T9000 - A NEW GENERATION TRANSPUTER (I'ts architecture and applications) Part II

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KEY WORDS: transputer, T9000, multiprocessing, embedded computer systems, Virtual Channel Processor, programmable memory interfaces, communications subsystems, application

ABSTRACT: In this two part article a new generation transputer T9000 is described. Part I deals with it's basic concept and architecture, while Part II describes main areas of it's applications.

T9000 - TRANSPUTER NOVE GENERACIJE (Zgradba in uporaba) II.del

KLJUČNE BESEDE: transputerji, T9000, multiprocesiranje, sistemi z računalnikom, virtualni kanalski procesorji, programabilni pomnilniški vmesniki, komunikacijski podsistemi, uporaba

POVZETEK: Omenjeni članek v dveh delih opisuje transputer nove generacije T9000. V prvem delu je podan osnovni koncept in zgradba T9000, v drugem pa so opisana glavna področja in načini njegove uporabe.

INTRODUCTION

In terms of applications the T9000 has been specifically designed for embedded applications,which make special demands on a processor in terms of its ability to switch context efficiently when responding to system interupts or time slices between tasks.

The T9000 provides direct hardware support for context switching and process sceduling with sub-microseconds response time for multiple level interrupts. Furthermore, its unique virtual channel communications model provides direct hardware support for message passing.The ability to handle a single task error such as overflow without resetting the system is an exclusive feature of the T9000. There is no other microprocessor which is able to achieve this attributtes in a single design.

Main three applications areas for which the T9000 has been specifically developed are:

- imaging
- computing
- communications

IMAGING APPLICATIONS

The imaging market covers a brad spectrum of applications ranging from printers to image processing systems. These applications require the generations,manipulation and transmission of image data, high performance processing for tasks such as image compression, and Postcript interpretation. These applications demand efficient communication links for I/O and a high level of system integration for minimal system size and cost. The current range of transputers effectively supports imaging applications with a range of performance options and multiprocessing capabilities. The T9000 offers, in addition to its high performance, single cycle bit and byte manipulation for fast image data handling and a fast 2-D block move function for image movement.

* Page printers

System cost and software support are key elements in any high volume laser printer design and consequently the choice of the CPU is the focus for laser printer designers. The T9000 has all the necessary characteristics for mid-range and high-performance laser printers not only as a uniprocessing solution but also as a truly scalable element within a multiprocessing system. It provides te raw procesing power essential for image manipulation,and has the added benefit of an efficient Postcript interpreter.

Typical characteristics for this kind of applications are :

- 200 MIPS peak integer performance
- 25 MFLOPS peak integer performance
- Postcript support available
- C-Exec real time kernel available
- 10X raster image performance of current single processor laser solutions
- High speed DMA link technology working concurrently with CPU for image data transfer to main memory,print engine and host interfaces
- Low memory interface costs,direct interface to 8 Mbytes DRAM (including on-chip refresh logic)

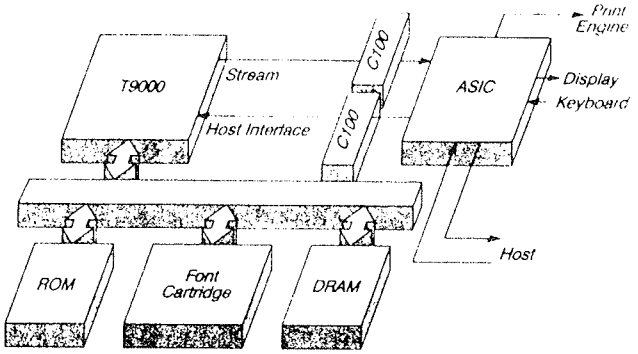

Fig. 1: Page printer application

X - Terminals

Having a workstation dedicated to a single user can be an expensive solution. X - Terminals bring the features of a workstation to the desktop: local intelligence, processing power and communications at a price of a standard personal computer. The transputer family offers a variety of solutions from low and monochrome systems using the T4 family to high-end, high-resolution colour systems using T9000.

Typical characteristics for this kind of applications are :

- Industry software including full port of X11R4 and TCP/IP
- Scalable performance
- System level solution - T9000 and IMS G3XX Colour Video Controller
- Fast single cycle bit manipulation for graphics operation
- 2-D block move instruction
- Hardware concurrency to support communications,local computation and display management simultaneously
- Direct support for 8 Mbytes of DRAM (on-chip refresh logic)

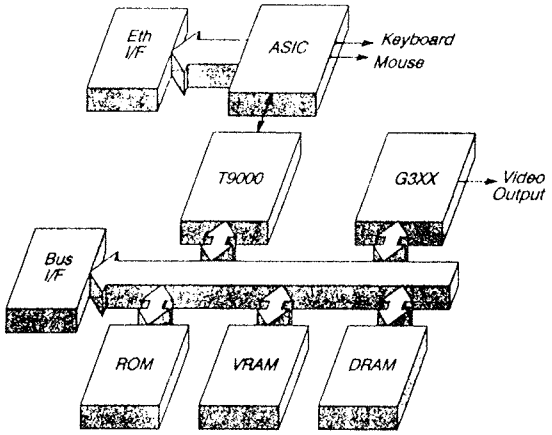

Fig. 2: X-terminal application

* Scanners

Similar in application to laser printers, but with an emphasis on data stream manipulation,scanners present designers with several problems: high speed data stream routing, image compression and optical character recognition. The T9000,unlike most microprocessors, has the processing power to cope with all these areas.

Typical characteristics for this kind of applications are:

- High performance for optical character recognition and image compression algorithms
- Link concurrency with CPU for simultaneous image manipulation and data transfer
- High integration for low cost and size
- 80 Mbytes/serial data transmission capability

COMPUTING

The T9000 offers many ways of increasing system performance. The T9000's 200 MIPS peak execution rate and 25MFLOPS peak floating point performance, coupled with the ability to build multiprocessor systems, means that thousands of MIPS and hundreds of MFLOPS can be employed to achieve almost unlimited real-time performance. Alternatively, system performance can be increased by employing the T9000 in subsystems such as disk arrays, application accelerators etc.

*Disk arrays

Whatever the power of the central processor in a mainframe or workstation, a major bottleneck is in the data storage subsystem. System down-time in many cases

can be narrowed down to failure of a hard disk drive within the infrastructure. The way ahead lies with an array of disks rather then one single large capacity drive. The speed of data retrieval has become a major issuse in disk system design and a fault tolerant architecture has become a necessity. The T9000, along with the rest of the transputer family, is suitable for disk array design in mainframe, workstation or PC.

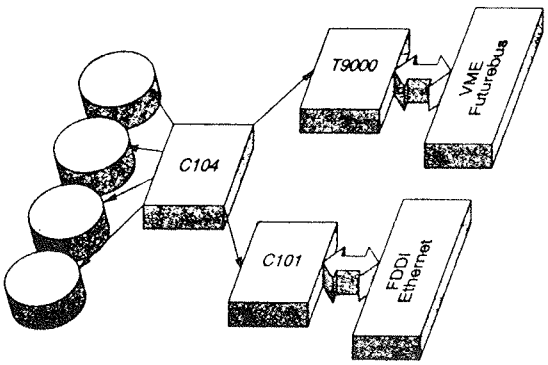

Fig. 3: Disk array application

Typical characteristics for this kind of applications are:

- Link technology operating at 5 times the speed of SCSI.
- Fault tolerant design capability without external arbitration logic
- Scalable architecture allows any configuration
- CRC error checking algorithms can be executed as a concurrent process

* Application accelerators

Used as an embedded processor in application accelerators, the transputer provides transparent processing power to overcome the problems of increased performance requirements. From PCs to mainframes there will always be a need for more processing power, regardless of the application running or the number of users.

Transputer-based application accelerators speed up dedicated software such as finacial modelling packages, relational data bases and complex numerical algorithms, leaving the host CPU to concentrate on the system tasks for which it was intended.

Typical characteristics for this kind of applications are:

- Scalable solutions for performance upgrades to main frames/PCs/workstations etc.
- Links to parallel interface chips
- Standard range of motherboards and modules for many hosts
- Driver software availability

Supercomputers

Natural, scientific, engineering and commercial tasks are inherently parallel. Sequential processors are often unable to perform complex calculations such as finite element analysis,computational fluid dynamics and geographical survey analysis efficiently. The transputer offers almost limitless performance trough its modular, scalable architecture and parallel and multi processing capabilities. The virtual channel concept of the T9000 and the dynamic configurability of the C104 packet routing switch allow supercomputer designers to incorporate various network topologies- N-cube, hypercube, tree, mesh, ring, toroid etc. -within the same system. A key requirement for any large parallel computer is the ability for each individual node to communicate with others. In T9000/C104 networks, wormhole routing techniques ensure that message latency is minimised and transmission is continious,allowing the construction of large systems with full node connectivity.

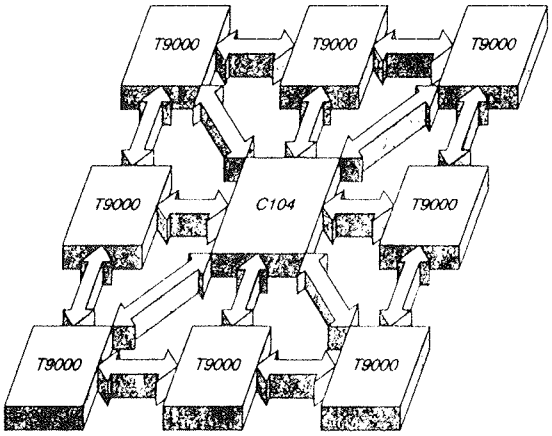

Fig. 4: Supercomputer application

Typical characteristics for this kind of applications are:

- Exceptional performance - 200 MIPS, 25 MFLOPS (peak)
- Minimal link latency
- Dynamically configurable network topologies using C104 routing switch
- Modular, scalable, parallel architecture
- Virtual channel message passing capability in hardware

Robotics

From spot-welders to automotive production line installation, real time control of machinery is vital to efficient production. Communications capability is essential in a

control system since processing nodes in remote locations often need to relay information about their status to a central control unit. The numerous axes of a robotic arm can now communicate and relay position and attitude data to each other for accurate and fast positioning trough the use transputer's link technology. The ability to build fault tolerant systems with ease is also important; sub-microseconds response time is crucial for safety- critical systems.

The transputer family provides the essential communications and multiprocessing capability for large and complex control systems. The T9000's unique ability to pre-emtively schedule and reschedule interrupts to the pipeline, and to use the interrupts as outputs, gives flexible real-time responsiveness.

Typical characteristics for this kind of applications are:

- Multitasking kernels available for real-time control-VRTX and C-Exec
- Sub microsecond pipelined interrupt scheduling
- Integrated Floating point Unit for accurate positional control
- Ability to mix current and T9000 family members for optimum system efficiency
- Pre-emptive scheduling of interrupts

COMMUNICATIONS

The worldwilde telecommunications market is going trough a period of tremendous change, with new communications standards and technologies creating new growth markets. Digital computer networking and network interconnection,the digitisation of telephone networks, and new markets like cellular radio all place greater reliance on processing performance and software than previous analog systems.

*Internetworking

The market for the equipment that interconnects different networks together, bridges, routers, gateways, etc., has experienced rapid growth as corporations seek to unify their networking operations. Increasingly sophisticated protocols and higher data rates, particularly with 100 Mbit/s FDDI standard, raise the processing performance required significantly. The shared-bus architecture adopted in many of these multi-processing systems becomes a significant bottleneck as data rates increase, resulting in a reduction in performance and network throughput.

Using the T9000 with its high-speed communications capability, for the interface card controllers to token-ring, ethernet, FDDI, etc. and the low latency C104 packet routing switch, bridges routers and gateways can be constructed using the dynamic message routing architecture which naturally fits the application.

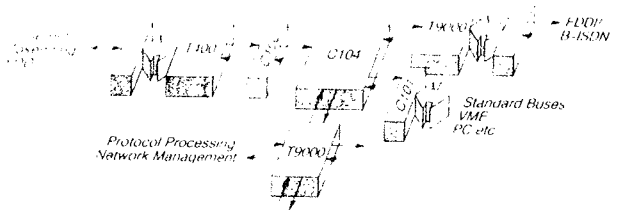

Fig. 5: Internetwork application

Typical characteristics for this kind of applications are:

- Single CPU performance up to 200 MIPS for fast, efficient protocol processing
- Scalable, multi-processing architecture supports flexible, modular equipment design
- Serial link speeds up to 100Mbits/s provide fast,flexible interprocessor communications
- Sophisticated message-passing architecture avoids limitations of bus-based systems

*Switching

Telephone switches, from small digital PABXs to large Central Office exchanges, are classic examples of real-time, distributed multiprocessing systems. The message-passing architecture of the transputer family provides an ideal foundation for switch control systems, offering a close match to the message-passing requirements of these applications. A choice of interfacing techniques trough links or bus-based cards like VME, offers a smooth migration path for the large systems that, of necessity, must evolve. At the same time, the latest generation of transputers and routing chips offers new opportunities for smaller systems to avoid the performance bottlenecks of conventional bus-based systems.

Typical characteristics for this kind of applications are:

- High speed protocol processing
- Sub microsecond message routing latency using wormhole algorithms in hardware
- 32 way virtual channel Packet Routing Switch C104 allows nondirectly connected processors to communicate with minimal latency
- High speed interface between exchange and network using the new 100 Mbaud T9000 links

*Network interfacing

Building cost-effective interfaces to today's high performance networks makes exceptional demands on the microprocessor at the heart of the interfacing system.

Higher data rates and increasingly sophisticated protocols require considerable processing performance,for today's networks and for emerging communications standards. At the same time, user demand for lower prices places greater pressure on the interface designer to minimise system cost.

Whatever the system, from low speed 64 kbit/sec ISDN trough Ethernet to FDDI and Broadband ISDN interfaces, from single processor add-in cards to distributed multiprocessing systems such as telephone switches, the transputer family satisfies all communications systems requirements.

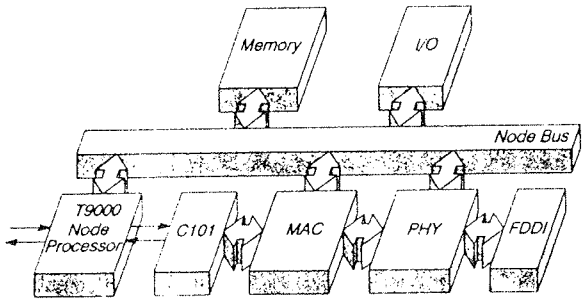

Fig. 6: Network intrafacing application

Typical characteristics for this kind of applications are:

- High performance interfacing to high speed digital networks, e.g. ISDN, FDDI, Ethernet/token ring
- High integration for low system cost
- 200 Mbytes/Programmable Memory Interface to all types of memory with minimal external logic.(No external circuitry for up to 8Mbyte DRAM).
- VRTX and Chorus (distributed UNIX) software available)

***Mobile communications**

Cellular radio has seen spectacular succes since its introduction in the early 1980s. New digital cellular standards like the PAN-European 'GSM', new systems such as Personal Communications Network(PCN), and the next-generation 'Digital European Cordless Telphones '(DECT) set the scene for further growth.

The massive scale of these new networks and the speed with which they have to be installed make it even more important to keep infrastructure investment as low as possible. With base station and handset processing requirements rapidly increasing as the networks go all-digital, the transputer family offers performance, and a flexible upgrade path at the lowest possible price.

Typical characteristics for this kind of applications are:

- Simple multiprocessing for flexible,modular base station design
- Low component cost+high integration=low system cost
- Low cost control of 'RF line cards'
- Base station control and management functions
- High performance protocol processing for call set-up/clearance

***Satellite communications**

There is no more demanding environment for any type of system than Space. Transputer is also here found as an ideal mean for the on-board processing systems of orbital vehicles and probes.

Typical characteristics for this kind of applications are:

- High integration/low system cost means space saving design and low mass
- Good intrinsic radiation tolerance
- Multiprocessing capability means easy to build multiple-redundant fault tolerant system

***Global positioning**

The T9000's fast,autonomous serial links,high performance CPU and low-cost package provide all the elements necessary for building a complete GPS receiver. All signal processing can be performed in software by the CPU, eliminating a costly ASIC, whilst interfacing to the RF front-end is simplified enormously through the use of the serial links.

The range of devices in the transputer family means the designer can easily make the right cost/performance decision. T4/T8 transputers provide an ideal performance level for the commercial GPS'P'-code products, whereas the T9000 can satisfy the demanding requirements for 'Y'-code system.

Typical characteristics for this kind of applications are:

- Economical single processor solution
- Low system cost
- Fast aquisition time
- Low power requirements
- No custom hardware required
- Global positioning software availability
- High accuracy positional determination
- Powerful enough for both 'P' and 'Y' code implementations

***Military**

Imaging, communications and control are all applicable to the military market.

All transputer products are compliant to the high quality Mil- Std-883C, and the T9000 brings a new level of processing capability to the military segment. The high speed core of T9000 allows the use of a general purpose processor in applications as diverse as phased array radar and fault tolerant control system. Its integer and floating point capability mean that is an ideal vehicle for signal analysis applications such as image processing and data acquisition.The high I/O capability enables the T9000's use in control applications for fast reaction to transducer input for ultimate real-time response. The T9000 is also supported by verified software in the form of ANSI C and the military standard ADA.

Po interni dokumentaciji SGS-THOMSON/INMOS priredil:

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