KAWASAKI STEEL TECHNICAL REPORT No. 44 June 2001

LSIs and Equipment for High Speed and Diversified Digital Communication Network*


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Synopsis:

A rapid spread of the multimedia and internet at home and offices produced various applications, involving a huge amount of data communication, and brought the paradigm shift in the communication and network. These are supported by high-speed LSI and optimized internet working equipment. Kawasaki Steel has developed communication and network technologies and offered various products. The technological trend, the product technologies, and the future trend of the communication and network will be discussed in this report.

1 Introduction

The rapid spread of intranets, extranets and the Internet has made a wide range of applications available, and created a paradigm shift in the field of networking. As shown in **Fig. 1**, the total volume of network communications in Japan has increased dramatically over the past few years (source: Merrill-Lynch). In the US, the data traffic on networks reportedly increases ten-fold every year. The various network applications in use demand different communication styles either one-to-one, one-to-many, or many-to-many. The multimedia data being sent can be any combination of text, sound, graphics and pictures. To send the massive amounts of data required for multimedia applications requires higher speeds and quality guaranteed to meet the requirements of the medium. The business world has responded dynamically to the spread of communications networks, adopting new ways of doing business such as e-commerce and virtual companies.

The spread of communications networks has been made possible by LSIs (highspeed hardware components), and internetworking equipment with an optimized partitioning of software and hardware functions. Kawasaki Steel develops and sales these types of communications/network technologies and products, which are one of our main business areas. This report discusses current trends in communication/network technology, gives some examples of LSI products and internetworking equipment that Kawasaki Steel manufactures for communication/network applications, and briefly describes the future of communication/network technology.

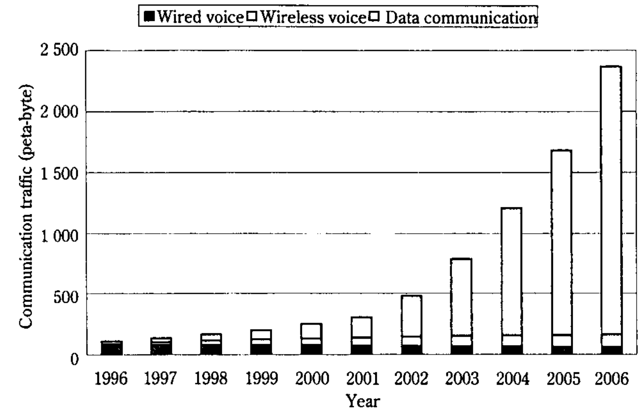

Fig. 1 Traffic of data communication in Japan (Total of exclusive line, ISDN, ATM and frame relay)

2 Current Communication/Network Technology Trends

2.1 Offices, Homes

E-mail and the Internet are now considered necessities in both offices and homes in Japan and other devel-

* Originally published in *Kawasaki Steel Giho*, **32**(2000)3, 277–280

oped countries. PCs have become so widespread that now each office worker has one, and every home has one and more.

Home users are connecting multiple PCs on Ethernet interfaces, or running multimedia applications by connecting peripherals such as external memory, CD ROM drives, DVD ROM drives, printers, scanners, synthesizers, digital cameras, PC cameras and headset microphones. Internet applications are diversifying and expanding away from just text-based e-mail and chat. Today's Web sites often feature music, animation, and still/moving pictures, and applications include karaoke, PC games, and video phones that exchange sound and moving pictures in real time.

In the past, interfaces between PCs and peripherals were almost always different for each peripheral, making them extremely troublesome to the average user. Today, the data transfer bus and interface used between PCs and digital multimedia equipment, and between PCs and peripherals have been standardized to the USB (Universal Serial Bus) 1.0 and IEEE 1394 standards. USB 1.0 is included in PCs as a low-speed interface for keyboards or printers. It has a data transfer speed of 1.5 or 12 Mbps. IEEE 1394 is used as a high-speed interface for VCRs with built-in cameras, or DVD players, and has a data transfer speed of 100 to 400 Mbps. Both standards are aiming at higher speeds. A next-generation USB standard, USB 2.0, has been created with a data transfer speed of 480 Mbps, and equipment for it is being developed.

As the USB became popular in PCs, interface equipment was needed that could use a USB port of PCs and act as an interface with LANs or with conventional peripherals without USB ports. USB interface equipment has been developed to meet this need.

In offices, terminals such as PCs and EWSs (engineering workstations) are connect on LANs such as Ethernet and exchange massive volumes of data. This data can be client information, database data for production or warehouse management, design data, printout data, or (in some types of business) moving pictures. The 10 Mbps transfer speed that has been used for roughly 20 years limits some of today's applications, so there is currently a move toward 100 Mbps. LAN equipment manufacturers are working on developing new products, and some next-generation 1 Gbps products have started to appear. These products require LSIs and various other technologies enabling higher data transfer speeds.

2.2 High-Speed Networking Technology Trends

While MPU performance levels have improved significantly, today's equipment still lacks the relay processing capacity required for large volumes of high-speed data sent from PCs or EWSs.

Routers are a typical example of relay processing equipment. Routers have anywhere from a few to over a dozen ports for Ethernet and public lines. They connect PCs, EWSs, other routers and public lines. Networks use several different protocols, and different quality is demanded for each type of data. For example, sound and moving picture data must be transferred in real time, but data omissions can be tolerated. However, CAD or database data does not need to be transferred in real time, but must be transferred accurately and with a constant bandwidth. Routers must be able to recognize the protocol and quality demanded from the received data, and execute the optimum transfer process based on the current network conditions. They must also be able to perform security control operations such as transforming or destroying data to protect it from electronic eavesdropping.

To meet the varied demands of today's networks, routers generally use rule tables for optimum control of the data transfer process. Rule tables must be able to be modified to flexibly adapt to the user's usage method, and must not lower the speed of high-speed data transfer. These demands are no longer being met by conventional software processes.

If data were sent simultaneously to all the ports of a router with sixteen 100 Mbps Ethernet ports, that router would need a processing speed of 1.6 Gbps. The router would have to search a massive amount of data at an extremely high speed, so a software process driven by an MPU with general-purpose memory would not be fast enough.

Network CAM (content addressable memory) has been acclaimed as a solution to this problem. CAM can be used for high-speed rule search engines. Processing methods (rules) are registered in a table, and the table is searched to determine which of its conditions the received data satisfies. CAM should become an indispensable item of network equipment in future since it makes rule registration and modification simple, and enables high-speed searches that do not depend on the number of rules.

Each PC, EWS or other terminal that transfers data on the Internet is assigned a unique identifying address which is included in transferred data. Networks have various protocols, and addresses in data packets are used in different ways. TCP/IP is a commonly used protocol, but other protocols such as IPX/SPX (Inter-packet Exchange/Sequenced Packet Exchange) and Apple Talk are also in use. Network equipment must quickly determine which protocol is being used, and use the corresponding transfer method. In the past, this determination was often handled by the computer, but as networks get faster and the mobile Internet plays a bigger role, hardware-driven protocol engines are becoming indispensable.

LSIs have made an extremely large contribution to the development of the communication/network technology discussed above. Kawasaki Steel has developed a product lineup worthy of an industry leader, meeting the needs of the communication/network industry. Our products include ASICs (application-specific integrated circuits: customized products for individual users), ASSPs (application-specific standard products: standard LSIs), and LSI-driven internetworking equipment. Some examples are described below.

3 Product Technology

3.1 LSIs for USB

Table 1 lists the specifications of Kawasaki Steel's USB products and the technology used in them.

Our USB-Ethernet controller includes components such as a 16 bit CPU, mask ROM, buffer RAM, clock generator circuit, Ethernet interface, UART (universal asynchronous receiver-transmitter), IRQ (interrupt request), watchdog timer, SIE (serial interface engine), external memory interface, and serial port interface. The SIE is completely compatible with USB 1.0/1.1. The device functions are defined by firmware, and stored in an externally-mounted EEPROM, for transfer to internal RAM, and high-speed execution. A windows 98 driver is also available. The user can upgrade functions by downloading the latest firmware and driver from our Web site, or obtaining it directly.

The USB 2.0 transceiver is an LSI that consists of a high-speed transceiver block, full-speed transceiver block, shared logic block, external SIE interface, and clock generator circuit. It transfers data to/from an external SIE, converting USB 2.0 data for high-speed (480 Mbps) serial transfer or for full-speed (12 Mbps) serial transfer to 8/16 bit parallel data. Kawasaki Steel is planning to also release the USB 2.0 transceiver as an ASIC IP (intellectual property), and the SIE component as an IP. These components let system designers create USB 2.0-compatible devices without having to take the actual USB 2.0 specifications into consideration.

Kawasaki Steel has also developed and released other USB products in addition to those above. Among the products available are USB-Serial, USB-Parallel and USB-Home PNA 1.0.

Table 1 LSIs for USB

	Performance	Realized technology
USB-Ethernet	· 10 BASE Ethernet full support · Full speed USB1.0/1.1	· Advanced 16 Bit processor for USB transaction processing and control data processing · Fully IEEE 802.3 compliant 10 Mbit/s Ethernet MAC layer · Built-in transceiver and SIE
USB2.0 transceiver	High speed USB2.0	High accuracy clock recovery and clock synchronization circuit

3.2 Gigabit Serial Link

Kawasaki Steel's gigabit serial link uses a normal CMOS device. Its data processing circuit blocks include a serializer/deserializer, data/clock recovery circuit and comma detection circuit. A PLL (phase-locked loop) circuit with a built-in filter sends a high-speed clock signal to each of these circuit blocks. There is also an 8/10 bit data coding circuit that conforms to the Fiber Channel standard. The device enables a high data transfer speed (1.25 to 2.5 Gbps per cell). It is a macro-cell that can be combined with other Kawasaki Steel ASIC library cells, letting the user easily create an LSI Gbps-class data transfer interface.

3.3 Network CAMs

Table 2 lists the specifications of Kawasaki Steel's network CAMs and the technology used in them. CAM devices are a type of function memory, used as follows:

(1) The user stores rule data in each word of each memory device.

(2) Input data is simultaneously checked and compared against each word's data (rule), and the rule the data matches is output externally.

This method enables the conditions for data transfer control to be acquired instantaneously, making CAM devices indispensable for communication equipment demanding high speed and multi-functionality.

Kawasaki Steel is continually striving to develop CAMs that are the state of the art in terms of speed and capacity. Our first CAM devices were developed for use in address processor LSIs for address relay processing in internetworking equipment. Since then, we have moved on to developing and marketing the next generation of CAM devices. These gigabit CAM devices incorporate high-speed, large-capacity CAM technology, and include 1 and 4 Mbit classification CAMs with advanced func-

Table 2 Network CAMs

	Performance	Realized technology
Gigabit CAM 256 Kbits (Binary CAM)	· Search time: 30 ns · Table configuration: 64 bits × 4 K (Binary CAM) · 16 Global masks · Automatic self learning of search data	· High speed data input control · High speed command decode · High speed search circuit · Hierarchical priority and encode circuit · Multi-hit detection
Classification CAM 1 Mbits (Binary/Ternary CAM)	· Search time: 15 ns · Table configuration: 6 types · Table divide: 8 types · 16 Global masks · Each local data with local mask (Ternary CAM)	· High speed data input control · High speed command decode · Control of multi-table · High speed and low power search circuit · Hierarchical priority and encode circuit

Table 3 TCP/IP engine

Performance	Realized technology
· RFC1122 Host requirement standard · Throughput: >30 Mbps · Simultaneous sessions: >20 · TCP/UDP/ICMP/ARP · IP Fragment support · Socket I/F (Logical) · PCI Bus (Physical)	· Parallel and separate processing by weak connection type multi dedicated hardware · System level integration with built-in CPU

tions. Our classification CAMs enable high-speed classification and control in the upper network layers (layers 3, 4 and higher), to achieve QoS (quality of service).

3.4 TCP/IP engine

Table 3 lists the specifications of Kawasaki Steel's TCP/IP engine and the technology used in it.

The TCP/IP engine chip is an LSI chip that processes all protocols at and below the TCP layer within itself. Almost all normal data path processes are performed using hard-wired logic. TCP is a protocol that requires a lot of processing, but since our TCP/IP engine processes at high speed using hard-wired circuits, it enables TCP/IP to be mounted in devices without the powerful CPU resources needed in the past. Our TCP/IP engine chip enables a foundation for network connections to be created cheaply and easily. It can be used even in equipment in which it was previously difficult to mount TCP/IP protocol drives, such as phones, mobile terminals and household information appliances. It should become an increasingly important device as equipment networking becomes more widespread in future. As hard-wired logic increases processing speeds, TCP-based communication at speeds in the tens of Mbps (previously difficult to achieve) will become practical. The TCP/IP engine chip will also be effective in applications that require highly reliable high-speed data transfer such as storage devices.

3.5 Routers

Table 4 lists the specifications of Kawasaki Steel's routers and the technology used in them.

Network solutions are evolving to meet rapidly changing and diversifying needs. The systems for today's network solutions must be fast, adaptable, highly secure, and incorporate high value-added functions. The first router developed and released by Kawasaki Steel was Secured A2DIS, an access router/layer-3 switch for small and medium-sized offices. It features ASIC high-speed layer-3 switching, and IPsec/SSL/Socks security functions. Security functions are indispensable for e-commerce, an Internet application that has been the subject of much attention recently. Since the e-commerce market is expected to expand, Kawasaki Steel considers security technology as important an area as VoIP (voice over internet protocol), another area set to expand in future.

Table 4 Router

	Performance	Realized technology
Secured A2DIS	Layer 3 switching router 〈LAN〉 10 Base-T × 4 〈WAN〉 BRI × 1	· Dedicated ASIC for relay · Security software as IPsec, SSL etc.
Access point router for carrier	Access point router 〈NIF Card〉 –BRI × 16 –PRI × 2 –OC3_ATM × 1 –10/100 Base-T × 1 〈Performance〉 –32 Gbps (Backbone) –30 Mpps (Aggregate)	· Dedicated processing ASIC for routing · Switching control ASIC · Address search engine devices · Queuing control software

Anticipating these future trends, Kawasaki Steel is developing an access point router for next-generation telecommunications carriers, building on our past breakthroughs. This new router will be a large model for networks for telecommunications carriers offering services such as e-commerce and multimedia. Its main processing section will be driven by 5 different ASICs, enabling a relay capacity of 32 Gbps and packet exchange capacity of 30 Mbps. To enable DiffServe in networks, the router will come with a wide array of QoS functions, and will be compatible with new Internet services such as IP phones. Since the router will be installed at the central office, a redundant system can be designed, with multiple system cards, power supplies and cooling fans.

4 Future trends

Communications and networks are developing rapidly, with a succession of new applications appearing in both homes and offices. Faster processing speeds and a variety of new functions are reshaping communications and network technology. There are already an endless stream of new technologies that will shape the trends of tomorrow. These include xDSLs (digital subscriber lines), IEEE 1394, Home-PNA (Phone-line Networking Alliance), wireless car LANs, and Bluetooth. Although not covered in this article, mobile communications such as IMT-2000 (International Mobile Telecommunications 2000), and their applications are expected to change and grow dramatically over the next few years.

References

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