Zeitschrift: Comtec : Informations- und Telekommunikationstechnologie = information and telecommunication technology

Herausgeber: Swisscom

Band: 77 (1999)

Heft: 6

Artikel: SDH : a must, luxury or complication?

Autor: Bischoff, Jean-Claude

DOI: https://doi.org/10.5169/seals-877026

Exploration Programmes: Corporate Technology Explores Future Telecommunications

SDH: A Must, Luxury or Complication?

The number of manufacturers offering data equipment fitted with Packet over SONET, IP over WDM or ATM over WDM is steadily increasing. In the proposed architectures, the IP routers or ATM switches are directly interconnected by dark fibres or WDM systems. Does that mean that SDH is now obsolete and should be abandoned? There is no simple answer to this question and the presence of a legacy SDH network is one of the many factors that have to be taken into account before upgrading the network with a turnkey POS implementation as offered by many suppliers. SDH is still "a must" today, but independent management of SDH is a complication and closes opportunities for simplifications.

Exploration Programme «Transport Network Evolution» elaborates scenarios for optimised use and consolidation of the backbone transport network. The main topic is the economic migration of the network from the voice into the data world. Special emphasis is on the introduction of an optical transport layer and the optimised use of the SDH, ATM and IP client layers. The choice of the needed layers depends on the service portfolio to be offered and has a strong impact on the investment and operation costs of the network, and the flexibility to introduce new services.
With Exploration Programmes Corporate Technology is exploring telecommunication technologies and new service possibilities within projects having a long-term focus of 2–5 years to build up expertise enabling active business innovation support.

A keyword exciting the telecommunication world today is POS, Packet over SONET/SDH. POS has found favour with providers whose core business is focused on data networks. However, some problems arise

JEAN-CLAUDE BISCHOFF, BERN

with this technique that does not use ATM and can bypass the legacy SDH network. Without ATM, QoS must be implemented in layer 3 (IP). Different schemes (RED, WRED, DiffServ and MPLS) are proposed by the IETF and manufacturers to offer QoS or CoS. However no solution has really imposed itself yet. Without SDH, the optical network layer or the IP layer must provide protection. In principle, both are possible today, with corresponding advantages and drawbacks.

The present generation of IP/WDM or ATM/WDM systems uses SDH interfaces and this is not likely to change very soon. The key of success resides in the integration of SDH and data systems management which is best done by merging them. Thus, SDH will become a part of data systems and the present role of SDH as a transport network will be largely taken over by the optical layer whose bandwidth granularity is better adapted to the new traffic profiles.
One could say: SDH is still «a must» today, but independent management of SDH is a complication and closes opportunities for simplifications. In this article, we shall attempt to shed some light on the challenge of data transport by SDH networks, on protection alternatives and on the possible future of SDH systems [1].

Towards a better Bandwidth Utilisation

SDH is a transport network which, with its capacity to aggregate a very large number of low-bit rate flows, is perfectly adapted to transporting voice. The beauty of SDH ADM and SDH hierarchical structure is that information can be added or dropped without processing the main stream data flow. The efficient transport of information requires that the added, dropped or transported VCs are optimally filled. This is however not automatically the case when transporting ATM or IP data, which is not required to obey the SDH hierarchy. Furthermore, with the explosion of data traffic and the capacity increase in backbone trunks, the bandwidth granularity of SDH has become too fine.
The following different configurations can be identified when transporting ATM or IP over SDH.

Programme Scenario

The basic lead question for the Exploration Programme Transport Network Evolution is how to provide a radically more cost-effective backbone network for supporting emerging multi-services markets.

Embedded IP or ATM Transport

In conventional SDH systems, ATM cells or IP packet are completely transparent to the SDH NEs. The STM fabric cross-connects only the STM paths under STM management. Two main drawbacks appear immediately:

– Bandwidth may be wasted. SDH capacity is allocated for point-to-point links between the ADM to which the data systems are connected. This bandwidth is reserved and cannot be freed when the data equipment does not use the totality of this capacity.
– Because most presently installed SDH cross-connects work with VC4, they cannot switch data pipes with more than 149 Mbit/s. Thus, it is not possible to attribute more than 149 Mbit/s to a single ATM VC. An even more severe limitation is that statistical multiplexing is constrained inside these 149 Mb/s even when the total capacity set-up between the ATM systems is much larger. When IP traffic is carried, load

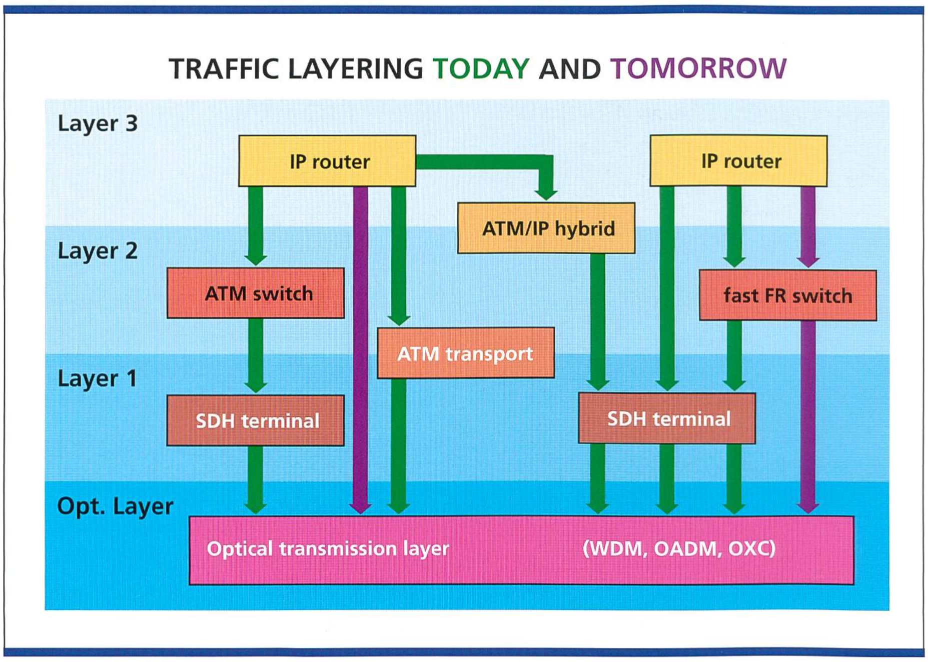

Fig. 1. Traffic layering, today and tomorrow.

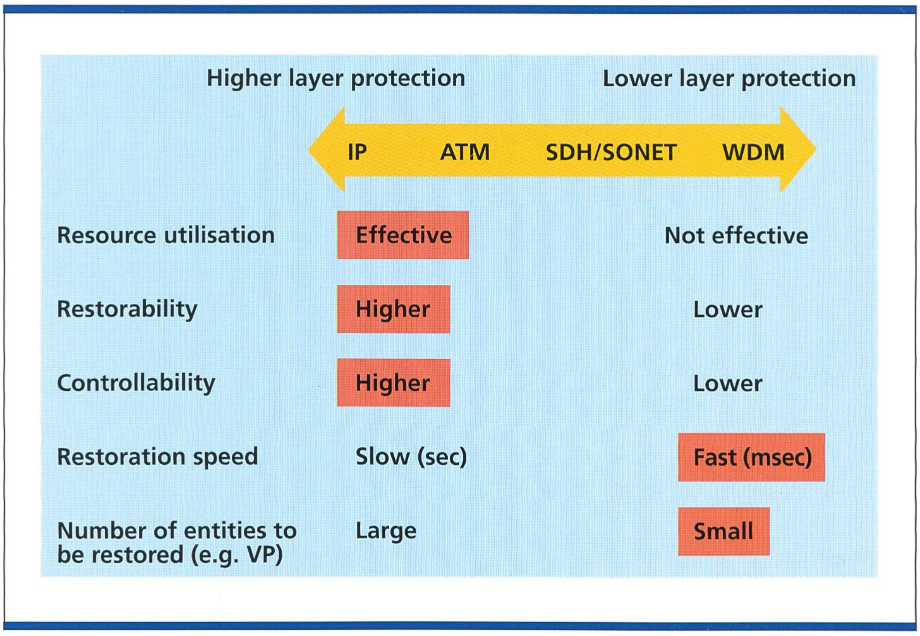

Fig. 2. Characteristics of each layer protection.

balancing has to be done between the different VC4.

To eliminate drawback no. 1, some SDH manufacturers are introducing ATM or IP capable interfaces for their SDH cross connects or ADMs. These are called hybrid SDH cross connects or ADM. In the rest of this paragraph, the example of ATM is taken, but in essence, the same applies to IP. The ATM cross-connect fabric in the NE is used to aggregate ATM traffic to achieve better fills of the concatenated mode of STM tributaries carrying ATM cells. The STM paths containing ATM traffic are dropped at the ATM fabric, while the STM fabric provides STM cross-connects. Therefore, this NE requires both STM and ATM management.

Drawback no. 2 is alleviated by the use of concatenated virtual containers. For example, with VC4-4c containers, 599 Mb/s are available as one big chunk instead of the 4 × 149Mbit/s available with VC4 containers. On the downside, backward compatibility with older SDH equipment is not guaranteed.

Pure IP or ATM Transport

When pure IP or ATM transport is achieved, the single tributary in the STM pipe is used only for ATM or IP traffic under IP or ATM management. This configuration is achieved when IP routers or ATM switches are directly interconnected by dark fibres. ATM allows then to transport non-ATM traffic by using Circuit Emulation. IP does not offer this capability.

Protection

Protection in Traditional Networks

One of the main assets of SDH networks is their protection features [2, 3]. The protection techniques are useful to improve the availability performance of the network. Several protection schemes have been defined by international standards and each scheme has different characteristics in terms of switching criteria, external commands, switching time, APS protocol, etc.

It is necessary to distinguish between protection that uses a pre-assigned capacity between nodes in order to replace the failed or degraded transport entities and restoration that uses any capacity available between nodes in order to find a transport entity that can be used to replace the failed one. Restoration is based on a re-routing algorithm and requires a management system. When restoration is used some percentage of the transport capacity will be reserved for re-routing working traffic.

A main characteristic of a protection scheme is the manner of assigning protection entities to working entities.

- In a 1+1 protection architecture, 1 protection transport entity is used for the protection of 1 working transport entity. The traffic is always transmitted on both the working and the protection transport entity.
- In an M:N protection architecture, M transport protection entities are used for the protection of N working transport entities. The protection entities can be used to carry extra traffic when not in use for protection. 1:1 and 1:N protection are particular cases of this type of protection architecture.

The 1+1 and 1:1 protection architectures are also called dedicated protection architectures because each working entity has 1 protection entity dedicated to itself.

The 1:N and M:N protection architectures are also called shared protection architectures because the working entities share one or more protection entities.

Two protection schemes, the SDH sub-network-connection protection and the SDH MS trail protection, are widely used.

Sub-Network Connection Protection Schemes

Sub-network connection protection (SNCP) is a dedicated protection mechanism that consists of replacing a working sub-network connection with a protection sub-network connection. It is a protection switch method applied in the client layer when a defect condition is detected in a server layer, sub-layer or other transport network layer. Sub-network connection protection can be used on any physical structure (i.e.: meshed networks, rings, and mixed networks).

Trail Protection Schemes

In trail protection a working trail is replaced by a protection trail when it is affected by a failure or degradation. The failure or degradation is detected by the trail termination functions and the protection switch is performed by a protection matrix.

Depending on the layer where the protected trail is located, three types of trail protection are possible:

Multiplex section trail protection. In the MS trail protection schemes the detection of failure events is performed by the multiplex section termination function. The reconfiguration can involve protection switching in multiple SDH network elements. The co-ordination of such switching in multiple SDH network elements is by means of an automatic protection switch (APS) protocol. Three different MS protection schemes are defined: linear MS protection, MS dedicated protection rings and MS shared protection rings.

Higher order and lower order VC trail protection. VC trail protection provides end-to-end protection of higher order or lower order paths by means of a trail protection sub-layer. The trail termination function is expanded to form the trail protection sub-layer. In the VC trail protection schemes the detection of failure events is performed by the path termination function and the resultant reconfiguration uses the protection matrix that is located in the protection sub-layer. This reconfiguration can involve protection switching in multiple SDH network elements. The co-ordination of such switching in multiple SDH network elements is by means of an automatic protection switch (APS) protocol.

Multi-Layer Network Restoration

The Internet Protocol is becoming dominant in the network layer. The current ATM layer overlays the SDH layer and a WDM or photonic network layer is frequently found below the SDH layer. Therefore we are placed in front of a network that may count up to 4 layers: IP/ATM/SDH/WDM (fig. 1). All of these layers may provide restoration. If restoration systems are applied to all layers independently, network structure and resources become redundant, and cost effectiveness is impossible [4].
To choose the most appropriate layer for restoration, the trade-offs (fig. 2) existing between higher and lower layer restoration must be considered. It is also possible to achieve non-redundant resource utilisation with multiple layer restoration by linking the restoration schemes of each layer. This technique is called escalation. One can distinguish between layer, sub-network, and scheme escalation.

Protection Provided by the Optical Layer (Layer 1)

Numerous optical architectures, based on wavelength routing, have been conceived for the introduction and development of an optical transmission network layer. The protection of optical rings has already been elaborated in detail and therefore this type of optical architecture seems to be more mature than optical mesh architectures. A very complete and detailed description of optical architectures can be found in [5].
The two principal methods of having protection in an optical network, namely in the OCH layer and in the OMS-section layer, are illustrated in figure 3.

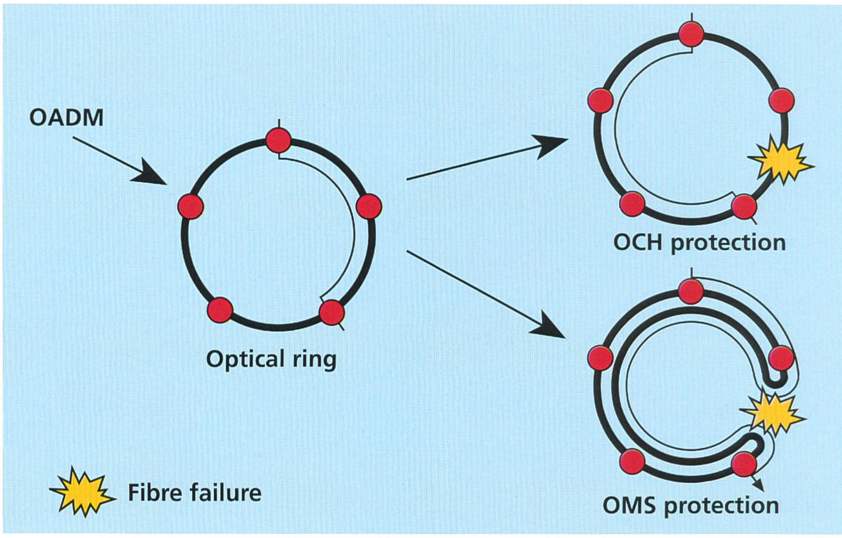

Fig. 3. Optical channel protection and optical multiplex-section protection.

- OCH protection means that in case of a failure the affected channels (only the ones that are protected) are automatically switched over to pre-assigned protection channels.
- OMS protection means that the whole affected OMS (with all the optical channels it is carrying) is automatically switched over to a different pre-assigned route.

Notice the equivalence between the two optical protection methods, and the SDH sub-network-connection protection and the SDH MS protection, respectively.

Protection in Integrated Switching-Transmission Networks (Layer 2/3)

Protection Based on SDH Interfaces

When data equipment offers Automatic Protection Switching (APS), this functionality is usually provided by SDH interfaces, as is the case for Packet over SDH and most ATM interfaces (ATM over SDH). In 1+1 architecture, a protect interface is paired with each working interface. The same signal payload is sent to the working and protect interfaces. The working and protect circuits may terminate in two ports of the same adapter card or in different adapter cards in the same router/switch or in two different routers/switches. When correctly implemented in data equipment, the functionality and performance of APS in integrated switching-transmission networks should be identical to that of SDH network. However, as data manufacturers tend to implement only a "light" version of SDH, the full functionality is either not offered or only when data systems are connected over a conventional SDH network.

Protection Provided by the ATM Layer

ATM Protection Switching is described in COM 13-41-E which is the draft of the

Abbreviations

ADM	Add-Drop Multiplexer
APS	Automatic Protection Switching
CoS	Classes of Service
DiffServ	Differentiated Services
DPT	Dynamic Packet Transport
IPS	Intelligent Protection Switching
MS-SPRing	Multiplex-Section Shared Protection Ring
NE	Network Element
OAM	Operation Administration and Maintenance
PNNI	Private Network to Network Interface
POS	Packet over SONET/SDH
QoS	Quality of Service
RED	Random Early Detection
SNCP	Sub-Network Connection Protection
VCG	Virtual Channel Group
VPG	Virtual Path Group
WRED	Weighted Random Early Detection

References

[1] Tai H. Noh, "ATM Scenarios for SDH/SONET Networks", Bell Labs Technical Journal, January-March 1998, pp.81–93

[2] ITU-T Recommendation G.841, "Types and Characteristics of SDH Network Protection Architectures", July 1995.

[3] EURESCOM Project P409, "Protection, Performance and Synchronisation of pan-European SDH Networks", Deliverable 1: Types and characteristics of protection in SDH networks, August 1995

[4] Ryutaro Kawamura, "Architectures for ATM Network Survivability", IEEE Communications Surveys, Fourth Quarter 1998, Vol.1 No. 1, pp. 2–11.

[5] EURESCOM Project P615, "Evolution towards an Optical Network Layer", Deliverable 1: Understanding Optical network Architectures, August 98.

[6] www.data.com/lab_tests/brains.html

[7] "Dynamic Packet transport Technology and Application Overview", White Paper, Cisco Systems, Inc., 1999

[8] "Reconstructing Core Transmission Networks Using ATM, SONET and DWDM", White Paper, Ascend Communications, September 1998.

future I.630 recommendation of the ITU. It will provide the architectures and mechanisms of ATM VP/VC protection switching and ATM VP group protection switching.
With individual VP/VC protection, the bandwidth necessary for protection can be reduced, because only the part of VPs/VCs needing high reliability is protected and the rest of the VPs/VCs remain unprotected. This protection scheme can be used for protection against ATM layer defects and physical layer defects, although application for protection against only physical layer defects is also possible.

With VPG/VCG protection, fast protection switching (on the order of SDH layer protection switching completion times) is obtained through the treatment of a logical bundle of VP/VC network and/or sub-network connections as a single entity of VPG/VCG after the commencement of protection actions. Although VPG/VCG protection aims primarily to protection against physical layer defect, it can also be used for protection against ATM layer defects. One possible protection concept involves the use of VPG/VCG protection for protection against physical layer defects in conjunction with VP/VC protection for protection against ATM layer defects.
An ATM network using the PNNI protocol can also re-route traffic around broken links. Although this is a fast restoration scheme, the information necessary for the re-routing is maintained by the PNNI protocol and the management system doesn't have to intervene. The time that is necessary to re-establish the connection, measured from the number of lost cells, depends on the implementation, but can be clearly below 50 ms [6].

Protection Provided by the IP Layer
IP manufacturers also work to fit their routers with fast restoration mechanisms. Intelligent Protection Switching (IPS) in rings based on the Dynamic Packet Transport Technology (DPT) shall provide [7]:
- Proactive performance monitoring and fault detection and isolation via the SONET/SDH overhead bytes
- 50 ms self-healing via ring wrapping after layer 1 fault/event detection.
- Protection switching hierarchy for cases of multiple concurrent faults/events.

Cost Saving Opportunities

Suppliers of multi-service switches claim cost savings of up to 70% for integrated compared to non-integrated switching-

Zusammenfassung

SDH: Ein Muss, Luxus oder Komplikation?

Immer mehr Hersteller bieten heute Übertragungsausrüstungen mit sogenannter Packet over SONET/SDH (POS) Technologie an. Die dabei vorgeschlagenen Architekturen verbinden die IP Router oder ATM Switches direkt über sogenannte Dark Fibers oder WDM-Systeme miteinander. Was bedeutet dies für die bisher bewährte SDH Technologie? Ist sie überflüssig geworden und sollten Investitionen möglichst zurückgestellt werden? Oder wird SDH noch einige Jahre gute Dienste leisten?
Es gibt heute keine eindeutige Antwort darauf. Insbesondere ist das Vorhandensein eines bereits bestehenden SDH Netzes ein gewichtiger Faktor, der beim Entscheid für den Einsatz einer schlüsselfertigen POS Implementierung berücksichtigt werden muss.
Obschon die installierte SDH Basis nicht für Datentransport optimiert ist, werden heutige Generationen von IP/WDM oder ATM/WDM Systemen mit SDH Schnittstellen ausgerüstet. Und dies wird so bald nicht ändern. Der Schlüssel zum Erfolg liegt in der Integration des SDH Management in dasjenige für die anderen Schichten. So wird SDH ein Teil von einem Gesamtsystem für Datenübertragung. Die heutige Rolle als Transportnetz wird in Zukunft mehr und mehr durch die optische Schicht übernommen, deren Bandbreitengranularität den zukünftigen Verkehrsprofilen für Datenübertragung viel besser angepasst ist.
Zusammenfassend ist SDH heute immer noch ein Muss, aber eigenständiges SDH Management bringt Komplikationen und verschliesst Chancen für Vereinfachungen.

transmission solutions. They claim even higher cost savings in service provisioning and network maintenance.
Cost savings are mainly due to reduced investments and operations costs. To use less boxes implies less operations and maintenance costs for the various platforms. And this means less people and thus lower costs to operate the network.

Conclusions

SDH framing will still be used for some years because it allows the efficient transport of OAM overhead information. However, SDH protection features can now be replaced by protection in the optical network layer or/and in the ATM layer and restoration in the ATM or IP layers. They can also be integrated into IP or ATM equipment through their SDH interfaces. Thus SDH is not absolutely necessary anymore for protection. Integrated switching-transmission equipment offer a better bandwidth efficiency for data and their suppliers claim that they are cheaper to buy (up to 70%) and to operate.
Should we abandon SDH immediately? We don't think that such a decision is needed now because a smooth evolution path is permitted by the introduction of WDM. Indeed, WDM allows the allocation of some wavelengths to the legacy SDH network, thus preserving the invested capital and other wavelengths to the new integrated switching-transmission systems, taking advantage of their better bandwidth utilisation and easier service provisioning.
In the future, the basis of the transport network will not be a SDH network, but a WDM-based optical layer. This optical infrastructure will be shared by IP, ATM and SDH and their relative importance will be dictated by the transported services. 9.4

Jean-Claude Bischoff *has a diploma in Electrical Engineering from the Swiss Federal Institute of Technology in Lausanne (EPFL, 1982). After a stay as visiting research engineer at Bell Communications Research (N.J., 1986-87), he returned to EPFL where he obtained a Ph.D for his work on high-speed opto-electronic devices (1988). Jean-Claude then worked as scientific collaborator at EPFL and as research engineer at Rolex (Geneva) before joining Swisscom in 1991. Since then he has been active in the domains of optical-fibre characterisation and broadband networks, especially ATM, and is now mainly involved in the EURESCOM project P918, "Integration of IP over Optical Networks: networking and management".*

Neuer Impuls für Galliumarsenidchips?

Die Bell Laboratories von Lucent Technologies berichten über einen Durchbruch bei der Realisierung sehr dünner Oxidschichten auf GaAs-Substraten. Mithilfe von Molekularstrahl-Epitaxie hat man auf GaAs extrem dünne Schichten aus Gadoliniumoxid realisiert, einem Element aus der Gruppe der Seltenerdmetalle. Das Element mit der Ordnungszahl 64 ist in der Physik und Hochfrequenztechnik nicht unbekannt. Die Entdeckung der Bell-Forscher kam sehr überraschend, weil Verbindungen mit Gadoliniumoxid keinerlei Strukturähnlichkeiten mit Galliumarsenid haben. Man rechnet nun damit, dass auch in GaAs ähnlich feine Strukturen realisiert werden können wie bei künftigen Siliziumschaltkreisen.

AT&T Bell Laboratories
Media Relations, 600 Mountain Ave
Murray Hill, NJ 07974
Tel. +1-908-582 4760
Fax +1-908-582 4552

Japan Electronic Show vom 5. bis 9. September 1999

Die diesjährige Japan Electronic Show findet von Dienstag, 5. September bis Samstag, 9. September 1999 in der Makuhari-Messe, Nippon Convention Center in Chiba statt. Die Show ist traditionellerweise breit angelegt und auch für das normale Publikum ein Anziehungspunkt. Wenn es überhaupt thematische Schwerpunkte gibt, dann eher in der verbrauchernahen Elektronik. Für den ausländischen Besucher ist in vielen Fällen lästig, dass die Hälfte der Exponate nur in japanischer Schrift ausgezeichnet sind.

Japan Electronics Show Association (JESA)
Homepage: http://www.jesa.or.jp

IBM baut Muster des PowerPC-Chips mit Röntgenlithografie

Die Diskussion um die «richtige» Lithografie für künftige Chipstrukturen ≤ 130 nm hält unvermindert an. Für den Bereich zwischen 130 nm und 100 nm plädiert eine Mehrheit nach wie vor für die Röntgenlithografie, die vielerorts über den langen Zeitraum von mehr als zehn Jahren verfolgt wurde. Die IBM Corp., die in East Fishkill (US-Bundesstaat New York) über eine entsprechende Röntgenquelle verfügt, hat jetzt versuchsweise verschiedene Speicherchips und den PowerPC 604e in Röntgentechnologie belichtet, um die Machbarkeit zu beweisen. Für den Lithografiebereich unter 100 nm gelten heute aber andere Verfahren als Favoriten, wie beispielsweise EUV oder das von den Bell Labs entwickelte SCALPEL.

IBM Corp.
Old Orchard Road
Armonk NY 10504, USA
Tel. +1-914-765 6630
Fax +1-914-765 5099