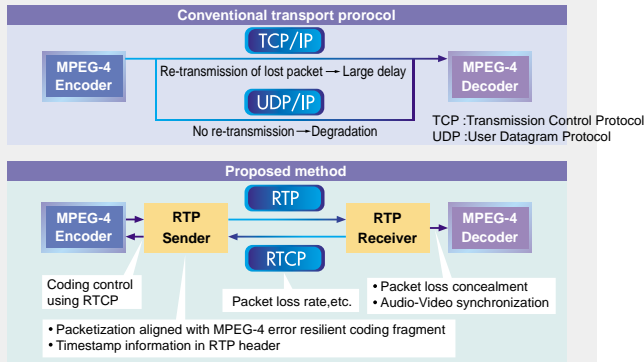


The Corporate Research and Development Center and the Corporate Manufacturing Engineering Center contribute to both current business and the future of the Toshiba group through their fundamental/advanced research & development activities providing technological leadership.

Technologies on which Toshiba is focusing include: in the field of IT—wireless network, media processing, knowledge management and software technology; in the field of materials and devices—nanotechnology including storage technology; and in the field of manufacturing engineering—environmentally friendly production technology and digital manufacturing.

"MPEG-4 RTP" Mobile and Internet Video Signal Transmission Protocol



MPEG-4 RTP and other transport protocols

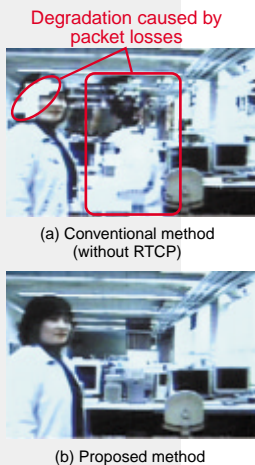
Toshiba has proposed a transport protocol "MPEG-4 RTP (Moving Picture Experts Group-phase 4 Real-time Transport Protocol)" for the transmission of video signals over IP (Internet Protocol) networks such as LANs, the Internet and mobile packet-switched networks.

Toshiba invented the basic concept of MPEG-4 RTP and made a joint proposal for its adoption as an International Standard with four other companies, NEC Corporation, Oki Electric Industry Co., Ltd., Matsushita Electric Industrial Co., Ltd., Nippon Telegraph and Telephone Corporation.

It was adopted by the IETF (Internet Engineering Task Force), and further adopted by the 3G-PP (Third Generation Partnership Project) in its packet switched multimedia streaming standard for mobile phones, and by the ITU-T (International Telecommunication Union-Telecommunication sector) in its recommendation for multimedia conferencing over packet-based networks.

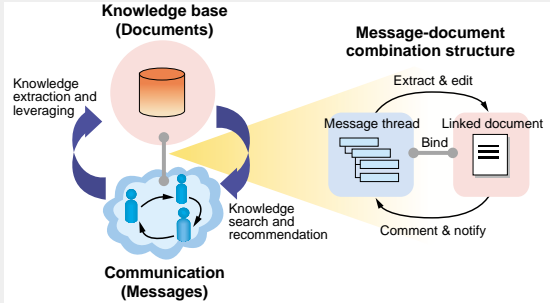
A characteristic of MPEG-4 RTP is the provision of MPEG-4 video error resiliency tools. It also enables control of MPEG-4 video encoding parameters using RTCP (RTP Control Protocol) feedback messages. It reduces degradation of reconstructed video signals caused by packet losses.

Toshiba has developed a prototype based on this standard. Toshiba will develop products for video distribution on the Internet and next-generation cellular phones.



Quick error recovery of trans.-mitted video signal using RTCP

CIKLE: Knowledge Leveraging Communityware



CIKLE knowledge management model with message-document combination structure

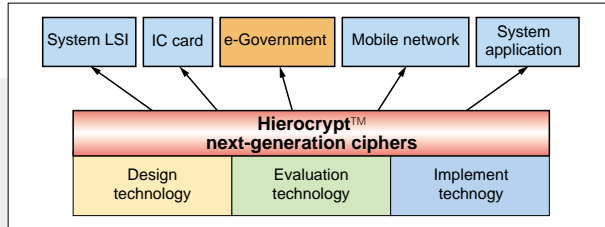


Toshiba has developed a knowledge leveraging communityware, CIKLE (Community-based Interactive Knowledge Leveraging Environment), based on an original knowledge management model which combines two different types of information: communication (a message thread) and knowledge (a document).

CIKLE provides outstanding functionality: extraction of knowledge from a given communication and a knowledge search engine, which facilitates natural language queries. The former enables users to create topic-related documents easily. The latter enables a wide range of knowledge sharing beyond communities. The combination of the model and functionality can effectively power the cycle of communication-knowledge.

CIKLE has been in experimental use by over 6,000 people in Toshiba since July 2000, and is also commercially available as KnowledgeMeister™ community module in a product line offering a variety of knowledge management solutions.

"Hierocrypt™" Next-Generation Symmetric Ciphers



Main fields of application for Hierocrypt™

Toshiba has developed a pair of next-generation symmetric ciphers Hierocrypt™-3 and Hierocrypt™-L1, which simultaneously realize high security, high speed on any platform, and flexibility. Hierocrypt™-3 is an AES^{(*)1}-class 128-bit cipher for next-generation use, and Hierocrypt™-L1 is a 64-bit cipher for legacy-use. The two algorithms have many common components. Both ciphers were presented to CRYPTREC^{(*)2}, which is an official evaluation project for cryptographic technologies for electronic government in Japan, and were evaluated as top-class in each category with respect to both performance and security.

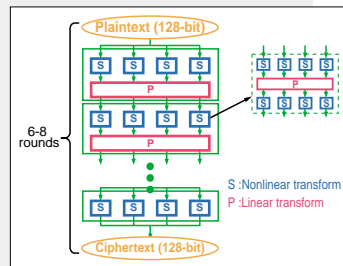
The most important technical feature of Hierocrypt™ is its original "Nested SPN^{(*)3} structure", which ensures provable security against the most significant attacks, differential cryptanalysis and linear cryptanalysis.

Performance is also excellent. The encryption is very fast in most software implementations, from a low-end 8-bit CPU environment to a high-end 64-bit CPU environment. In hardware implementation, a very high encryption speed of 3.1 Gbps was achieved by ASIC (Application Specific Integrated Circuit) design (0.13 μm), due to the high level of parallelism.

*1 AES: Advanced Encryption Standard, a 128-bit symmetric cipher which was approved by NIST (National Institute of Standards & Technology) in 2001 as a predecessor of the DES (Data Encryption Standard) cipher

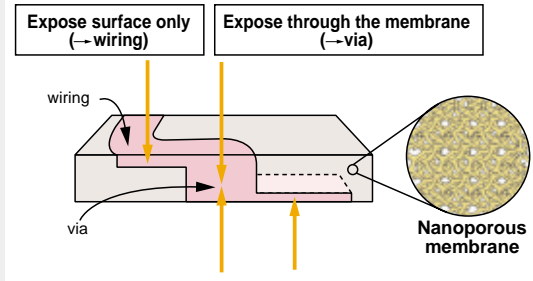
*2 CRYPTREC: Cryptography Research and Evaluation Committee, a public committee, which has evaluated various cryptographic techniques for Secure E-Government in Japan

*3 SPN: Substitution Permutation Network

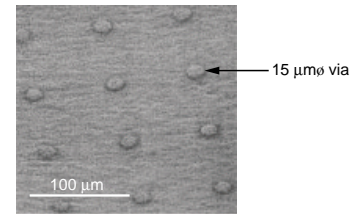


Structure of the data randomizing part of Hierocrypt™-3

New High-Density Wiring Technique Using Nanoporous Membrane



Simultaneous formation of surface wiring and via



Fine via array (15 μm diameter)

Toshiba has developed a new wiring technique for obtaining high-density packages to be used in portable information devices.

This technique is characterized by the use of a nanoporous membrane as a substrate. A fine three-dimensional wiring matrix is created within the membrane by selective impregnation with copper. This selective impregnation required the development of a new photoinduced selective plating method. The portions that are to be wiring are exposed to light. These exposed portions are thus activated, and copper is selectively deposited within the exposed portions by electroless plating.

Both surface wiring and vertical wiring (via) can be formed simultaneously by controlling the exposure depth. Surface wiring is installed by exposing the surface of the membrane, and vias are formed by exposing through the membrane. Because this simultaneous formation prevents displacement of the surface wiring and vias, high-density wiring is possible using this process. This technique has potential applications in advanced information apparatus such as a wearable computer.

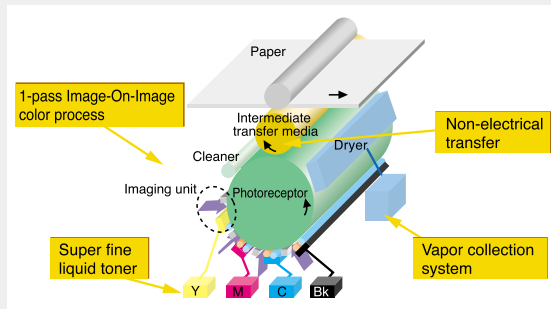
Development of High Quality Color Electrophotography Using Liquid Toner

Toshiba has developed a color printing technology which realizes a high quality image equivalent to that of offset printing, while maintaining high print speed and low print cost.

The limitations of dry electrophotography were overcome by the development of new liquid toners and a unique color superimposing process. A digital color proofer (apparatus for the test print), which was developed using this technology in collaboration with Toshiba Machine Co., Ltd., will be put into commercial use in 2002.

Compared with conventional proofers, this will deliver five times the print speed, and at one tenth the print cost.

As the basic technology for faster printing process is also developed, Toshiba is aiming at applications in an on-demand-printing system, which is a next generation plateless printing system, and in office-use color page printers.



Configuration of color electrophotography system using liquid toners



REAL PROOF digital color proofer

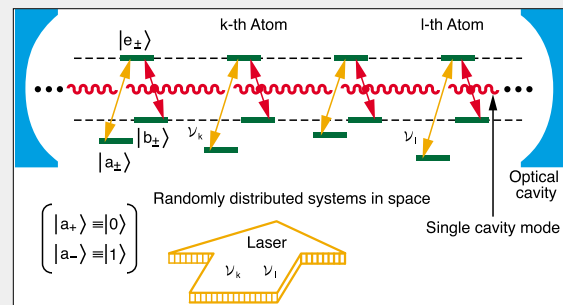
Proposal for New Solid-State Structure of Quantum Computer

Presently there is tremendous interest in quantum computation, which is a new concept of information processing and promises to exceed the computational efficiency of current machines. The real physical systems necessary for practical implementation of quantum computation are currently being sought.

In Toshiba's newly proposed scheme, individual qubits (quantum bits: atoms, ions, and so on) have two transitions, and the frequencies of one transition are equal for all qubits, but those of the other transition are different for each qubit. Therefore, it becomes possible to address each qubit using frequency difference, and communication between qubits can be mediated by a single cavity mode resonant with the same-frequency transition. In short, qubits can be treated almost completely within the frequency domain, and the position of qubits has no significance.

Thus randomly distributed systems in space, such as ions in a crystal and semiconductor nanocrystals, can be directly employed as qubits, and no nanofabrication technology, which was thought to be essential to realize quantum computers with a practical number of qubits ($>10^3$), is necessary.

An application of solid-state EIT (Electromagnetically Induced Transparency) medium ($\text{Pr}^{3+}:\text{Y}_2\text{SiO}_5$) for the newly proposed quantum computer has been shown to be practicable in theory.



Basic concept of frequency-domain quantum computer

Lead-Free Soldering Technologies for Electronic and Electric Apparatus

Toshiba has developed lead-free soldering technologies to omit lead from the soldered parts on printed circuit boards. Lead reduction is the company's policy in line with the worldwide concern for the environment.

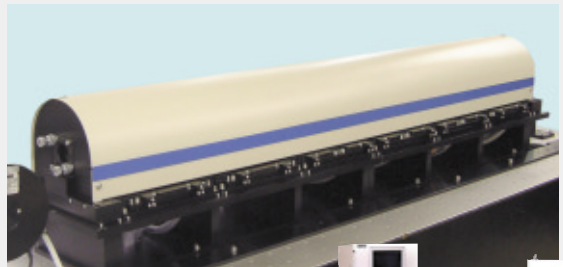
The lead-free solder and flux materials were selected in order to obtain good soldering quality and joint reliability. Moreover, techniques for the optimization of the temperature profile in soldering, predicting the life of the soldered joint and mass production control techniques on the manufacturing line were also newly developed. As a result, the quality and joint reliability of lead-free soldering has proven equal to that of tin-lead soldering.

Using these technologies, household electric appliances, personal computers, and so on have been merchandised. Toshiba aims to use lead-free soldering exclusively in all products by fiscal 2003.



Notebook PC (top) and washing machine (bottom) manufactured with lead-free solder

10 kW Laser Diode-Pumped Nd:YAG Rod Laser



10 kW LD-pumped YAG laser



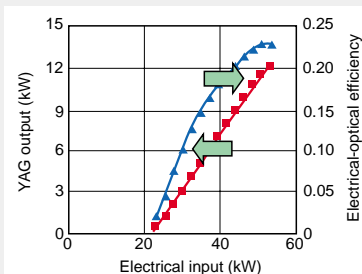
LD-pumped YAG laser product

The "Advanced Photon Processing and Measurement Technologies" project supported by the Ministry of Economy, Trade and Industry is a 5-year project that began in FY1997. In the project, Toshiba is developing a laser diode (LD)-pumped Nd:YAG rod laser with high-power, high-efficiency oscillation.

The high efficiency LD-pumping module is developed using an optical and thermal simulation technique. To achieve average output power of 10 kW, the laser head is configured with several LD-pumping modules arranged in series.

Toshiba has also succeeded in reducing the laser head volume, obtaining output power of 12 kW with an efficiency of 23 %, and laser head volume of 0.045 m³.

Toshiba transferred the technology to Shibaura Mechatronics Corporation, who now offers an LD-pumped Nd:YAG rod laser system with output power up to 4.5 kW.



Output characteristics of 10 kW laser head