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C1. LSI for Telecommunications

Video codec LSIs: Realtime MPEG2 encoder chip-sets which realize single-board encoder systems for PC use have been developed. One of these has achieved a processing capability for MP@ML with 6 LSIs and 5 DRAMs, which includes an exhaustive motion estimation LSI with a 16x8 search range [Matsumura et al., 1995]. Another has achieved an SP@ML capability with only 2 LSIs and 2 DRAMs by using a hierarchical telescopic search algorithm which provides a 32x32 search range in small silicon area and low power consumption [Suguri et al., 1996].

Wireless access chips: There are strong movements toward compact and low-power dissipation handsets for digital cellular and personal handy-phone system. A 1.9 GHz Si-bipolar receiver with no intermediate frequency (direct conversion), which is suitable for compact handsets, has been developed [Takahashi et al., 1995]. To achieve low power dissipation, very low power supply voltage of 2 V for 2 GHz quadrature modulator IC has also been reported [Tsukahara et al., 1994]. In order to integrate bypass capacitors in the GaAs RF-IC, on-chip ferroelectric capacitors of barium strontium titanate (e=300) were used [Nagata et al., 1993].

Gb/s transmission chips: Compact 10-Gb/s optical transmitter and receiver circuit packs were developed using GaAs MESFET ICs [Kobayashi et al., 1994] and Si bipolar ICs [Noda et al., 1995]. Test chips for 40-GHz baseband amplifier [Sano et al., 1994] and 40-Gb/s D-F/F [Kuriyama et al., 1994] using AlGaAs/GaAs HBTs were reported. A 60-GHz-bandwidth distributed baseband amplifier module [Shibata et al., 1994] and 90-GHz amplifier IC [Kimura et al., 1995] using InP HEMTs were reported.

ATM switch LSIs: A 320 Gb/s ATM switching system using multilayer copper-polyimide MCM and Si bipolar LSI technologies were developed [Yamanaka et al., 1995]. A 5.6 Gb/s 2x2 BiCMOS ATM switch LSI [Nishikido et al., 1993] and a 20 Gb/s 2x2 GaAs MESFET chip set [Hino et al., 1995] using optical interconnection were reported.

Low voltage LSI technology: Multi-threshold CMOS (MTCMOS) technique, which use two sets of threshold-voltage levels, has been proposed for low voltage baseband LSI's [Mutoh et al. 1993]. Using this technique and an embedded processor for efficient power management, a 1 V DSP LSI achieved 26 MOPS and 1.1 mW/MOPS performance in battery-driven mobile phone equipment [Mutoh et al., 1996]. Instead of additional threshold-voltage process, another concept, called variable-threshold-voltage scheme, has been proposed. This concept is that a substrate bias is variable during stand-by and in active mode [Kuroda et al., 1996]. A/D and D/A converters using swing-suppression noise-shaping scheme performed very well to improve the S/N ratio when operating with a 1-V power supply [Matsuya et al., 1994].

(Y. Sakai)

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C2. Digital Signal Processing
Digital filter design methodologies from one to three dimensions have been an active research area. A design method for 3-dimensional FIR filters was proposed by using McClellean transformation [Yoshida et al., 1993]. A design method of IIR digital filters was proposed by using all pass networks [Ikehara et al., 1994]. A design method of 3-dimensional separable denominator digital filters was proposed by using minimal decomposition [Hinamoto et al., 1994]. A design method of 2-dimensional maximally-flat diamond shaped half-band FIR filters was proposed [Inui et al., 1994]. An optimal design method of separable denominator 2-dimensional digital filter was proposed based on genetic algorithm [Kawamata et al., 1995].

In the fields of spectral estimation, an adaptive ARMA four-line lattice filter was proposed for spectral estimation with frequency weighting [Haseyama et al. 1993]. A two dimensional line spectrum estimator by polar coordinate AR models was derived [Sakurai et al., 1993].

Some major developments in adaptive signal processing have been also observed. A fast convergent algorithm for adaptive FIR filters with sparse taps was proposed [Sugiyama et al., 1994]. A unifying treatment of general gradient ADF and convergent analysis was given [Chao et al., 1995a] and a stable and globally convergent IIR ADF was also proposed [Chao et al., 1995b]. An adaptive algorithm based on nonuniform resolution filter was proposed [Naito et al., 1995].

Multirate signal processing techniques also continued to be an active research area. A design of 2-dimensional perfect reconstruction filter banks for arbitrary sampling lattice was proposed [Ikehara et al., 1993]. A simple design method of Perfect Reconstruction QMF banks was proposed [Kurosawa et al., 1994]. An over sampling subband adaptive digital filter with rational decimation ratios was proposed [Kiya et al., 1994].

Some real valued decimation in time and decimation in frequency algorithms were proposed and sampling rate conversion systems was proposed by using a new generalized form of DFT [Murakami 1994,1995]. A design method of nonuniform division multirate FIR filter banks was proposed [Wada 1995].

In the fields of nonlinear signal processing, a median type fuzzy filter and its optimum design were proposed [Arakawa et al., 1992]. A 2-dimensional neural hybrid filter was proposed for image processing [Muneyasu et al., 1993]. A multidimensional isomorphic operator was proposed, which exactly relates two multidimensional signal spaces of finite support where finite convolution and and usual addition, respectively, are defined as binomial operations [Yamada et al., 1994].

In the fields of fundamental theory of digital signal processing, the optimum approximation of multidimensional signals was proposed based on the quantized sample values of transformed signals [Kida, 1995]. A multidimensional phase unwrapping algorithm that computes zero distribution of complex polynomials was proposed [Yamada et al., 1995a]. A global optimization technique was proposed based on excluding hyperspheres [Yamada et al., 1995b].

It should be emphasized that numerous works have been intended to improve soft ware environment for signal processor. A new DSP compiler was proposed for matrix and vector expressions with automatic computational ordering [Sugino et al., 1995].

(S. Tsujii)

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C3. Optical Signal Processing

In the field of optical fiber transmission, optical signal processing such as optical time-division multiplexing (TDM) has been developed as practical technologies for next generation multi-ten Gbit/s systems. A simple optical-TDM demultiplexing technology using an electro-absorption modulator has been demonstrated in a 20 Gbit/s, 11,500 km soliton transmission experiment [Suzuki et al., 1995]. All optical multi/demultiplexing and timing extraction technologies have been studied for short-haul 100 Gbit/s transmission systems [Kawanishi et al., 1995]; those include an optical timing extraction phase-lock-loop technology using optical four-wave-mixing (FWM) in a traveling-wave laser-diode amplifier [Kamatani et al., 1994] and an optical demultiplexing technology using FWM in a polarization-maintaining fiber loop [Morioka et al., 1994].

Optical TDM is also an important optical signal processing technology as well as frequency- or wavelength-division multiplexing (FDM or WDM) in cross-connecting systems for optical network. Demultiplexing and routing of a 5.24 Gbit/s 2 channel TDM signal has been achieved by using FWM in a dispersion-sifted fiber and a wavelength router consisting of optical circulators and fiber gratings [Yamamoto et al., 1995]. Optical FDM technologies have been studied for cross-connects [Sato, 1994] and add/drop multiplexing (ADM) [Oda et al., 1993], both of which are key technologies to site and to distribute the optical paths between access nodes in optical network.

In switching systems, photonics may not be able to replace electronics within one or two decades. As an approach to utilize the advantage of photonics, space-division switching networks can be used for rearranging optical interconnections among the electronic function blocks. A strictly nonblocking 16x16 matrix switch using silica based planar waveguides have been developed for such switching networks [Okuno et al., 1994]. Many studies to develop all-optical switching devices have been continuing for approaching to future photonic switching. Recently, all-optical picosecond full switching has been achieved with the use of spin relaxation in a quantum well etalon [Nishikawa et al., 1995].

In the field of optical computing, massively parallel processing (MPP) technologies have been extensively studied because of recent needs for image processing. Massive optical
interconnections with 64 optical channels for interconnecting 64 processing elements has been developed as an approach to MPP [Araki et al., 1995]. A new type of reconfigurable space-variant interconnections between arbitrary processors using binary computer-generated hologram has been proposed and experimentally investigated [Ishida et al., 1995]. Optical neural computing is also of great interest in terms of MPP for image processors. An optical learning neurochip with internal analog memory, consisting of 2-D variable-sensitivity photodiodes array vertically integrated on a one-dimensional LED array, has been fabricated and its capability of parallel processing in vector-matrix-operations has been demonstrated [Nitta et al., 1993]. An artificial retina chip has also been made of a 128x128 array of variable-sensitivity photodetectors and its application for image processing with arbitrary two-dimensional filters has been demonstrated [Funatsu et al., 1995].

(K. Amano)

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C4. Circuits and Systems

Studies on circuits and systems have been very active in Japan also in these three years. The most remarkable activity was seen in the study of nonlinear theory and its applications. A large part of the recent results of this field can be found in the proceedings of the Symposium on Nonlinear Theory and its Applications (abbreviated as NOLTA), which has been held annually and was held in Hawaii (1993) and Las Vegas (1995) as a very large international symposium. Several hundreds researchers from many countries have attended the NOLTA Symposium every year. Also, the Joint Technical Conference on Circuits/Systems, Computers and Communications (JTC-CSCC) and the Karuizawa Workshop on Circuits and Systems continued to be held annually, and a lot of fruitful discussions were made there.

Related to nonlinear circuits, the study on chaos and periodic oscillation has been very active, and many researchers have studied this problem. It is known that asymmetric Lienard's equation can have more than one periodic solution. The problem of finding the maximum number of such solutions is known as a special case of Hilbert's sixteenth problem. This important problem was solved by T. Koga [Koga et al., 1993]. Also, chaotic dynamics observed from a widely used second-order phase-locked loops was studied [Endo et al., 1993], and some qualitative properties of an inductively coupled circuit containing two Josephson junction elements with a dc source were investigated [Ueta and Kawakami, 1994]. Statistical properties of chaotic binary sequences generated by Chebyshev maps was discussed, and an important role of the Perron-Frobenius operator in evaluating statistics of chaos by means of the ensemble-average technique was confirmed [Kohda et al., 1994]. A simple algorithm for the deterministic nonlinear prediction of chaotic time series with noise was proposed [Ikeguchi and Aihara, 1995]. Also, synchronization phenomena in oscillators coupled by one resistor was discussed [Moro et al., 1995].

The study on self-validating numerical methods and interval analysis is one of the most remarkable topics in the past three years. A numerical validation method for nonlinear equations using interval analysis was proposed, and a practical system for finding solutions with guaranteed accuracy was developed [Kashiwagi and Oishi, 1994]. It was shown that the nondeterministic operator theory developed by K. Horiuchi and the theory for nonlinear boundary value problems developed by M. Urabe have deep relationship with the interval analysis, and these theories suggest future directions of the interval analysis and the self-validating numerics [Oishi, 1994]. Also, based on the Horiuchi's theory, a mathematical theory of system fluctuations using a new concept of the fuzzy mapping was developed, and some applications including the generalization of the fail-safe principle and the sensitivity analysis were shown [Horiuchi and Endo, 1993, 1994].

In relation to LSI simulation, the study on the homotopy method has been developed remarkably in Japan, both in theory and in application. A simple algorithm using hyperspheres was proposed, which is easily implemented on the current circuit simulators such as SPICE [Yamamura, 1993a]. Using this algorithm, the homotopy method was realized in practical LSI simulation, and more than 20,000-dimensional modified nodal equations describing a bipolar
analog circuit have been solved efficiently by the spherical-type homotopy method [Inoue, 1994]. Also, a priori estimation was presented for a computational complexity of the homotopy method applying to a certain class of strongly monotone nonlinear equations [Makino et al., 1993].

The study on the number of solutions of nonlinear resistive circuits and the algorithms for finding all the solutions is a very important problem in circuits and systems. Related to this problem, the necessary and sufficient conditions were given for the basic equation of nonlinear resistive circuits containing ideal diodes to have a unique solution [Nishi and Kawane, 1993], and the number of solutions of a class of nonlinear equations related to neural networks with tapered connections was discussed [Nishi et al., 1995]. Also, efficient algorithms have been developed for finding all solutions of piecewise-linear resistive circuits [Yamamura, 1993b].

The study on neural networks have also been very active. A middle-mapping learning algorithm for cellular neural networks was proposed [Ushida et al., 1994], and highly parallel analog image coding and decoding by cellular neural networks was described [Tanaka et al., 1994]. A systematic synthesizing method to realize the parallel binary image-thinning algorithm by a discrete-time cellular neural network was proposed [Mori et al., 1994]. The mathematical programming formulation for neural combinatorial optimization algorithms was studied [Urahama, 1995]. Also, fully connected recurrent neural networks were investigated for blind separation of sources [Amari et al., 1995].

In relation to the problem of diagnosis of deviation faults in linear analog circuits, it is an important problem to check the unique determinability of the element-values in a given linear analog circuit from the node-voltage measurements at its accessible nodes. For this problem, many excellent results have been derived [Shinoda et al., 1994]. Also, the problem of obtaining an optimal file transfer on a file transmission net is discussed [Kaneko et al., 1995], and the universal graphs for graphs with bounded path-width is considered [Takahashi et al., 1995].

(K. Horiuchi and K. Yamamura)

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C5. Information Theory

In the area of Shannon Theory, significant advances on the derivation of the capacity of Gaussian channels with feedback are worthwhile mentioning. A general formula for mentioning has been derived in [Yanagi, 1995]. A general formula for channel capacity has been derived in [Verdu et al., 1994].

Research in source coding and universal coding are very much active. Research work on Lempel-Ziv codes, as well as on universal coding [Oohama, 1994] has been reported. Data compression for fractal sets is a new and promising area.

Error control coding is still one of the most active research areas in information theory. Code constructions for channels with unidirectional errors [Saitoh et al., 1993] and byte-oriented memory systems [Fujiwara at al., 1994] have been accomplished. A general decoding algorithm for Reed-Solomon (RS) codes was presented in Morii et al. [1992], which may be useful in implementing fast decoders for RS codes. A new Viterbi algorithm for efficient implementation of convolutional coded ARQ systems has been introduced [Hashimoto, 1993]. A new construction of orthogonal sequences, reported in Kirimoto et al. [1994], may have important consequences in designing spread spectrum systems. A new fast algorithm for joint equalization and channel estimation was introduced. The milestone paper [Kamabe, 1994] presents new theoretical results for designing good spectral null codes, which are useful for digital recording on constrained channels. The trellis structure of linear block codes is now very well understood [Kasami et al., 1993], and relatively low complexity soft-decision decoding algorithms for linear block codes have been introduced [Takata et al., 1993].

Cryptography and its applications to information security are active research areas in information theory. There has been a great deal of progress in linear cryptanalytic methods for DES-like block ciphers. In particular, powerful methods for known-plaintext attack of DES have been presented [Matsui, 1993]. And the first experimental attack using twelve computers was carried out. As a result, the full 16-round DES was broken in fifty days based on the condition that random plaintexts and their ciphertexts must be available [Matsui, 1994]. Search algorithms for the best linear expression on the linear cryptanalysis were improved [Ohta et al., 1995]. The required time was decreased from over three months to only about two and a half days. Fast RSA-type public-key schemes were also proposed [Koyama, 1995]. Their decryption speed is about 2.0 times faster than the RSA scheme. The author claims that breaking the proposed schemes is computationally equivalent to breaking the RSA scheme.

(H. Imai)

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C6. Spread Spectrum Technology

In a SS (spread spectrum) technology, CDMA (code division multiple access) systems and many techniques involving CDMA have been actively studied and many papers have been presented. Especially, great interest has been focused on DS (direct sequence)/CDMA cellular systems, which apply CDMA to land mobile communications.

Most actively studied are co-channel interference cancellation techniques because they can greatly increase the channel capacity of a CDMA system. Many techniques have been proposed that use, among others, an DS/CDMA adaptive interference canceller [Yoshida, 1994], interference cancellation using radio channel estimation [Fukasawa, 1994], orthogonalizing matched filter detection [Fukawa, 1994], a DS-FH CDMA with interference cancelling [Tomisato, 1994] and M-ary SS with interference cancellation techniques [Tachikawa, 1993].
Multiuser detection techniques for removing co-channel interference are also active research subjects for the DS/CDMA system. The many studies encompass joint decorrelating multiuser detection [Kawahara, 1995], multiuser detection using a neural network [Miyajima, 1993] and multi-user receiver with an array antenna [Kohno, 1995].

Active study is under way on RAKE combining and diversity techniques to improve BER performance over land mobile radio channels. Papers cover such topics as coherent detection and RAKE [Higashi, 1995], path diversity based on path selection [Moriyama, 1994] and coherent detection with a pilot channel [Abeta, 1994].

Other techniques relating to SS such as synchronization, FH (frequency hopping), and modulation/demodulation schemes, are still very popular research subjects. Various kinds of interesting papers have been presented. Among them are discussions of a delay lock loop for mobile communications [Takeuchi, 1993], an MFSK/FH-SSMA system [Mabuchi, 1993], an SS system for selective fading [Miyatani, 1994], and SS pulse position modulation [Okazaki, 1993]. In addition, a variety of subjects were studied as basic research.

For the practical use of SS systems, studies about CDMA cellular systems, SS modem implementation, and field experimentation on SS systems are very important. Great progress has been made in CDMA cellular systems shown in studies on wideband coherent DS-CDMA [Ohno, 1995] and CDMA/TDD cellular systems [Hayashi, 1995]. The many papers relating to implementation and experimentation of a demodulator that uses a SAW correlator [Nakase, 1994], and field testing of an SS land mobile satellite [Ikegami, 1993].

(S. Sasaoka)

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C7. Radio Communications

C7.1. Satellite Communications

(1) Domestic Satellite Communication

An advanced satellite communication system, DYANET-II, was integrated into a terrestrial ISDN and transportable earth station serving subscribers in the network [Otsu et al., 1995]. The damage to telecommunications facilities by the Hanshin-Awaji earthquake disaster that occurred on January 17, 1995. NTT used its nationwide resources to tackle recovery from this major disaster [Takei et al., 1995]. The Japanese national satellite, ETS-VI, was launched in 1994, where NTT's newly developed Ka-band fixed and S-band mobile multibeam transponders and
antennas have been confirmed to be operating and verified for space use [Sakamoto et al., 1996]. One of the largest communication satellite, N-STAR, was launched in 1995. It covers S-, C-, Ku- and Ka-band single beam and Ka-band multibeam systems. [Nakagawa et al., 1995]

(S. Samejima)

(2) International Satellite Communications

In recent three years, development study of several personal communications systems using non-geostationary satellites has been proceeded to meet demand of mobile communication via small, low power handsets.

Network architectures, and location determination and registration methods for handheld terminals of communications systems with medium earth orbit (MEO) satellites are investigated [Araki et al., 1993]. A gateway earth station (GES) assignment method, which is one of important networking issues associated with ICO (Intermediate Circular Orbit) and LEO (Low Earth Orbit) systems is described. One is the "time-independent service area", and the other is the "time-dependent service area". A GES assignment method making use of advantageous features obtained by adopting the time-dependent service areas are proposed [Araki and Shinonaga, 1994, 1995]. Interference characteristics between a non-GSO MSS gateway station and a GSO FSS earth station, under the implementation of reverse band operation is described [Kobayashi et al., 1995a]. The present and future mobile satellite communications focusing on Inmarsat standard systems as existing systems and Inmarsat-P personal satellite system using non-geostationary orbiting satellites as the future systems are reviewed [Kobayashi et al., 1995b]. A novel position determination method suitable for personal satellite communication systems using non-GSO orbiting satellites is proposed. The proposed method has a capability to provide the higher position accuracy by using one non-GSO satellite [Ishikawa et al., 1995].

A Ku-band Ultra Small Aperture Terminal (USAT) network offering various kinds of multimedia communications services are considered. As the key technologies for the realization of the USAT system, low sidelobe simple antenna which meets ITU-R recommendations, carrier power spectrum density reduction technique for suppressing interference level toward the adjacent satellite systems, and an efficient multiple access method are proposed [Inoue et al., 1995].

The use of enhanced digital video coding and FEC technique is an effective way to reduce the size of transportable terminal for satellite news gathering (SNG) transmission services. To achieve a high link availability, an information and FEC coding rate control scheme is proposed. This scheme selects an appropriate information and FEC coding rates, referring to the monitored link condition. An outline of the developed SNG transmission system and its experimental results by using existing domestic Ku-band satellite transponder is described [Inoue et al., 1994].

A hierarchical network architecture is proposed to perform a satellite-based data distribution to a vast number of receive-only user stations reliably and effectively. The network consists of one hub station and several regional host stations each of which manages data transmission and user information, respectively. The network also employs terrestrial lines for a receipt acknowledgment procedure between the user and regional host stations, and the regional host and the hub [Nohara et al., 1995].

A new type of optically controlled BFN (beam forming network) is proposed. The experimental results show the feasibility of utilizing an electro-optic BFN in future advanced microwave and millimeter-wave array systems [Kamiya et al., 1995].
(T. Shiokawa)

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(2) International Satellite Communications


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C7.2. Terrestrial Radio Communication

High transmission quality of non-regenerative repeating digital radio systems has been proven through a field trial [Watanabe et al., 1992]. It has paved the way to a broadband non-regenerative repeating digital radio that performance of a common control broadband combiner was theoretically and experimentally confirmed [Kagami et al., 1994].

Based on the results of field trials over a four-year period, a new 26 GHz microwave system with an increased rain attenuation margin was developed in order to realize almost outage-free access links [Manabe et al., 1993].

Recently in the field of modulation techniques, a fully digitized modulator for multi-level modulation up to 256 QAM has been applied to high capacity transmission over 10 Mbaud [Shirato et al., 1992]. Also attractive techniques have been reported on a new digitized group modulator for handling multi-carriers [Yamada et al., 1994] or modified symbol-rate-increased trellis coded modulation [Tanaka et al., 1993].

(A. Hashimoto)

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C7.3. Terrestrial Mobile Communications

Personal Communication Systems (PCS) have been developing. Many papers concerning PCS are reported. One of the remarkable topics is practical use of Personal Handy Phone System (PHS). PHS is introduced as one of the advanced PCS [Ishikawa, 1995; Hattori, 1995] and a high-speed data communication on the PHS is proposed [Takanashi et al., 1995].

CDMA system is very hot research field. For example, wideband system [Ohno et al., 1995], transmitter power control [Kudoh, 1993], path diversity [Esmailzadeh et al., 1993], interference canceller [Yoshida et al., 1994] are explored. There are many papers of equalizers which are mainly based on both DFE [Ishikawa, 1994] and MLSE [Kubo, 1994] schemes. In their application, interference cancellers [Yoshino, 1994] are investigated.

In control techniques, the papers concerned with dynamic channel assignment method [Furukawa et al., 1993], handoff algorithm [Kinoshita et al., 1993] and signaling protocol [Hirata et al., 1993] are mainly investigated.

In propagation and antennas, propagation loss and delay characteristics for digital mobile systems and personal communication systems have been very actively studied. Especially, in microcellular systems, many papers concerned with delay spread characteristics [Taga et al., 1995] and bidirectional base station antennas [Hori et al., 1995] are presented. Wideband propagation models [Iwai et al., 1993; Kozono, 1994; Yamaguchi et al., 1995] for the next generation multi-media personal communication systems are also actively discussed.

Mobile and personal terminals including modems, synchronization controllers, voice codecs and LSI implementation are actively studied and developed. Typical topics are the one-chip baseband LSI for PHS terminals [Kato, 1994] and the half-rate PDC system [Satoh, 1995].

(T. Hattori)

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C8. Optical Fiber Communications

A high-speed fiber transmission system for STM-64/10 Gbps was developed for a commercial use. Its application fields and technologies [Hagimoto et al., 1992], and the design philosophy for the linear-repeaters (fiber-amplifiers) system [Kobayashi et al., 1994] was discussed in details based on the SDH hierarchy. The system were reported in general [Nakagawa et al., 1995]. The 10 Gbps submarine system was also developed for a commercial use [Murakami et al., 1995].
The high-bitrate transmission experiments were conducted in another method of WDM technology for 16 wavelengths [Oda et al., 1995], and 128 wavelengths [Oda et al., 1995]. Nonlinear technologies were on trial introduced into submarine system experiments [Edagawa et al., 1995].

For the higher bitrate, sub-terabit transmission experiments were reported for 200 Gbps [Kawanishi et al., 1995], and 400 Gbps [Morioka et al., 1995a]. The systems were composed of some new key-elements cleverly adopting nonlinear effects. Light source [Takara et al., 1995], pulse generator [Morioka et al., 1994], optical DEMUX [Morioka et al., 1995b], clock recovery circuit [Kawanishi et al., 1993], and optical sampling [Takara et al., 1994] were reported.

Path layer technologies will play a key role in future B-ISDN. A new technology, optical paths, was proposed [Sato et al., 1993]. The optical path concept exploits and consolidates the layered transport network architecture, WDM transmission and wavelength routing technologies. A new optical path cross-connect system architecture was proposed [Watanabe et al., 1994]. The architecture has various advantages like the maximum commonality with WP and VWP (Wavelength/Virtual Wavelength Path). A very effective novel WP/VWP accommodation design algorithms were proposed [Nagatsu et al., 1995].

Network reliability is a basic requirement for high-speed optical fiber communication systems. An ATM VP-based Self-Healing Ring (VP-SHR) of 2.4 Gbps optical access networks was developed [Kajiyama et al., 1994]. An Optical Path based Self-Healing Ring (OP-SHR) was proposed [Tokura et al., 1995].

Many other experiments were attempted for pulsed lightwave frequency supply [Nakagawa et al., 1994], optical ADM filter [Toba et al., 1994], photonic cross-connect system [Matsumoto et al., 1994], and optical duobinary transmission for dispersion/scattering tolerance [Yonenaga et al., 1995].

In an access network, many experiments and introduction trials have led the systems to modernization based on fiber and photonic technologies. The compendium were reported [Miki et al., 1994]. One of the most important technologies in the field may be an ATM-PON [Kanada et al., 1993].

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C9. Communication Networks

The advent of browser software to handle World-Wide Web (WWW) services has brought a surge of users to the narrow-band integrated services digital network (N-ISDN) in Japan. Broad-band ISDN (B-ISDN) services were visualized in the field trials (Joint Utilization Tests of Multimedia Communications) from 1994 through 1995 in cooperation with leading enterprises. The following are the underlying technologies for the above potential users in forthcoming multimedia worlds to enjoy convenient and comfortable network services.

- Asynchronous transfer mode (ATM) specifications for network elements
- Network architecture
- Network integration
- Network and service management
- Evolution strategy towards multimedia networks

ATM technology is an intrinsic part of B-ISDN, and a wide variety of ATM studies have been reported: network planning [Yoshida and Okazaki, 1993], ATM node and link systems [Aoyama et al., 1993; Koinuma and Takahashi, 1994; Tokizawa and Kikuchi, 1994], photonic technology [Matsunaga et al., 1993; Saruwatari, 1994; Miki, 1994], traffic control schemes [Yamanaka et al., 1993; Esaki et al., 1994; Saito, 1994], self-healing virtual path architecture [Kawamura and Tokizawa, 1995], performance evaluation of ATM connections [Taka and Murakami, 1994; Murakami et al., 1995], and ATM-LAN internetworking [Kinoshita and Saito, 1994; Murata and Miyahara, 1995].

While both studies and applications of network architectures have made steady progress [Kano, 1993; Suzuki, 1993; Ishihara, 1994], there have been significant advances in the Telecommunications Information Networking Architecture (TINA) [Iizuka et al., 1994; Dupuy et al., 1995; Yagi et al., 1995].
Network integration [Aoki, 1993b; Kinoshita et al., 1995] is a synthetic technology developed for creating information services in multimedia networks, which imply both connection-oriented and connectionless networks. Network and service management are indispensable for network users to enjoy sophisticated services at a preferable level of "Quality of Service"; an approach to this via operations systems has been reported [Yoshida, 1994; Ejiri and Yoshida, 1995; Matsushita et al., 1995].

Based on the above technologies, requirements for future switching system [Aoki, 1993a] and several possible migration scenarios from existing networks into multimedia ones have been studied [Fukuda et al., 1993; Aoki and Makino, 1994; Inoue and Terada, 1994; Kinoshita et al., 1994]; open telecommunications management [Matsushita et al., 1994; Miyagishi et al., 1994] has also been studied.

(T. Aoki)

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C10. Broadcasting

Practical test broadcasting of Hi-Vision started on November 25, 1994, in preparation for fullscale broadcasting under the new licensing system (in which broadcasting rights are given by days of the week and time, with new program organization). A Hi-Vision receiver with a second generation MUSE LSI now sells for under 500,000 JPY. As of November 1995, the number of Hi-Vision receivers installed in Japan totaled more than 110,000.

The large screen and flat TV receiver are also indispensable if Hi-Vision is to penetrate the homes. Research on a large plasma display has made it possible to increase the area of the panel display to 40 inches [Yamamoto et al., 1995a].

Luminance has been further improved to build a large plasma display that promises to make wall Hi-Vision a practical proposition. A long-life 40-inch fluorescent wall screen panel has been developed, the quality of motion pictures improved, and a signal processor LSI and transparent electrode also developed [Yoshikawa et al., 1995].

Research on digital broadcasting technology is being conducted for broadcasting in the multimedia era. The focus is on ISDB, an audio and video encoding and multiplexing systems, transmission systems, satellite and terrestrial ISDB, and service and application technologies [Kawai et al., 1994].

In the area of satellite ISDB, an information bit rate and a system for 21 GHz-band satellite broadcasting have been studied; basic data to counter rain attenuation has been obtained; the channel plan for the 12 GHz-band satellite broadcasting system reviewed to meet WRC’97 requirements [Katoh et al., 1993].

Research and development on FM multiplex broadcasting systems (DARC: Data Radio Channel) has been carried out. The chosen modulation is Level-controlled Minimum Shift Keying (LMSK) [Kuroda et al., 1992].

Requirements for improving mobile reception, the single frequency network (SFN), and protection ratio were selected for terrestrial ISDB. A multicarrier modulation scheme and band split transmission (BST) system were studied [Saito et al., 1994].

Analog/digital hybrid optical broadcasting, demand-access digital optical broadcasting system, optical CATV digital transmission technology and ultra-wideband optical transmission have been studied for CATV and optical fiber broadcasting, which will allow the digital transmission of large capacity interactive services [Yamamoto et al., 1995b].

The D-3 VTRs have been installed in the NHK Broadcasting Center and other major local stations. The cart machines have also started operation. In June, 1993, the D-3 was standardized as SMPTE 263M for tape cassette, SMPTE 264M for 525/60 system and SMPTE 265M for 625/50 system. All the documents were approved as ANSI standards in January, 1994 [Uehara et al., 1993].

Studies have been carried out to develop a commercial speech-speed conversion hearing-aid system to compensate for hearing impairments due to aging. The system has been miniaturized for use by the rising population of the elderly [Nakamura et al., 1994].

Research has been conducted on 3D Hi-Vision without use of goggles, photographic conditions and screen effects with 3D images and 3D image information processing, which will be indispensable when the 3D image system is developed [Isono et al., 1993].
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