, and should be automated to gather immediate results such that tentative conclusions can be used to simplifying the task of network diagnostics further.
- Application Integration: by representing the network as a service by which users and applications can interact, it is hoped that applications will be able to more use of network resources and improve application performance and experience. Examples include large scale replication efforts being steered by Performance Forecasting, and automatically diagnostics of network connectivity and performance problems.

In addition we wish to deploy the perfSONAR and related tools on the Pakistan Educational and Research Network (PERN). This will add another country's NREN to the worldwide set of NRENs able to be monitored and communicate via perfSONAR. It will also provide a means by which the network operator is not only held accountable for the performance of their network, but also provide mechanisms by which network engineers can better utilize their efforts.

Through the contribution of internal development teams at NUST, who will work closely with PERN and SLAC, tools built on the perfSONAR framework will place PERN as a major contributor to the National Research and Education Networks (NRENs) and will aid the performance and deployment of network dependent applications such as CERN's Large Hadron Collider (LHC) Network[4], telemedicine, etc.

With the emphasis on production quality code and algorithms, it will be important for us to impose testing, quality assurance and extensive documentation of both the technical and managerial aspects of the project.

The NUST Institute of Information Technology has been playing its part for more than three years by maturing a collaborative research initiative with SLAC, USA. With expected growth in bandwidths, PERN will also be able to benefit from more advanced tools being developed by SLAC and its collaborators in the US and Europe. The interdisciplinary composition of this proposal encompasses the following: computer networking, software engineering, statistical analysis, high energy physics/science and geopolitics.

[1] NIIT will be funded out of a separate grant from the Pakistan Higher Education Commission (HEC).
[2] The perfSONAR framework is supported by the perfSONAR consortium (http://www.perfsonar.net) recently initiated by the joint collaboration of Internet2, the European Union-funded GEANT2 project, the DoE energy Sciences Network (ESNet), Georgia Institute of Technology (GaTech) and the Stanford Linear Accelerator Center (SLAC). Since NIIT is working in strong collaboration with SLAC, PERN shall be able to benefit from the experience of our collaboration by virtue of PETWORK.
[3] Network diagnostics tools such as OWAMP, NDT, BWCTL (a scheduler for iperf) have proven to be vital for Internet2 to understand the performance trends and in solving network performance problems.
[4] The Pakistan NIIT and National Center for Physics (NCP) sites are both building Grid clusters to provide services for the LHC, and so will need both excellent networking for data distribution, and perfSONAR in Pakistan to diagnose network problems end-to-end.
[5] "Correlating Internet Performance Changes and Route Changes to Assist in Trouble-shooting from an End-user Perspective", C. Logg, J. Navratil, R. L. Cottrell, PAM 2004 (see in particular Table 1).