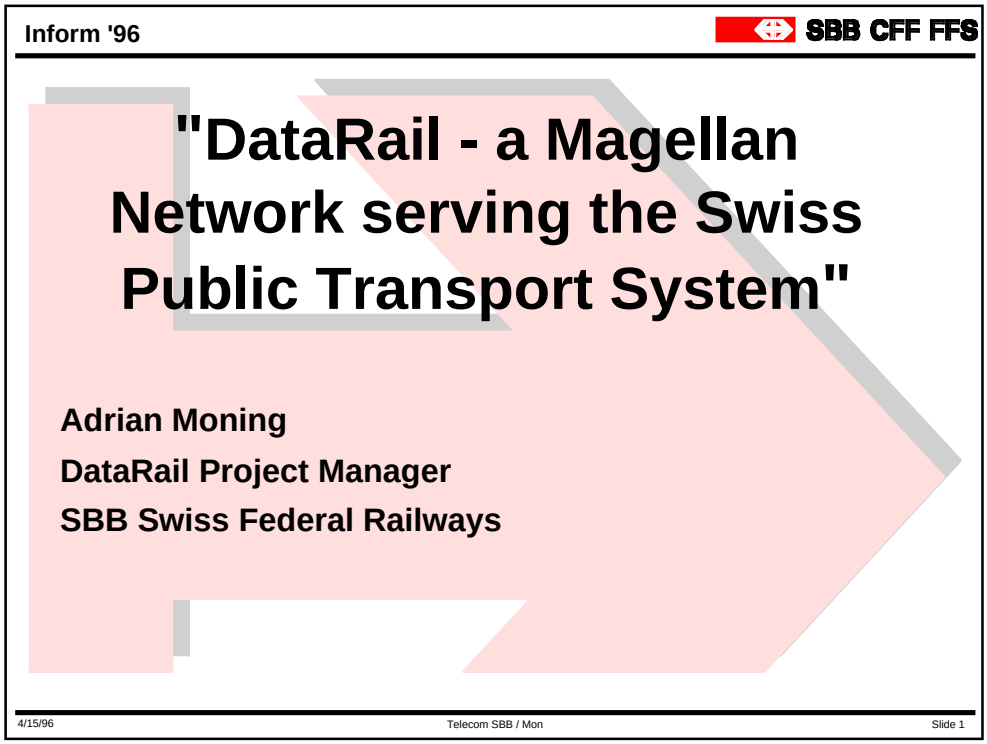


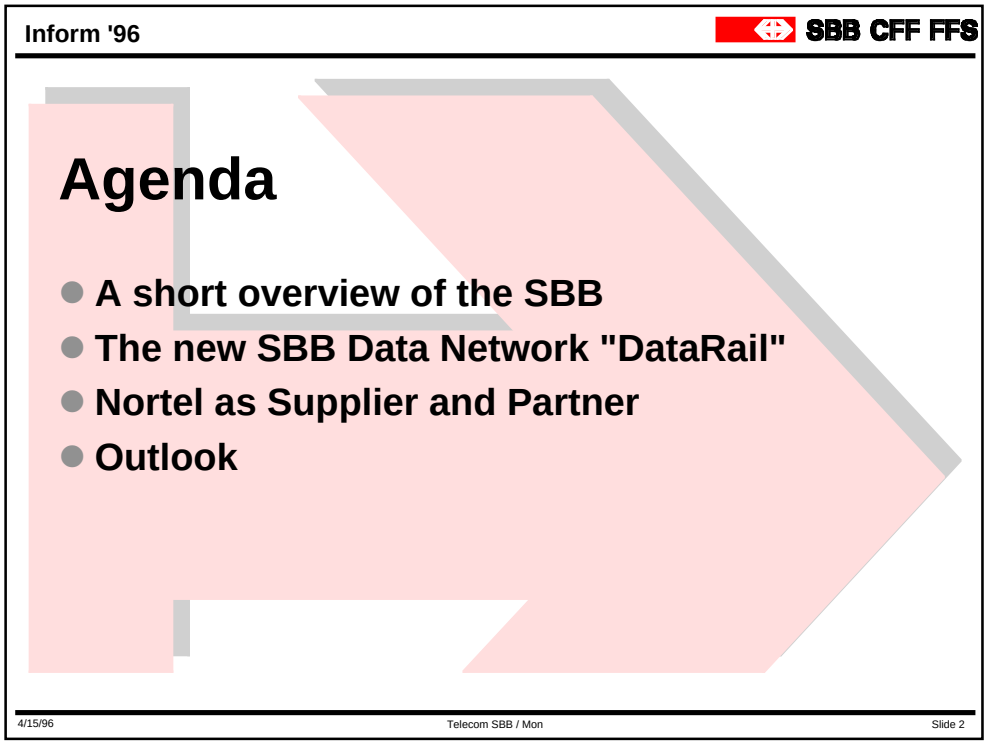
Summary:

In order to meet extensive new demands such as LAN to LAN connections, broader band widths, additional protocols, etc., the SBB is currently installing a modern, future oriented network based on cell and packet switching technology which will also enable the transmission of voice and video.

About the presenter:

Adrian Moning, Electrical Engineer HTL

Following an apprenticeship as a telecommunications and electrical technician, Mr. Moning studied at the Engineering School in Biel, Switzerland. Upon completion of his studies, he took a position as Manager of Information Systems at the Paper Mill in Utzenstorf, Switzerland. Following this, he moved on to take a position a a Systems Engineer for Data Communications at Ebauches SA (now known as the Swatch watch company). He began to work part-time as a professor at the Engineering School in Bern, Switzerland. In 1991, Mr. Moning accepted the position of Group Manager for Data Communications for the SBB - Swiss Federal Railways - and in 1992 he was also named the Project Manager for the DataRail Network Project. Mr. Moning continues to hold professorship for Data Communications at the Engineering School in Bern.

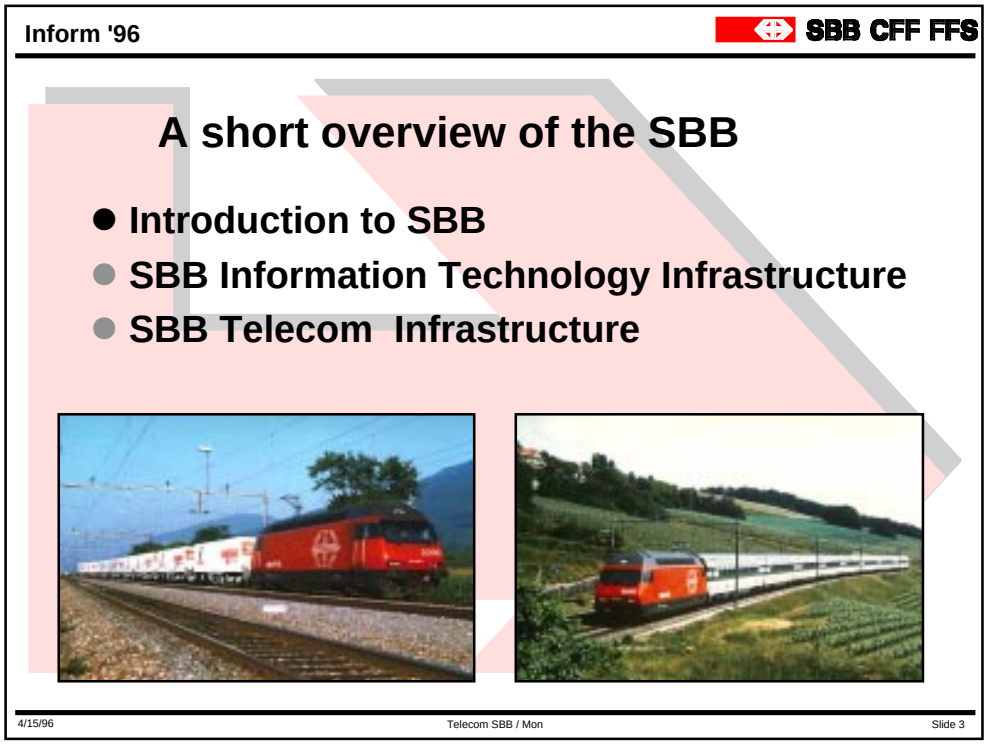


Following a brief introduction to the SBB Organisation and its information technology and telecommunications infrastructure, the new SBB “DataRail” data network will be presented.

The problems confronting the SBB network systems in 1992 as well as the present and future demands on a new, company wide data network will be clarified.

The technical concept and the project situation today will be explained.

A report on Nortel as a supplier and partner as well as a look to the future will round out this presentation.

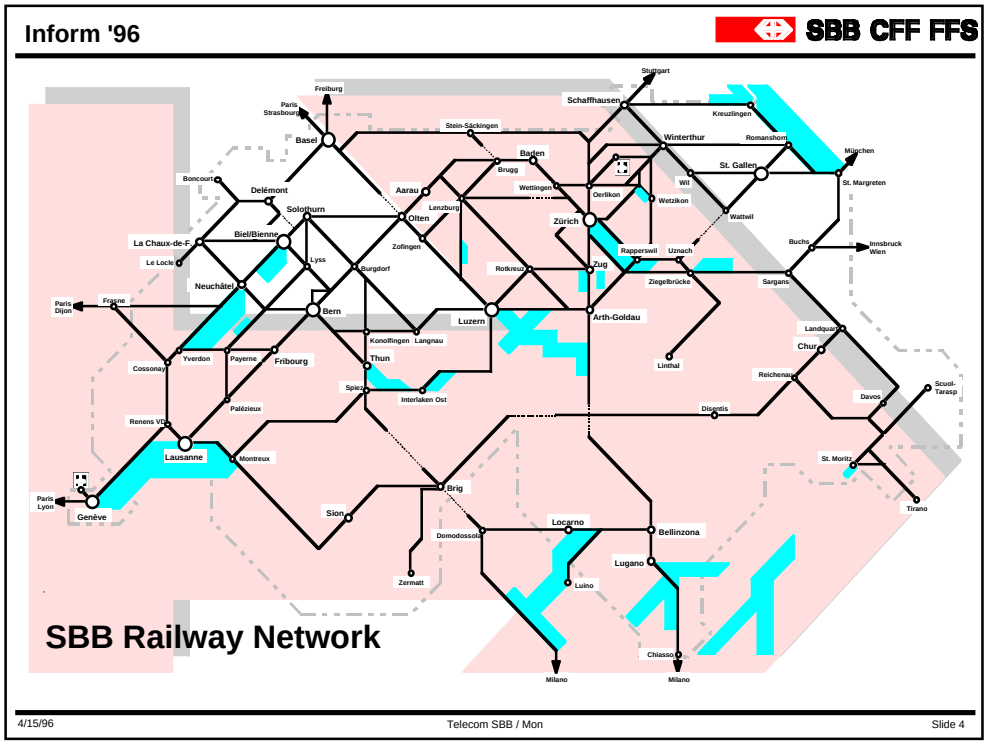


Following a brief company portrait, we will introduce you to the information technology and telecom infrastructure of SBB.

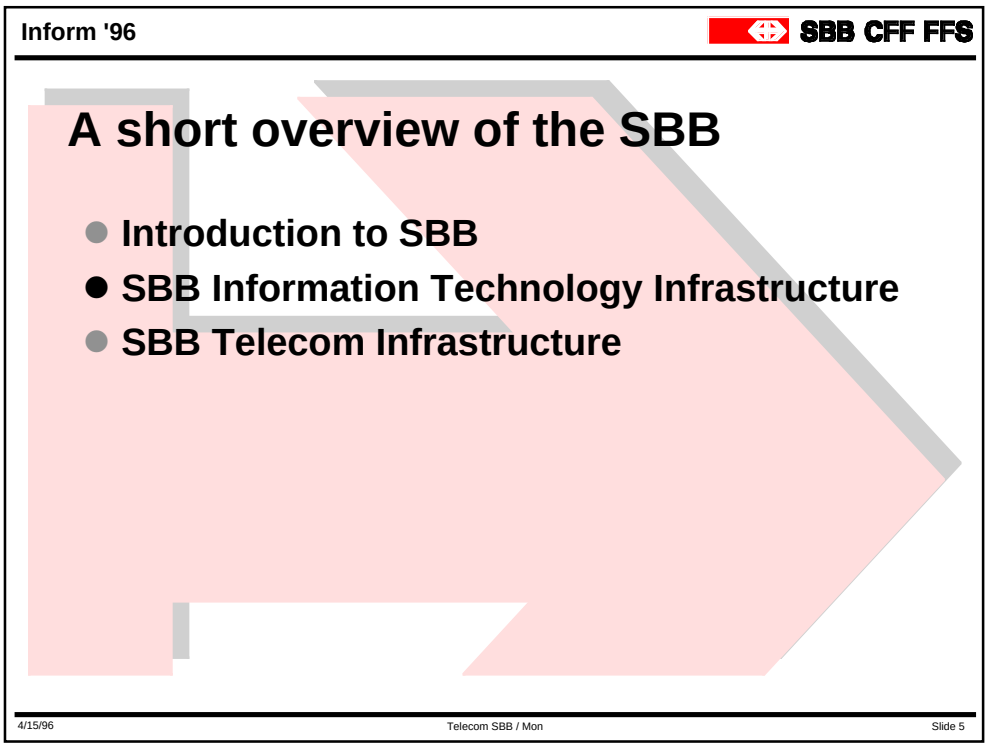
The railway plays a very important role in Switzerland which lies in the heart of Europe. The main north-south and east-west transit axis cross through our country and connect Germany to Italy and Austria to France.

Every year the Swiss Federal Railways transport some 270 million passengers and up to 45 million tons of freight. Each day, all SBB trains combined travel a distance equal to more than 8 times the circumference of the globe. SBB trains call at approximately 800 stations throughout the country and just under 33'000 railway personnel master their task with the help of highly developed technical tools. The annual turnover of the SBB exceeds 6.5 billion Swiss francs.

The SBB have increased their operating performance (and thus their pallet of transport services) vary considerably in the past 20 years. In terms of passenger-train kilometers , the increase since 1970 exceeds 50 %. The number of staff per 100'000 train kilometers has decreased from 46 (1970) to just under 28 (1995).



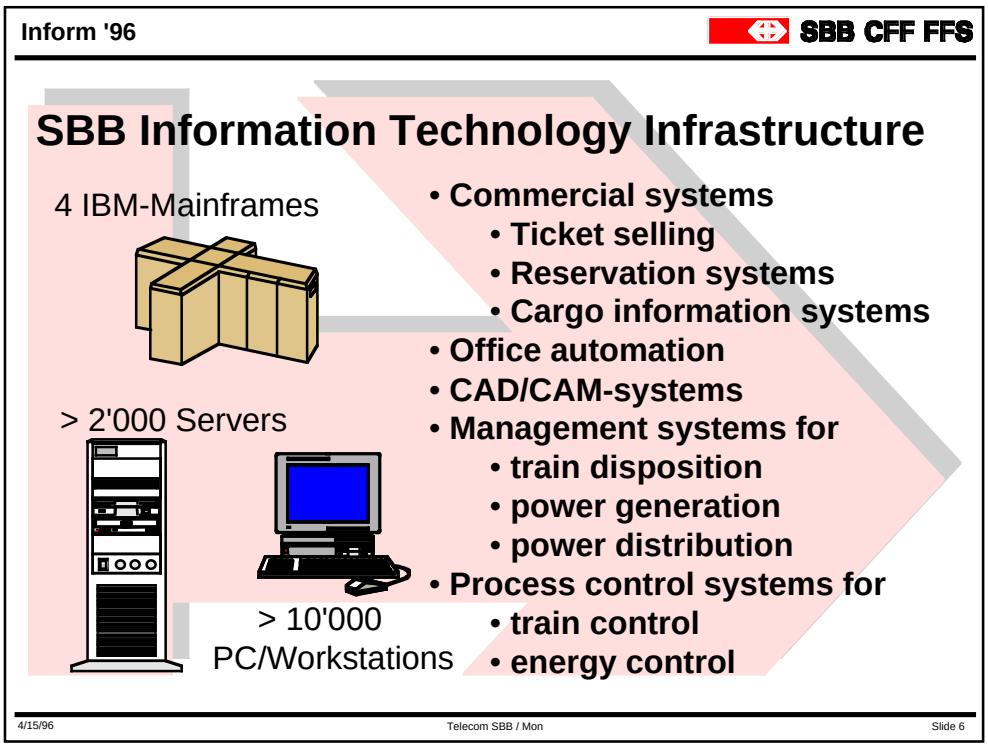
The SBB **railway** network measures roughly 3000 km and is fully electric. 52 % of the rail lines are double track with 208 line kilometers leading through 265 tunnels and 81 kilometers leading over 5’351 railway bridges. A further 990 bridges exist for the many large and small roads overpassing SBB lines.



We would now like to introduce you to the information technology infrastructure of our company.

The SBB operates a very modern, extensive computer infrastructure.

Information technology has enabled us, among other things, to increase the productivity of our organisation by 50% in the last 25 years.



The computer systems which are in operation at SBB can be classified as follows:

1. Commercial Systems : 4 IBM-Hosts with more than 1 TByte mass storage and 20'000 cassettes.
   5'000 PC-Workplaces
   1'500 Servers
2. Office Systems : Running DOS/Windows or OS/2 with some 5'000 PC's
3. CAD/CAM Systems: Some 100 stations running AutoCAD
   Some 100 Intergraph workstations
4. Energy and Train Management Systems:
   Approx. 100 MicroVAX systems
   Approx. 100 IBM/SUN workstations
5. Process control systems Approx. 200 PDP-11and MicroVAX systems

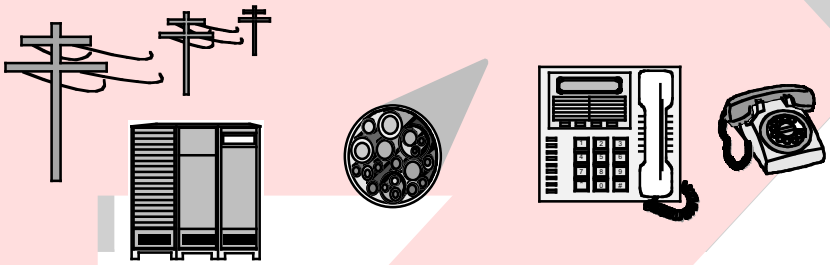
Overall more than 10'000 systems, workstations and PC's.

An ever increasing number of systems are based on modern Client/ Server concepts.

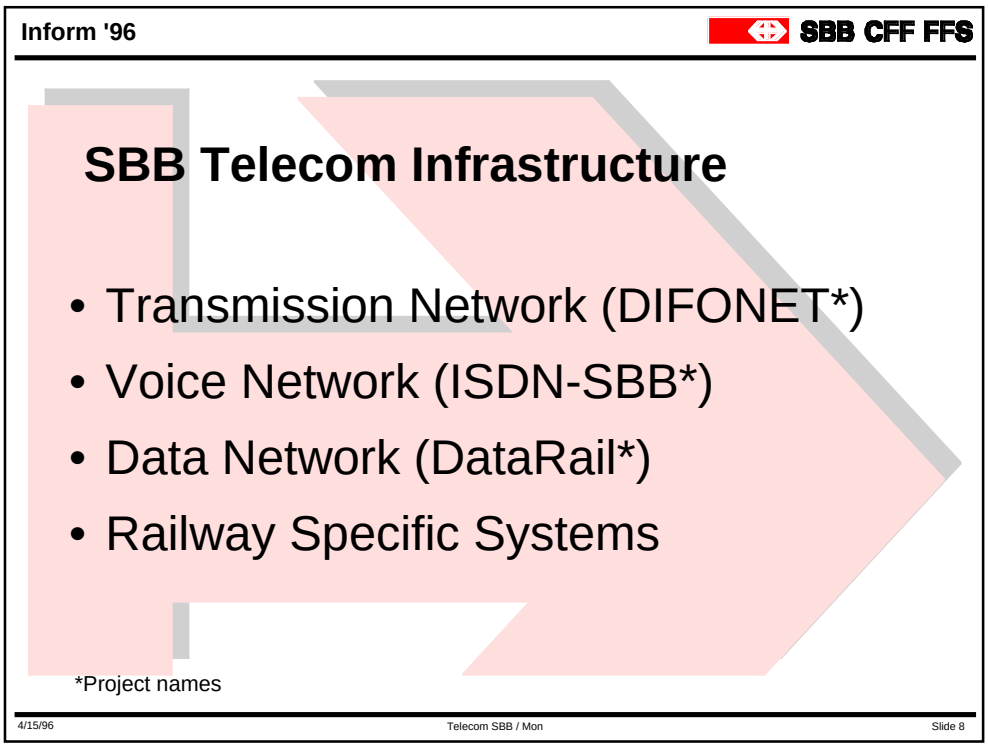
As we will see later, these systems all lead to extensive new demands on the data communication network.

A short overview of the SBB

- Introduction to SBB
- SBB Information Technology Infrastructure
- SBB Telecom Infrastructure

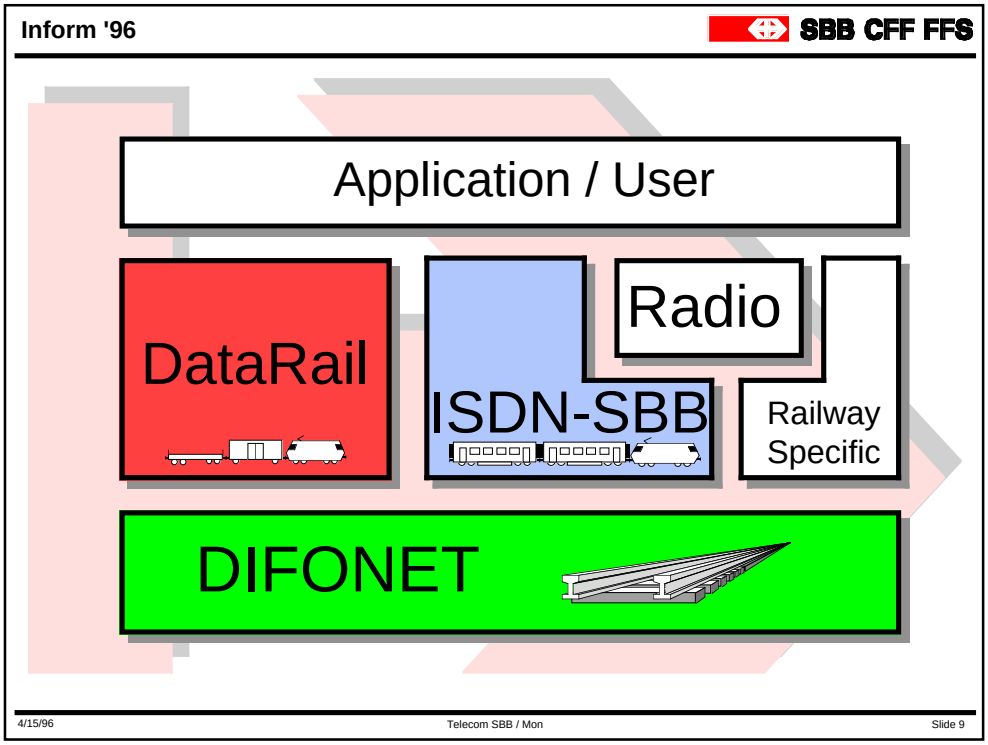


As the owner of their own national network system, the railways and therefore SBB have long had their own extensive telecom infrastructure which I would like to introduce to you.



We differentiate between :

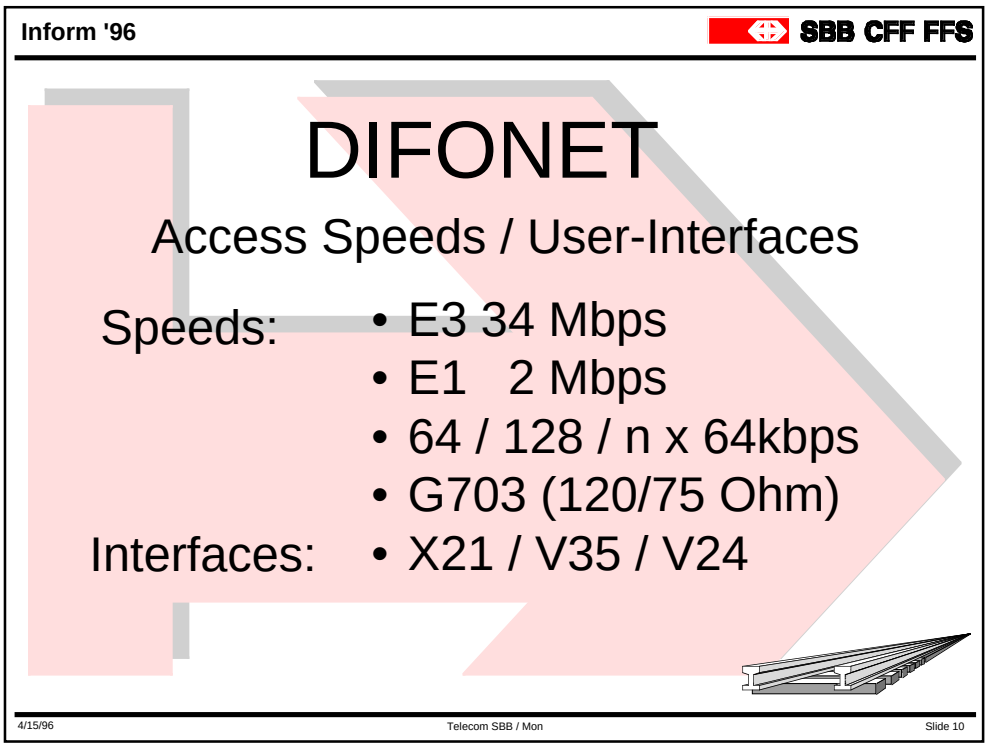
- transmission network called DIFONET
- voice network called ISDN-SBB
- data network called DataRail
- railway specific telecommunication systems such as the various customer info systems, etc.
- and radio systems should not be forgotten



All of these telecommunication networks and systems can be schematically presented as follows :

- The DIFONET Project is based on fibre optic and PDH technology and serves as an efficient transmission network. Over 1'700 km of fibre optic lines had been laid along the railways tracks in Switzerland by the end of 1995 and some 360 locations were already connected.

- The voice and data networks as well as the railway specific telecommunication systems all run along this network



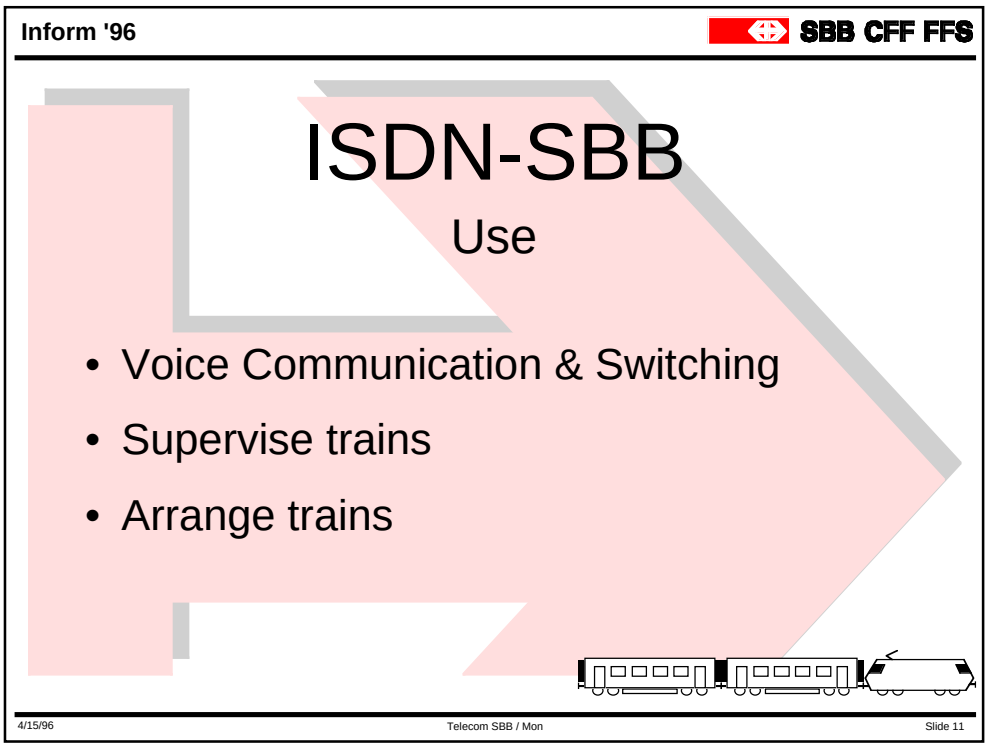
The DIFONET transmission network has the following access speeds

- E3 34Mbps
- E1 2 Mbps
- 64 / 128 / n*64kbps
- 2400 - 19200bps

and user interfaces

- G703 and
- X.21 / V.35 /V.24

available.



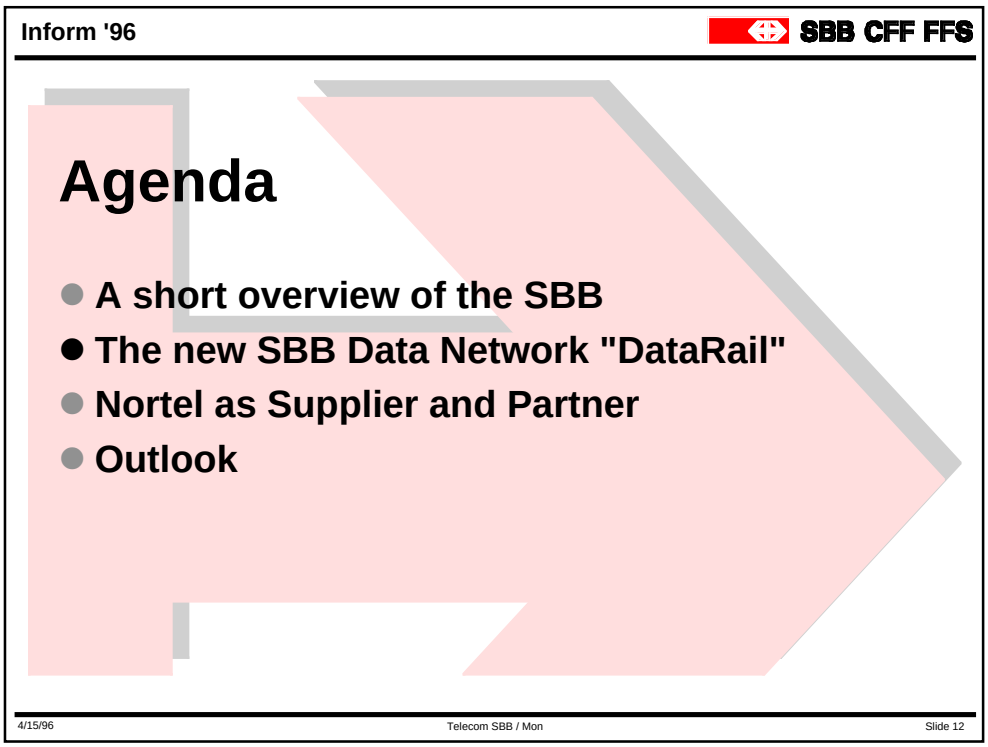
Still under construction, the digital voice communication system ISDN-SBB utilizes 70 Alcatel Type SNE System 12 exchanges to connect some 20'000 parties.

The goal within the framework of the ISDN-SBB Project is to replace 300 analog exchanges and to consolidate the various, railway specific voice communication systems and networks.

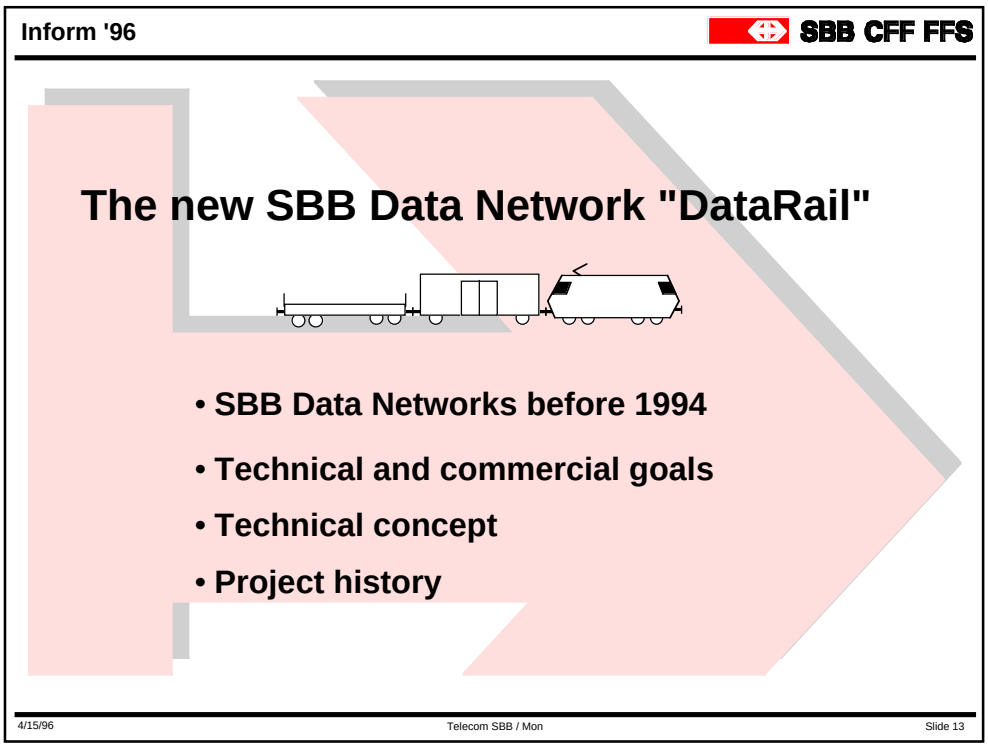
The following network connections are available :

- Primary Rate Access (PRA; 30B+D)
- Basic Rate Access (BRA; 2B+D)
- Analog Subscriber Line (a/b)

Due to time restrictions it is unfortunately not possible here to examine these networks more closely.



Now please allow me to come to the main topic of this presentation which is our new “DataRail” network.

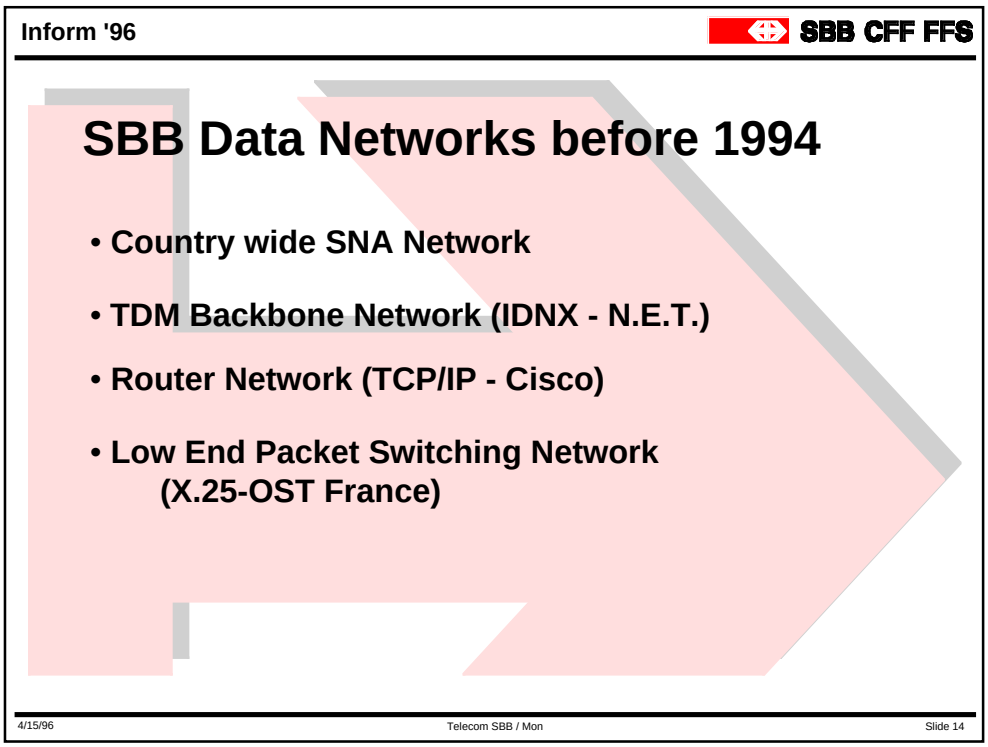


In order to understand the DataRail Project better, we must first look back to the early 90's and briefly explain the data networks which the SBB then had available.

The commercial and technical goals shall be explained in the second section.

The DataRail technical concept will then be introduced.

We shall conclude this chapter with a history of the project and its situation today.



Up until 1994 there were several data networks in use at the Swiss Federal Railways (SBB) :

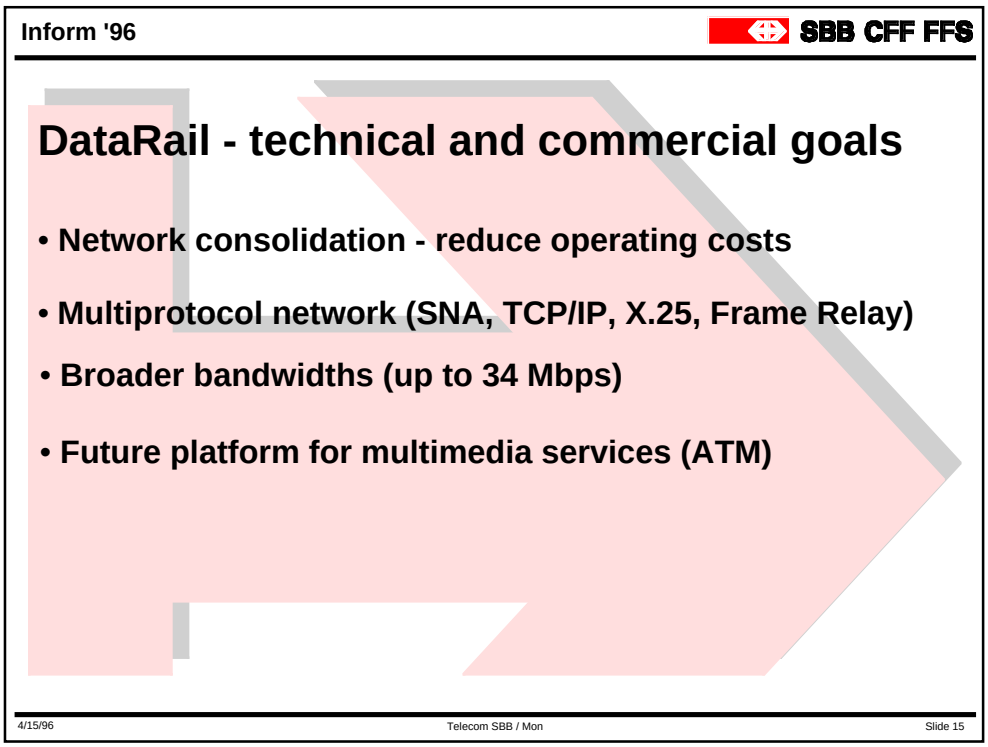
- a national IBM/SNA data network for host based computer applications with 28 remote IBM-FEP's, 900 SDLC lines and over 10'000 PU's (physical units).

- a TDM backbone network for the consolidation of the various trunk connections.

- an X.25 based Packet Switching Network (PIDN) for operative rail operations in eastern and central Switzerland consisting of over 70 ECOM packet switching nodes from OST of France.

- a Router Network for LAN to LAN connections within the framework of the CAD Project called DfA (Datenbank fester Anlagen) utilizing 15 Cisco Routers.

- various project based data networks within the energy and train management areas.



The most important goal of DataRail is to consolidate the existing networks step-by-step in order to lower operating costs (network management expenditure, leased line costs and hardware/software maintenance expenses) and to meet the extensive new demands which have been created by fast paced changes in the computer world (LAN to LAN connections, open systems, client-server applications, etc.).

They can be classified as follows :

Multi Protocol Networks (IBM/SNA, TCP/IP, ISO/OSI, Frame Relay, X.25/X.28) : High interoperability between various network architectures.

LAN/LAN Connections (Tokenring and Ethernet) : In this area we are currently experiencing an explosive growth rate.

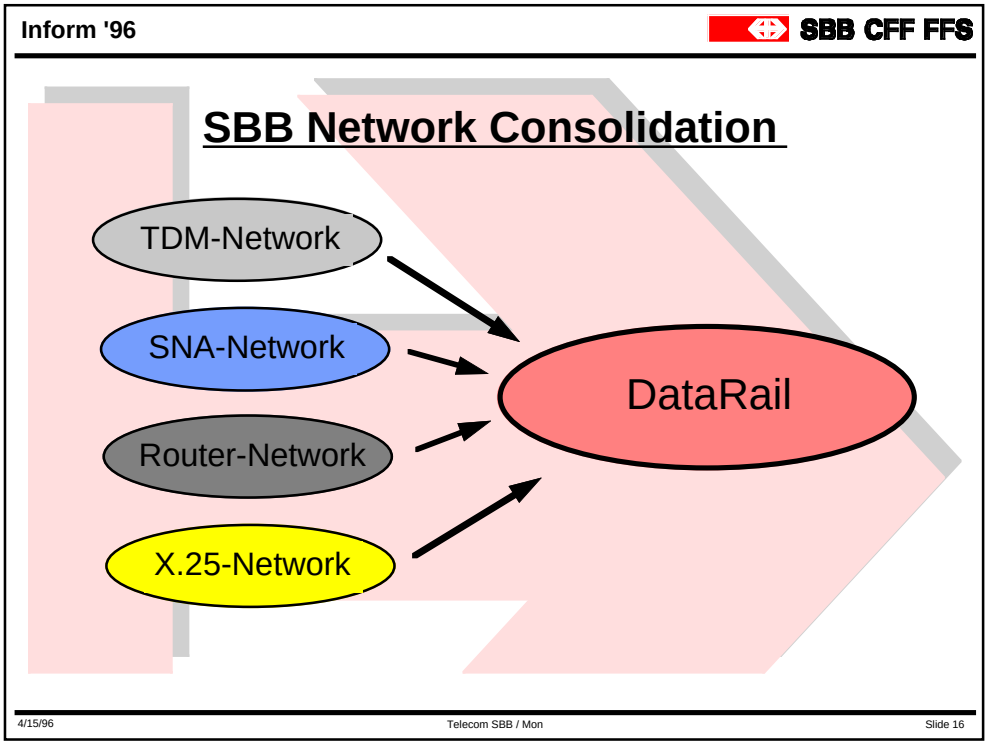
Efficient and **uniform network management**.

Future Oriented Architecture with a View to ATM (Asynchronous Transfer Mode) for multimedia applications (video, voice and data).

Higher Access Speeds : up to 34 Mb/s.

Optimal Band Width Utilization for existing transmission lines.

Failure safe system architecture because DataRail is the backbone of the SBB organisation and is therefore mission critical for rail operations.



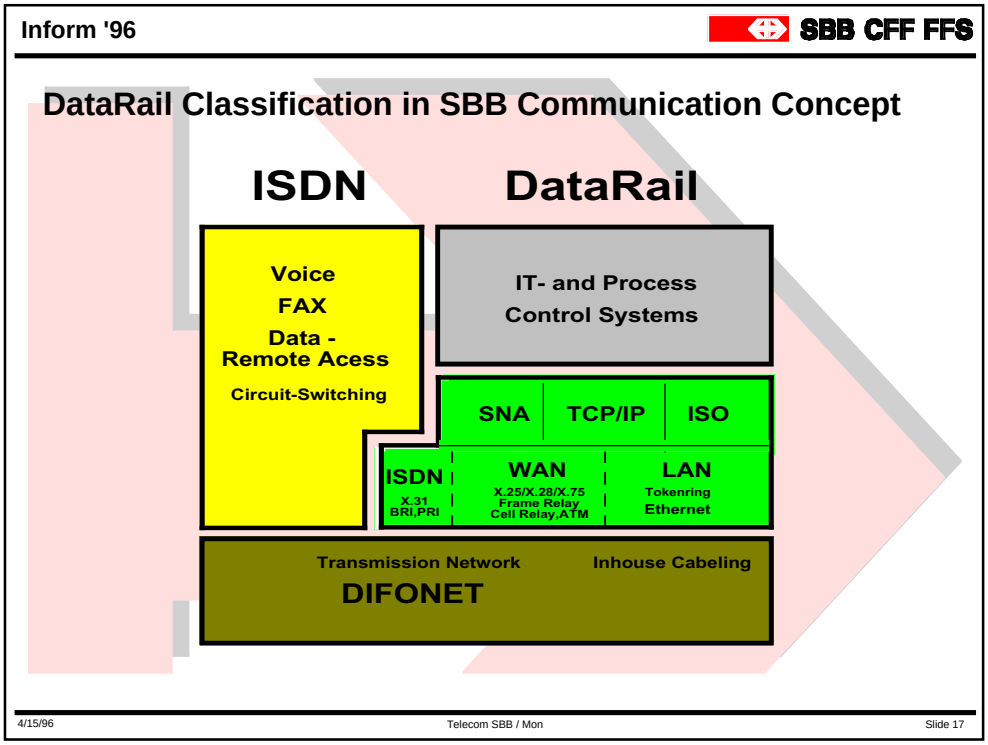
The different existing networks used their own, often under-utilized or overloaded transmission lines and were controlled and configured using separate network management systems.

A data network study carried out in 1992 indicated that the extensive new demands, which would arise from computer projects that were in the planning and execution stages, could only be met with the installation of a new, multi-purpose data network.

Technical and commercial goals could not have been achieved with the expansion of the existing data networks.

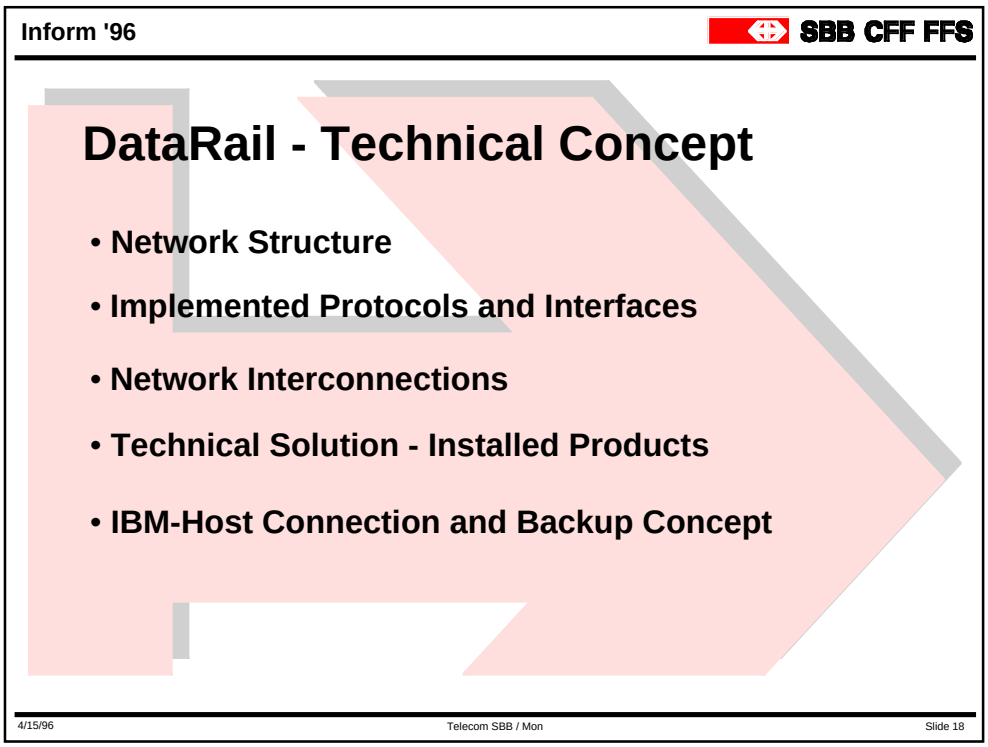
The data network study of 1992 showed that a new data network with 4 or 5 times the capacity of the existing networks and containing additional new features would not lead to additional operating costs.

The installation of a new data network has enabled the stabilization of recurring costs despite the enormous increase in capacity and functionality.



DataRail can be classified within the SBB communications concept as follows :

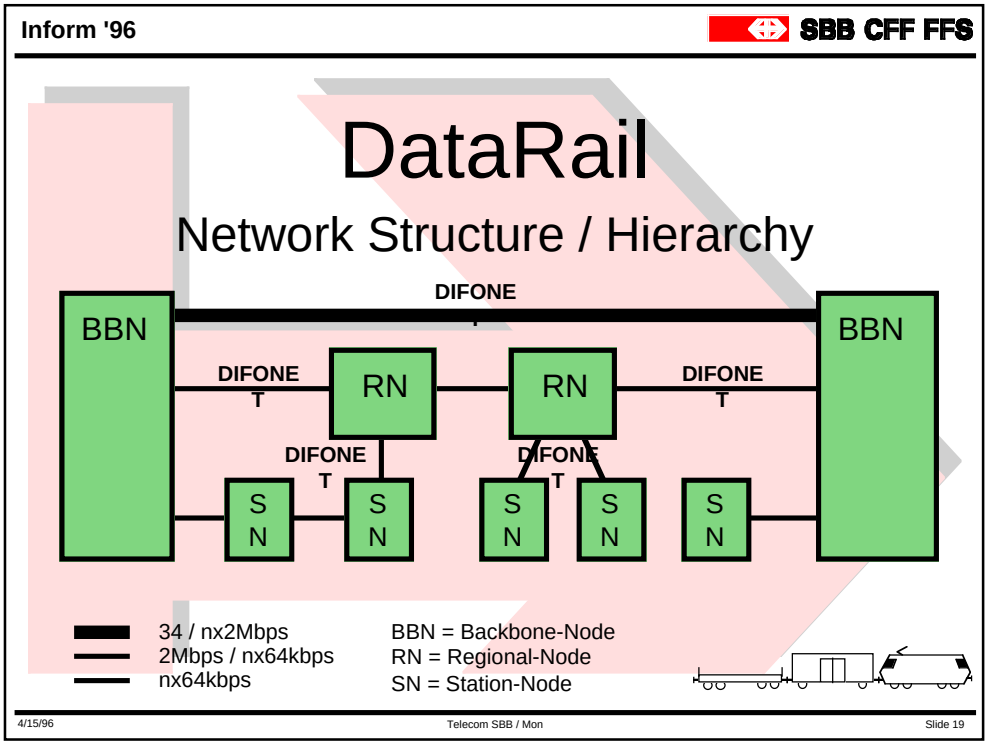
- SNA and TCP/IP protocols and, if necessary due to market demands, ISO will be supported.
- DataRail covers both LAN & WAN areas and utilizes the DIFONET transmission network for WAN. Universal cabling systems can be utilized for the LAN.
- Due to ISDN connections on the network, access to remote parties is possible.



Now we will look more closely at the DataRail technical concept.

After introducing the network topology, the implemented protocols and the planned network connections, we will present the technical solution and the products which are being utilized.

One of the central points of the DataRail Project, the IBM Host Connections and the Back-up Concept for disaster recovery will be discussed at the end of this chapter.



DataRail recognizes three network levels :

- **Backbone Nodes** : in the SBB General and Regional (Kreis) management location and in both EDP centers ERZ-2 and ERZ-3.

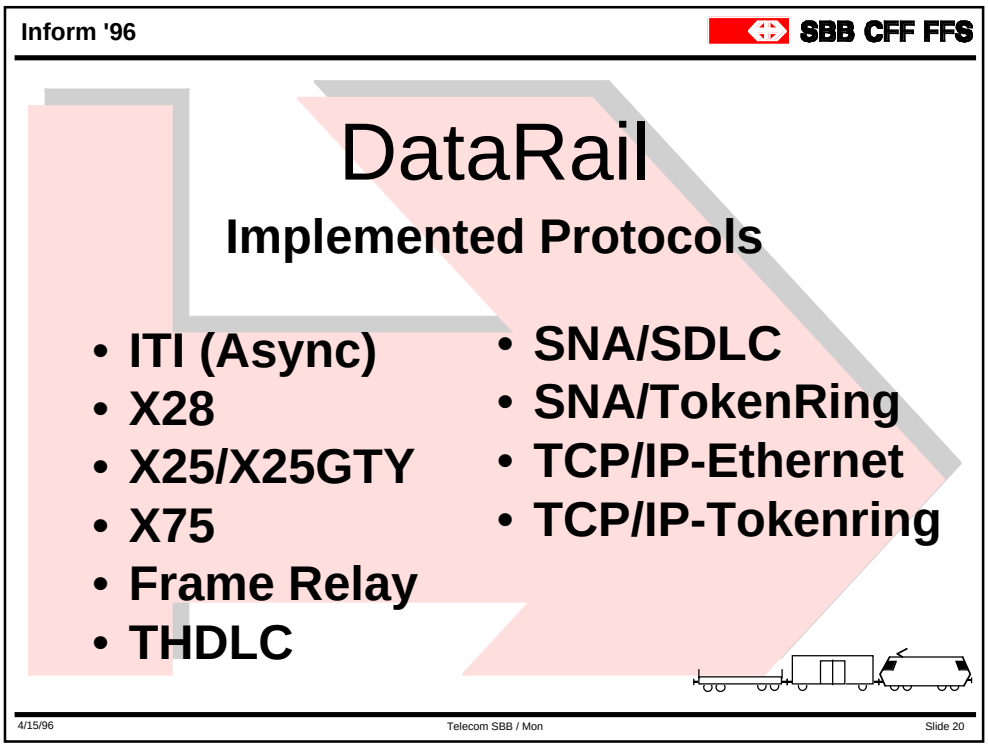
- **Regional Nodes** : large train stations and organizational units as well as major workshops and the SBB power generating stations.

- **Station Nodes :** medium and smaller size train stations.

The backbone and regional nodes are fully intermeshed to ensure the required network reliability.

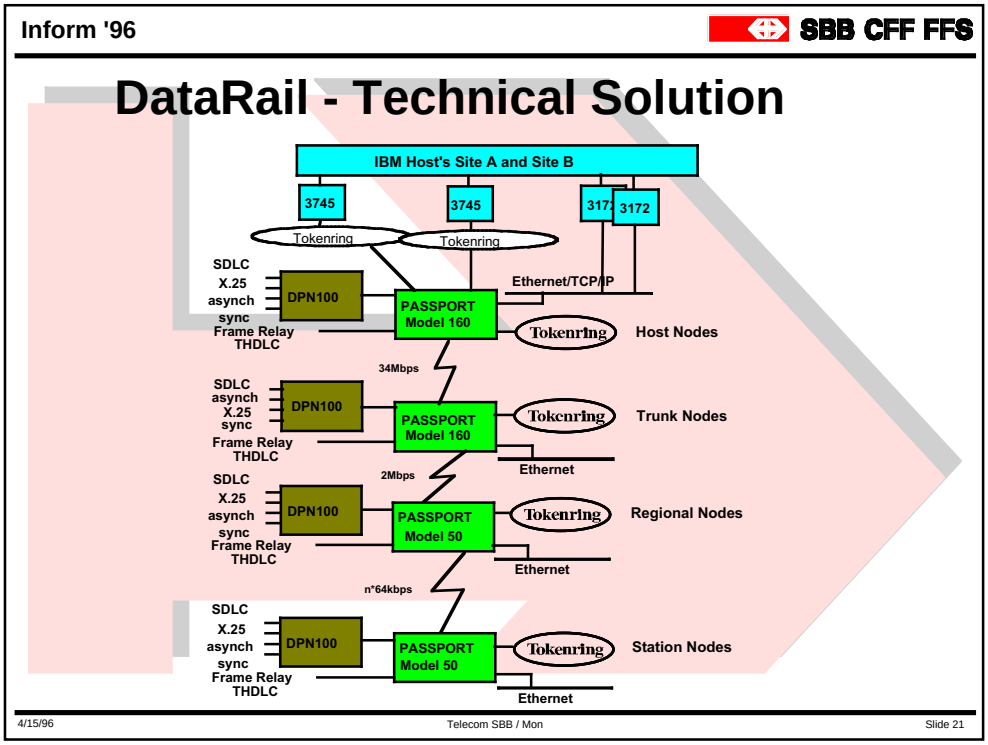
The station nodes are either intermeshed with point to point connections or are individually connected to the nearest regional node.

The trunk speeds between the nodes are between n*64kbps to 34 Mbps, depending upon the network level and the requirements which must be met.



The following protocols are presently implemented in the DataRail network :

- ITI (Async)
- X28
- X25 / X25GTY
- X75
- FrameRelay
- THDLC
- SNA/SDLC
- SNA/TokenRing
- TCP/IP-Ethernet
- TCP/IP-Tokenring



The DataRail project utilizes Nortel's DPN-100 and PASSPORT packet and cell switches from the Magellan family of products.

At the Host and Trunk Level : Passport-160 and DPN-100/10 RM

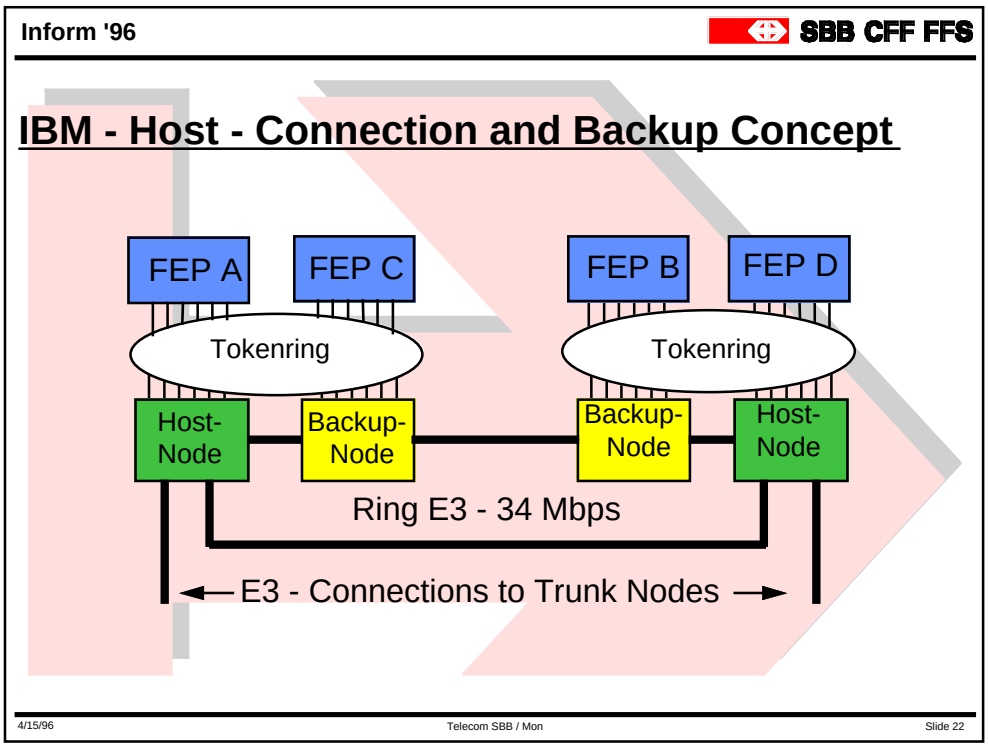
At the Regional Level : Passport-50 and DPN-100/10 or DPN-100/3

At the Station Level we are unfortunately still waiting for the Small Passport which was contractually guaranteed in 1993. This Small, Baby or Micro Passport should be installed in combination with DPN 100/3 (*MAS*), DPN-100/1 or with the Magellan Access PAD MAP.

Such traditional protocols as X.25, X.28 and SNA/SDLC are handled through DPN-100 packet switching nodes.

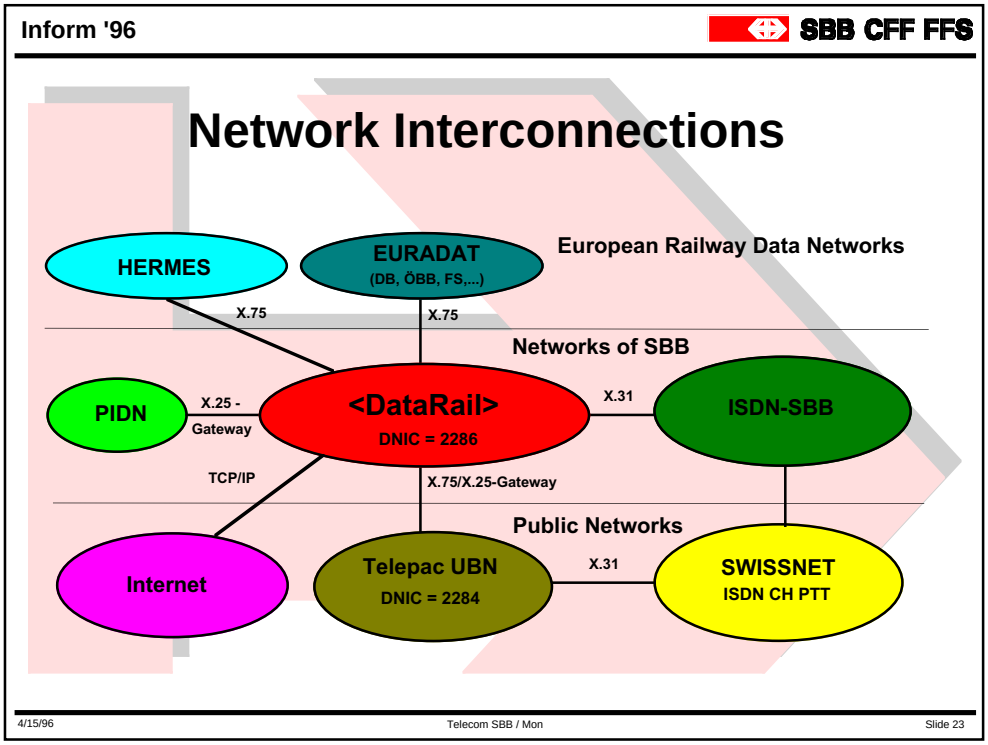
The cell and frame switching PASSPORT nodes serve as backbone network nodes and offer network access protocols such as Frame Relay, transparent HDLC and bit transparent services. Integrated Passport Router cards assume the function of LAN to LAN communications.

The network nodes are controlled and managed by the Magellan network management system.



The connections between DataRail and the IBM Hosts are over local Token Ring networks. The DPN-100 packet switching nodes convert the SNA/SDLC serial protocol traffic from the over 5000 SNA terminals to Token Ring. The data traffic from another 5000 PC's is transmitted directly from Token Ring to Token Ring.

The switching of traffic over local networks provides a very flexible and economic solution. The traffic will automatically be switched to a second machine if one of the hosts does not respond. This is very elegantly done through the use of hunt groups.



The planned network connections will make DataRail the global data network for SBB.

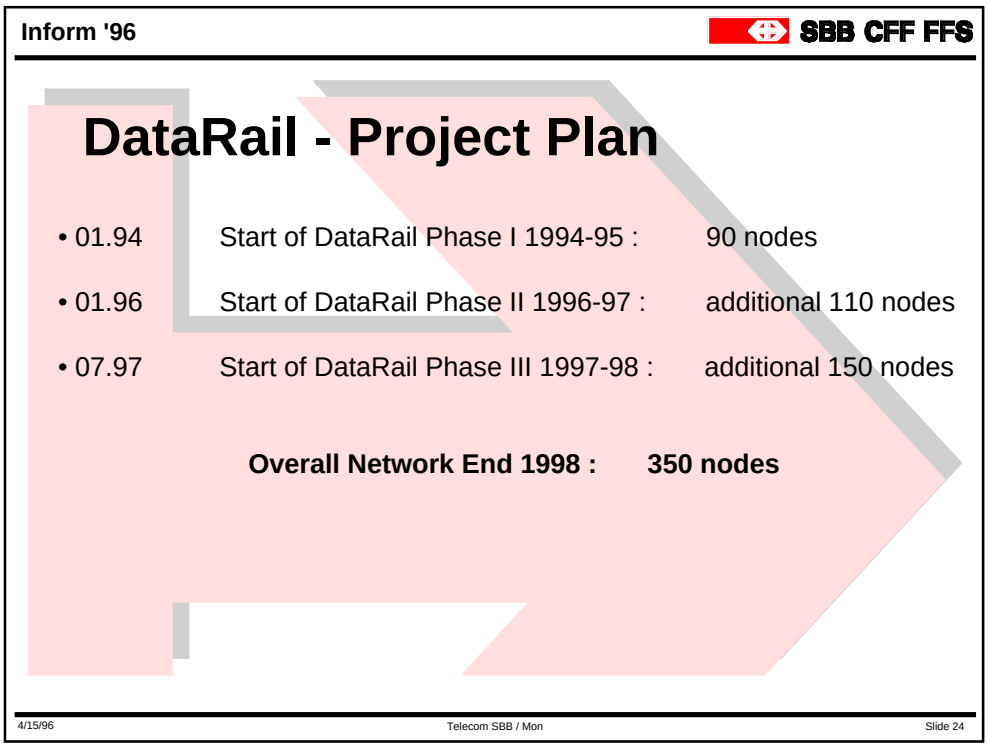
- For investment protection, the existing PIDN packet switching network is connected to DataRail over X.25 gateways.

- The connection to data networks of the European Rail Organizations such as DB (German Federal Railways), OBB (Austrian Federal Railways), etc. will be realized over X.75 gateways. An X.75 connection already exists between the DB and SBB.

- An ITU-T recommended X.31 gateway is planned in order to enable access to DataRail over the ISDN-SBB.

- The network connections to the public packet switching networks can be realized over an X.25 or X.75 gateway.

- Last but not least, DataRail is connected to the Internet over a Firewall Server.

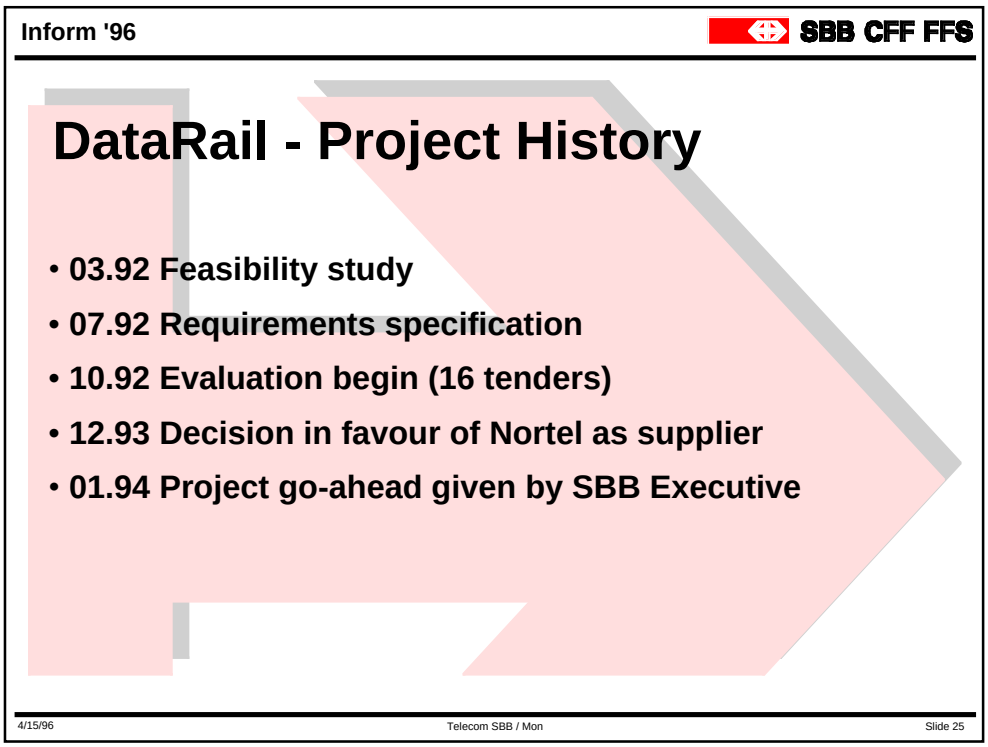


The DataRail Project will be carried out in three phases.

- In the first phase, the network management system and 90 nodes were installed.

- In the second phase, which just started, an additional 110 nodes will be installed by the middle of 1997.

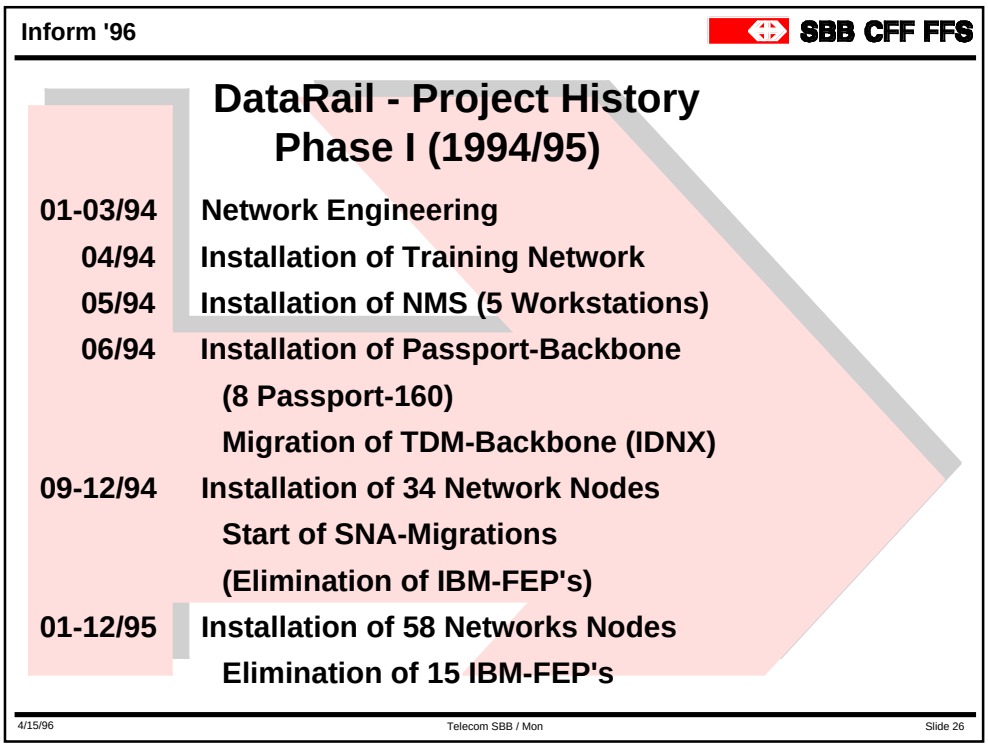
- In a third phase, we intend to reach an installation level of 350 nodes in order to connect all important operational locations.



A data network study carried out in 1992 indicated that the extensive new demands, which would arise from computer projects that were in the planning and execution stages at that time, could only be met with the installation of a new, multi-purpose data network.

Technical and commercial goals could not have been achieved with the expansion of the existing data networks.

- Following the specification phase and the setting of guidelines, an intensive system and supplier evaluation began.
- In July 1992, the first invitations to tender were sent to 26 companies with pre-selection being the goal.
- A second and more detailed documentation was then sent to the five leading companies : IBM, AT&T-NCR, MDS-NETRIX, DATUS and NORTEL.
- In August 1993, contract negotiations and internal acceptance procedures began.
- In January 1994, the SBB Executive approved the turnkey project and its being awarded to Nortel.



A brief list of a few milestones achieved in Phase 1:

01/94 Start of Phase 1 of the DataRail project.

03/94 Conclusion of the global network engineering work.

04/94 Installation of a DataRail Training Network.

The training for SBB network engineers, network operators and first line maintenance staff will encompass more than 1000 working days.

05/94 Installation of the network management system in Bern.

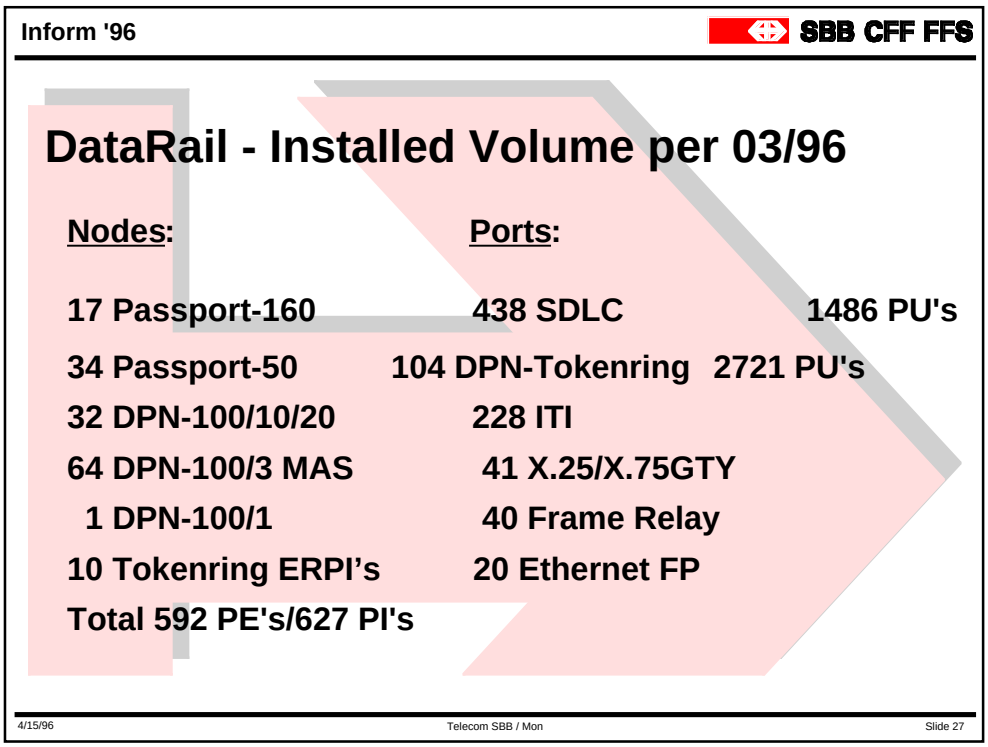
06/94 Installation of the Passport Backbones (8 Passport 160).

Migration of the TDM based backbone network (IDNX) to DataRail. This enabled a more effective utilization of the 2 Mbps transmission channels. After migration we recognized a trunk utilization of 10-20% instead of 100%!

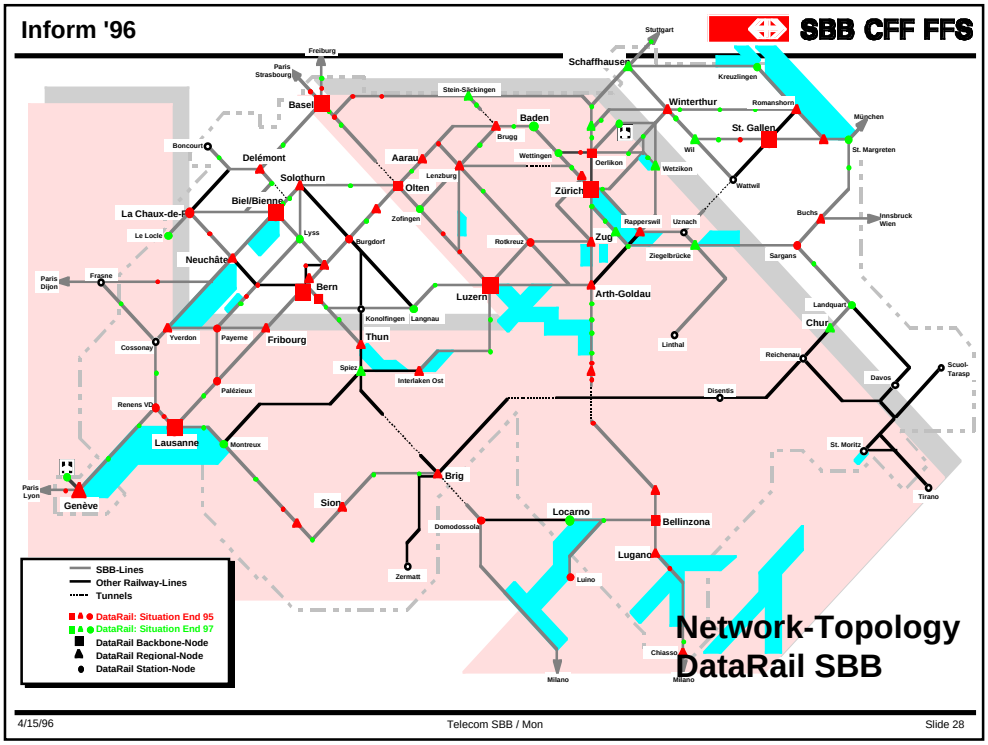
09-12/94 Installation of an additional 34 network nodes.

01-12/95 Installation of a further 58 network nodes.

In 1995, 15 of the 28 remote IBM-FEP’s could be eliminated by migrating approx. 400 SNA lines to DataRail.

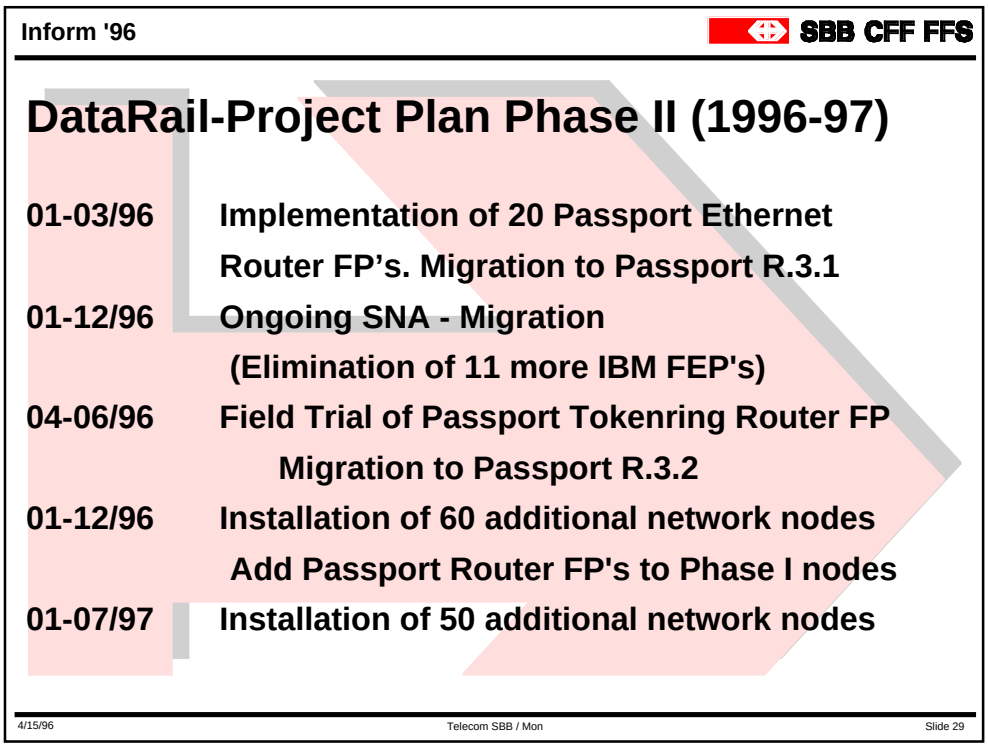


These figures provide an overview of the capacity of the active network components in DataRail.



This map provides an overview of the actual network topology.

Red represents active nodes as per March 1996.
Green represents the locations which are to be installed in 1996 -1997.



1996 will be the year for Passport Router Implementation.

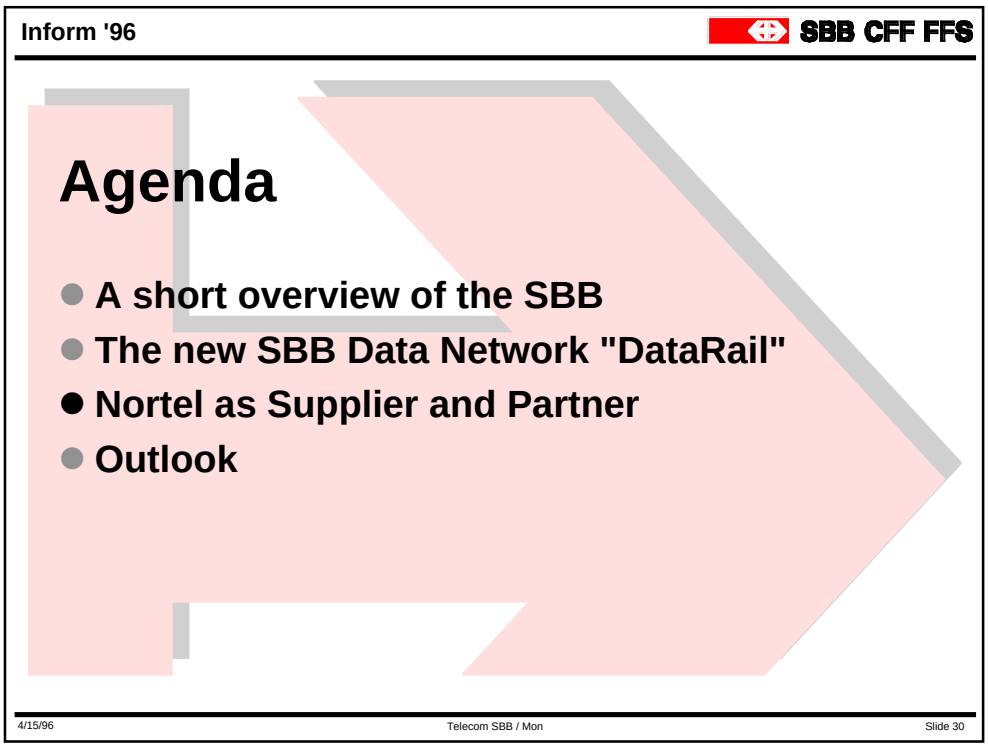
Following the integration of 20 Passport Ethernet FP's in the network in the first quarter of 1996, the network will be outfitted with approximately 100 Tokenring FP's beginning the middle of the year.

The success of DataRail depends upon the implementation of the Passport Router because it is only with this Router that the network consolidation and the expansion of a wider router network can be achieved!

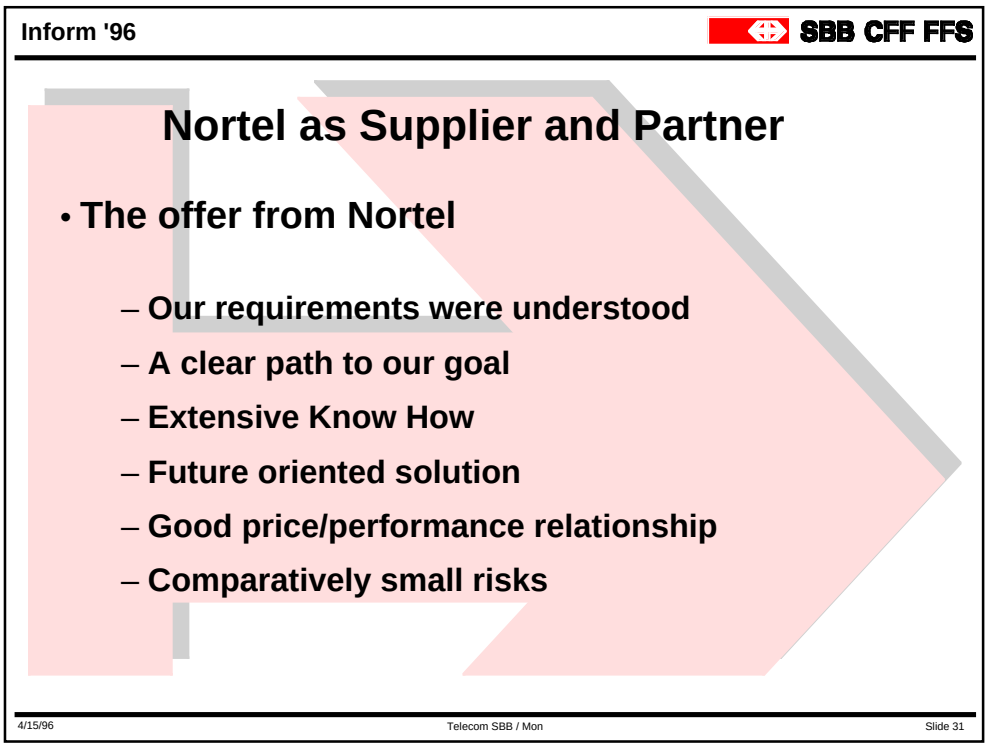
The goal of this Network Consolidation :

Lower operating costs through :

- uniform network management
- uniform physical network
- optimal bandwidth utilization

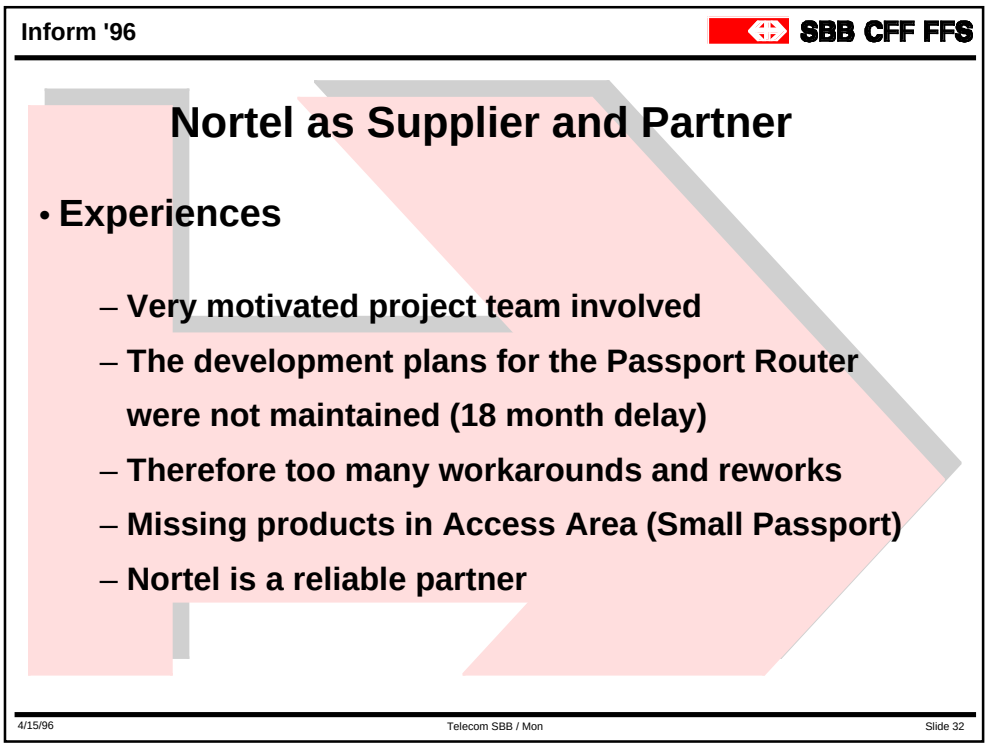


A few comments about Nortel as supplier and partner.



First I would like to clarify why we were positively impressed by Nortel in the offer phase :

- Nortel understood our guidelines and recognized our requirements.
- Nortel provided a clear path to our goal (analyzed our guidelines and translated this to the availability of the new Passport product pallet).
- Nortel commanded extensive Know-how and impressive references (especially in the SNA area.)
- The offer contained a good, future oriented solution (ATM, APPN, etc.)
- The offer provided a good price/performance relationship.
- The project risk with Nortel is relatively small.



What are our experiences following the first project phase :

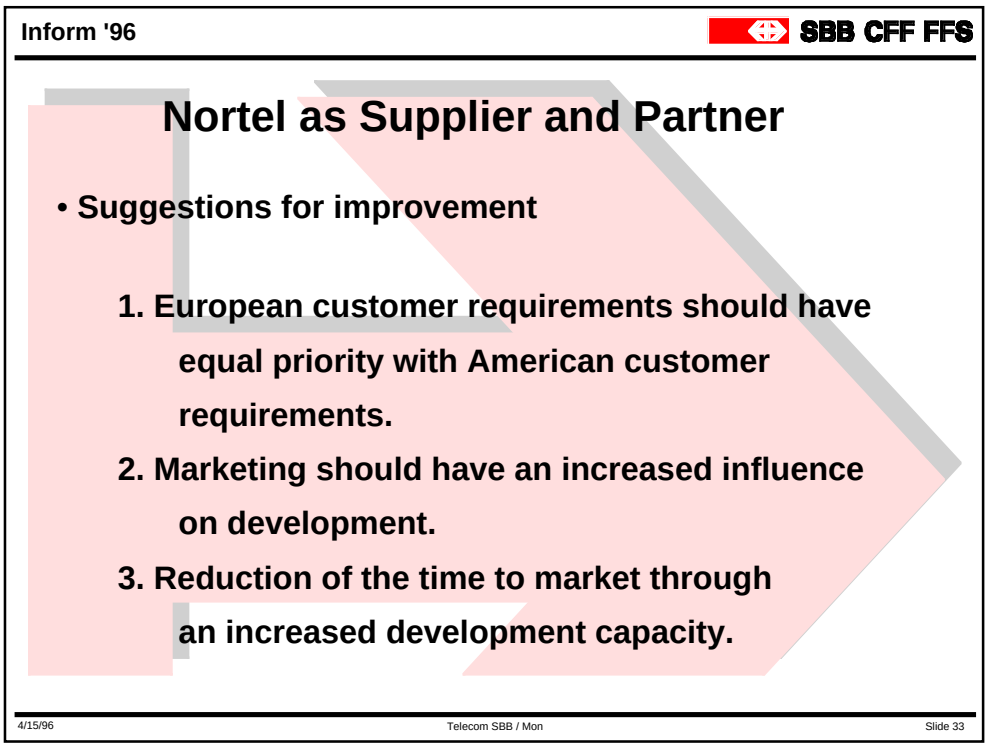
- We are working with a very motivated, excellently educated team of Nortel employees and appreciate the exceptionally close contact with the development group at BNR.

- The proposed development plans for the Passport Router could not be maintained (miracles do not happen overnight!). We have had to accept a delay of 18 months. Nortel appears to have incorrectly estimated the Router Age.

- This delay has resulted in too many reworks and workarounds which are work, time and cost intensive for both parties.

- We have been battling for over two years for the products (Small Passport) in the Access area which were contractually promised to us.

- Nortel is a reliable partner who honours its contracts and makes every effort to maintain costs and schedules. It is these efforts which have made it possible to achieve our technical and commercial goals.

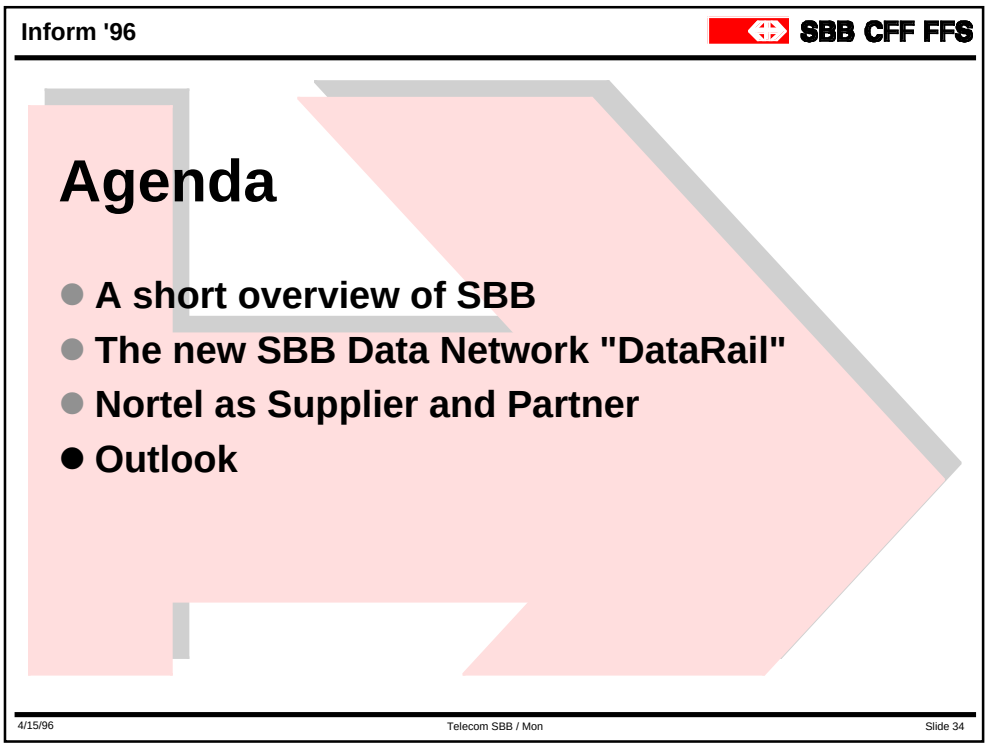


Suggestions for Improvement:

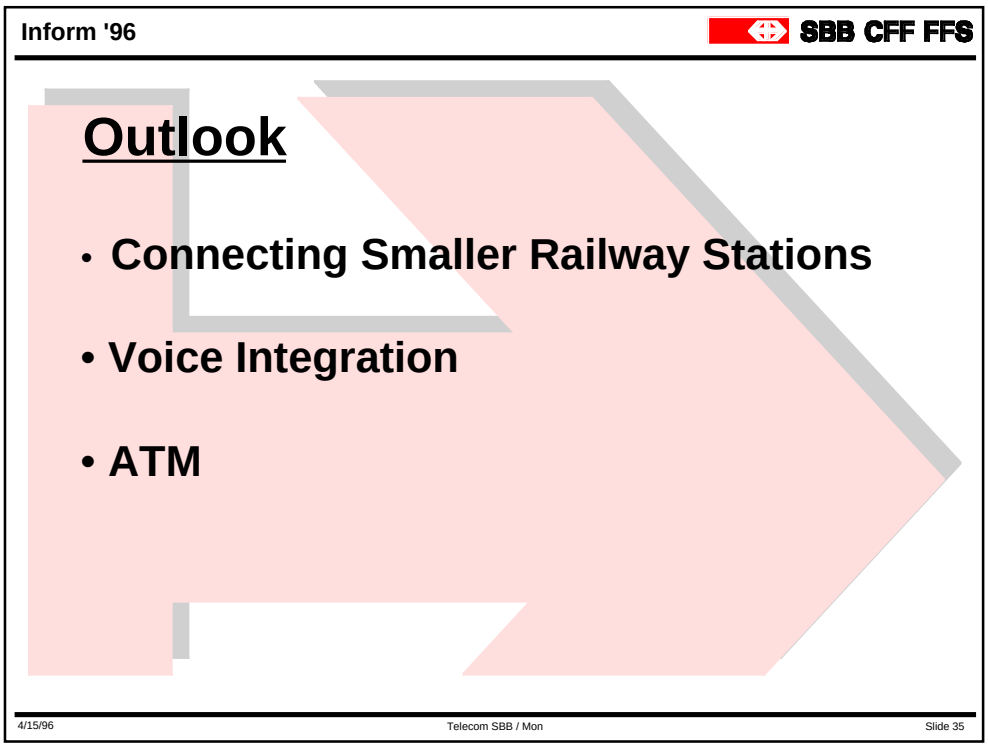
- European customer requirements must be given equal priority with American customer requirements. We have often had the impression that Nortel does not show enough recognition of the European market and its needs.

- European marketing must have an increased influence on development.

- The time to market could be decreased with an increase in development capacity.



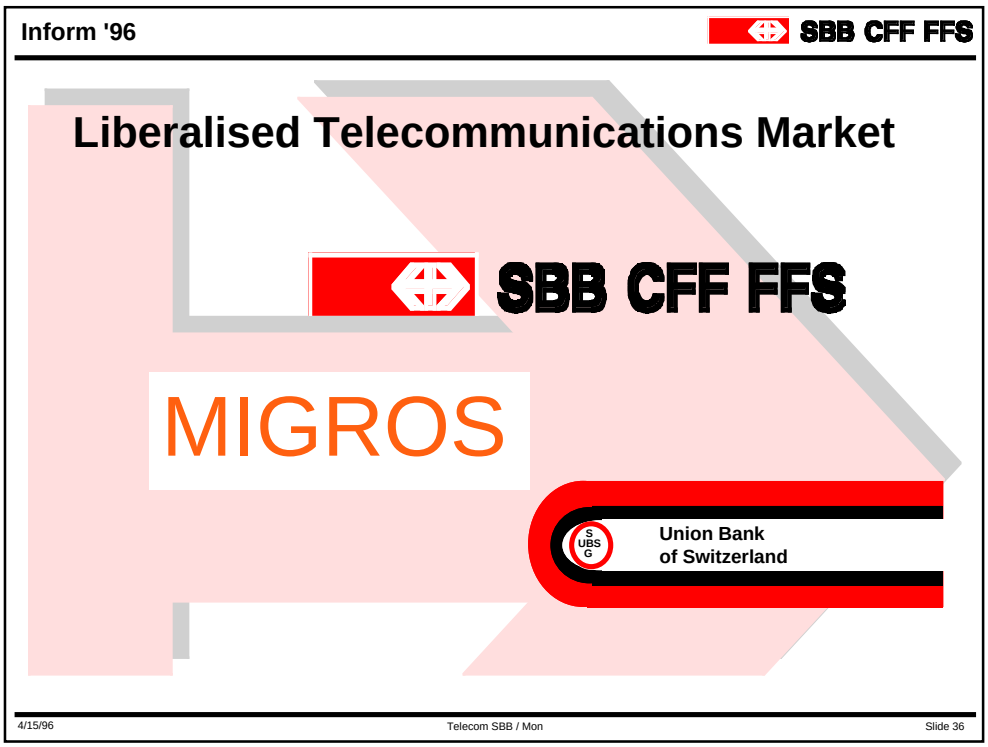
In closing my presentation, I would now like to take a small look to the future.



- In Phase 4, an additional 200-300 locations with 1-3 work stations (small railway stations) must be connected. Here we would like to see an inexpensive, simple plug-and-play solution with low operational costs.

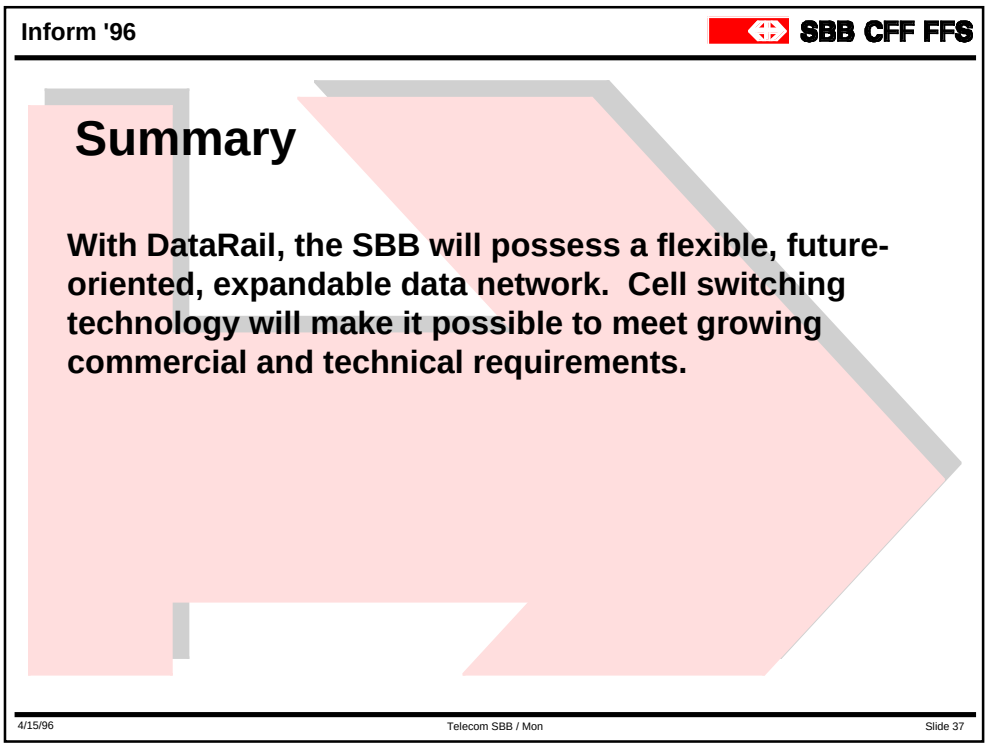
- Voice Integration : As long as the SBB possesses enough transmission capacity, a consolidation of the voice and data networks is not economically interesting. The voice and data services are deliberately separated at the station level in order to ensure the security of the rail operations. The voice and data networks serve as back-ups to one another in case of operational failure. For this reason, the combining of these two services is not to be considered in the short term.

- ATM: Multimedia applications in rail operations are not foreseeable at this point in time. These applications can only be successful when they provide both the rail customers and organisation with a real service at an acceptable cost. As soon as such a situation exists, the goal will be to bring it to the market as quickly as possible. DataRail is already providing SBB with the necessary infrastructure.



- The liberalisation of the telecommunications market in Europe will enable the railways to market their telecommunications infrastructure in the future.

- In preparation for the coming liberalisation of the telecommunications market in Switzerland, the SBB, the Union Bank of Switzerland and Migros (the largest Swiss retailer and distributor) have formed a development company.



Allow me to summarize :

" With DataRail, the SBB possesses a flexible, future-oriented, expandable data network. Cell switching technology will make it possible to meet growing commercial and technical requirements."

Ladies and gentlemen, this brings me to the end of my presentation.

Should you be planning a trip to Switzerland in the near future, I can recommend our World Wide Web server to assist you in making your travel plans.

The server offers general information, timetables, special offers and a wonderful gallery of photographs.

Do not hesitate, call :

http://www.sbb.ch

We would be happy to welcome you to beautiful Switzerland.

Thank you for your attention.