VIOLA: A testbed for advanced network services

Abstract
The VIOLA testbed has been started in summer 2004 in the region of North-Rhine-Westphalia with an extension to Bavaria. It is an integrated testbed for applications and advanced network services, organised as a consortium with partners from industry, research laboratories, universities and the DFN association. Major goals are the test of different signalling mechanisms in an heterogeneous environment of routers and switches and the development of a user-driven dynamical bandwidth allocation. The results will give input for the stepwise implementation of the X-WIN, the next generation research network in Germany.

Introduction
In June 2004 the project VIOLA (Vertically Integrated Optical Testbed for Large Applications in DFN) has been started. Within VIOLA a consortium with partners from industry, research laboratories, universities and the DFN association will implement a German „Optical Testbed“ in the region of Aachen–Bonn–Cologne (State of North-Rhine-Westphalia) and an extension to Erlangen–Nuremberg (State of Bavaria).

The major goals of VIOLA are:
• Test of advanced network equipment and network architectures;
• Development and test of software tools for the user-driven dynamical provision of bandwidth;
• Interworking of network equipment from different manufacturers;
• Enhancement and test of new advanced applications (e.g. Grid, Virtual Reality);
• Cooperation with similar projects in Europe and elsewhere.

These goals shall be obtained with integrated work in the areas of network technology and application development, both as part of a testbed environment. The integration of applications into VIOLA will offer a realistic and near-operational environment to test such new network equipment.

The results of VIOLA shall support DFN, the application groups and the industrial partners for their respective interests:
• DFN is currently preparing the next generation of the German science network (X-WIN) and VIOLA will provide know-how about the according network technology. This know-how includes the knowledge about new network equipment, the collection of operational experiences and the ongoing overview about the available technique.
• User groups from the areas of distributed computing and Virtual Reality (VR) get an innovative network environment to enhance their existing applications. Both areas are of special interest. Distributed computing is an essential part of the Grid-concept and Virtual Reality is of great interest in many scientific and commercial areas (e.g. architecture, car industry, weather forecast service, ...) for planning processes.
The industrial partners get the possibility to test their equipment in a close-to-production environment. They will get results about e.g. stability, user-friendliness of operation and performance parameters. The experiences in VIOLA will help them to enhance their products and services.

**Technical goals of VIOLA**

The implementation of the X-WIN with a high performance backbone with trunk capacities of 10 to 40 Gb/s is a major goal of DFN in the coming years. But not only the increase of bandwidth is a necessary task for the X-WIN. The increase of network intelligence is as much as important, especially the user-driven dynamical provision of bandwidth based on WDM or SDH-channels. The basic X-WIN implementation will start in 2005. Its further development will be an ongoing process with input from VIOLA. Thus, the project VIOLA will deal (with respect of further usage in X-WIN) with following aspects:

- Which switching and management capabilities future generations of network equipment will have? In which way the dynamical provision of bandwidth is implemented? In which way the optical layer and the IP layer will be combined?
- Which network properties are depending either on different architectures of network protocols (e.g. IP, Gigabit-Ethernet over WDM, with or without usage of a SDH layer) or just on higher bandwidth?
- In which way the operational functions of the equipment can be measured with respect to simplicity, stability, fault tolerance etc?
- Which problems occur with the cooperation of different manufacturer equipment in real life?
- Which additional components (middleware tools) must be developed for the interest of applications?

To deal with these issues the cooperation of network technology and applications is an integral part of the VIOLA concept. Such integrated structure will provide to the network specialists the chance to test their components under near-operational conditions which forms a good base for later operational/commercial usage. The other way around, application developers might enhance their (already existing) tools within an attractive environment which elsewhere will be available only in future. This concept will be realised in VIOLA to demonstrate the advantage for applications with high transmission demands and QoS requirements that cannot fulfilled for single users in today operational networks.

At the beginning the applications in VIOLA will stem from the areas of Grid computing and VR which are of special interest in the scientific community.

Grid applications using mainly distributed resources like super computers, large data bases or large experimental equipment have (or will have) strong requirements for the performance of networks (throughput, dynamical connectivity, QoS) and such applications will certainly form a large user community in future science networks. Apart from high throughput a special goal of the Grid projects within VIOLA is to test the ability for user-driven dynamical bandwidth requirements. VR applications will mainly have requirements for QoS (real-time) and high burst traffic.

Currently the following application projects will be realised within VIOLA:

- VIOLA-Support: Implementation and operation of a compute-Grid,
- MetaTrace: Simulation of pollution distribution on distributed SMP-clusters,
- TechSim: Distributed simulation of various complex technical systems,
- AMG-OPT: Optimal hierarchical-algebraic solver
- KoDaVis: Collaborative visualisation of large atmospheric data within heterogeneous environments.
Further application projects shall be integrated later on.

Altogether VIOLA will provide an environment for operational field tests with advanced network equipment. The participating research institutions may collect network experiences and enhance applications. In that sense VIOLA forms a link between laboratory test environments and production-like networks.

**International Cooperation**

Many other research networks execute important tests and preparations of future network technology. A lot of work is done e.g. in CANARIE, but also in European networks (e.g. SURFnet, UKERNA, CESNET or PIONIER). Further on there has been started a number of European projects, e.g. MUPPET and GN2 (funded within the 6th framework program of the EU). VIOLA forms the German national base for European projects that are set up on top of national activities. In that sense VIOLA and other international projects complements each other.

**Network Structure in VIOLA**

The testbed VIOLA will be implemented at the beginning in the region Aachen–Bonn–Cologne (State of North-Rhine-Westphalia) with an extension to Erlangen–Nuremberg (State of Bavaria).

The task of the transport network is to interconnect the Gigabit-Ethernet-Switches or workstations at the application site with n times 1 Gigabit-Ethernet (1 GE) or n times 10 Gigabit-Ethernet (10 GE). As project time goes on this should be done dynamically depending of the requirements of the users. Figure 1 presents a topological overview about the locations and the used bandwidth in VIOLA.

![VIOLA topology](image)

**Figure 1:** VIOLA topology
It is planned to integrate further locations into VIOLA later on, e.g. Munich. Further on there shall be a connection link with the testbed „Global Seamless Networks“ (GSN, GSN+) of Deutsche Telekom which is used also in the project MUPPET.

The VIOLA backbone includes sites in Sankt Augustin, Jülich, Bonn, Nuremberg and Erlangen with OEO switches (Alcatel 1678, Siemens hiT 7070, Sycamore SN 16000) connected via 10 Gb trunks. In addition there will be 10GE switches (Riverstone 15008) in Sankt Augustin, Jülich and Bonn again connected via 10 Gb trunks. The further 7750 SR from Alcatel and the hiT 7070 from Siemens may be connected either with the other local OEO switches or via 10 Gb trunks with each other.

It is planned in phase 2 of VIOLA to transfer the Siemens SDH switches (hiT 7070) from Bonn and Sankt Augustin to further locations (e.g. Munich).

The other VIOLA user sites are connected with 10GE or 2 x GE to the backbone. Details of the equipment and the connections to each other are presented in Figure 2 for the sites University of Bonn/FhG/FZ Jülich.

**Figure 2:** Equipment and connections at the backbone sites in North-Rhine-Westphalia

In Figure 3 the extension to Bavaria and to the testbed of Deutsche Telekom is presented. The SDH switch Sycamore SN 16000 in Nuremberg is connected with the Rhineland area with a 10Gb link. Nuremberg forms the distribution point to Erlangen and possible further locations in Bavaria.
The usage of OEO switches based on SDH and 10GE switches in the backbone offers the chance to test different advanced signalling methods for dynamical bandwidth reservation in parallel:

- Signalling based on MPLS, VPLS or H-VPLS at the 10GE backbone switches;
- Signalling of dynamical bandwidth allocation based on different protocols like GMPLS, UNI, I-NNI, E-NNI at the OEO backbone switches and routers of various manufacturers.

The provision of appropriate interfaces at the equipment, the development of signalling mechanism and of resource managers shall achieve these goals. Altogether, the variety of hardware and signalling methods will result in extensive experiences.

**VIOLA lab**
In addition to the backbone with its test field environment including real applications, there will be a so called VIOLA laboratory. Within that context further test with additional equipment from other manufacturers are planned. Such additional equipment might be available just for special tests and short periods.

**Status of VIOLA**
Currently (October 2004) the physical network backbone is nearly established. Almost all hardware equipment from Alcatel, Siemens and Riverstone is delivered and installed. In the very near future it will go into operation. Afterwards the tests and developments will start.

The applications are prepared also to start the usage of the VIOLA network. They will connect to VIOLA in the next few weeks.
Information and contact
Further information about VIOLA (including contact information) is available at „www.viola-testbed.de“ or contact

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Partners in VIOLA
Leader of the VIOLA consortium: DFN-Verein

Members of the VIOLA consortium:
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- Fraunhofer Institute for Algorithms and Scientific Computing (SCAI)
- Research Centre Jülich (FZJ)
- Alcatel
- Siemens
- T-Systems International
- Research Center caesar
- RWTH Aachen University
- University of Bonn
- University of Applied Sciences (FH) Bonn-Rhine-Sieg

Associated partner: GasLINE

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