ETNA: the Ericsson Transport Network Architecture

How to build for a future you can't predict

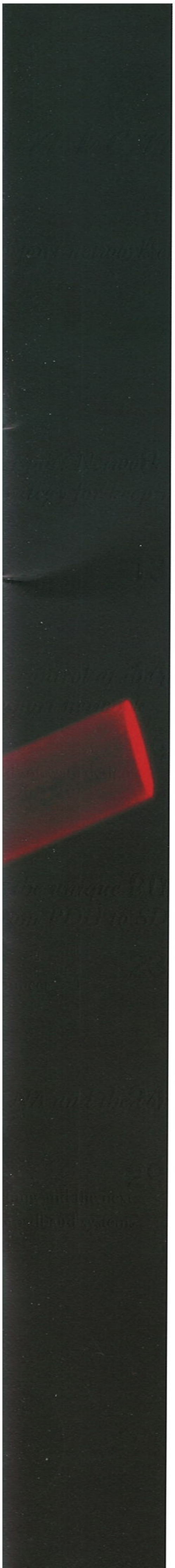
ERICSSON

THE REVENUE PIPELINES

Optical fibres – the transmission medium of today and tomorrow. Made from glass so pure, 110 km of fibre is as transparent as a pane of window glass.

In today's long-distance transmission systems these fibres could be carrying the equivalent of nearly 9,000 simultaneous telephone calls.

Ericsson's Transport Network Architecture could help you make much more efficient use of this fibre: you could carry four times as much traffic. And earn four times as much revenue.



Contents

In the 1980s it was digital switching that changed the way telecoms networks operated, bringing new levels of performance and reliability, and a wealth of new, revenue-generating services.

Now, the focus is shifting to the transport network.

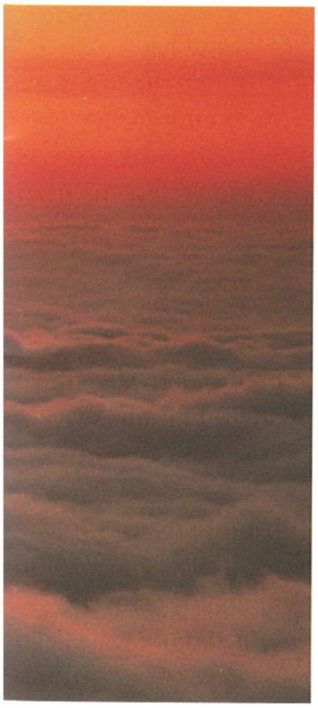
Dawn of the transport network era

Transmission systems are the backbone of the telecom network: the core resource through which all services, switched and unswitched, are provided.

Most of the transmission systems in service today are essentially passive, static and inflexible devices. The network's intelligence and dynamism are located elsewhere — in the switches.

This architecture is acceptable when all that a network has to handle are POTS — Plain Ordinary Telephone Services. But demand from business users for flexible, high-bandwidth services is increasing. And as deregulation and liberalization progress, these customers have a growing choice of whom to buy these services from.

In this environment, upgrading the transport network becomes a strategic imperative for long-term revenue protection. If a network cannot offer advanced, high quality, flexible, high-bandwidth services, it will lose revenue.



This revolution is already beginning. And the pace of change will be rapid, stimulated on the one hand by the demands of business customers, and on the other by competition among service providers.

The race is on to meet these new demands. Meeting them involves introducing a new generation of equipment, that will turn 'transmission systems' into 'transport networks'.

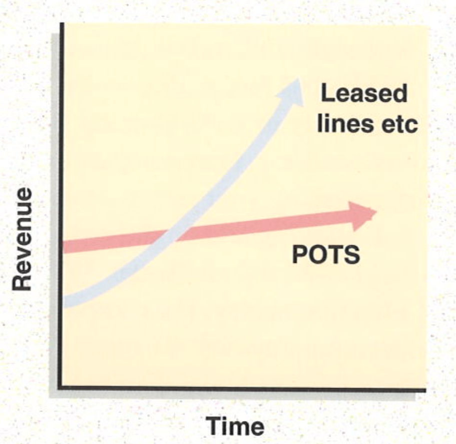
From transmission systems to transport networks

The new generation of transport networks, working to the international SDH (Synchronous Digital Hierarchy) standard, will deliver major advances over earlier generations of transmission equipment.

The most important difference is software control. In today's highly-complex PDH (Plesiochronous Digital Hierarchy) transmission networks, making changes — from a major reconfiguration to the delivery of a single leased line — can involve weeks or even months of planning and preparation, as well as on-site hard-wiring of connections. In an SDH transport network, software control means these changes can be carried out in seconds from a central control point.

Much more than with the previous generation Plesiochronous Digital Hierarchy (PDH), the SDH transport network works as a complete network: with full compatibility and interoperability from end to end, and centralized control.

Faults can quickly be spotted, and traffic re-routed to avoid them. This increases the overall reliability and performance of the network — and of the services it provides. It also means that fewer reserve systems are needed to provide backup capacity — effectively, the network can handle far more traffic than before.



In developed countries, revenues from leased lines and other broadband business services are set to outstrip revenues from traditional telephony services before the year 2000.

The big business opportunity

The business opportunities offered by the new-generation transport network are immense. The market for high-bandwidth services is growing fast — by the end of the century, worldwide revenues from leased lines and similar broadband business services will exceed those generated by telephone services.

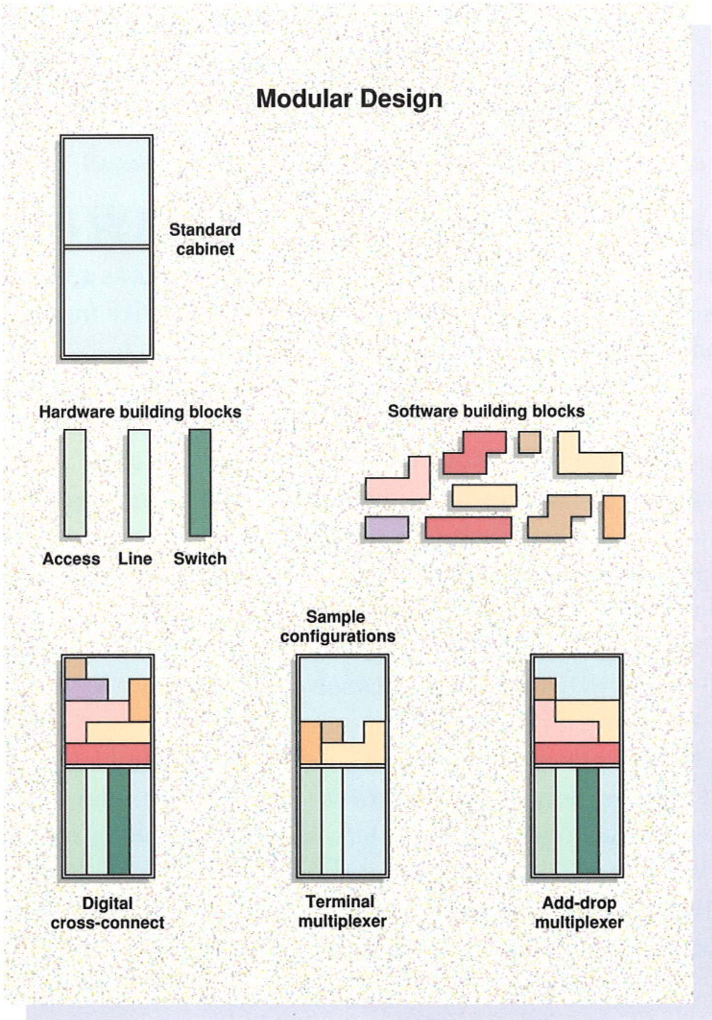
Using the advanced management facilities of the SDH transport network, business customers can be offered services that are far more flexible and responsive than today's. Leased lines can be set up in seconds or minutes; bandwidth can be increased or decreased at will; customers themselves can be given control over their leased-line networks.

And in the future, the SDH transport network will form an infrastructure for broadband and multimedia communications, using emerging technologies such as Asynchronous Transfer Mode (ATM).

ETNA: A strategic opportunity for the network; a core business for Ericsson

The transport network is a strategic issue. Investment decisions have to be made on the basis of time to market; the ability of systems to work on a network-wide basis; the services they can deliver ... and, of course, their ability to work with, and add value to, existing PDH transmission systems.

ETNA components have a highly modular design, reusing hardware and software components in different combinations to make up different types of network element.



For Ericsson, meeting these challenges has involved thousands of man-years of development work, in research centres in ten countries.

The result is the Ericsson Transport Network Architecture (ETNA). A comprehensive range of SDH systems, with a completely new design from the ground up. A modular design that simplifies hardware and software architectures, and makes for highly-versatile components. And including the industry's most advanced transport network management system.

These are systems that can take you smoothly and quickly into the SDH era, and prepare you for broadband and multimedia services such as ATM. And just as important, systems that fit seamlessly into the existing transmission environment, increasing its capabilities and maximising your return on investment.

Designing and engineering SDH systems is a huge technical challenge. With a relatively large software content, the components of an SDH transport network are more closely akin to switching systems, than to previous generations of transmission equipment. The challenge of centralised management, too, draws heavily on a supplier's familiarity with network-wide solutions.

Development of the ETNA family has involved R&D centres, and joint ventures, in ten countries.

In the development of the Ericsson Transport Network Architecture, Ericsson has put to work much of the experience gained in large system design through AXE — Ericsson's hugely-successful public switching system.

R&D IN TEN COUNTRIES

Ericsson's research and development work in transmission and transport network issues is undertaken at R&D centres in ten European countries.

Strategic joint ventures have been set up with a number of other telecom suppliers, to concentrate on advanced technology in specific areas of transport network development; and to ensure Ericsson can act as a supplier of complete solutions to all transport network demands. The most significant of these are with Ascom in Switzerland, Bang & Olufsen in Denmark, and FUBA Hans Kolbe & Co. in Germany.

Ascom Ericsson Transmission, based in Switzerland, is a joint-venture company working in several areas of transmission and transport networks: its activities include the development of STM-1 (155Mbit/s) multiplexers, Universal Multiplexers for subscriber access to SDH-based services, and PDH line terminal equipment.

In Denmark DIAX Telecommunications, a joint venture between Ericsson and Bang & Olufsen, is working on Flexible Access Systems. Its products include the DIAmuX flexible multiplexer, which combines a variety of access methods from POTS to ISDN and leased lines in a single access unit that connects to the transport network.

In Germany another joint-venture company, Ericsson FUBA Telecom, is working on high-end SDH multiplexers and cross-connect systems.

In Austria, Schrack-Ericsson AG is working on systems that can deliver high-capacity services across normal copper-wire subscriber loops.

In the USA the joint-venture company Ericsson Raynet is a world leader in the development and deployment of Passive Optical Networks (PONs), for subscriber access to telephony and broadband services in Fibre To The Curb (FTTC) and Fibre To The Home (FTTH) applications.

Also in the USA a long-standing partnership between Ericsson and Tellabs integrates Tellabs' PDH cross-connect systems with Ericsson's FMAS-NM transport network management system, to deliver managed, switched networks from 64 kbit/s to 2 Mbit/s, integrated with the Ericsson Transport Network Architecture.

It's clear that future service demands will be for more bandwidth, provided more flexibly. But the specifics of market and service development are not so clear — and they have to be reconciled with the need to cut costs and increase reliability throughout the transport network.

The Ericsson Transport Network Architecture: a strategy for keeping your options open

This is where the strength of the ETNA concept shines through. It has been designed to let you keep your options open. Rather than narrowing the choices for future network and service development, ETNA opens up new doors, enabling you to provide whatever the market demands.

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A full transport network architecture, delivering all the benefits promised by SDH, requires a complete family of cross-connect and multiplexing systems, together with a comprehensive network management capability — all optimised to work together effectively.

ETNA creates a stable, flexible, standards-based and intelligent transport network, open for the provision of any kind of end-user service, and ready to fit in with any backbone network implementation strategy.

For end-users of network services, this means fast, flexible, bandwidth on demand. For instance, a leased-line service could be set up to operate for only one or two hours a week, at times specified by the customer; and its capacity could be expanded at will.

There are three main components: cross-connect systems, synchronous multiplexers, and network management systems.

The network management systems control the complete transport network, providing rapid configuration and reconfiguration of network resources, instant response to faults, and full information on performance from a central point.

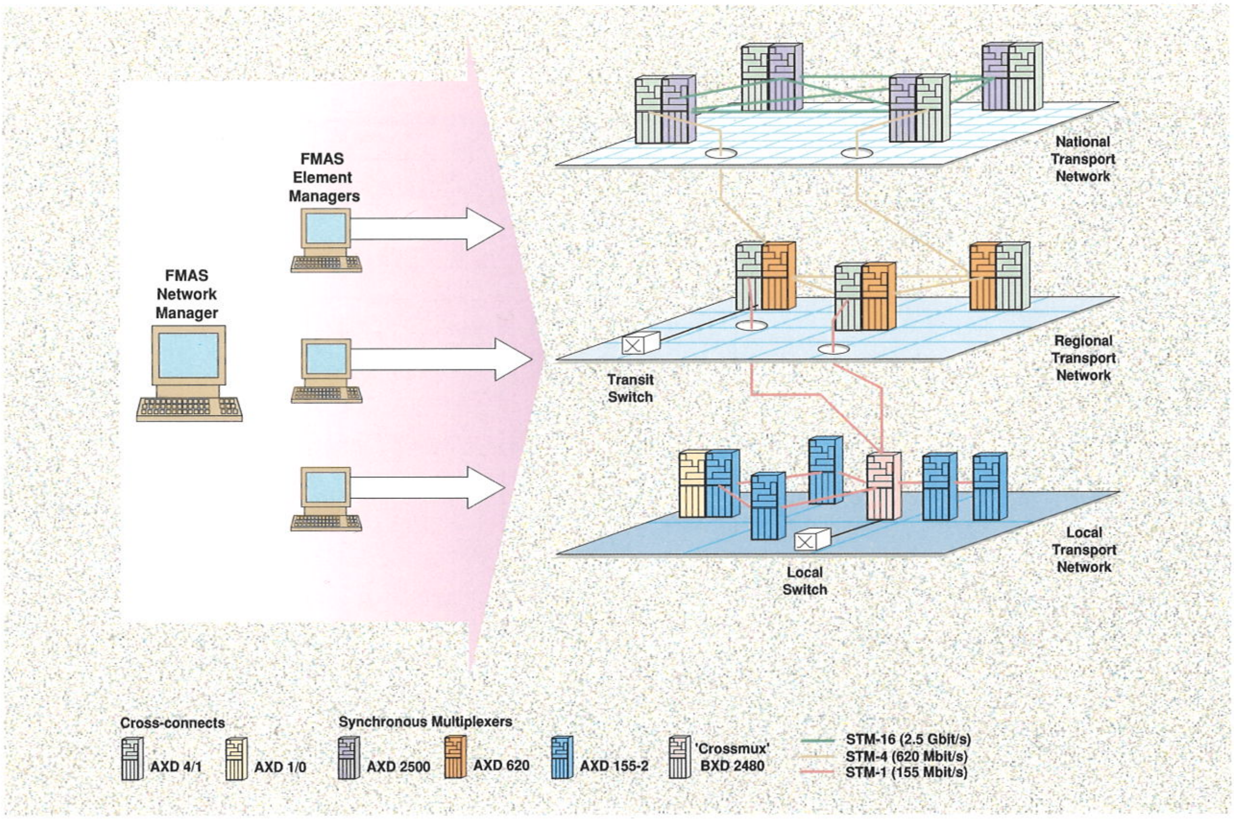
ETNA IN THE BACKBONE NETWORK: HIGHER CAPACITY, LOWER COSTS

Deployed in backbone networks at the regional, national or international level, ETNA brings increased capacity, greater reliability and reduced operational costs.

Increased capacity is brought about by two means. Firstly, ETNA line systems today operate at up to 2.5 Gbit/s (STM-16), a four-fold increase over what can be achieved with PDH transmission systems. Secondly, ETNA cross-connect systems can 'groom' traffic, ensuring that the maximum number of low-speed channels is crammed into a higher-speed link.

Greater reliability comes through the ability of ETNA systems to re-route traffic dynamically in the event of a fault, with no or minimal interruptions to service. And because of the intelligence built in to ETNA network elements and their network management systems, the requirement for back-up transmission lines is significantly reduced. More of your network's capacity can be used to carry revenue-generating traffic, instead of standing idle in reserve.

Operational costs are cut, thanks to the centralization and rationalization of operations and maintenance services, and the reduced need for on-site engineers to maintain equipment. And since ETNA equipment itself is mechanically more compact and modular than



ETNA: the Ericsson Transport Network Architecture

ETNA consists of three main product lines: digital cross-connects, synchronous multiplexers and network and element management systems. There are two cross-connect models:

AXD 4/1 is likely to be widely deployed in SDH networks, replacing the numerous back-to-back multiplexers currently used in PDH transmission networks. It cross-connects signals at 2, 34, 140 and 155 Mbit/s (STM-1), and terminates signals at all these levels, as well as 620 Mbit/s (STM-4) and 2.5 Gbit/s (STM-16). Because it can handle both PDH and SDH traffic, the AXD 4/1 can act as a 'bridge' between the two standards in the backbone network.

AXD 1/0 handles 1.5/2 Mbit/s and 64 kbit/s channels. Its main application is in the provision of low-speed leased-line services, and in grooming 64 kbit/s channels to fill 2 Mbit/s channels more efficiently.

The ETNA family includes three synchronous multiplexers: AXD 2500, AXD 620 and AXD 155-2. Operating at STM-16, STM-4 and STM-1 respectively, they can be configured as add-drop or terminal multiplexers, repeaters and small cross-connect switches.

AXD 2500 and 620 systems are mainly used in regional and national networks, feeding 140 and 155 Mbit/s tributaries into high-speed, long-haul lines. The AXD 155-2 system is a low-cost system intended for local access networks, mapping digital signals from 1.5/2 to 34/45 Mbit/s channels on to one 155 Mbit/s optical signal.

The BXD 2480 'Crossmux' is an exceptionally powerful and flexible node for demanding applications in local and access networks. With a modular design that provides for flexible, easily modified configurations, the Crossmux can be configured as a small 4/1 cross-connect system, as well as a powerful multiplexer with the ability to extract 2 Mbit/s signals directly from STM-4 (620 Mbit/s) bitstreams.

A range of network and element management systems complements these network nodes. At the top end, FMAS-NM provides comprehensive management for the complete ETNA range; while FMAS-EM systems provide cost-effective sub-network management specific for each network element type.

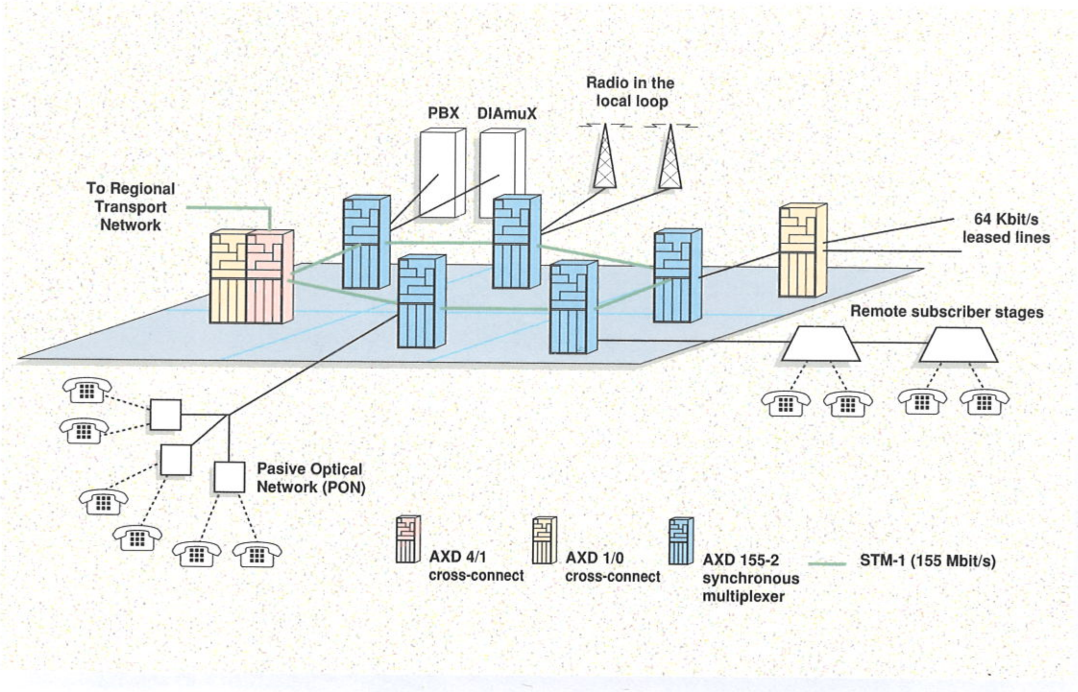
previous generations of transmission equipment, spares holdings and installation training needs are reduced.

ETNA IN THE LOCAL NETWORK: BETTER SERVICES FOR BUSINESS USERS

Deployed in the local network, ETNA systems will form the basis for advanced service provision to both business and residential customers. With high-capacity fibre-optic loops extending into the local network from local exchanges, a wide variety of 'bandwidth-on-demand' services can be offered alongside traditional POTS, through add-drop multiplexers and other flexible access systems.

End-to-end provision of leased lines, for instance, becomes far more

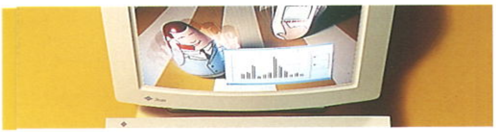
ETNA and the local loop
STM-1 rings will support the distribution of a wide variety of services to end-users in the local network. Add/drop multiplexers are used to feed various subscriber access devices.



dynamic. Instead of needing weeks or even months of preparation as connections are hard-wired at various points in the network, an end-to-end connection can be set up or torn down in a few minutes, by an operator sitting at a network management system.

It's not just service provision that improves, either. End-to-end service monitoring becomes a reality with ETNA: enabling you to offer business customers an audited, premium-quality service, at a premium price. And as a further option, customer control of services is feasible too, by giving customers restricted access to network management systems.

In the access network, SDH will be installed either in 'green-field' sites, or as an overlay to copper-based networks in areas where business users demand high-bandwidth services. Here, the arrival of SDH will



Network verification guarantees high performance in service

A complex network verification facility has been built at Ericsson's headquarters in Stockholm. It incorporates all the ETNA cross-connects, multiplexers and network management systems, and interfaces with Ericsson's PDH transmission equipment. Here, complex network functions such as network synchronization and path/ring protection can be verified; and the behaviour of equipment under load in complex network configurations can be studied.

This facility provides objective proof of present-day functionality, and also makes it possible for Ericsson to design and prototype functions in real-life configurations, in the most complex networks. It ensures that ETNA systems will give high performance and reliability in service.

be an important phase in the deployment of optical fibre close to end-users, as well as a platform for high-speed data services, such as SMDS/CBDS, based on ATM technology.

Ring networks running at STM-1 (155 Mbit/s) or higher speeds will be used, with add/drop multiplexers and DXCs providing star access to end-users.

Ericsson's vision of access network development allows these SDH rings to be used for all access technologies — not just broadband. In the medium term this will allow network operators to cost-justify a rapid deployment of fibre close to subscribers (Fibre in the Loop or

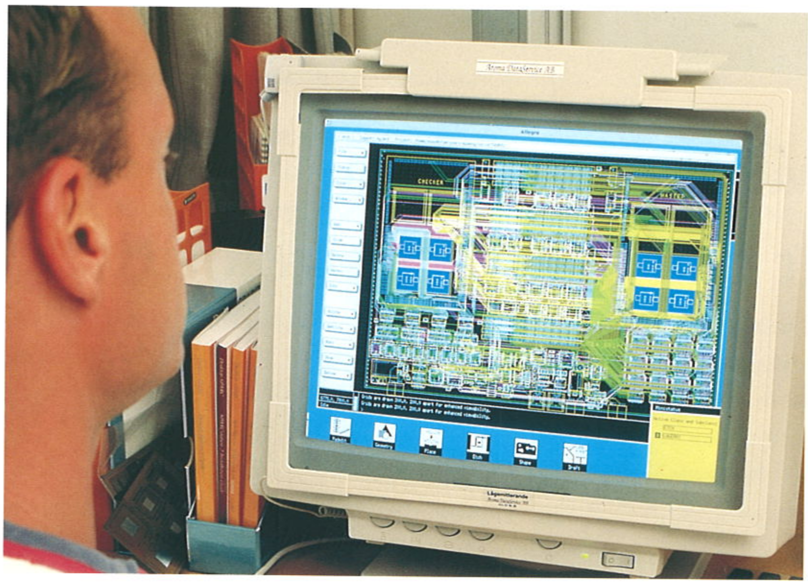
FITL), in preparation for the provision of true broadband services to all end-users, by installing fibre in the last segment of the local loop.

In this vision, fibre connections are extended to a number of local access devices, from add-drop multiplexers installed in the STM-1 fibre ring. These include remote switching units and subscriber multiplexers for telephony; Flexible Access Systems (such as Ericsson's UMUX and DIAmuX flexible multiplexers) for business customers requiring access to multiple services at up to 2 Mbit/s; passive optical networks (PONs); and radio base stations for cellular mobile networks and radio in the local loop (RLL) applications.

Management support for services in the access network can be provided through Ericsson's FMAS-NM and other management systems.

Technology briefing 1

VLSI design: the key to modularity, reliability and simplicity of operation



Very Large Scale Integration (VLSI) is highly important in developing compact and reliable systems with low power consumption, and high immunity from electromagnetic interference.

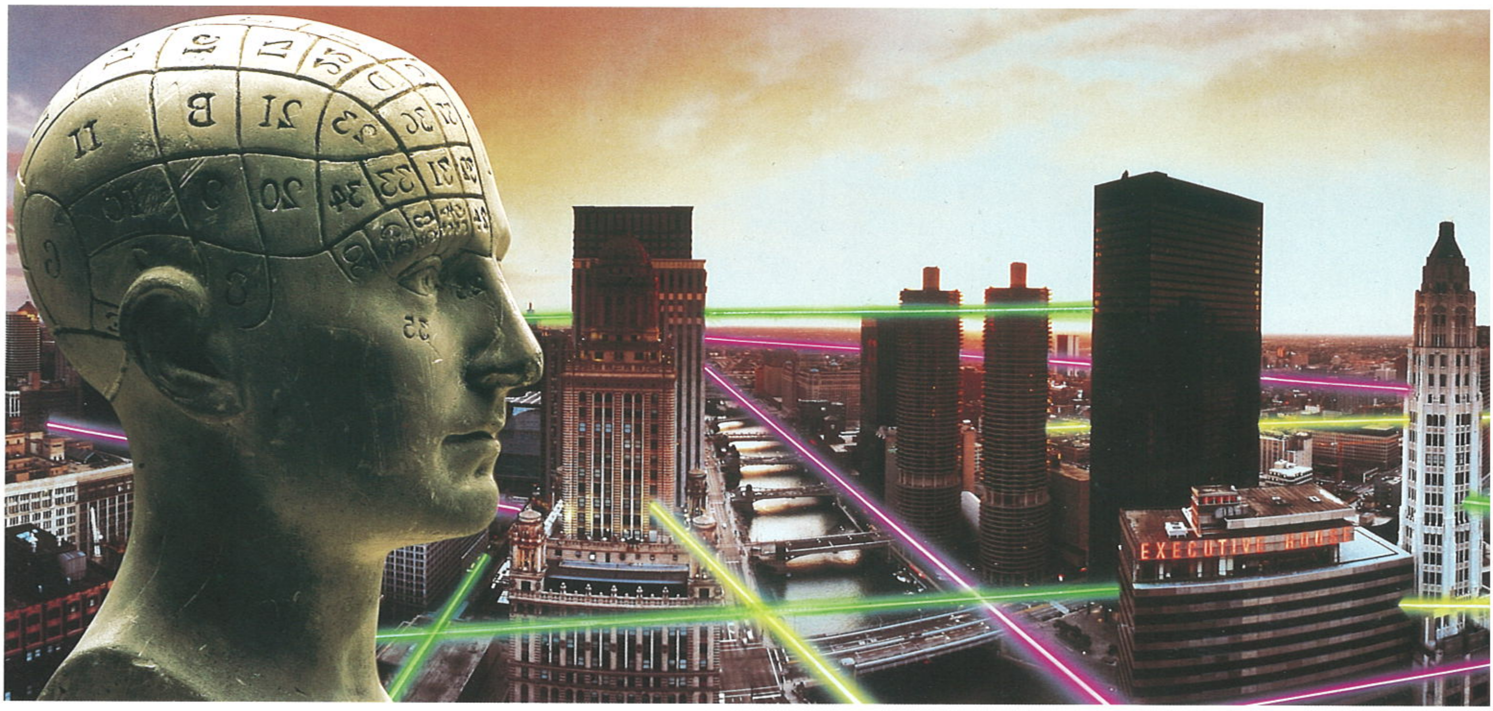
More than 25 large-scale application-specific integrated circuits (ASICs), with an average gate-count of over 75,000, have been developed for the ETNA cross-connect and multiplexer systems. The design work alone involved over 100 Ericsson engineers at development centres in Sweden and Italy. As a result of these efforts, ETNA cross-connects and multiplexers have a significantly lower chip-count than competitive systems.

Designing ASIC components 'from the bottom up' in this way has enabled Ericsson to develop highly adaptable and re-usable designs. Technology upgrades can be easily incorporated, and ASICs can quickly be adapted to meet the specific needs of different national markets.

Most of the ASICs were realized through a long-term technical collaboration agreement between Ericsson and Texas Instruments, which gives Ericsson access to the latest fabrication technology.

Looking to the future, Ericsson researchers are now working on 'micro-interconnect' technologies, which will allow integrated circuits to be placed physically closer together. This will enable the production of transport network systems capable of handling very high bit-rates.

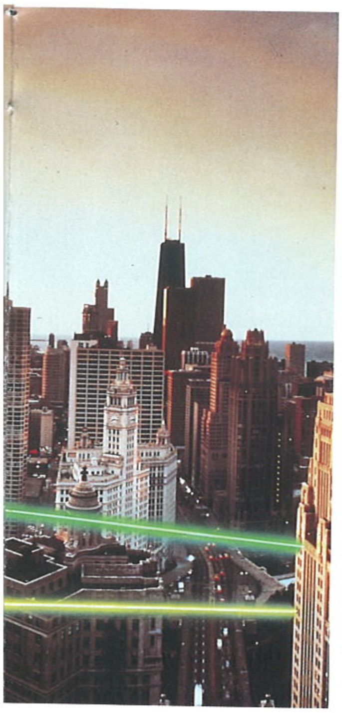
One of your primary aims in building an SDH transport network is to establish and maintain a commercial competitive edge, by providing customers with better service offerings, faster and at lower cost than anyone else.



Management and control at the nerve-centre of the transport network

The trick is not just to have the resources, but to use them in the right way.

Ericsson's SDH network management systems, an integral part of the ETNA concept, gives you complete, real-time control of the transport network and its services. A wide range of solutions is available: from low-cost local and remote terminals that manage one network element at a time, through element and sub-network management systems, right up to FMAS-NM, which can manage all ETNA systems — and interface other vendors' equipment as well — to provide a strategic control centre for the total network.



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SDH transport network systems have most of their functions flexibly controlled by software, rather than fixed by hardware design. This allows the configuration of these systems — and thus the services provided by the network — to be managed dynamically, by remote control. An SDH transport network is an immensely powerful and flexible machine.

But how do you harness that power and flexibility? Although the basic transmission standards of SDH have been defined, standardization of management issues and systems is still a long way away. And yet it is the management systems that provide the real key to exploiting the benefits of an SDH network.

Maximising the profit from the transport network

A well-managed transport network can create many new revenue-earning services. Leased lines, for instance, can be set up and torn down in minutes, with just a few commands from an FMAS-EM or FMAS-NM terminal. This is a vast improvement from the days when it took weeks or months to hard-wire every connection.

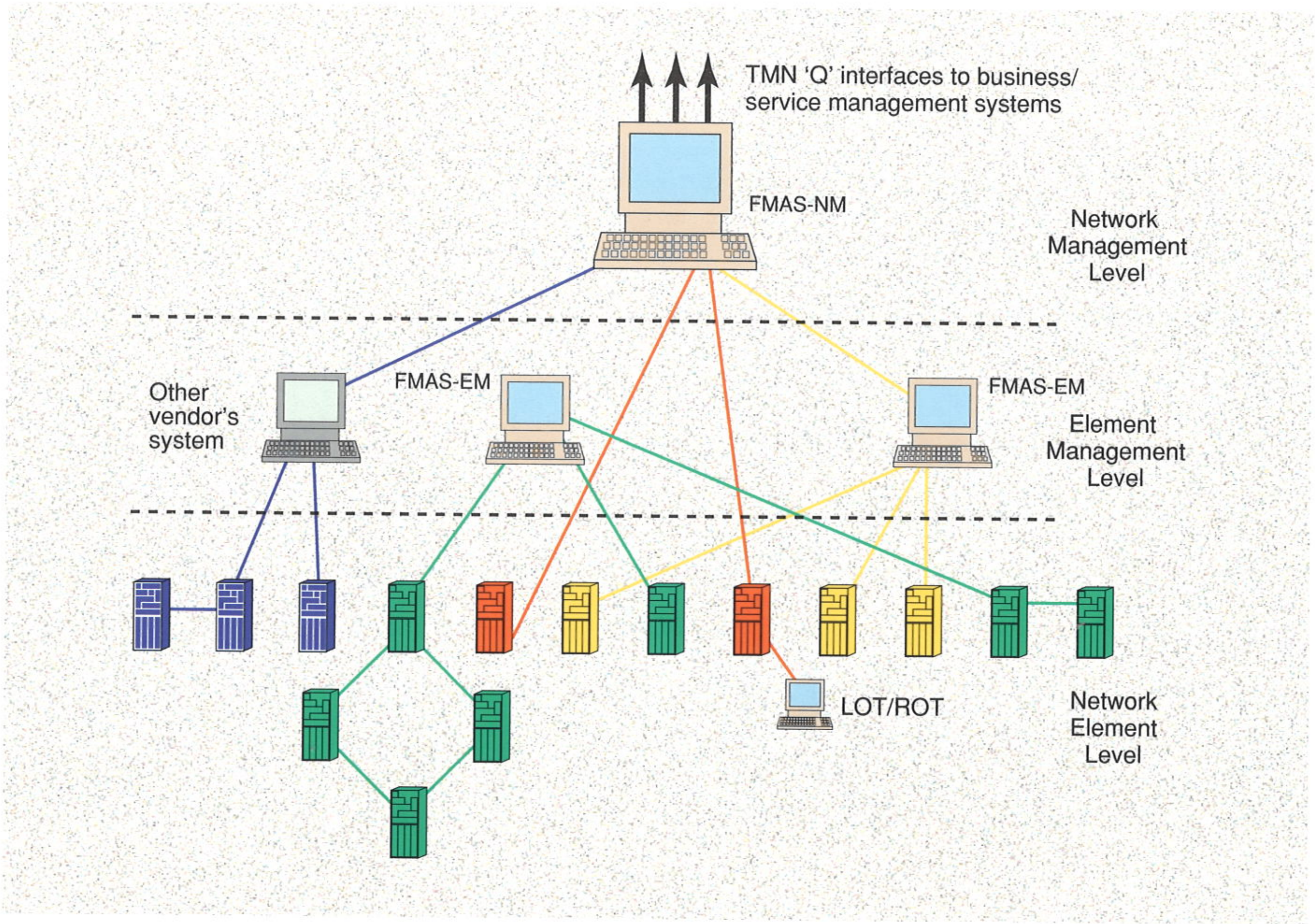
With this kind of responsiveness, a whole new market for leased-line services opens up. Wideband and broadband 'pipelines', which were once only sold to users who could cost-justify having the capacity permanently on-line, can be provided to customers flexibly, on demand.

Service quality is an issue of critical importance for many of today's leased-line users: and it's an area of special weakness when connections are hard-wired within PDH networks. In an SDH network, Ericsson's management systems can provide end-to-end quality measurements on any end-user service: giving you the chance to spot problems and solve them before your customers do; and the opportunity to provide audited reports on service quality.

Our management systems also give you full control of the grade of service your customers receive: from FMAS terminals you can specify protection schemes to give your most important customers guaranteed service — at a premium price.

The multi-service transport network

It's not just your traditional leased-line customers who can give you extra business. As the telecoms service provision industry fragments, more and more operators will enter the market with niche service offerings. Cellular telephone networks were the first example; in the



Ericsson's SDH management and control systems work at all levels of the hierarchy. The variety of solutions available means that appropriate and economic management systems can be supplied for any SDH implementation strategy: top-down, bottom-up or overlay. As the SDH network expands, and its applications become more sophisticated, FMAS-EM and FMAS-NM systems can be upgraded as necessary.

near future, the number of specialist data network providers can be expected to grow quickly.

All of these new operators need transport network capacity. Your ability to provide that capacity quickly, flexibly and economically will win you the business. And Ericsson's SDH management systems will ensure you can do this.

Developing a network management strategy

No two SDH networks are alike; and so neither are their network management requirements. At Ericsson, we have developed a network management strategy that allows you to build management solutions that are always cost-effective and appropriate to the stage of development the transport network has reached.

There are four levels of SDH management system, each suited to particular needs, or particular stages of network evolution:

Local Operations Terminal (LOT) This is a single terminal, to manage a single network element. It is used on-site, to initialize and configure a network element when it is first installed, and by field engineers to make adjustments and reconfigurations as necessary.

Typically, the LOT might be installed on a portable terminal, which is moved around from one network element to another.

Remote Operations Terminal (ROT) This has the same functions as the LOT, but it is centrally located. The ROT can communicate with network elements via the ECC (Embedded Control Channel) in an SDH signal, and can be run in a window on an element or network management system.

Facility Management System – Element Manager (FMAS-EM) This is a centralized application, which manages a group of network elements of the same type, at a relatively low cost. FMAS-EM systems run on PC or UNIX platforms, and can manage from a handful to several hundred network elements, depending on their size and configuration. In some cases, they can be used for end-to-end service provision within local and regional sub-networks — or across a complete national network, while the network is growing towards its full size and scope. FMAS-EM systems can also provide a 'gateway' to the FMAS-NM system, for fully-integrated network management.

Facility Management System – Network Manager (FMAS-NM) FMAS-NM provides centralized management for the entire SDH network, with the possibility also to manage multi-vendor network elements via TMN Q interfaces. In a large, fully-developed SDH network, FMAS-NM controls end-to-end service provision, and can completely take over this application from FMAS-EM systems. FMAS-EM systems are controlled via a graphical user interface from FMAS-NM, and act as 'gateways' between FMAS-NM and the network elements.

FMAS-NM is a member of Ericsson's TMOS (Telecommunications Management and Operations Support) family of network management systems. It implements industry standards in computing and telecommunications, and uses modular and scalable hardware and software. As a TMOS system, FMAS can be integrated with other TMOS applications: for instance systems for the management of PSTN services, cellular networks, and in the future for broadband service management. FMAS can also provide standards-based interfaces upwards to operators' service and business management systems.

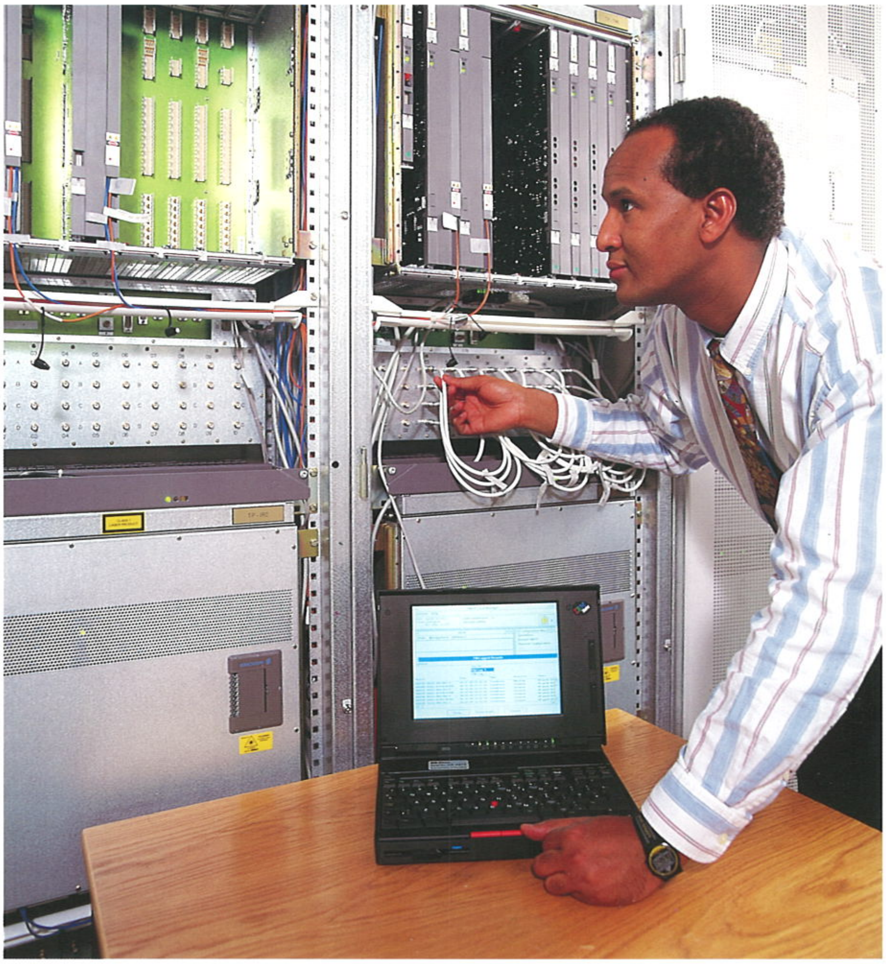
FMAS-NM provides a strong platform for centralized management of backbone network resources, and can act as a 'manager of managers' for element management systems lower down in the network hierarchy – both for Ericsson and non-Ericsson equipment.

Ready for a multi-vendor environment

Most SDH networks will contain network elements from at least two vendors. While functions such as alarm handling and fault management can be handled from the individual management systems for each vendor's elements, there are some areas — such as configuration management — where a network-wide view will be a big advantage.

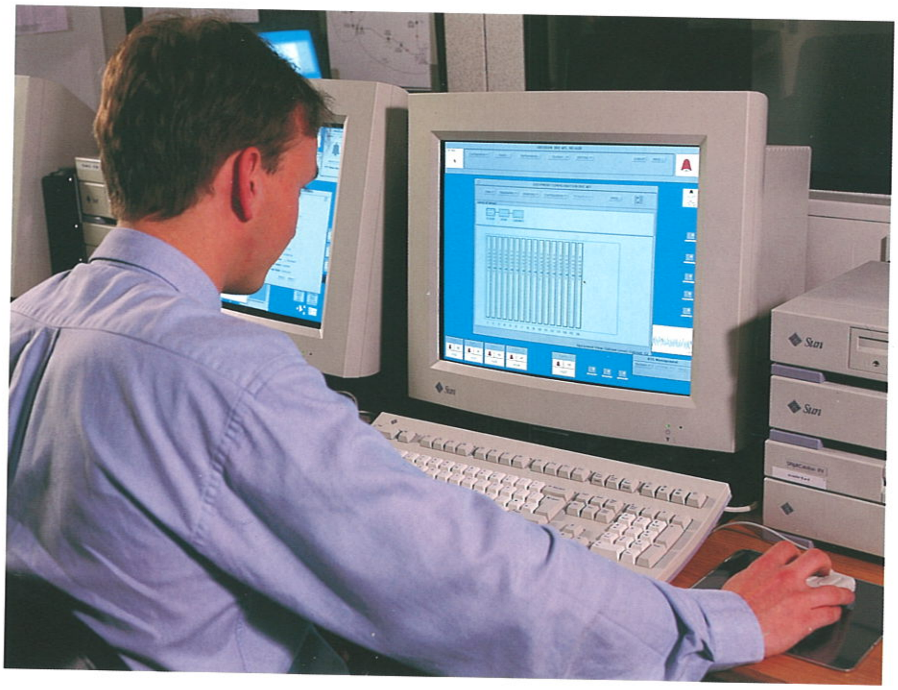
In this case, FMAS-NM can become a powerful solution for multi-vendor networks. Thanks to its foundation on industry standards, such as TMN, and its modular architecture that permits special interfaces to outside systems to be built, FMAS-NM can grow to take on configuration management facilities across a multi-vendor SDH network.

These multi-vendor advantages can be exploited in various ways. FMAS-NM can be extended to manage all the elements in a multi-vendor transport network. Alternatively, it can manage just the Ericsson network elements, and pass information up via a standard interface to a higher-level network management system.



The LOT (Local Operations Terminal) is used to manage and configure single network elements on-site. The software is typically installed on a portable PC, for use by field engineers.

The ROT (Remote Operations Terminal) has the same functions as the LOT, but is centrally located. It can log in to several network elements, handling them one at a time for functions such as configuration and fault management.



Technology briefing 2

Object-oriented software design will speed future developments

The importance of software, rather than hardware, in determining functionality is one of the key differences between the new SDH transport network systems, and their PDH predecessors. The size of the software development task is one of the main reasons why only the most committed and resourceful telecoms suppliers have been able to develop a complete SDH range.

The development of the ETNA family of SDH systems has involved a programming commitment similar in size to the development of a new switching system. For Ericsson, this meant drawing on software development skills and techniques used in the AXE switch.

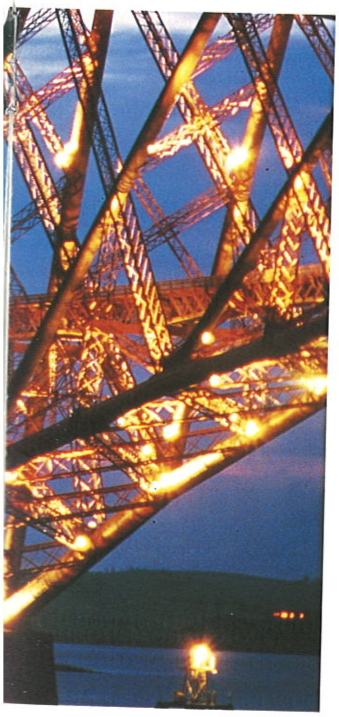
The ETNA software development project spanned over three years — and is of course continuing as functionality is enhanced and standards are refined. It was one of the first large-scale software development projects in the world to use object-oriented design and programming methods.

This object-oriented approach is expected to pay big dividends as systems develop in the future. With software packaged in re-usable modules, systems should be both robust and easy to upgrade with new functions. Flexibility will be another key benefit: object-oriented code can be moved at will between external platforms (such as UNIX workstations) and embedded systems within network elements themselves.

No network is a green field. In almost every telecom network, the deployment of the first SDH systems will mark the beginning of a long-term evolution from PDH to SDH, lasting maybe a decade or more.

Building bridges: the unique ETNA migration path from PDH to SDH

How do you cope during this transition period? How can you make your existing PDH equipment co-operate with newer SDH systems? And how can you maximise the return on your previous investments in PDH?



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Today, the migration of the transport network to SDH technology is universally accepted. But there are still major differences in the strategies for migration.

For some operators, the national backbone network is the focus of attention. Here, a high-capacity SDH network may be urgently needed to carry the traffic that overloaded PDH systems cannot.

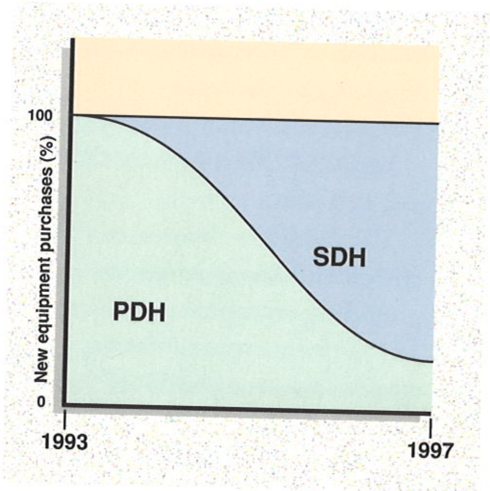
For others, the priority is new services for business customers: for these operators, local SDH rings, connected by an overlay backbone SDH network, are the strategy.

In all cases, networks will have to cope with a long-term migration from PDH to SDH. Here, ETNA has some unique advantages, that will add value to existing PDH investments.

Adding configuration flexibility to PDH

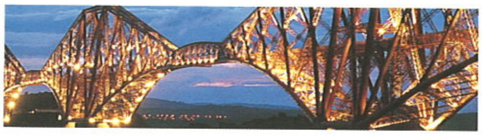
Although PDH systems themselves have no dynamic control over their configuration, the addition of ETNA digital cross-connect systems to a PDH network can compensate for this, by providing flexible switching and grooming facilities within the PDH environment. This can greatly increase the 'fill-factor' — the effective traffic-handling capacity — of a PDH network.

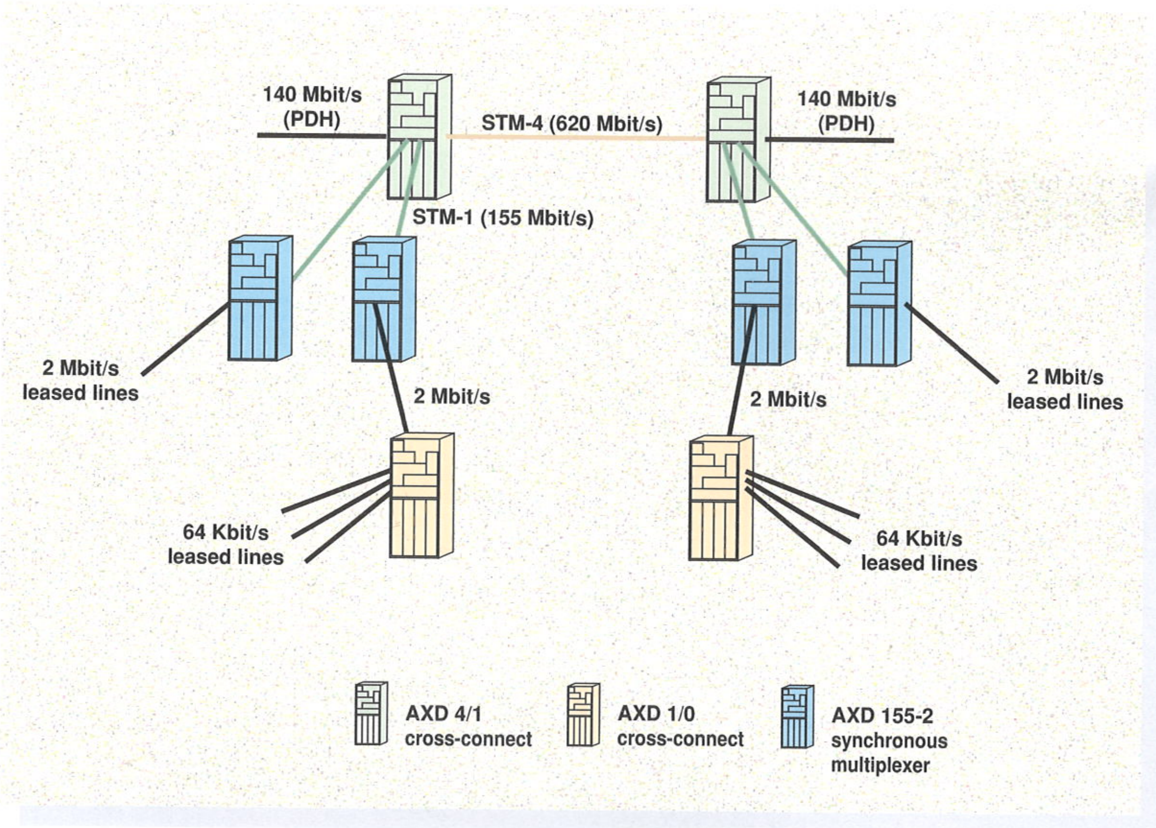
For instance, the Ericsson AXD 1/0 system, with its ability to 'groom' transmission channels — feeding 64 kbit/s channels from two or more under-utilized 2 Mbit/s channels into a single 2 Mbit/s channel — increases the traffic-handling capacity of existing PDH systems.



It will take years, or even decades, to establish a 'pure' SDH network. In the meantime, you have to cope with different technologies operating in parallel.

Further up the plesiochronous hierarchy, AXD 4/1 systems can perform protection switching and routing functions with higher-order signals. They can also perform a bridging function between PDH and SDH; enclosing plesiochronous tributaries





ETNA cross-connect systems can handle both PDH and SDH traffic, encapsulating PDH tributaries within SDH signals.

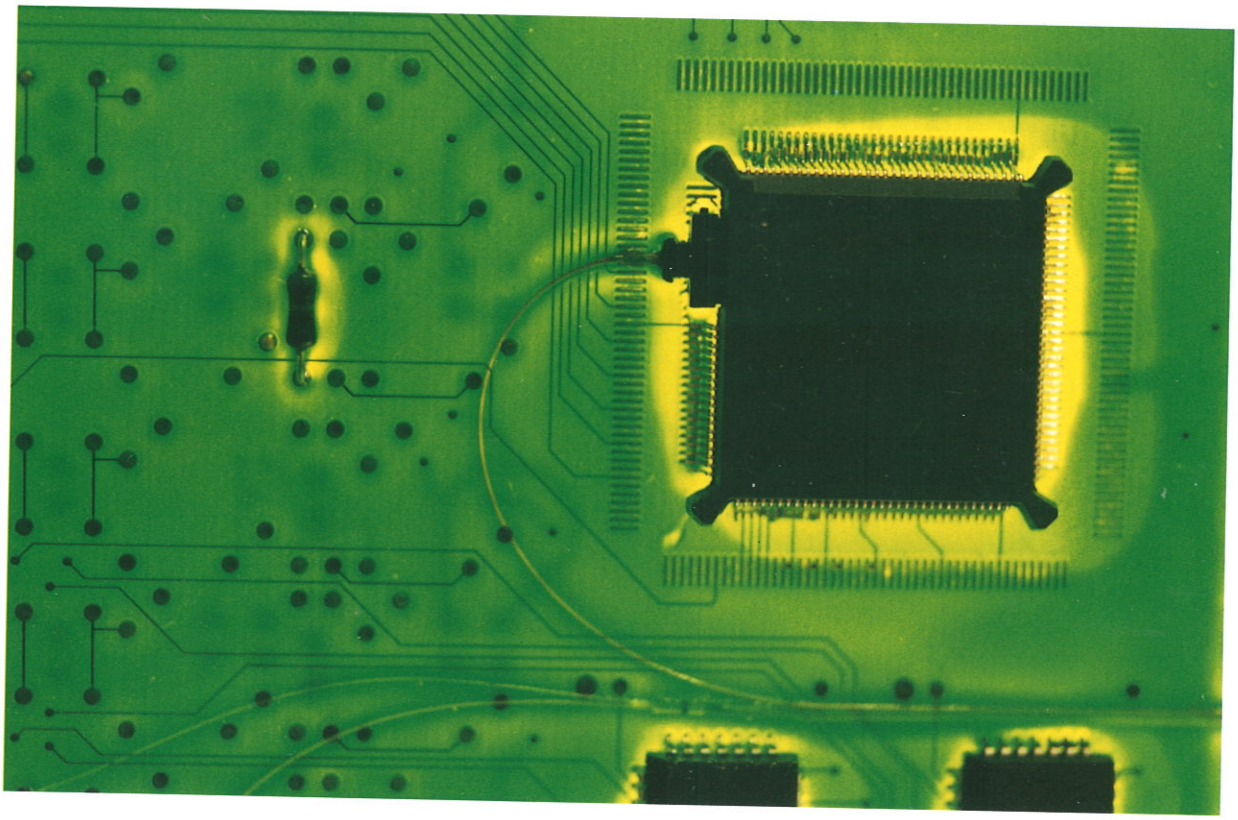
within synchronous 'virtual containers'; and then unbundling the plesiochronous signal at the other end.

All of these functions are performed under the central control of the FMAS-NM system: in this way, a PDH network can acquire many of the attributes of a managed SDH network; and SDH transmission facilities can be added in a step-by-step way, as capacity or service requirements arise.

PDH PERFORMANCE AND FAULT MANAGEMENT

The Ericsson Transmission Management System (ETMS), together with stand-alone monitoring systems, enhances your PDH network by providing a graphic interface for alarm surveillance, fault localization and performance monitoring. This allows you to extend many of the advanced features of SDH network to services that pass through PDH equipment too.

Optical interconnect: pushing the speed limits higher



The conversion of electrical signals to optical signals, and vice versa, is a basic function of all types of high-speed transmission system — PDH as well as SDH. Ericsson has been at the forefront of developments in this area since the introduction of the first fibre-optic systems.

Continuing research work is being carried out in-house at Ericsson's Fibre Optic Research Centre. It is aimed at developing low-cost optical interconnection devices, which will be used at first within, and then between, pieces of equipment.

The first applications of this technology will be to provide very high bit-rate connections between equipment cabinets. Subsequently, the technology will be deployed within equipment cabinets to form 'optical backplanes'; and ultimately on circuit-boards, to connect together individual integrated circuits.

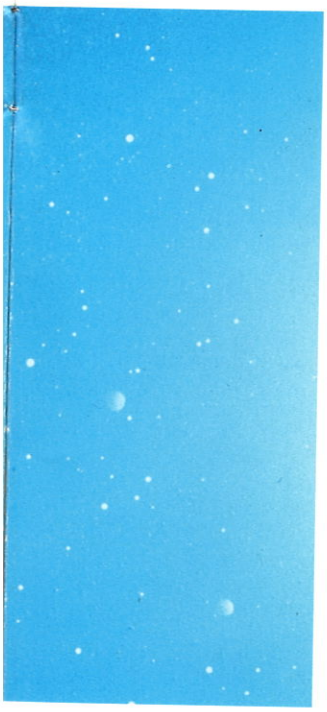
These developments will bring three principal benefits. Firstly, they will eliminate problems of crosstalk associated with electrical signals, which will enable high bit-rates to be handled. Secondly, they will occupy less space. Thirdly, they will consume less power than electrical connections, and therefore produce less heat.

Other basic research at Ericsson's Fibre Optic Research Centre includes the development of very high-speed lasers, capable of transmitting signals over long distances at speeds of 10 Gbit/s or higher.

How will the era of broadband, multimedia communications evolve? Will it be subject to monolithic, all-embracing broadband ISDN standards? Or will competition in a deregulated environment mean a plethora of suppliers chasing tiny niche markets with precisely-tailored network services?

Beyond SDH: ETNA and the broadband services of the future

The truth probably lies somewhere between these two extremes. But Ericsson is already charting a technology path encompassing a wide variety of potential broadband solutions, with SDH as the core transport mechanism.



5

A fundamental paradigm shift is occurring in telecoms networks. Today, basically separate networks are used to provide different services — telephony, mobile communications, cable TV etc. Tomorrow, a much greater variety of services will be provided, across a single network infrastructure.

These multimedia services will require networks that support a mixture of simultaneous connections, at much higher bandwidths than are used today.

The driving services behind this move to broadband services are data communications for the business community; and entertainment services for residential customers.

Implementing broadband, bit by bit

In the world's most deregulated and liberalized telecom markets, many niche operators are targeting large businesses, hoping to carry their lucrative high-speed, high-volume data traffic.

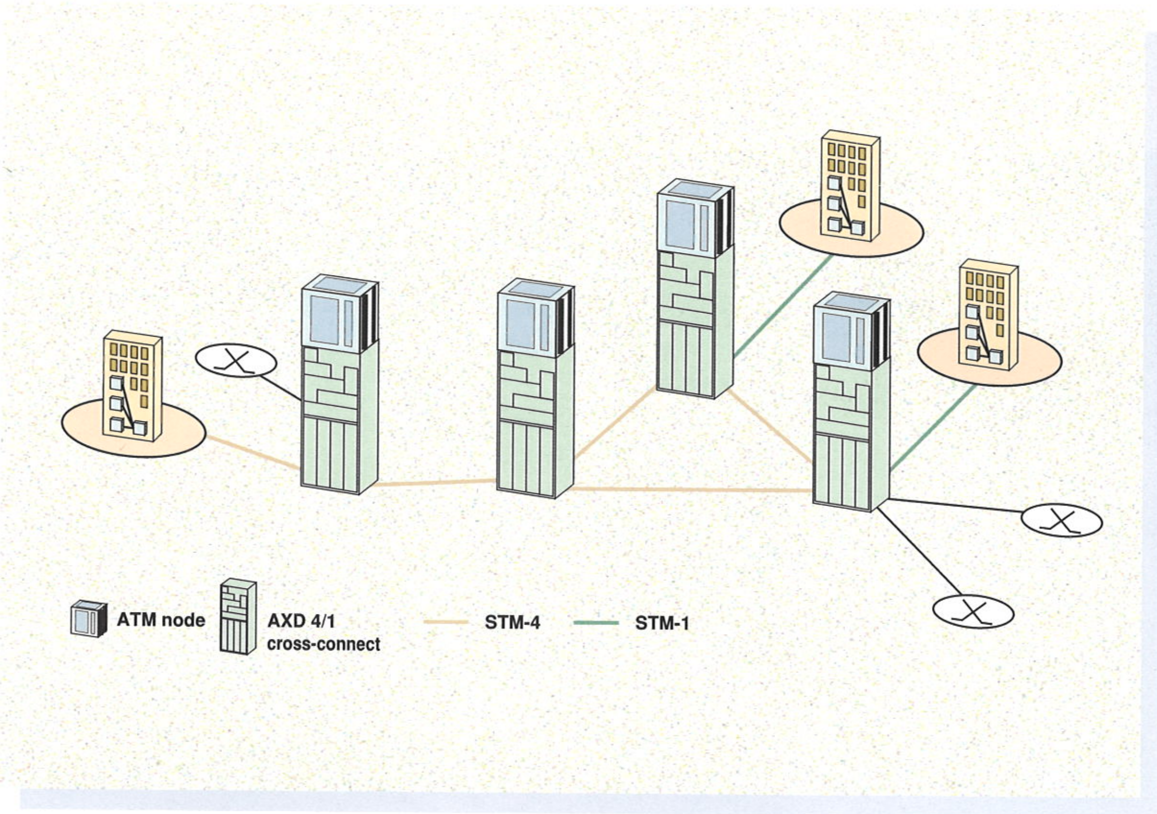
Big infrastructure concepts, such as B-ISDN, do not necessarily fit well into this world. In many markets we can expect to see a number of core networks, operated by traditional network operators as well as newer operators arising out of power companies, railways and cable television operators. And possibly an even greater number of value-added service providers who, by attaching various functional nodes to these networks, will serve different market niches.

Get into the transport business

In this complex environment, the transport network could come of age, as a business in its own right. It would operate the 'pipelines', selling capacity in bulk to service providers — including POTS providers as well as more esoteric operators.

This is a situation that is both envisaged and enabled by the Ericsson Transport Network Architecture — and by the new generation of ATM-based switching systems Ericsson is developing to sit on top of ETNA as a multimedia service provision mechanism.

Essentially, SDH and ATM are complementary technologies. SDH systems, such as ETNA, create a structured, flexible and manageable transport network resource. ETNA can handle existing bit-rates and services in a highly cost-efficient way; and create new business opportunities through its ability to allocate bandwidth dynamically.



The introduction of ATM: as a first step, broadband 'pipes' are implemented through the network, using access, local and transit nodes equipped with STM and ATM cross-connect functionality. This enables the provision of Virtual Leased Line (VLL) services for end-users.

While ATM will support a wide variety of broadband services, SDH will be needed to support the network itself, providing the basic network flexibility, protection switching, performance and fault management. SDH is the best possible mechanism for carrying ATM traffic: it will ensure the high quality and availability of the physical network, that is a prerequisite for high-quality services.

Introducing ATM and multimedia services on top of ETNA

Here is one possible scenario for the development of broadband and multimedia services, with ETNA as its foundation.

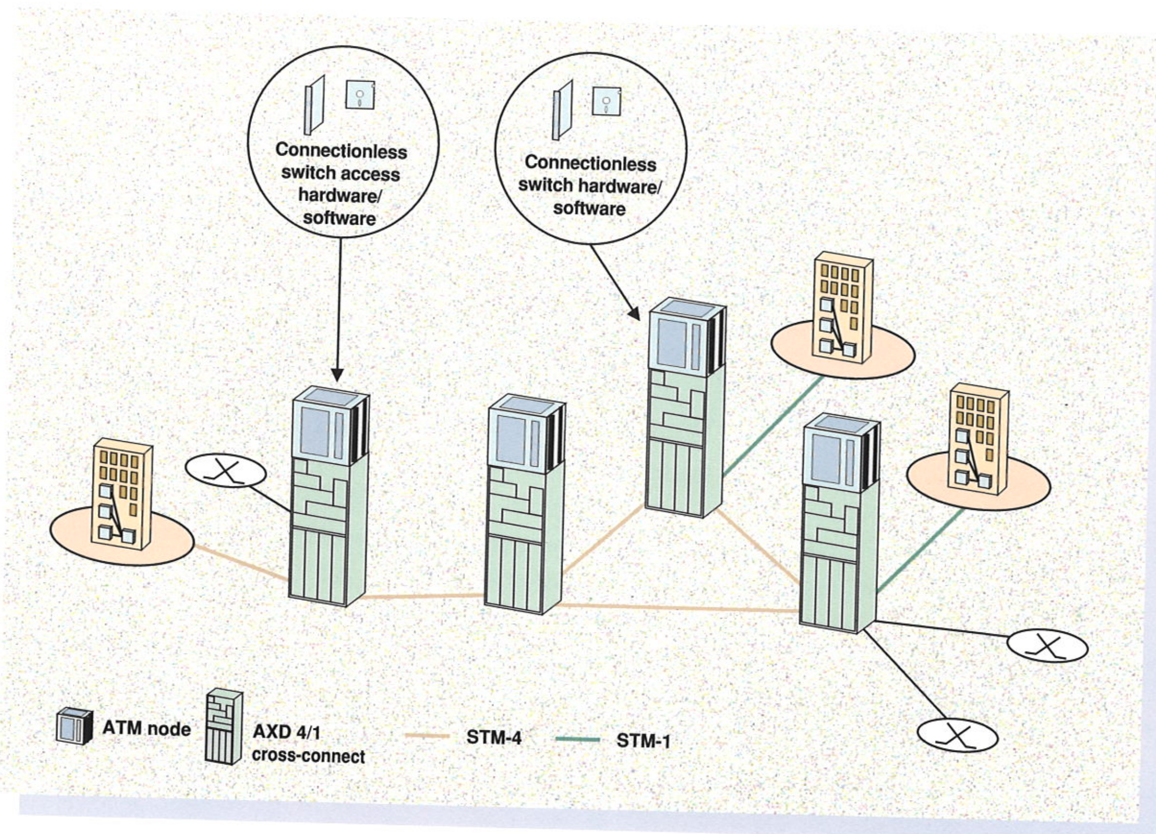
Applications for broadband and multimedia are likely to appear first in private networks, with high-speed data communications as the first service. Since all switching will be handled by customer premises equipment, all that these private networks require are broadband 'pipelines' through the public transport network. These can easily be provided in an SDH network.

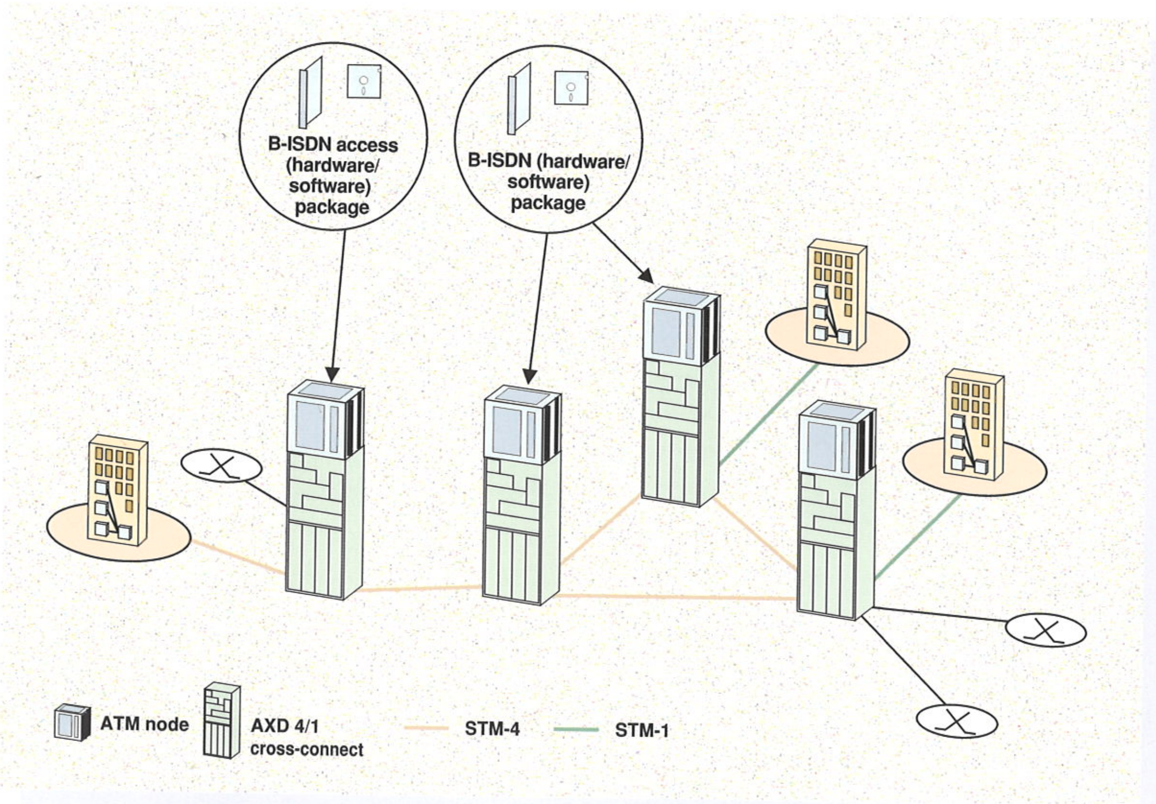
The first introduction of ATM functionality in the public network will be of nodes with cross-connect functionality. They will be interconnected using the SDH regional and national transport levels, at 155 Mbit/s and higher speeds. Smaller business areas can be connected to this overlay ATM network using ATM multiplexers.

The main applications will be to provide Virtual Leased Lines (VLLs) — semi-permanent interconnection of variable-bit-rate services. At a later stage, the ATM nodes can be upgraded, through the addition of hardware and software modules, to provide for connectionless services, such as frame relay or SMDS/CBDS, as well as VLL.

Not all the ATM nodes need to be upgraded for this: one or more connectionless servers can serve an entire country, depending on the demand for services. This is an attractive prospect for 'niche' service providers, who can implement their own services using SDH transport capacity bought as needed from the national network operator.

A connectionless server is added to the broadband systems, to provide services such as SMDS/CBDS. Not all nodes need to be upgraded.





Broadband signalling and routing capabilities are added, to allow per-call switching of virtual channels and full, multimedia, B-ISDN capabilities.

A third stage in broadband network development is to introduce the signalling and routing capabilities needed for applications such as multimedia calls. These can be installed on existing ATM nodes, or as new local or transit exchanges dedicated to broadband communication. Users can initiate and terminate calls as needed, using whatever bandwidth they require.

ATM technology added to an SDH network provides a smooth migration path to an enhanced infrastructure and support for future services, for both business and residential users.

In corporate networks, ATM technology will support high-speed data, voice and video transmission in and between LANs.

In the residential sector, ATM technology will support a multitude of new and enhanced entertainment and information services such as video on demand, distance learning, home shopping and games.

Photonic switching and the next generation of broadband systems

4

Technology briefing

Photonic switching devices use electrical signals to control the paths taken by optical signals as they pass over a semiconductor substrate. By allowing direct manipulation of optical signals without first reconverting them back to electrical signals, they offer the potential for simple, low-cost broadband devices, which could ultimately be used in advanced Fibre To The Home (FTTH) applications.

Ericsson's Fibre Optics Research Centre has scored several notable 'firsts' in photonic switching. In conjunction with Ellemtel, the R&D joint venture between Ericsson and Televerket, it has developed pre-commercial demonstrator systems using optical cross-connect techniques.

Development of optical components at Ericsson began in the early 1980s. The first-generation integrated optical device was an electro-optic directional coupler, implemented in lithium niobate.

A laboratory prototype 8X8 non-blocking crossbar matrix, unveiled in 1986, was the world's most complex optical circuit.

Current research is looking into other materials such as gallium arsenide and indium phosphide, as the basis of optical components that will combine switching and amplification functions.

Most recently, Ericsson demonstrated the world's first 'zero-loss' optical component: a 4X4 switch matrix in indium phosphide that does not attenuate signals as they pass through it. This property allows large numbers of individual switches to be 'cascaded' together to form very large optical switching matrices — and is a major step towards commercially viable photonic switching systems.

Technical terms and abbreviations

ASIC Application-specific integrated circuit. An integrated circuit (or 'chip') that is designed specifically for one application — as opposed to general purpose chips, whose functions are determined by software. ASICs are faster, but less flexible, than general-purpose processors.

ATM Asynchronous Transfer Mode. An information transfer mode, standardised by CCITT, in which information is carried in the form of packets with a constant, predetermined length. ATM integrates the switching of continuous-bit-rate traffic, such as voice and video, with variable-bit-rate services such as data communication. It is the chosen transport mechanism for B-ISDN services.

AXD Ericsson's family name for its series of digital cross-connect systems (AXD 4/1 and AXD 1/0), and synchronous multiplexers (AXD 2500, AXD 620, and AXD 155-2).

B-ISDN Broadband ISDN. The future multi-service network providing broadband as well as narrowband services. Standardised by CCITT.

Broadband The term broadband is generally used to refer to communication at speeds from 1.5/2 Mbit/s upwards.

BXD Ericsson's abbreviation for its second generation of SDH systems, which combine multiplexing and cross-connection facilities in a single node. BXD systems are named according to their total switching capacity: thus the BXD 2480 is a node that can switch a total of 2,480 Mbit/s.

CBDS Connectionless broadband data service. A connectionless, high-speed (1.5-45 Mbit/s) data service mainly intended for the interconnection of LANs. CBDS is the European (ETSI) standard: a similar north American standard is called SMDS.

ETMS Ericsson Transmission Management System: a graphical system for alarm surveillance, fault localization and performance management in PDH networks.

ETNA Ericsson Transport Network Architecture: the Ericsson family name for the AXD series of cross-connect and multiplexer systems, and the FMAS transport network management system.

FITL Fibre in the loop. This refers to the extension of high-capacity fibre-optic links, which can carry a full range of services, to distribution points close to end-users, and ultimately all the way to the end-users themselves.

FMAS Facility Management System: Ericsson's term for network and element management systems within ETNA. FMAS-NM (network manager) is a complete network management system for all ETNA systems. A number of FMAS-EM (element manager) systems are also available to manage sub-networks composed of a single type of network element.

Frame relay A connection-oriented, fast packet-switching data communications technology providing virtual circuit connections from origin to destination.

HDTV High-definition television. One of the services which will be distributed through B-ISDN.

PDH Plesiochronous digital hierarchy. Present-day transmission multiplexing hierarchy, to be evolved into SDH.

PON Passive optical network: a method of constructing an optical fibre network without switching capabilities, for FTTC applications.

RLL Radio in the local loop: a method of connecting telephone subscribers to the network using radio instead of cabling. RLL is particularly interesting in environments where a lot of new subscribers have to be connected to the network quickly, or where the physical environment makes traditional cabling too expensive.

SDH Synchronous digital hierarchy. An international standard for transport network systems, developed by the CCITT.

SMDS Switched multi-megabit data services. US version of CBDS (see above).

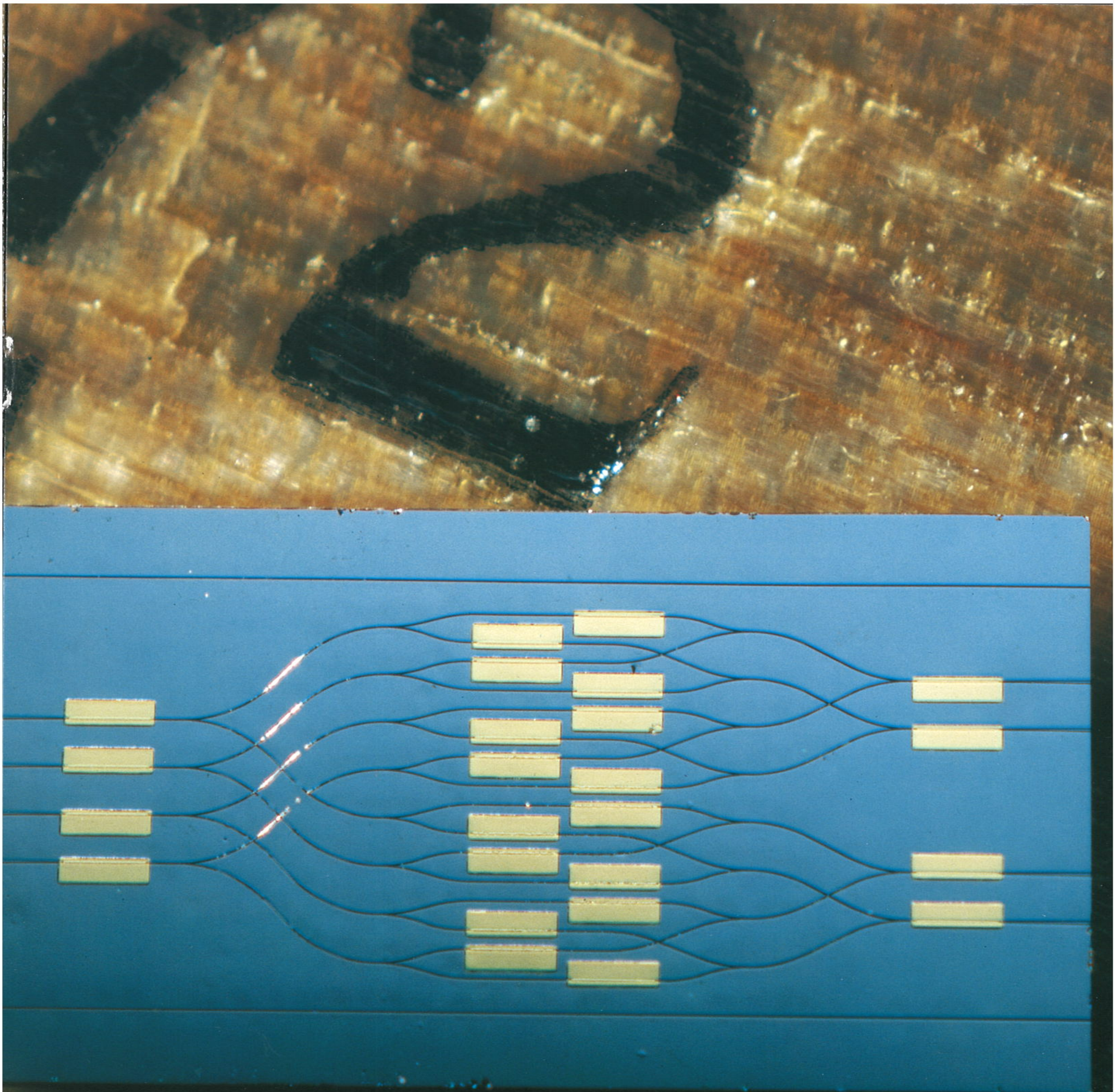
STM Synchronous transfer mode: the information transport mechanism used within SDH systems, in which information is transferred as octets at regular time intervals. Different transport bit-rates are referred to in the following ways: STM-1 = 155 Mbit/s;
STM-4 = 620 Mbit/s (4 x 155 Mbit/s);
STM-16 = 2.5 Gbit/s (16 x 155 Mbit/s).

TMN Telecommunications management network. Standard for network management systems, developed by the CCITT.

TMOS Telecommunications Management and Operations Support: Ericsson's family name for its TMN-based public network management systems.

VLL Virtual leased line. An ATM-based service, similar to the ordinary leased-line service. However unlike a conventional leased line, a VLL uses capacity in the network only when there is traffic to be sent. VLLs allow the network to be utilised more efficiently, reducing the cost of providing the leased-line service.

VLSI Very large scale integration. The process of integrating large numbers of discrete electronic components onto a single 'chip'. This increases processing speed, and reduces the size and power requirements of equipment.



A NEW KIND OF LIGHT-SWITCH

The chip shown above is the world's first 'lossless' optical switching component: a 4X4 space switch that switches optical signals directly, without converting them to electrical signals.

'Lossless' optical switching is an important breakthrough. Previous optical switching components attenuated the signals that passed through them; and this attenuation was too great for them to be considered for use in commercial systems.

Much work must still be done before optical switching becomes a commercial reality: but when it does, it will be a major enabling technology for universal, low-cost broadband communications.

Ericsson's 75,000 employees are active in more than 100 countries. Their combined expertise in switching, radio and networking makes Ericsson a world leader in telecommunications.

Business Area Public Telecommunications creates, markets and supplies advanced systems and products for public telecommunications networks.

The successful AXE system for switching and intelligent network applications has been installed in more than 100 countries. Other important product areas are transport network systems and network management and operations systems.

Ericsson Telecom AB
S-126 25 Stockholm, Sweden

EN/LZG 305 306/32 R2

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