The Implementation of a High-Speed-Network for the DFN-Community

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Abstract: This article will describe basic concepts, technical structures, status and future extension plans of the implementation of a high-speed network for the DFN-community.

After an introduction about the status of DFN in chapter 2 our concept is described. Due to the high costs for leased lines in Germany DFN has chosen a stepwise approach. In the first phase regional high-speed networks will form the start-up solution. This reduces clearly the needed budget for the lines. Further on from the very beginning a number of dedicated users and advanced applications should be available which really need the new capacity. Thus, the implementation of the regional networks is accompanied by projects which realize and use advanced applications. For the technical implementation a combination of ATM and router technology on top of leased lines was chosen.

In chapter 3 the proceedure for realisation is shortly presented. Among several proposals DFN has chosen five so called Regional Testbeds for realisation: Bavaria, Baden-Württemberg (BaWü), Berlin, North Germany and North-Rhine-Westfalia (NRW).

In chapter 4 the current status of the network implementation and the current status of the application projects is described. Finally in chapter 5 our next steps are presented: Going to a national backbone, bringing ATM service to the end users, integration of the telephone service.

Content

1 Introduction

Within the DFN-community a number of regional high-speed networks have been implemented. This article will describe basic concepts, technical structures, status and future extension plans of this ongoing activity.

Before describing these new facilities some information on the current network status of DFN: Until now DFN is providing the WIN (Wissenschaftsnetz) at user access capacities from 9.6 Kb/s to 2Mb/s. More than 400 sites are connected to the WIN, more than 50 sites have 2 Mb/s access. The WIN is connected to the rest of Europe via EuropaNet (2*2Mb/s) and a 1,5Mb/s line to ESNet provides the connection to the USA. Similar to all networks one finds an exponential increase of transferred bytes also in the WIN. Thus, an upgrade of all above mentioned network components is urgently needed.

DFN has discussed since some time possibilities to implement a high-speed network for the German research community. As preparation for such an upgrade several DFN-projects with high-speed-connections have been implemented already in the past (e.g. 34Mb/s between Erlangen an Munich). These limited projects had the task to test and understand the various techniques (e.g. SMDS/DQDB, ATM) and to enable applications to run within new test environments.

Now the time has come to provide such high-speed networks on a broader scale. They will form the extension component of the current WIN, i.e. the Broadband-WIN.

2 Concept

A major problem when realising high-speed networks in Germany are the enormous costs for the monopoly lines needed. This is also true for DFN as Deutsche Telekom (DT) is not allowed to directly give special tariffs to DFN, for example.

This cost problem limits the possibility to establish a national Broadband-WIN in one step: Neither DFN had the budget to subsidize such a national backbone, nor the potential users/customers have the budget to pay the charges needed then. In this context it is worth mentioning that DFN has to pay regular charges to DT for the current WIN and that these costs are covered by the overall (capacity dependent and volume independent) charges of the customers of the WIN. No subsidy is involved in the provision of the WIN.

To overcome or at least minimize this cost problem a stepwise approach was choosen. In the first phase regional high-speed networks form the start-up solution. This reduces clearly the needed budget for the lines. Further on from the very beginning a number of dedicated users and advanced applications should be available which really need the new capacity. Thus, the implementation of the Regional Networks should be accompanied by projects which realize and use advanced applications.

The idea was that the actual use of the regional high-speed networks by new applications (beyond classical applications) would enlarge the visibility of the needs and of the possibilities. An increased visibility should form a better basis to get more funds (from either source) for the implementation of an expensive national high-speed network. The next step after implementing the regional networks would then be the interconnection of these high-speed islands via a national backbone.

The time gap between the first and the second phase should result in:

- a decrease in prices for 34/155 Mb lines,
- a growing awareness within the customer organisations to increase their budgets,
- an inceased funding for DFN to allow subsidising (for a certain time) such a national high-speed backbone.

Hopefully a mixture of all three components will be the result and allow to enter actually the second phase as soon as possible. It is foreseen that this should happen in 1995.

For the technical implementation several possibilities were discussed. One idea was the usage of the MAN/DQDB-based Datex-M service of DBPT. But the combination of certain technical and performance restrictions and volume dependent charges finally led to the decision to implement a combination of ATM and router technology on top of leased lines.

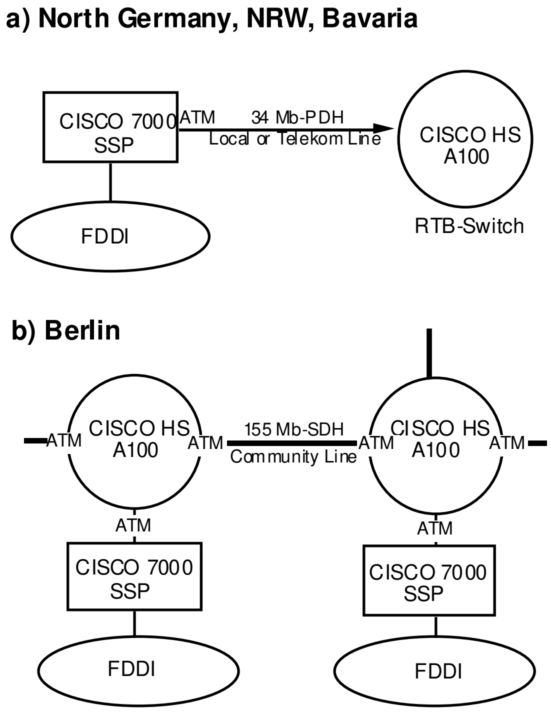

Fig.1: Technical Configuration

This final technical concept is shown in fig.1. Each participating organisation will get a router. The interface of the router to the inner part of the Regional Network will provide ATM. Within the inner part of the Regional Network ATM-switches are used. The interface to the user will provide only IP (on a FDDI-interface) at the beginning. Thus, ATM is used at the beginning mainly as an invisible transport and multiplexing mechanism. Some users will get an ATM-access also from the beginning. But this is strictly experimental and it will be withdrawn if that experimental ATM-access disturbs the production IP-access. More details are discussed in chapter 4.

3 Preparation Phase

In spring 1993 DFN issued a “call for proposal” for the implementation of “Regional Testbeds” (RTB). The proposals for such RTBs had to include technical concepts for the implementation of the regional networks and advanced application projects in need of using these regional infrastructures.

In autumn 1993 a number of good proposals were submitted to DFN. During winter a careful analysis and a further detailed specification of these proposals took place. Finally, in summer 1994, the process of technical tuning was finished. In the first run five RTBs will be implemented: Bavaria, Baden-Württemberg (BaWue), Berlin, North Germany and North-Rhine-Westfalia (NRW). In each of these

RTBs a number of application projects are funded by DFN (see below). Also the investment costs (router/switches) for all participating organisations in all RTBs are financed by DFN.

The line costs are handled differently in each RTB: In the RTBs of Bavaria, North Germany and NRW DFN is funding about 50% of the line costs for a period of two years, the other 50% must be paid by the participating organisations. The state of Baden-Württemberg finances all line costs of the RTB BaWue. In Berlin the participating organisations will use fibre optical lines of the City of Berlin (instead of lines of Deutsche Telekom) without any charges.

4 Status

4.1 Status of Application Projects

There are about 35 application projects which are funded by DFN within the concept of RTBs. Most of these application projects can be grouped into the following categories :

*** Libraries and Journals**

One task is the provision of catalogue information on books and journals. These catalogue information shall be used for the exchange between libraries and for inquiries of end users. Such information are stored at distributed servers. Thus, easy and transparent search tools and user interfaces are needed. A significant problem is the agreement of different libraries on a powerful but easy to use catalogue scheme.

A second task is the provision of books and journals themselves (not only catalogue information). In addition to the text information images, graphics and , later on, audio and video shall be presented. Full text retrieval must enable well-directed enquiries of certain parts of the document. Apart from technical problems accounting and copy right problems must be handled.

*** Medical Applications**

The whole area of health and medicine includes a very large range of many different aspects concerning networking. It is much to large to be covered by DFN projects. Thus, only some aspects in the field of image and signal processing were chosen as work items. Often special medical instruments are the source of data which then must be transferred to dedicated computers for evaluation and storage purposes. Finally, users (physicians) at different locations must have access to data and results. The work items include for example:

- Planning data from a hospital for a radiation therapy will be transferred to the specialised radiation center. Thus, at the radiation center no further examination of the patient (e.g. X-Ray) must be done.
- Different techniques to take images of brains will be integrated for a common diagnosis.
- Results of computer tomography examinations will be 3D-visualised.

*** Distributed Teaching and Learning**

One goal is the interactive multimedia communication between teacher and students during a lesson. Another task is the provision of multimedia lectures that may be studied self-controlled by students.

*** Simulation and Visualisation**

In the field of natural science and engineering classicly two methods were applied in the past: theory and experiments. Often modern problems are much too complex, too expensive or too time consuming for experimental or theoretical analysis (e.g. climatic research, aero dynamic problems in car and airplane design). Thus, with growing computer power a third basis for research and understanding is formed by computer simulations.

Such simulation (often with visualisation afterwards) within distributed specialised environments (super computer, graphical work-station, render server, etc.) must be available also for remote users outside a LAN environment to exploit the expensive hard- and software. This creates a large need for high speed networks. Often also real-time access into simulation and visualisation processes is needed for the adaptation of parameters to save expensive super computer time. Thus, apart from bulk transfer of resulting data also a high bandwidth access for the real-time interaction is necessary.

Distributed virtual reality forms a special application in this area. Here several participants of the same virtual reality interact in real time not only with the environment but also with each other.

*** Multimedia Teleservices**

This area covers the provision and adaptation of generic teleservices (multimedia-mail, video-conferencing, multimedia information server) into special user environments. Most of the above mentioned areas (teleteaching, health, libraries etc.) need one or several multimedia teleservices.

The table of projects funded within the concept of RTBs and a short description of their special tasks is presented in the Appendix.

All projects within the RTBs of Bavaria, Berlin, North Germany and NRW have been started in September and October 1994; the projects in BaWue will start in summer 1995. The usual project period is two years.

DFN-funding for these application projects is about DM 3,5 mio. (ca. ECU 1,9 mio.) in 1994, about DM 6,5 mio. (ca. ECU 2,9 mio.) in 1995 and about DM 4,8 mio. (ca. ECU 2,5 mio.) in 1996.

More information about these projects and their ongoing activity are available via DFN-WWW (http://www.dfn.de/). Further references to the different RTB-WWWs can be found there.

4.2 Status Network Implementation

In September 1994 DFN ordered the necessary line capacity from Deutsche Telekom for the RTBs in Bavaria, North Germany and NRW. In spring 1995 the situation is as follows:

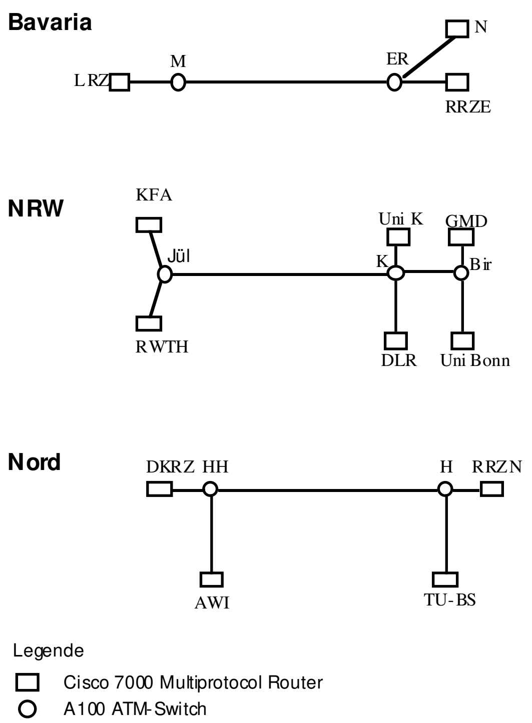

Fig.2a:Configuration of the Regional Testbeds of DFN

In Berlin almost all 155 Mb-lines are in operation. Also the 34 Mb-lines in Bavaria, North Germany and North-Rhine Westfalia are in operation. In Baden-Wuerttemberg the contract between the state of BaWue and Deutsche Telekom about the ATM-based network must still be discussed, but in the meantime (since summer 1994) the nine universities use the Datex-M service (SMDS) of Deutsche Telekom.

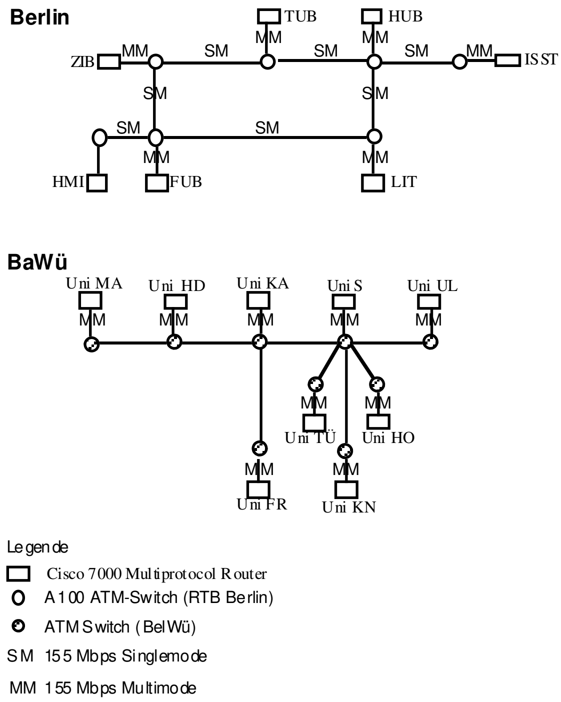

Fig.2b: Configuration of Regional Testbeds of DFN

Also in September 1994 DFN ordered 30 Cisco 7000-SSP routers and 15 Cisco (NEC) Hyperswitch A100 ATM-switches. In fig. 2a+2b the abstract topology of the RTBs and in fig.1 more specific technical details of the access properties are shown. As mentioned above, each participating institution gets a router with FDDI interface to the user side and with an ATM-interface to the network side. In the RTBs of Bavaria, of North Germany and of NRW 34 Mb PDH-interfaces are needed; in Berlin (and lateron in BaWue) a combination of 155 Mb multimode/singlemode SDH-interfaces is needed.

The routers with SDH/multimode interfaces and with PDH interface had been delivered before christmas 1995. The same holds true for the ATM-switches with SDH/multimode interfaces. The ATM-switches with PDH interfaces and with SDH/singlemode interface have been delivered in March and April 1995. Thus, apart from few connections in Berlin almost all participating institutions have started their operation (the rest will follow within the next few weeks).

The ATM-switches are located in the following institutions:

RTB Bavaria: Univ. of Erlangen, LRZ/Munich;

RTB Berlin: TU Berlin, FU Berlin, HU Berlin, FHG/ISST, LIT, HMI, ZIB;
RTB North: University of Hannover, DKRZ/Hamburg;
RTB NRW: University of Cologne, GMD/Birlinghoven,KFA/Juelich;
RTB BaWue: The final topology is not yet agreed.

These institutions may use in addition to the FDDI-interface at the router also a direct ATM-interface at the switches. Whereas the IP/FDDI-interface is for production service within the RTB the ATM-access will be at the beginning only for “experimental” purposes. That means that the institution will make this kind of access on their own risk and their own expense (e.g. additional interfaces). If the production

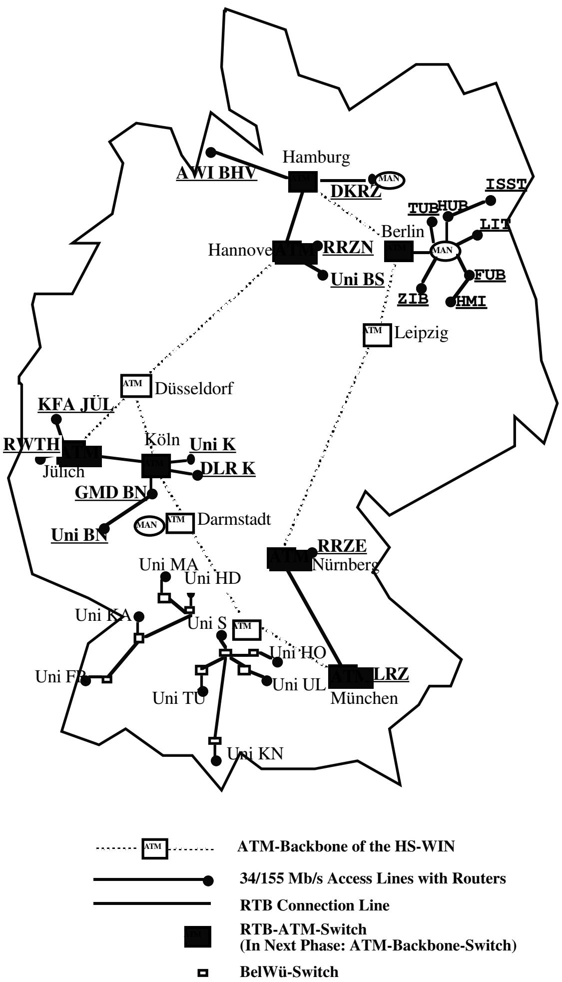

Fig.3: RTB-Connectivity (Phase 0) and HS-WIN Backbone (Phase 1)

service will be disturbed the direct ATM-connections may be withdrawn.

The startup funding for the network implementation is about DM 3,5 mio. (ca. ECU 1,9 mio.) for the equipment and about DM 3 mio. (ca. ECU 1,6 mio.) for the lines.

5 Outlook

Of course, the current realisation phase is only the first step in an ongoing upgrade of the WIN. Our stepwise approach includes four successive phases of implementation:

Phase 0: Start of the RTBs: Implementation of regional networks based on lines with 34- and 155 Mb/s. The participating institutions get IP-access for the production service. Additionally, they may use the ATM-access at their own risk and at their own expense. This phase is currently being implemented.

Phase 1: Start of the Broadband-WIN: The regional networks will be interconnected via a backbone. The probable topology of this backbone is shown in fig.3 with thin dashed lines. The production access is still IP; experimental ATM-access is possible. Additional institutions (outside the former RTBs) may participate. The new Broadband-WIN is integrated with the current WIN via gateways. This phase should be implemented in automn 1995.

Phase 2: ATM production service: Stability, interoperability and needed service features (e.g. flow control mechanism, PNNI-interface, ABR-service) are implemented and successfully tested. The Broadband-WIN provides production ATM-service. This phase might be implemented at the beginning of 1996.

Phase 3: Integration of the telephone service into the ATM-based Broadband-WIN. Precondition for that phase is an overall upgrade to line capacities with 155 Mb/s. Experiments could start in 1996.

Regarding the technical network components and the availability of fibre optical lines in Germany the Broadband-WIN could be implemented very fast. But any further network upgrades in DFN are very sensitive to the reduction of charges for lines. Both, the reduction of charges for high-speed lines by the (monopoly) Deutsche Telekom or the licensing of competitors will speed up that process.

At the beginning of 1995 DFN launched a “call for tender” for the implementation of the national backbone. At the end of March 1995 several proposals arrived at DFN. Currently these proposals are examined due to their financial and technical conditions.

Appendix A: Involved Institutions

RTB Bayern: Univ. of Erlangen, LRZ (Munich), TU Munich, University of Munich
RTB BaWue: Universities of Stuttgart, Mannheim, Freiburg, Karlsruhe, Konstanz, Ulm, Heidelberg, Tuebingen, Hohenheim
RTB Berlin: TU Berlin, FU Berlin, HU Berlin, HMI (Hahn-Meitner-Institut), LIT, ZIB (Konrad-Zuse-Inst.), FHG/ISST
RTB Nord: TU Braunschweig, Univ. of Hannover, AWI/Bremerhaven, DKRZ (Climatic Comp. Cent.)
RTB NRW: RWTH Aachen, University of Bonn, Univ. of Cologne, GMD/Birlinghoven, DLR/Cologne, KFA/Juelich

Appendix B: Application Projects

RTB Bavaria

* IRIS: Usage of a distributed editor within a video-conference.

* Collaboration of electronic libraries: Provision of electronic documents and electronic query tools.

* Tera-Back: Transparent back-up service for distributed fileservers. Central mechanism for the migration of data to cheap storage memory will be implemented.

* Clinical and histological conference: Physicians will use video-conference tools to discuss dermatological results and images (stored in image data bases).

* Multimedia-based teaching and information systems: Implementation of a WAN teleteaching infrastructure between Erlangen and Munich with integration of ISDN-based homework places.

* Distributed computing for engineering applications. Usage of work-station clusters for the computing of very large parallel algorithms.

* Processing of medical images and signals: Application of modern methods of image processing (analysis, image transformation, noise reduction) and image transfer in six different clinical areas.

* Visualisation of molecular models: Chemists in Erlangen will use the Cray in Munich (LRZ) for simulation and visualisation of electrostatic properties of molecules.

* Multimedia-based decentralisation of interdisiplinary teaching: Implementation of an infrastructure to perform looked-after computer trainings resp. practicals with a distributed group of participants from economic informatics.

RTB Berlin

* Visualisation of scientific data: Implementation of a center for visualisation (super computer, archive server, render server, video production) for users in different working areas of universities and research laboratories in Berlin (e.g. chemistry, astronomy, nuclear scattering, mathematics).

* Medical image processing: Resulting images of nuclear spin tomography procedures will be 3D-visualised and stored in a data base for tissue samples. The diagnosis of the results will be supported via multimedia teleservices (multimedia-mail, video-conference).

* Hypermedia-based lessons for student lectures: Development and provision of multimedia-based teaching material in the area of economic science.

* Hotline und consulting system: Provision of a help-desk system including fault data base and human on-line-support (video-conference).

* Unified data environment with heterogenious computers: Implementation of AFS (or DCE/DFS) for a distributed filesystem in Berlin with an unified name space.

RTB Nord

* Video production via networks: In an already existing service center the results of simulations are transferred into video movies. This process will be (partly) controlled by users and the resulting movies will be distributed to the users via the network.

* Distributed computing in the field of “Global Change Research”: Users in the Alfred-Wegner research laboratory in Bremerhaven will make simulations and visualisations at the dedicated super computer (Cray) in the German Climatic Research Center (DKRZ) in Hamburg.

* Visualisation of hydro- and aerodynamical calculations: The simulations will be carried on at the super computer in Hannover, the results will be visualised in the University of Braunschweig.

* Calculation and visualisation of global climatic data sets: Simulation at the Cray in the German Climatic Research Center (DKRZ) in Hamburg with visualisation in the University of Hannover afterwards.

* Online-documentation: Multmedia documents and journals will be presented online (collaboration with a publisher). Short response times shall create an impression of leafing (“book paradigma”).

* Multimedia collaboration in the field of climatic research: Users from that working area in different institutions in North Germany will apply multimedia teleservices (multimedia-mail, video-conference) for their cooperation.

RTB NRW

* Usage of the SNI super computer at the Univ. of Aachen for other users in the state of NRW.

* Distributed (heavy parallel) super computer center: An Intel Paragon (at KFA) and the CM5 (at GMD) will be used as a virtual common super computer by certain applications (e.g. aerodynamic calculations).

* Interactive aerodynamic simulation for components of power plants: Simulation at the University of Cologne, visualisation on dedicated computers at GMD (St. Augustin), transfer of results to users at DLR (Cologne).

* Visualisation of large multi-dimensional parameter spaces: Meteorological data from the University of Cologne will be examined at the Cray of KFA (Juelich). The results are used in the KFA and in Cologne for further research.

RTB BaWue

* Implementation of a mutual backup service between several computer centers.

* Provision of user support for the DFN-RPC (Remote Procedure Call): This software tool is widely used by scientists for distributed applications running on different super computers and work-stations.

* Implementation of an distributed electronic library for scientific literature (PhD theis, diploma, “unpublished” papers, etc).

* Helpdesk: Implementation of a distributed online helpdesk for all universities in BaWue based on information servers and multimedia teleservices.

* Distributed numeric laboratory: Mathematicians from the University of Freiburg will implement their numeric algorithms at the parallel computer in the University of Stuttgart. Experts from the computer center in Stuttgart will interactively support this implementation by using the software tool PAGEIN.

* Simulations in Computational Physics: The output of simulations on a super computer in Stuttgart shall be transferred directly to the work-station of the user instead using the expensive memory space temporarily at the super computer.in the meantime

* Distributed laboratory based on virtual reality: Experts from the computer center of the University of Stuttgart and different user groups (astrophysicists and biologists from Tuebingen) will implement application specific distributed virtual environments.

* Distributed provision of software: The access of arbitrary work-stations to distributed software servers shall be realized as automated as possible.

* Integration of services into the environmental information system of the state of BaWue.

Author Information

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